Table of Contents, part II / 2

Conference Volume	5th Symposium for Research in Protected Areas 10 to 12 June 2013, Mittersill	pages 421 - 422

Analysis of potential breeding habitat for the White-tailed Eagle (*Haliaeetus albicilla*) in Austria

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Nationalparks Austria Science Award 2013

Keywords

White-tailed Eagle, *Haliaeetus albicilla*, habitat, CORINE Landcover, GIS

Abstract

This study was undertaken to predict potential breeding habitats for the White-tailed Eagle (*Haliaeetus albicilla*) in Austria and in consequence to estimate how many pairs could still colonise adequate breeding areas in the country. CORINE Landcover and additional data on water bodies were analysed with the help of a geographic information system (GIS) in a grid of approximately 10x10 km. The study was conducted within Austria and its neighbouring countries (Czech Republic, Slovakia and Hungary). The results confirm the species well known preference for aquatic habitats such as wetlands and water bodies. Furthermore mixed and coniferous forests as well as shrub and herbaceous vegetation associations turned out to be significant for the choice of the breeding place. The assessed size of the national breeding population in future ranges between 30 and 50 pairs. These numbers allow for the possibility that certain detected cells may not be suitable for the White-tailed eagle or that a predicted cell is convenient enough to be colonised by more than a single breeding pair only. Due to the small scale of the data and the consequential inaccuracy the results have to be viewed and interpreted cautiously. Additionally large scaled characteristic of the breeding habitats, such as the availability of nutrition or the stock of old growth and especially disturbing factors like silvicultural, touristic and hunting activities would have improved the prediction of suitable habitats but could not be gathered within the framework of this study. The results provide nevertheless a strong basis for further analysis and support different conservation efforts in favour of the local White-tailed Eagle population in Austria.

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Conference Volume | 5th Symposium for Research in Protected Areas, 10 to 12 June 2013, Mittersill | pages 423 - 424

Comparison of herbivore communities on the native Field Maple *Acer campestre* (L.) and the invasive neophyte Box Elder *Acer negundo* (L.) in the NP Donau-Auen, Lower Austria

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Nationalparks Austria Science Award 2013

Keywords

alien plants; invasive species; insect herbivores; Danube floodplain forest; generalists; specialists; leaf area loss; enemy release; *Acer negundo*; *Acer campestre*

Abstract

Neobiota are one of the main reasons of biodiversity decline in the world (e.g. KOWARIK 2003; HULME 2007). They cause high financial costs for monitoring, management and control measures and thereby also represent a significant socioeconomic challenge (COLAUTTI et al. 2006; OLSON 2006). In Austria there occur at least 225 well established alien plants (ESSL & RABITSCH 2002), of which 112 species (76 neophytes and 26 archeophytes) have thus far been found in the National Park "Donau-Auen" (DRESCHER & MAGNES 2002). Hence, alien plants nowadays comprise about 13% of vascular plant biodiversity in this nature reserve (DRESCHER & MAGNES 2002). One of these non-native plant species is the North American box elder tree *Acer negundo*. Since the beginning of the 19th century this tree species has spread mainly in anthropogenically disturbed areas, including softwood floodplain forests along rivers. Box elder were rated in Austria as an invasive species first in 2002 (DRESCHER & MAGNES 2002; ESSL & RABITSCH 2002; WALTER et al. 2005). The Danube east of Vienna is one of the last near-natural, extensive and free-flowing rivers in the middle of Europe (LAZOWSKI 1997). Its associated floodplain forest is characterized by dynamic processes triggered through the annual high water 4 in summer, caused by alpine snow-melt (LAZOWSKI 1997). Such disturbance regimes support the formation and persistence of open gravel and sand banks, where specialized flooding-tolerant pioneer plant communities can establish (LAZOWSKI 1997; GEPP 1986). In these dynamic open habitats box elder *Acer negundo* can establish highly efficiently. In its native range this very fast growing pioneer tree utilizes a broad range of habitat types (MĘDRZYCKI 2011). The fast spread of an alien plant frequently has a negative impact on autochthonous ecosystems, i.e. biodiversity decline or loss (via hybridization), competitive displacement of native species, changes in (abiotic and biotic) habitat conditions, including the deprivation of the nutrition basis for a certain specialist fraction of the native fauna (SCHULDES & KÜBLER 1991; KOWARIK 1995, 1996), and other ecosystem functions (e.g. PYŠEK et al. 2009; VILÀ et al. 2000, 2009, 2011). In the case of the Danube floodplain forests, *Acer negundo* has a negative influence on the silver willow floodplain in open and disturbed habitats (DRESCHER et al. 2005). Due to its fast germination and growth rate (MĘDRZYCKI 2011; PORTÉ et al. 2011) it can rapidly build a second lower tree layer which is increasing canopy cover and consequently reduces the growth and establishment of light-demanding young willows and other pioneer plants (ESSL & RABitsch 2002; PORTÉ et al. 2011). In the present study we examined the invertebrate herbivore communities (ectophages and endophages) of two syntopic maple tree species, the invasive *Acer negundo* and the native *A. campestre*, in a floodplain forest in eastern Austria. The associated invertebrate fauna of *A. negundo* remains largely unknown in the European range. We assessed whether *A. negundo* (1) experiences a lower herbivore load; (2) has a different herbivore community, (3) dominated by generalist feeders; and (4) may be overall less damaged by herbivores than the co-occurring native *A. campestre*. Field work started in April 2011 with the selection of 21 trees of *Acer campestre* and *A. negundo*, in a floodplain forest near Orth an der Donau. We collected herbivorous insects, snails and slugs (4,342 individuals; 100 species) and also recorded the leaf area loss on 630 leaves (15 leaves per tree) over the vegetation period. Furthermore we measured various micro-habitat descriptors like tree height, trunk diameter, distance to nearest forest edge, and distance to nearest water body. Rarefied herbivore species richness and diversity on *A. negundo* and *A. campestre* was almost identical, whereas nearly twice as many herbivore individuals were found on the native tree species. Nevertheless, *A. negundo* experienced similar proportional leaf damage (36.6%) as *A. campestre* (44.9%). The proportion of specialized herbivores was six times higher on *A. campestre* (19 species, 281 individuals) than on *A. negundo* (7 species, 40 individuals). Leaf miners and plant gulls did not infest the invasive *Acer* species. Hence, insect assemblages on *A. negundo* were more strongly dominated by generalist feeders. For species composition of host specialists, tree species identity was the most influential factor, whereas communities of polyphagous herbivores were affected more strongly by structural tree and site characters. Many studies detected that herbivore richness may strongly depend on the time of introduction of an invasive alien plant species because the formation of assemblages of insects on these plants needs considerable time (time hypothesis: SOUTHWOOD 1961; BRÄNDLE et al. 2008). In our study the less homogeneous communities on *Acer negundo* could be explained by the not yet completed co-evolutionary process. Our study show that, in line with expectations, (1) the native field maple harbors a herbivore community comprising many specialists, which is relatively predictable and compact; (2) herbivore communities on the invasive alien box elder are dominated by opportunists and less predictable; (3) faunal differentiation between the native and neophyte tree depends on whether in a focal herbivore taxon specialists or generalists

prevail; (4) these patterns are rather similar with regard to herbivore species composition and abundance, whereas herbivore species richness and diversity do not show noticeable differences. Accordingly, *Acer negundo* is colonized from the meta-community of regionally available herbivorous invertebrates by basically the same rules as every other tree, but turns out to be rather unattractive (or impossible to colonize) for most of the *Acer campestre* host specialists. My study from the Danube floodplain showed that the invasive alien tree species *Acer negundo* and its native congener *A. campestre* are affected by a similar herbivore pressure, which indicates that the invasive tree species is already integrated into the food web of the Danube floodplain forest (with regard to the herbivore feeding damage and to the species composition of the local fauna). Herbivorous invertebrates are an important component of terrestrial food webs. Many other taxa (i.e. zoophagous predators) depend on them for food (TALLAMY 2004). Should *Acer negundo* be able to replace native pioneer trees (especially the silver willow floodplain) in the National Park "Donau-Auen", the consequences for the associated food web, however, cannot yet be predicted. Herbivore communities of *Salix* do hardly overlap with those of *Acer* species, because they do not share similar secondary plant metabolites phytochemical substances. Hence, specialist *Salix* herbivores are not expected to switch on the neophyte and would therefore lose their host if this would be completely outcompeted. The specialist herbivore community of *Salix alba* would likely be replaced by an insect assemblage dominated by generalists recruited from other deciduous broad-leaved trees occurring in the region. This could have unpredictable effects on interactions at higher trophic levels (GRATTON & DENNO 2005). Two major question will be (1) whether herbivore damage can contribute to constrain the fitness of *A. negundo* to such an extent that this may affect the future distribution and abundance of this tree species in the Danube floodplain forest and (2) to what extent the different herbivores that occur in the area (whether specialist or generalist) will be able to include the invasive box elder more strongly into their host range.

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Investigations of ship-induced waves on the Austrian Danube in the Donau-Auen National Park

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Abstract

The Donau-Auen National Park has initiated a research project to investigate the physical characteristics of ship-induced waves in the bank zone (littoral zone) of the free-flowing section of the Danube, east of Vienna. Using capacitance wave gauges the waves of about 40 passing ships were recorded with high temporal resolution. Supported by a statistical analysis, the characteristic parameters of the measured water-level variations (maximum rise of water level, deepest depression of water level, frequency and duration of waves, spectra) have been determined and related to the type and speed of ships. Obviously there is a huge influence of the form of the hull and the speed of the ships.

Keywords

Donau-Auen National Park, ship-induced waves

Figure 1: Map of the Donau-AuenNational Park (DONAU-AUEN NATIONAL PARK 2013)

Introduction

Through the area from the east of Vienna to the Slovakian border, the Austrian Danube flows, without a hydro-power plant, through the 93km² Donau-Auen National Park, as shown in Figure 1.

The Danube is part of the Pan-European Transport Corridor VII, which is the only route of the trans-European transport infrastructure comprising an inland waterway. This importance of the Danube waterway sometimes causes a lot of ship traffic which leads to increased stresses on the river shore areas. Such waves are known to have severe impacts on juvenile fish and other animals and plants living in the riverbank zone (GABEL 2012). They are a real challenge for the protected area of the Donau-Auen National Park.

Moreover, in recent years high-speed catamarans (the 'Twin City Liner') have intensified those problems in our study reach.

To study these waves and their dependence on different parameters, the Donau-Auen National Park administration approached the Consulting Engineer Gerhard Klasz and the Department of Hydraulic and Water Resources Engineering of the Vienna University of Technology to measure the ship-caused waves along the banks of the Danube, to evaluate and interpret them physically.

Aim of the research project

The aim of this research is at first to record the ship-induced waves depending on the discharge of the Danube River, ship type, direction (up- or down-stream), distance of the ship from the bank and the slope of the embankment. Based on these measurements it was desired to draw conclusions about the mechanical action and characteristics of the waves as a function of the most important parameters.

Experimental Investigations

Test Scheme

The monitoring program was divided into two series of measurements with different river discharges. The present paper represents the results of the first one. The second series is planned for the spring and summer of 2013. Each measurement series includes measurements on two days at two different embankment slopes.

The recorded data of each passing ship are the ship´s type and name, up- or down-stream travel, distance from the bank and the clock time. With the help of DoRIS, a GPS based data acquisition system of the *via donau* organization, the accurate route and the travel speed of each ship can be assigned.

In addition to the measurements of the water level, the maximum fluctuation range of the wave run-up on the bank was recorded and the velocity of the flow in the region of the water level sensors was continuously monitored.

Measuring Equipment

To be able to measure the height of the waves, the wave frequency, but also the angle and the speed of the wave fronts at which they strike the bank, three water level sensors were arranged in a triangle with a side length of about 1 m.

Because it was necessary to use the test equipment for both flat as well as steep banks, and the expected frequent transport of it through the National Park to the banks of the Danube, we had to design a lightweight structure with high flexibility. These conditions led to the choice of triangular aluminum lattice girders, consisting of four 2 m long individual elements which are assembled on site to form two main trusses. These two girders, mounted together with an intersection angle of 60 degrees, were arranged to rest on height-adjustable bearing blocks and carried the three measuring sensors. They are shown in Figure 2.

Figure 2: Overview of the experimental setup (© John Fenton)

The adjustment of the horizontal position of the trusses was carried out using a digital spirit level. Subsequently, the arrangement was secured by distance tubes and additional guys.

Measurement and recording techniques

Water level sensors

For an accurate measurement of the quickly and widely fluctuating water levels of the ship waves on the Danube we used the capacitive two-rod probes for continuous measurement in liquids with a rod length of 1500 mm. The continuous monitoring of the data was carried out by an online transmission of the analog 4-20 mA signals which were sampled at a frequency of 50 Hz.

In case of high waves when the lateral load capacity of the probes could be exceeded, additional guys to the truss system were mounted to stabilize the sensors.

In addition to the capacitance measurements of the water level, for all the measurements visual checks were carried out by means of a video-controlled vertically mounted scale, mounted so that it did not disturb the flow around the water level sensors.

Flow velocity measurement

Measurement of the local fluid velocity of the Danube was recorded for reference purposes during the complete test duration by means of a portable vane anemometer. To ensure that the anemometer was always oriented in the flow direction, it was arranged on a vertical axis with a vane.

Speed and paths of the ships

The determination of the ship's speed and exact position was carried out with the River Information Services DoRIS operated by the *via Donau*. DoRIS is based on the "Automatic Identification System" (AIS) and enables, by way of AIS transponders which are part of the mandatory equipment for vessels with more than 300 gross registered tonnes on the Danube since 2002, to identify the current position of the vessels using global positioning systems (GPS). It is a system in which ships continually transmit their ID, ship dimensions, maximum draught, position, course, speed, and other data to all other nearby ships and land-based authorities on a common VHF radio channel. Figure 3 shows an example of the evaluation of the navigation way of one ship.

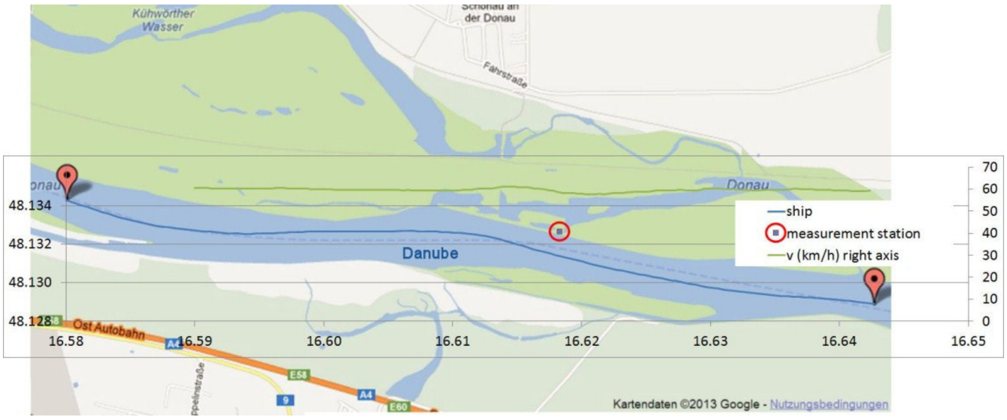

Figure 3: Example of the navigated way of a ship (Vessel 9: "Twin City Liner" – see below) by DoRIS (© Boris Huber)

The lateral distance between the vessels and the observation bank were additionally measured by means of a Tevion laser distance measuring device with a precision of ±1 m.

Wave run-up on the bank

The measurement of the maximum fluctuation range of the wave run on the bank of the Danube, according to the occurring Sunk and wave phenomena, was performed using a visual check using a measuring tape fixed along the bank. With every ship transit the maximum deviations from the undisturbed water levels, both up and down, were recorded.

Remaining measurements

All other observations and measurements carried out, e.g. the direction (up- or down-stream), measurements of the distance between the ships and the bank, the maximum values of the water level fluctuations, etc. were noted manually with the ship´s name, the ship´s type and time of day.

Test Results

Figures 4 to 8 show typical wave records and wave spectra from representative vessel types. On the left of each figure is shown the wave record, with a constant vertical scale for all figures, so that the magnitudes can be compared between different vessels. On the right is shown the raw amplitude spectrum of the wave record, plus a line showing the smoothed spectrum.

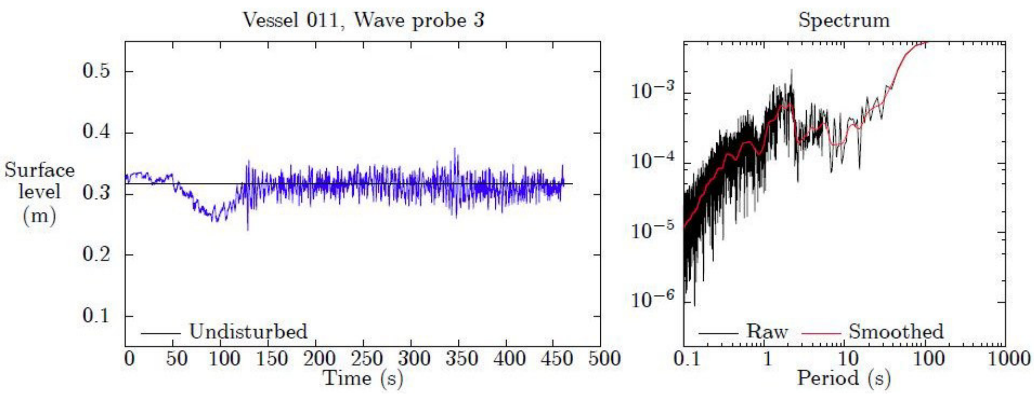

Figure 4: Vessel 11: "Max" Self-propelled barge, upstream, 67 m from bank, heavily laden, with a relatively strong bow wave (© John Fenton)

Figure 4 shows the record from a typical self-propelled river barge. In this case the vessel was heavily-laden, with a strong bow wave, travelling slowly upstream. It is surprising that, relative to others, this bulky vessel with a strong disturbance, only created a small drawdown and relatively small and short waves, although these continued for a long time. The persistence of disturbances to the river was surprising to the observers, partly due to strong reflections. An interesting video film of such a vessel on a canal in Belgium shows this clearly: http://www.flickr.com/photos/rothar/3604754330/.

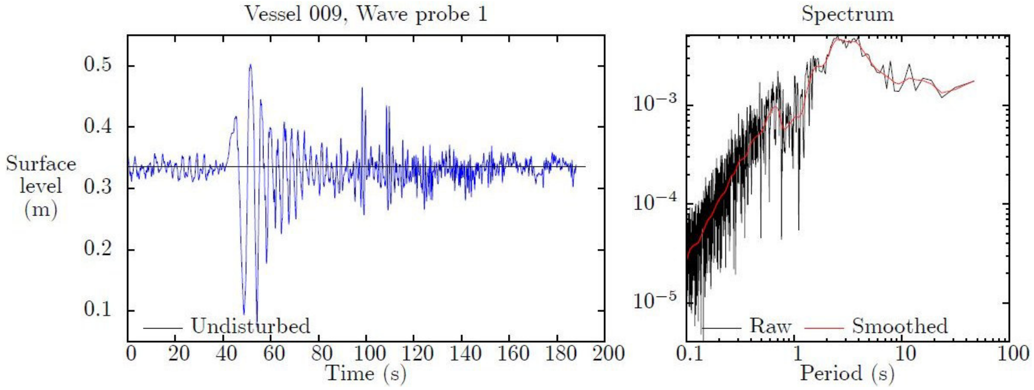

Figure 5: Vessel 9: "Twin City Liner" fast passenger catamaran, downstream, 130 m from bank (© John Fenton)

Figure 5 shows a very different situation, where the vessel was a fast passenger catamaran, clearly travelling at supercritical velocity. There was no drawdown, but the waves created were largest and longest of all the vessels we observed. In fact, this vessel made several passes during the day, as it has a regular service between Vienna and Bratislava. The record shown was the most dramatic of those passes. The highest waves were 0.4m, while the clear spectral peak was at about a period of 3 s. There were some reflections, but the disturbances to the river died down relatively quickly.

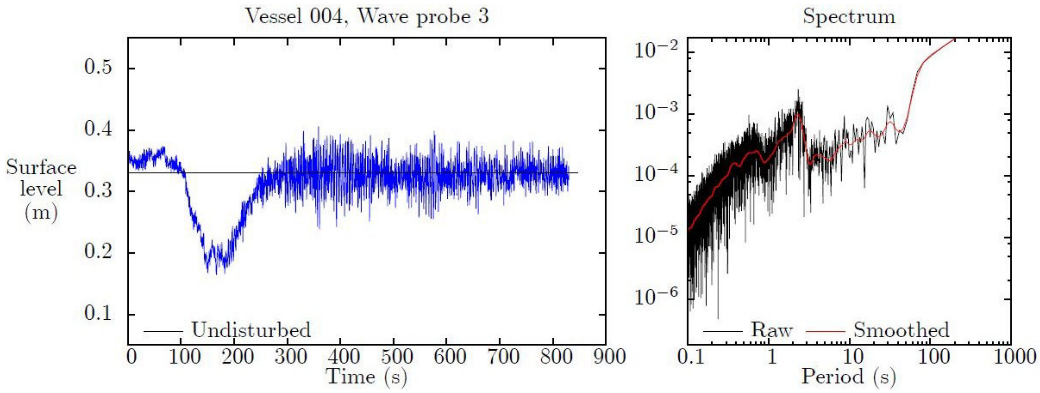

Figure 6: Vessel 4: "Ybbs" Push Tug with 2 barges laterally, a large obstruction, upstream, 86 m from bank, strong transverse secondary waves (© John Fenton)

The vessel, that created the record shown in Figure 6 was a very large combination of a push tug with two barges, all arranged side-by-side. It can be seen that with such a large blockage, there was a drawdown of some 0.2 m. The ship waves persisted for a very long time, with little diminution, and a marked spectral peak at about 2 s.

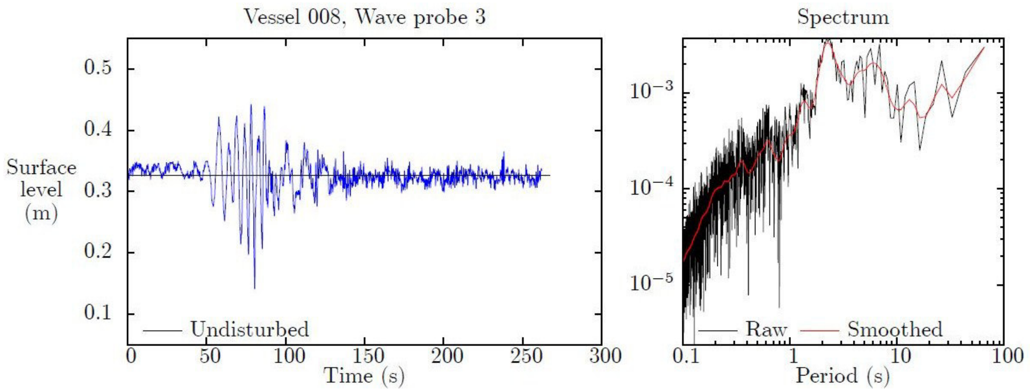

Figure 7: Vessel 8: "Wildungsmauer", Navigation Authority Motorboat, upstream, 62 m from bank (© John Fenton)

A large, but transitory effect was that caused by a single small but fast-moving motorboat, as shown in Figure 7. The effects were similar to, but slightly smaller than, the large passenger catamaran described above, and the disturbances decayed quickly.

Finally, another vessel very common to the Danube, is shown in Figure 8, which is a large passenger cruise boat, which, unlike commercial vessels, was well streamlined. It is notable, and surprising that the wave system generated was as large as it was. The drawdown was as large as the huge combination of three craft described in Figure 6, while the waves were not much smaller.

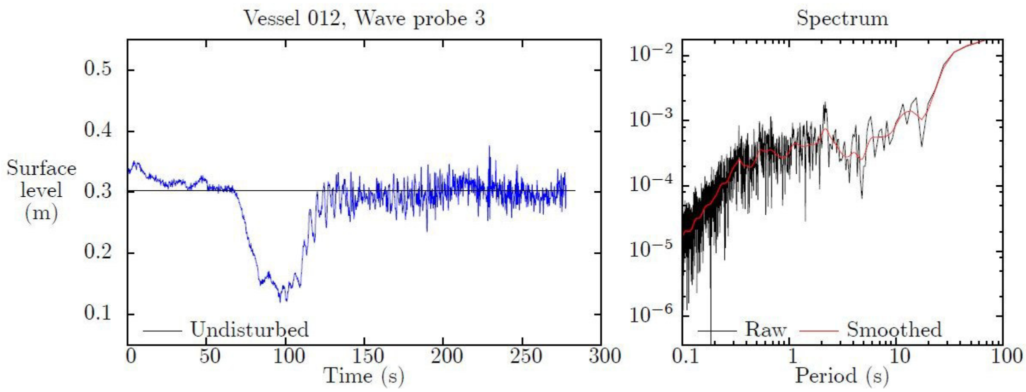

Figure 8: Vessel 12: "Scenic Emerald" Passenger cruise boat, upstream, 60m from bank (© John Fenton)

Conclusions

This study was not intended to examine the effects of various wave phenomena on the physical and biological environments, but rather to examine the disturbance characteristics of typical vessels on the river.

What was particularly notable to the investigators was the size of the drawdown created by vessels travelling at sub-critical speed. This, as suggested by simple theory, was proportional to the blockage cross-section of the vessel. Even if a vessel were streamlined, such as for the passenger cruise ships, the drawdown was large.

On the other hand, the waves created by streamlined sub-critical vessels were smaller than for bluff ones. For the super-critical fast catamaran and for the speedboat, the waves were highest and longest.

Another notable feature of the disturbances was the very long duration time of some wave systems. There must have been many reflections in the river, even though all measurements reported above were taken on a steep rocky bank, which would have absorbed short waves effectively.

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Leafhoppers and Planthoppers as bioindicators in European grasslands

Gernot Kunz

Keywords

Planthoppers, Leafhoppers, management, biodiversity, Alps, National Park, Gesäuse, meadow, grassland, bioindicators

Figure 1: Biodiversity in European Leafhoppers and Planthoppers (Photos: Kunz G.)

"From the insect conservationist´s point of view, grassland management should include as few treatments as possible, but also as many as necessary for reducing nutrient content and preventing growth of trees and shrubs. " (NICKEL & ACHTZIGER 2005)

Because of their species richness, high abundance, often high adaption to host plant(s) and the knowledge about their morphology, biology, ecology, distribution and threat status, Planthoppers and Leafhoppers (Figure 1) are known to be excellent bioindicators for all kinds of grasslands in Europe (ACHTZIGER 1999; ACHTZIGER & NICKEL 1997, MARCHAND 1953, WALTER 1998). Nevertheless most of the publications so far concern grasslands in the lowlands (ACHTZIGER, NICKEL & SCHREIBER 1998; ANDRZEJEWSKA 1965, 1971, 1976 & 1991; BORNHOLDT 1991; BURI et. al. 2013 in prep; EMMRICH 1966; HAHN 1996; HILDEBRANDT 1995; HOLLIER et al. 1994; HOLZINGER & NICKEL 2008; NICKEL & ACHTZIGER 2005; NICKEL & HILDEBRANDT 2003; NIEDRINGHAUS 1997 & 1999; MORRIS 1981a, 1981b, 1990 & 1991; PRESTIGE 1982, REMANE 1958; RÖSCH et al. 2013; SCHIEMENZ 1969).

Since 1999 several studies concerning meadow management of subalpine and alpine Leafhoppers and Planthoppers communities had taken place mostly in the Austrian Gesäuse National Park (BRUNNER et al. 1999 unpubl.; KOMPOSCH & HOLZINGER 2005, ÖKOTEAM 2005 unpubl., 2010 unpubl., 2012 unpubl., 2013a unpubl.). Further studies in the northern calcareous Alps in Salzburg and Bavaria (ÖKOTEAM 2013b) and one in the Swiss canton Valais are in preparation.

Studies on management effects on Leafhoppers and Planthoppers communities have shown so far that:

A. Cessation of management methods followed by reforestation lead to a loss of biodiversity.
B. Extensive meadow treatments (Figure 2) generally promote species richness and abundance of (often threatened) habitat specialists. However, in drained hay meadows, it might take decades to reestablish diverse leafhoppers and planthoppers communities even if former moisture conditions can be restored.
C. A mosaic of different extensive management regimes supports species richness.
D. Higher number of mowing events has generally a negative effect on species richness.
E. Cutting methods have a strong effect on mortality. Hand used sickle bar mover and the use of a scythe (HUMBERT et al. 2010) are strongly recommended. Cutting height should not be less than 10cm.
F. Fallow patches or strips rationally mown only every few years gives benefit to specialists of tall grasses.
G. The first cut should be delayed to end of July or even August to increase insect biodiversity (HUMBERT et al. 2012)
H. Uses of pesticides and mineral fertilizers have an extreme negative effect on species richness. On intensive grassland in Germany, only 13 species can theoretically establish populations compared to over 120 species in extensive grasslands (ACHTZIGER & NICKEL 1997). In low productive habitats an increase of abundance (but not of species diversity) could be observed within the first 3 years of intensive treatment.
I. A higher density of vegetation increases the total leafhopper abundance.
J. Higher grazing intensity has generally a negative effect on species richness, mostly on specialists.
K. Grazing in wet habitats such as salt marches and fens have an extreme negative effect on species richness and specimen densities.
L. Species richness can be negatively affected by increasing habitat isolation in small fragments surrounded by simplified landscapes due to lack of colonization events in comparison to extinction events.

Figure 2: Extensive grazing in calcareous grassland benefits Leafhoppers & Planthoppers biodiversity (Photo: Kunz G.)

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100 Years of National Park Idea in the Hohe Tauern, Salzburg

Patrick Kupper

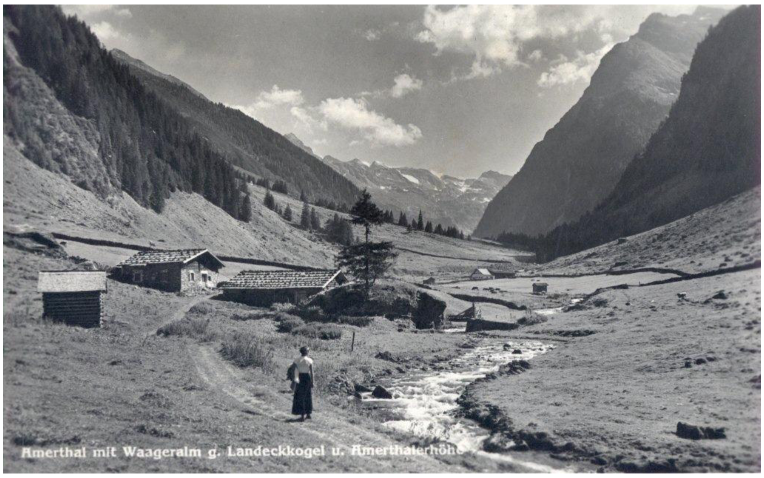
Keywords

History, National Park, Hohe Tauern, Global Conservation, Social Movement

Abstract

Since spring 2012 an international and interdisciplinary team investigates more than a hundred years of conservation practice in Austria's Hohe Tauern with a main focus on the Salzburg parts and the contested creation of the Hohe Tauern National Park. The Hohe Tauern National Park, founded in the 1980s, was the result of societal struggles, which lasted over several decades. First ideas took shape in the Austrian monarchy at the beginning of the 20th century when, in 1913, the German-Austrian Association for Nature Protection Parks (Deutsch-Österreichischer Verein Naturschutzpark) bought several alms in the Pinzgau valleys Stubach and Amer with a total area of approximately 1.000 ha. In the interwar years the German-Austrian Alpine Association, the Austrian League for Nature Protection, the socialist Friends of Nature and other organizations became involved into nature protection in the Hohe Tauern while during the time of National Socialist rule the region was subject to plans of Hermann Göring's Reichsforstministerium (Ministry of Forestry) to establish *grossdeutsche* national parks. In the post-war decades of reconstruction and growing prosperity different visions of development clashed. Ideas for strengthening nature protection were both driven and challenged by large infrastructure projects, mainly concerning water power, road construction, and an oil-pipeline, by agricultural intensification and by tourism. As in the decades before theseissueswere not restricted to the region or nation but influenced by developments on the international and global scale.

The main aims of the research projectare, first, to highlight the long-term historical legacies of the Hohe Tauern National Park and, second, to locate its history within global conservation history. The results are being published in a book in Hohe Tauern National Park's series *Wissenschaftliche Schriften* in autumn 2013 (in German).



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Do landscape structural patterns reflect Ecosystem Service provision? – A comparison between protected and unprotected areas throughout the Neusiedler See region

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Abstract

Nowadays, anthropogenic fragmentation is known as a major reason for the worldwide loss of biodiversity. Though nature conservation areas, such as Austria´s National Parks are in situ serving as retreat habitats for a broad range of biota, they are embedded in a complex of landscapes where diverse conflicts of interests like tourism, agriculture and nature conservation coincide. As a first step to enhance the connectivity of landscapes across the borders of protected zones, the status quo and trends of ecologically valuable landscapes have to be evaluated. The main aim of this study was to assess the additional benefit in the provision of important ecosystem services and structure based functional state thatprotected areas are sharing compared to unprotected sites, conducted within an Austrian-Hungarian transnational study region around the Neusiedler See. Therefore, we developed a methodological framework for assessing and mapping ecosystem services based on expert knowledge, spatial information and field data. Further, the crucial relationships between structural patterns and corresponding functional indicators were investigated by the comprehensive use of landscape metrics. Additionally, to get an overview upon landscape connectivity and quality of ecological networks within the region, a series of spatial analysis have been performed. The outcomes of this study provides local stakeholders with valuable information on the service provision capacity and functional statein and outside protected sites andadditionally illustrating hot and cold spots of network patterns.

Keywords

Ecosystem Services, Landscape Functionality, Landscape metrics, Biodiversity, Green Infrastructures

Introduction

During the last few decades, the demand for natural resources has grown considerably due to exponential economic growth, resulting in an enormous pressure on Earth´s ecosystems. As a consequence, our society is faced with various negative effects on the environment, such as habitat loss, fragmentation and degradation, climate change, biological invasions, overexploitation and pollution at global, national and regional level. Especially European cultural landscapes are characterised by a high level of anthropogenic fragmentation and habitat loss which are known as major reasons for the decline of biodiversity in industrialised countries. Countering this development requires an evaluation of the status quo and trends of ecologically valuable landscapes. Two promising possibilities to provide the knowledge basis in meeting the needs of a sustainable development and conservation management inside and outside protected areas are introduced and compared within this study. First, the concept of ecosystem functions, goods and services (MEA 2005) has gained increasing attention in the last years as it highlights the importance and benefits of ecosystems for human welfare. Several authors have dealt with function- and service evaluations (e.g. COSTANZA et al. 1997; DAILY et al. 2000; DE GROOT et al. 2002, 2006) and the implementation via stakeholders (Hein et al. 2006). Innovative conservation assessment and planning may profit from this approach because it allows for an integrative evaluation of conservation areas and their contribution to human well-being (CHAN et al. 2006; EGOH et al. 2008).

The second approach targets on geometrical aspects of the landscape as the crucial relationship between structural patterns and functional indicators in landscapes has continually been stressed (TURNER et al. 2001; MOSER et al., 2002; FORMAN 1995; amongst others). It comprises a combined assessment of structural-based landscape functionality (KUTTNER et al. in press) which had been developed to provide a comprehensive overview upon landscape connectivity and to evaluate the location and quality of ecologically valuable landscape elements and networks. In this regard, a functioning corridor network that provides dispersal and migration possibilities for a broad range of organismal groups is crucially contributing to the ecological viability and hence functionality of a landscape. Summarised under the term "Green infrastructure" (BENEDICT & MCMAHON 2002), the composition and configuration of suitable habitats and corridors for a virtual species group was also investigated within the target region.Another objective of this study is to implement and to compare both concepts of quantifying ecosystem services and landscape structural functionalityby placing a special focus on the comparison between protected and unprotected areas in the Neusiedler See / FertöHanság region. We are aiming to identify hot and cold spots of ecologically relevantecosystem services and ecological networks and to particularly test strength and quality of coherence between the aforementioned assessments.

Study region and methods

Study region

The investigation area is located on both sides of the border between Hungary and Austria. Altogether an area of 2,015 km² is covered (1,120.8 km² located in Austria and 894.2 km² in Hungary, respectively) (see Figure 1).

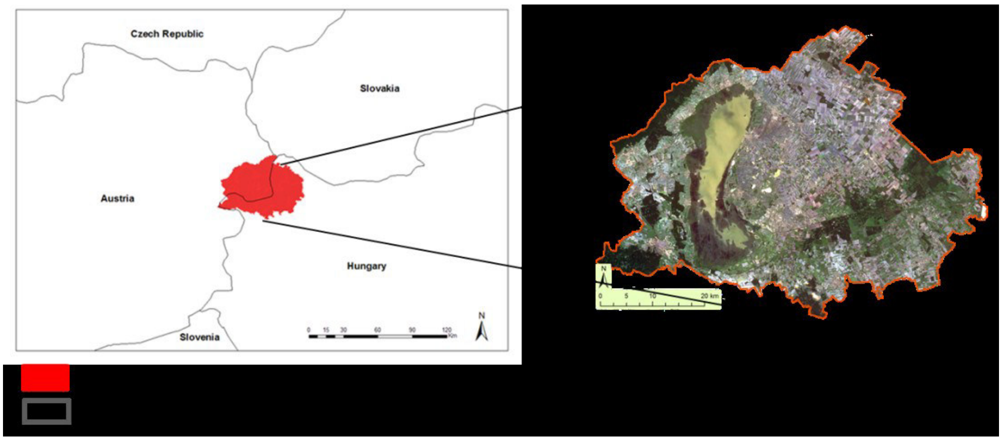

Figure 1: Location of the investigation area withinthe cross boarderregionAustria and Hungary

The predominant climate is Pannonian with annual precipitation rates around 600-800 mm and annual mean temperature of >9°C (ZAMG 2002). The continental lake basin between the Alps and the Carpathians is a north-western overhang of the Small Pannonian Plain at the foothills of the Leitha Mountains and the Rust Hills. The low-lying area encircled by hills and terraces of the immense gravel bed of the Danube was once interconnected with the former Hanság marshland. Today, artificial channels intermingle with the reclaimed lowland, stabilising the water level of the lake and the ground water.

The Neusiedler See and a series of small satellite lakes on the eastern part at 'Seewinkel' constitute the westernmost alkali lakes in Europe and the semi-natural zone around them still forms Europe's second largest reed wetland vegetation which is one of the most important bird refuges in Central Europe, both for breeding and migratory birds. Beyond the wetlands the area consists of extremely rich habitats, presenting a transition zone between the mountain ridges and the lowland of the Pannonian basin. From the unique dry alkaline steppe up to the closed deciduous forests a series of different vegetation types result in high biodiversity. Due to the bio-cultural richness of this landscape, nationally and internationally protected areasincluding National parks in Austria and Hungary, Ramsar sites, Biosphere reserves and Nature 2000 sites are predominant here, crowned by the cross-border cultural landscape being classified by UNESCO on its World Heritage List.

Today two main economic sectors are prevalent in the region: on the one hand intensive agriculture, particularly crop-growing, wine growing and greenhouse-vegetable gardening and on the other hand, tourism, especially around the Neusiedler See. Nowadays the main problem is the growing conflict between these two utilisation claims caused by increasingly land consumption for their uses and additionally interfering with nature conservation related issues.

Methods

In order to reach statistically neat results that could either be scaled up and compared, a common spatial reference system has been developed, including a nested sampling design for the selection of test siteswhich followed several stratifications and exclusion criteria. As a prerequisite, the region has been subdivided into seven single Landform types (LFT; KONKOLY-GYURÓ et al. 2010). These LFTs are expressed by geomorphological peculiarities that are forming the major characteristic shapes of the target region, also resulting in greatly varying land use strategies: "Lake Basin", "Marshlands", "River Floodplains", "Low lying terrace", "Elevated terrace", "Hilly area and hill range", "Low and middle range mountains". Within each LFT, six 2x2 km sample sites were randomly selected by applying a predefined set of exclusion criteria, thereof half of the sites are either located in protected or in unprotected areas (see also Figure 2).

Assessment of Structural Landscape Functionality

Single landscape elements were delineated within each of the 2x2 km sample plots by using object-based image analysis of latest orthophoto imagery and manually corrected afterwards by on-screen digitizing. Then, a key for visual land cover interpretation was applied, where the CORINE land cover interpretation system served as thematic basis to identify 65 different land cover classes. The resulting land cover maps were used for landscape structure analysis, where 46 landscape metrics on class level were calculated using *Fragstats 3.3* (MCGARIGAL et al. 2002). The resulting indices were computationally reduced to 13 in order to gain a core set of most meaningful metrics for the quantification of landscape functionality. As a precondition for proper assessing landscape functionality, the different land cover classes were sectioned into six functionality groups (*Connecting Corridors*, *Dissecting Corridors*, *Valuable Matrix*, *Disturbed Matrix*, *Artificial Matrix* and *Stepping Stones*) and metric outcomes were either positively or negatively related to each of the groups, followed by an aggregation process to reach one final value of landscape functionality. Further, to detect most valuable green infrastructure (GI) elements and network structures, a morphological spatial pattern analysis plus additional cost distance mapping were applied for a predefined virtual species group called "Specialists" which would require less or non-disturbed parts of the landscape as their living space. For further information on the technical part of this study please see also KUTTNER et al., in press.

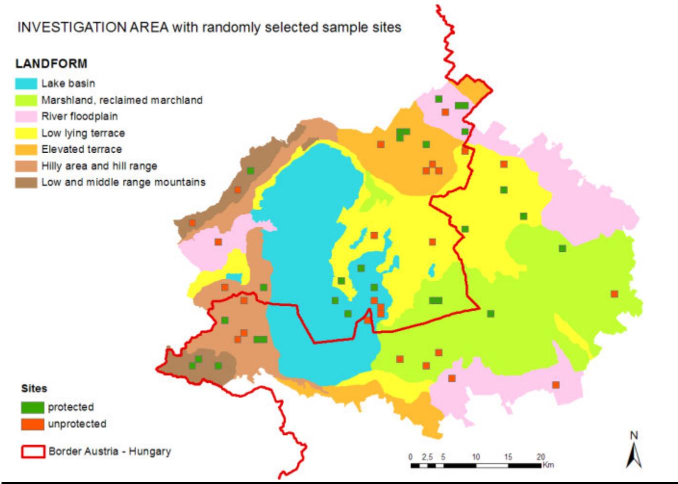

Figure 2: Overview of the entire study region, including the division into LFTs and location of local sample sites

Evaluation of Ecosystem Services

Embedded in the spatial reference framework, we assessed and mapped 14 ecosystem services grouped into three main service categories: *regulation* (local climate regulation, disturbance prevention, water regulation, water supply, soil retention, soil formation, nutrient regulation, pollination, *habitat (*refugium, nursery*)* and *provision (*food, raw materials, genetic resources, medicinal resources)(mainly adapted from DE GROOT 2006).Individual services were analysed at the landscape element scale within the 41 landscape sample sites throughout the 7 LFTs. For the distinction of different service providing units we used the broader habitat type (BHT) classification system (BUNCE et al. 2008, 2011). BHTs were linked to their capacities for providing various ecosystem servicesby an expert based classification system, ranging from "0"to "5". The higher one value turned out, the higher the general relationship between the BHT and its related service. This so called Broader Habitat Approach (HERMANN et al. 2013, in press) is based on a capacity matrix, with values being revised by semi-quantitative data gained from field work. In further steps, service data were aggregated to the main service categories and extrapolated to the LFTs.

Results

Results of the Structural Functionality assessment

The main outcomes of the structural functionality assessment are outlined in Figure 3, exemplarily including GI maps for each LFT. Ecologically most valuable GI-elements and corresponding functionality rating are marked, serving as potential habitats and migration routes for the virtual Specialist species group. In the background, outcomes of the cost surface modelling approach are outlined, ranging from areas that are easy to cross up to barriers within the landscape for the target species group.

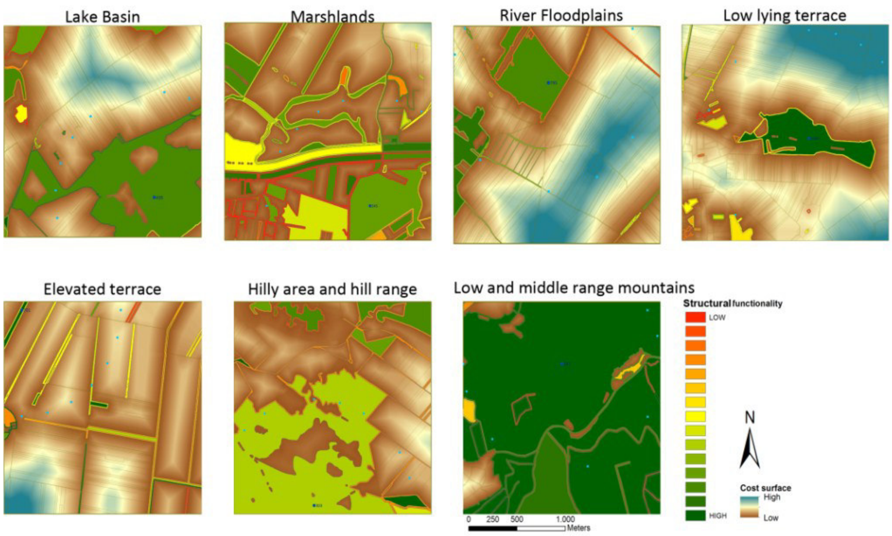

Figure 3: Representative Landscape Functionality maps for each LFT

According distribution of GI-elements, which have previously been classified into 4 subsections of core areas and linear elements, overall number of core areas decreased from 515 (> 0.1 ha) to 229 (> 1 ha) and 70 (> 10 ha). Additionally, 748 linear elements have been mapped, together resulting in a total area captured by GI-elements of approx. 5,800 ha which is about 35 % of the entire investigation area (16,400 ha). Thereof, the majority (56%) is located in the forest dominated LFTs “Hilly area and hill range” and “Low and middle range mountains”while only a minor part (15 %) appears in LFTs “River Floodplains”, “Low lying terrace” and “Elevated terrace” where the agricultural sector plays a predominant role.

Between protected and unprotected areas significant variations with regard to structural functionality were also visible. In this context, 838 GI elements were found in protected areas sharing a mean functionality value of 59.95, while in unprotected sites only 723 with mean functionality value of 52.84 were mapped. Subsequent ANOVA testing outlined a significant variance ($p < 0{,}01^{***}$) between these two groups.

Testing interdependencies between single variable outcomes on plot level by the use of unviariate regression techniques revealed a rather strong dependency of mean overall structural functionality (corr. $r^2=0.872$) and mean travelling costs (corr. $r^2=0.729$) per sample plot fromthe areal share of GI-elements located within each plot.

Results of the ESS-provision

The resulting ESS values ranging from “0” to “5” are representingLFT-based mean service values for the main categories *regulation, habitat and provision* (Fig.4).

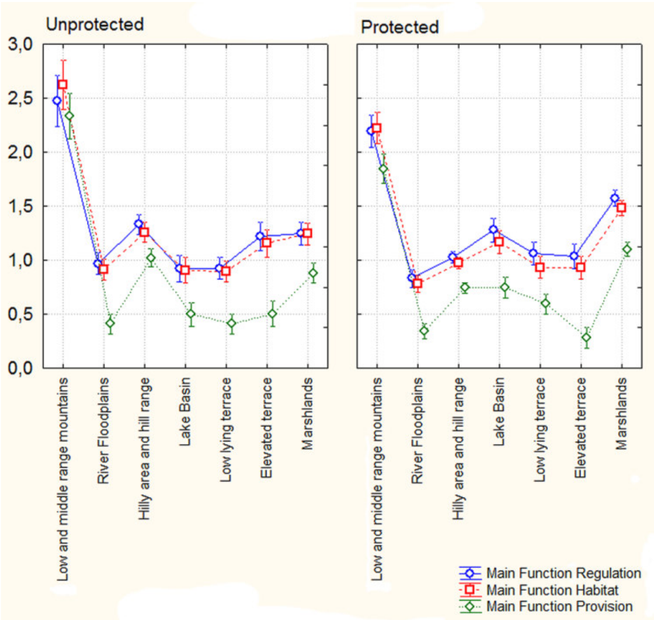

Figure 4: Two Boxplots of ANOVAs targeting main service distribution among the single LFTs in protected and unprotected areas

The course of the lines is quite similar, reflecting that there are no trade-offs between the different service categories. Whereas the *regulation* and *habitat* service values were close to each other, the *provision* services resulted in clearly lower values. Considering the different LFTs, outcomes showed the high diversity within the investigation area ranging from natural and semi-natural areas such as the shallow lake and its reed beds, the remaining marshland and flood plains to the extensively used hilly area and the intensive agricultural regions in the low lying and elevated terraces. Particularly noteworthy were the high values in LFT ‘Low and middle range mountains’, which were mainly based on the almost homogeneous oak-hornbeam forest and small grassland patches on the hillsides of the deep valleys in the Leithagebirge.

Comparing the main service values *regulation, habitat and provision* between protected and unprotected sites, almost all the LFTs differed significantly except from ‘Low and middle range mountain’ and ‘Low lying terraces’ (Fig. 4). However, among the protected sites only ‘Marshlands’ and ‘Lake basin’ showed significantly higher values ($F=6{,}7902$; $p \leq 0{,}001$) compared to the unprotected sites. All the other LFTs were characterised by lower values in comparison with the unprotected ones.

Comparison between Ecosystem services and Landscape Structural Functionality

As both assessments were following different theoretical concepts to quantify landscape sustainability with respect towards society on the one side and wildlife on the other, a series of unvariate linear regression analysis revealed coherences between the two approaches.

Scatterplots shown in Figure 5 are visualizing the outcomes of three different regression analyses targeting on the dependency of the Ecosystem main services from the outcomes of the survey on structural functionality. Relationships between the single variables proofed to be significant ($p=0.000$) in all of the cases and the strength of the statistical models turned out to be rather high, ranging from corr. $r^2=0.691$ for the habitat main service to corr. $r^2=0.737$ in case of the regulation main service and corr. $r^2=0.802$ for the provision main service, respectively.

The performance of a stepwise multivariate regression analysis conducted using all main service outcomes at once revealed that all service variables turned out significantly and were integrated in the final regression model, resulting in a corr. r^2=0,819.

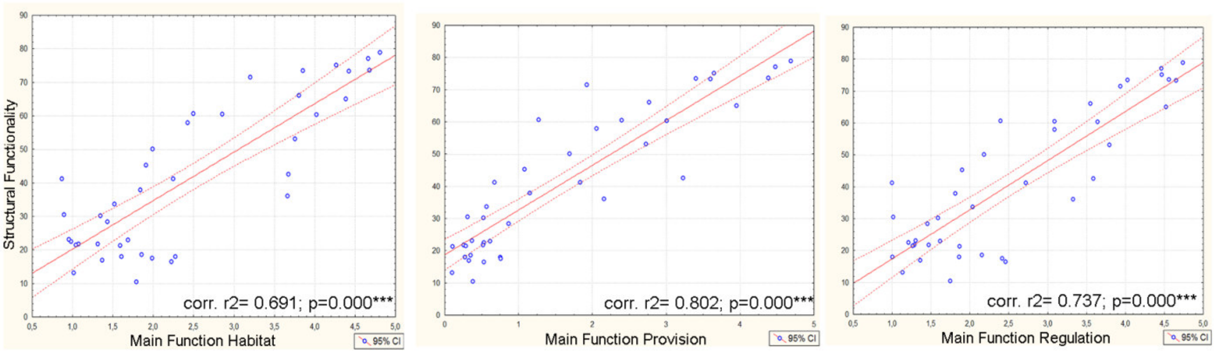

Figure 5: Three scatterplots visualizing outcomes of linear regression analyses between structural functionality and ecosystem main services

Discussion and Conclusions

The remarkable higher service values within the protected sites of the LFTs 'Marshlands' and 'Lake basin' (Fig. 6) might be due to the fact that most of these sites are covered by the national parks 'Neusiedler See-Seewinkel' / 'Fertó-Hansàg' and thus following a broader conservation concept, including core areas and buffer zones. Within the LFT 'Low and middle range mountains' that is characterised by huge forest habitats, the protection status might not be a determining factor regarding ecological quality and ecosystem service provision. As some of the sample sites within the LFT ' Elevated terraces' were also covered by large forested areas under private property, the lower values within the protected sites are thus comprehensible.

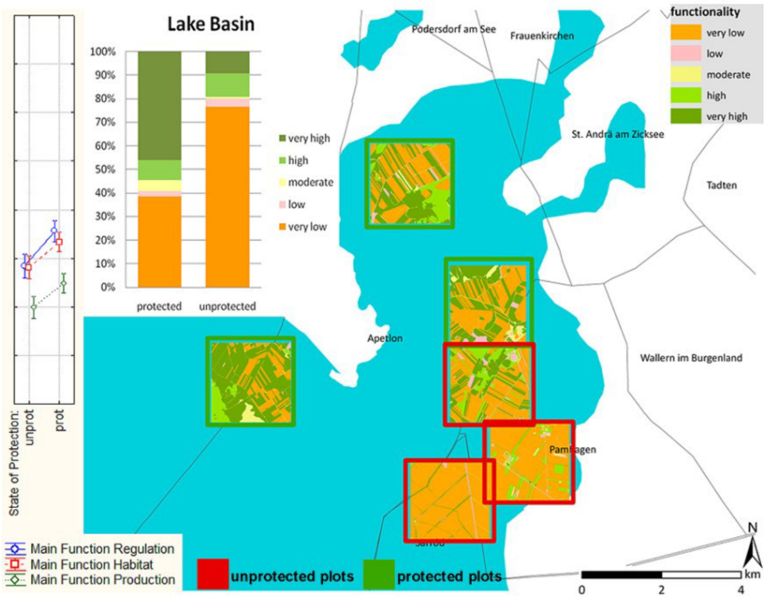

Figure 6: Overview on the sample plots selected in LFT "Lake Basin" and corresponding structural functionality and main ecosystem service charts distinguishing between protected and unprotected sites

Though, Ecosystem Service Provision did not turn out to be significantly higher in some of the protected areas within the single LFTs, distribution of GI-elements and structural functionality values consistently showed higher outcomes. Hence, we assume that the ability of Ecosystem Resilience, which has not been directly investigated in the frame of this study yet, is enhanced in those parts (FISCHER et al. 2006). Both assessments are strongly tied together as most ecologically valuable elements are sharing a rather high potential in the provision of pre-selected ecosystem services which have been quantified in the frame of this study. But vice versa, as abiotic functions such as climate-, nutrient regulation or soil formation were in focus, also non-protected but still sustainably managed areas shared a high potential in service provision. As our results confirm, land management seems not to be generally overexploited in the region, especially in non-favourable sites (e.g. forest dominated slopes and rather wet or dry areas that haven´t been reclaimed /drained). On the other hand, areas that have been intensively used for centuries such as LFTs "low and elevated terrace"preformed worst in ecosystem provision and structural functionality.

Our results are congruent with the outcomes of a global study carried out by NAIDOO et al. (2006). They explored thatregions selected to maximize biodiversity provide no more ecosystem services than regions chosen randomly.

However, it strongly depends on the target of the respective conservation area. Despite the lack of general concordance, "win–win" areas— regions important for both ecosystem services and biodiversity could also be identified, especially at smaller scales. However, the results are mostly biased by the methods chosen to assess ecosystem services. Levels of congruence between biodiversity and services are poorly understood, and the little quantitative evidence available to date has led to mixed conclusions (CHAN et al. 2006; METZGER et al. 2006). As some services such as pollination are locally explicit and other services, such as climate regulation are occurring at regional scale (HERMANN et al. 2011) it is difficult to assess a wide range of services within a specific service providing unit, e.g. a conservation area. However, despite these challenges we have to face, comparisons between biodiversity related and ecosystem service assessments have the potential to viably support decision-making processes. More research on the quantification and mapping of ecosystem services would improve our understanding on synergies and trade-offs between services and biodiversity. Sustainable development should involve managing for both, in order to enhance human welfare that is linked in diverse ways to biodiversity, conservation and ecosystem services (NAIDOO et al. 2006).

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EO-based monitoring of Europe's most precious habitats inside and outside protected areas

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Abstract

In order to response to international commitments and to fulfill its own strategy to maintain biodiversity, Europe is in need for updated information on biodiversity in general, and the status of habitats and related threats and pressures in particular. The FP-7 project MS.MONINA responds to this need by fostering the use of European space and in-situ infrastructure and advanced Earth observationtechniques. The developed services address the three levels of implementation of the Habitats Directive (i.e. site-, state- and EU-level). They are specifically tailored to user requirements in terms of relevance, level-of-detail and scale, steadiness and reliability, uptake and fitness to existing workflows. Drawn from the experiences made in MS.MONINA, this paper presents achievements and open challenges of using EO technology to effectively monitor nature sites of community interest but also precious habitats outside the existing network of protected areas to reduce the loss of biodiversity.

Keywords

Earth observation (EO), multi-scale, GMES/Copernicus, satellite remote sensing, Habitats directive, biodiversity monitoring

(Guiding theme)

Where do protected areas, their regions and their networks currently stand regarding research and management?

Europe in need of updated biodiversity information

The EU has set up an 'EU 2020 biodiversity strategy' in responseto the adoption of a global Strategic Plan for Biodiversity 2011-2020. Next to the general aim of "*halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020*", the strategy follows some specific objectives such as to "*fully implement the Birds and Habitats Directive*". The European Habitats Directive (92/43/EC, short: HabDir) is considered a flagship policy for the EU (Weber & Christophersen 2002), ascertaining the conservation of natural habitats, fauna and flora in the territory of the Member States (MS). Together with the Birds Directive (2009/147/EC) it is a highly effective legal instrument for nature conservation, as both directives are area intensive in the sense that they apply to the entire territory of the EU and consequently of each MS. The physical expression of this policy frameworkis a coherent ecological network of special areas of conservation known as NATURA2000. The purpose of the network is to assure the long-term survival of Europe's most preciousand threatened species and habitats across Europe.

HabDir foresees a reporting in regular intervals (currently every six years) to oversee the success of its implementation and to gain pan-European information on the status of biodiversity. This happens underdifferent territorial responsibilities:

The **EU,** responding as an entity to international commitments (UN Convention on Biological Diversity (CBD)and Bern Convention), requires MS to implement the HabDir in their national legislations; responsibility is transferred to the national level. Depending on their internal structure, the MS pass this responsibility on to lower administrative levels, e.g. federal states or provinces. The **MS** then need to aggregate information that is collected on **site** level, where the actual assessment takes place. While HabDir addresses the status of the entire MS territory, particular areas of protection are used as a means to directly enforce the directive (sites of community interest, SCIs). Whenever sites are on the edge of a country, the site border would follow the country's borderline.This may lead to trans-boundary effects to be observed in reporting, management practices, etc.

Within this ambitious setting, Earth observation (EO) techniques can obviously support the implementation of HabDir. Over the last years the technological framework has matured to such a degree that nowadays satellite remote sensing can offer objective (pre-)operational, yet economically priced solutions to provide timely information on pressures and impacts. It further helps toassignspatial priorities for conservation and tocollect long-term baseline data on multiple scales for evaluating the effectiveness of conservation strategies (Lang et al. 2012).

EO-based monitoring capabilities

The growing need for the civilian use of satellite remote sensing and other EO technologies has led to the European programme GMES (Global Monitoring for Environment and Security). GMES, recently renamed to Copernicus (copernicus.eu), is a conjoint initiative between the European Commission and the European Space Agency (ESA). It builds on European space infrastructure and the technological capability to turn data into information services.For this purpose,ESA is developing five types of satellites, the so-called Sentinels, which will provide global coverage with radar and optical data with a few meters ground resolution. Additional data from satellites of the so-called contributing missions will increase both, the variety of available data types and the temporal coverage with remotely senseddata.

Reproducibility, objectivity, transferability and the increased possibility for quantification have been reported as the mainadvantages of mapping approaches based on EO data. Semi-automated classification methodologies for EO data provide a more objective outcome as compared to visual interpretation(LANG & LANGANKE 2006).Over the last years, great advantages have been reported in the use of remote sensing technology for the mapping and the assessment of habitats in Europe (for an overview see VANDENBORRE et al. 2011a). This likewise applies to different broad habitat types (forests, grasslands, wetlands, etc.) and different scales of observations as fine as sub-habitat level(LUCAS et al. 2011).

Advanced GIS modelling techniques can be used to derive probabilities for the presence of habitats in different biogeographical regions (FÖRSTER et al. 2007) and potential habitat ranges under specific assumptions or even changing conditions. In addition, spatial analysis techniques can be applied in order to quantitatively assess and compare structural parameters related to the actual conservation status (STRASSER et al. 2012).

MS.MONINA –amultiscale EO-based monitoring concept

MS.MONINA (*Mulit-scale Service for Monitoring NATURA 2000 Habitats of European Community Interest*) fosters the use of GMES/Copernicus space and in-situ infrastructure and advanced EO-based analysis and modelling tools. The developed services are specifically tailored to user requirements in terms of relevance, level-of-detail and scale, steadiness and reliability, uptake and fitness to existing workflows. The project (www.ms-monina.eu) uses EO technology to effectively monitor nature sites of community interest but also precious habitats outside the existing network of protected areas to reduce the loss of biodiversity.

Three MS.MONINA (sub-)services are offered, reflecting the different levels of operation, i.e. .EU, .State, and .Site. This requires a concordant multi-user approach. Each of the service developments is tailored to the user and technical requirements that are specific for each level of implementation. User requirements surveys collect all details on existing work flows, data usages, and the responsibilities imposed by HabDir. Based on these requirements,the testing, comparison and integration of state-of-the-art methodologies is performed. Demonstrators, accompanied by a full-fledged user validation exercise, complete the service evolution plan and the final scoping towards market. MS.MONINA thereby addresses: (1) agencies on EU level, i.e. ETC Biodiversity, the EEA and DG Environment; (2) national and federal agencies in their reporting on sensitive sites and habitats within biogeographical regions on the entire territory; (3) local management authorities by advanced mapping methods for status assessment and change maps of sensitive sites; (4) all three groups by providing transferable and interoperable monitoring results for an improved information flow between all levels (VANDENBORRE et al. 2011a).

A multi-scale service design

The 'multi-scale' concept, described below, matches with particular information needs on the hierarchical implementation scheme of HabDir. It also reflects on the hierarchical organization of ecological systems in general (LANG et al. 2011), ranging from single species detection (e.g. tree species discrimination, or grassland compositions, cf. SCHMIDTLEIN & SASSIN 2004) up to coarse scale mapping and modelling of broad habitat types and habitat probabilities. For these purposes, specific EO data are utilized, e.g. very high resolution sensors such as WorldView-2 for the site level and RapidEye for the state level.

Site-level service

While specific information needs at the local level obviously vary from one site to another, a general knowledge of actual habitat locations and distributions is required. Also, the conditions in terms of overall quality, existing threats and pressures need to be known, as well as their trend of development. Such up-to-date information is of high value to site managers, to make informed decisions about the measures to be applied, as well as the effects of such measures, in order to steer adaptations and improvements (VANDENBORRE et al. 2011b).

The MS.MONINA Site level service provides on-demand geo-spatial information on protected nature sites to various users, such as site managers, local and regional authorities. The service delivers a broad range of information outputs to fulfill various HabDir related requirements (e.g. Art. 17reporting, Standard Data Form reporting, site management, etc.) in all biogeographical regions of Europe. The suite of information products comprises among others: (i) wider landscape context maps, indicating e.g. overall landscape configuration or, fragmentation; (ii) maps of habitat patches and vegetation types (ranging from broad habitat groups to Annex I habitats and even subtypes); (iii) maps of conservation status of habitats and areas, based on meaningful indicators that can be derived from remote sensing of (e.g. tree encroachment in open habitats, invasive species, soil moisture, land use intensity); (iv) change detection maps of land cover, land use or conservation status indicators.

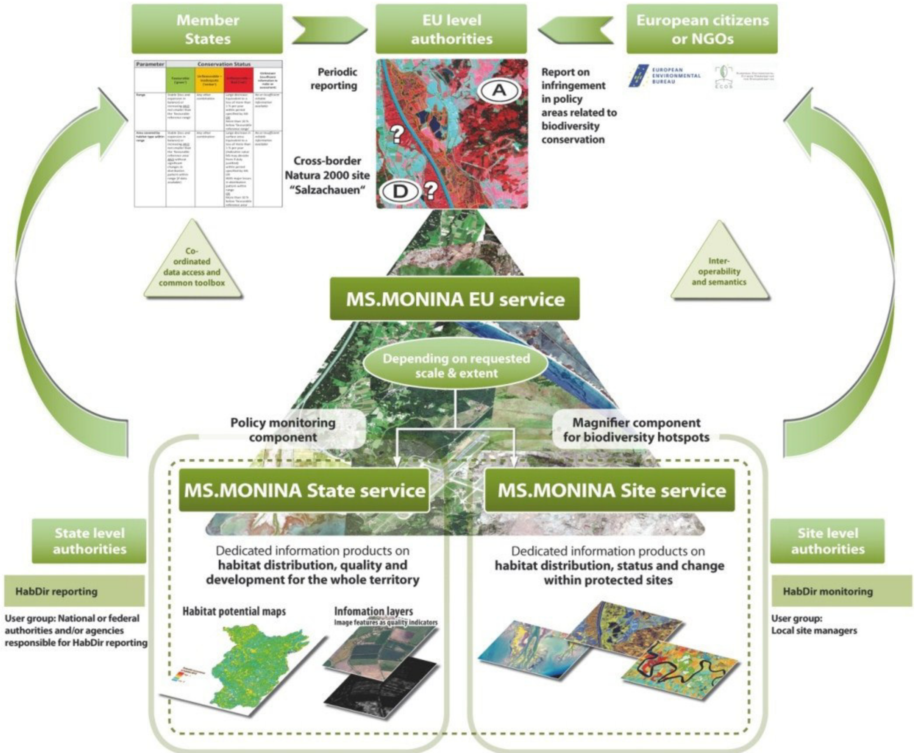


Figure 1: The overall, integrated service concept of MS.MONINA. On each level, the respective information services address specific authorities or management bodies. Depending on the primary roles assigned to the authorities by HabDir (Site level: monitoring, State level: reporting), dedicated information products are offered. The EU level service follows an on-demand logic.

<u>State-level service</u>

The MS.MONINA State service consists of an on-demand provision of geo-spatial information to support regional and national stakeholder activities related to the monitoring of precious habitats over the entire reporting territory (inside and outside of designated NATURA 2000 sites).Thereby,the State service establishes links to the Site level and the European level. To support the reporting obligations imposed by HabDir on MS level, theservice will utilise mapping and image analysis capabilities to provide critical information.The service is built around the concept of *information layers*that will act as 'containers' for relevant features such as vegetation stress, and should be easy to integrate into different systems with a common exchange format (LANG et al. 2012). The class features can be mono- or multi-temporal/multi-seasonal reflecting spectral, textural and structural information. The advantage is that thefocus is put on method development tackling habitat specific problems (e.g. shrub encroachment, temporal habitat variation, etc.) and that core image analysis models and components can be adjustedto service cases. In addition to the image analysis capabilities, expert models will be used to provide habitat potential maps. Based on a statistical modelling approach (maximum entropy model) the ecological niche of species and habitats is modelled based on abiotic factors (such as soil information, digital elevation models etc.). The resulting habitat potential maps can be included into image classification methods either by weighting the class probability or excluding classes due to a restricted natural potential of occurrence.

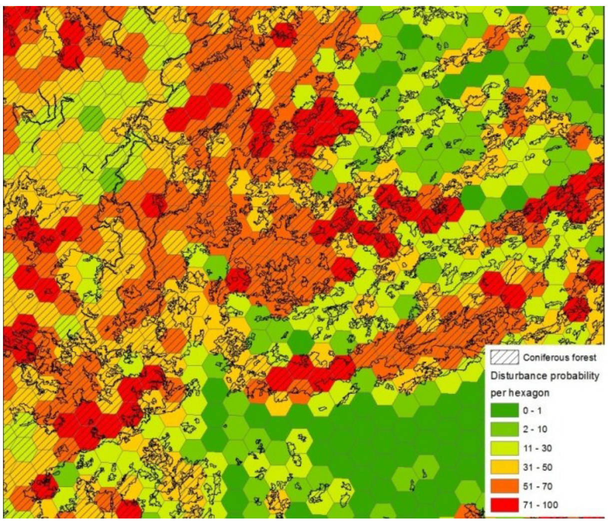


Figure 2: Hexagon-aggregated information layer on forest disturbance probability (Greek pilot site).Data source: RapidEye, analysed by different vegetation indices. Service provider: PLUS.

EU level service

The MS.MONINA EU service provides on-demand geo-spatial information to support EU stakeholders (e.g. DG ENV, EEA) activities related to: (1) the monitoring of biodiversity hotspots and (2) on-the-spot check of biodiversity reports and control of infringements to HabDir (e.g. activities which degrade and damage the habitat of the species). The concept is built around two main components (see Fig. 3): (i) **Magnifier component**: On-demand provision of habitat distribution and quality indicator maps for biodiversity hotspot sites (e.g. riparian areas, coastal areas); (ii) **Policy monitoring component**: On-demand provision of maps in "rush mode" as a means for external/independent validation of national biodiversity reports or to control infringement. Also on EU level, MS.MONINA makes use of remote sensing data for on-the-spot checks of biodiversity reports or for rapid mapping of protected sites (see Fig. 3).

When the service is triggered by EU mandated users, MS.MONINA examines the request, analyses the feasibility and the scale of the output products and accordingly tasks either the MS.MONINA Site service or the State service (cf.Fig.1).

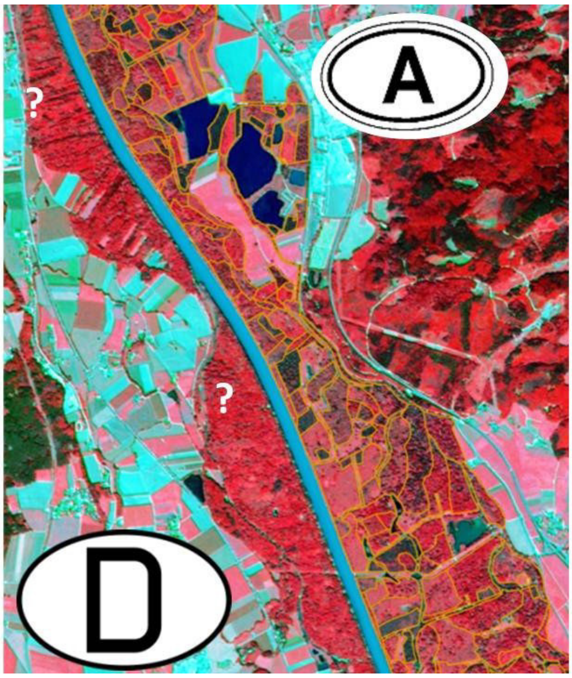


Figure 3: Trans-boundary NATURA 2000 site Salzachauen (Austria / Germany) – a case for the 'policy monitoring' component of the EU level service.

Demonstrators and web dissemination platform

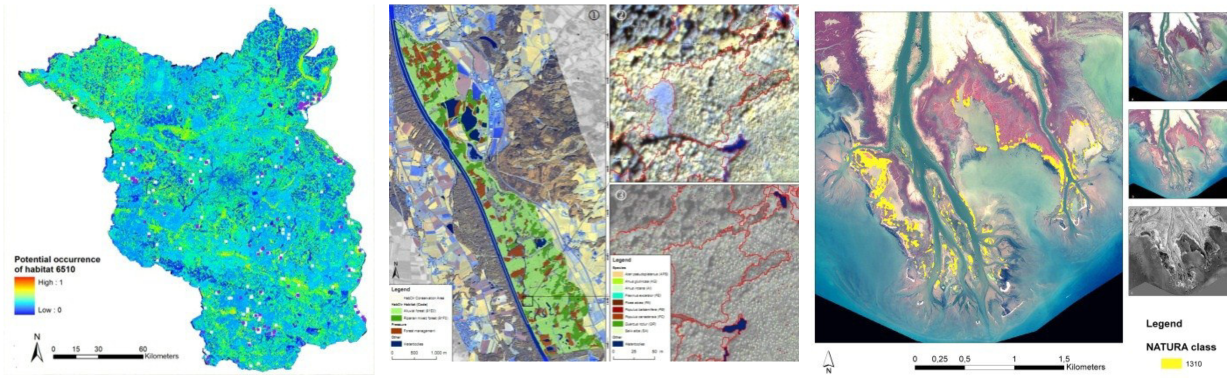
A key success factor of the GMES/Copernicus programme is to ensure the acceptance of services by users. This acceptance and further adoption requires high quality products that meet the specific information requirements of the user. MS.MONINA has selected a number of demonstrators as in-depth application scenarios of the services(see Tab. 1).In addition, a user validation exercise is currently carried out following a detailed validation protocol, which will demonstrate the potential and limitations in terms of methodological and technical achievements and the user involvement process.

Table 1: MS.MONINA demonstrators and related products on State and Site level.

State Level	Biogeogr. region	Focus of the service	MS.MONINA products
Languedoc-Roussillon, Loire, Isére and Savoie region (France)	MED, CON, ALP	- Mapping lowland vegetation in open areas independently of the biogeographical region	- Heathland map - Information layer for different types of grasslands based on their productivity
Federal State of Schleswig-Holstein (Germany)	ATL	- Strong focus on the information layer approach - Landscape is characterized by lowland rivers and dominated by pastoral agricultural land use	- Grassland information layer including biomass, line structures, homogeneity, agricultural intensity, slope and slope direction - Grassland classification including intense, dry, mesophile and wet grassland - Wetland information layer including tree and shrub encroachment
Federal State of Brandenburg (Germany)	CON	- Good example for state modeler output - Many special near-natural landscapes such as lowland fens, heathland and dry grassland	- Potential habitat map (range) for selected species and habitat types - Information layer for heathland quality indicators

Site Level	Biogeogr. region	Focus of the service	MS.MONINA products
Salzachauen (Austria)	CON	- Mapping riparian forest habitats in a trans-boundary Natura 2000 site - Habitat structure analysis	- Semi-automated object-based habitat classification - Visual interpretation (EUNIS 3) - Form, structure and core area analysis - Seasonal changes in vegetation - Monitoring of forest management measurements
Riesenferner-Ahrn (Italy)	ALP	- Mapping alpine habitats - Conservation status assessment	- Classification processing chain for habitat mapping - Processing chain for assessing conservation status for specific habitats based on shrub and tree encroachment
Döberitzer Heide, Kleine SchorfheideandKalmthoutse Heide (Germany, Belgium)	CON, ATL	- Knowledge-based heathland monitoring and change detection - Monitoring of grass encroachment, shrub encroachment and dune fixation - Conservation status assessment - Biomass accumulation	- Semi-automated object-based habitat classification - Automated classification of vegetation classes and habitat elements (indicator map) - Maps of conservation status indicators in heathland and inland dune habitats - Level of variation of structural elements within habitat patches (bare sand, dwarf shrubs, moss layer…) - Map of changes in habitat type and conservation status
Axios and Aliakmonas (Greece)	MED	- Mapping river delta habitats - Monitoring of conservation status - Assessment of land use pressure - Proportion of bare soil - Surface area and trend of habitat type changes	- Wetland habitat maps using ANAX (Advanced classification methds for inventorying and mapping protected areas using satellite imagery)
Larzac foothills (France)	MED	- Mapping of habitats in a limestone karstic area - Monitoring of conservation status - Assessment of land use pressure (grazing, farming)	- Semi-automated object-based classification of habitats

The maps shown in Fig. 4 illustrate three information products on State (Fig. 4a) and Site level (Fig. 4b and 4c).



(a) (b) (c)

Figure 4: (a) Habitat probability map for lowland hay meadows (6510) in Brandenburg (DE), service provider: Luftbild Umwelt Planung GmbH (LUP); (b) Habitat map for riparian forests (91E0*, 91F0) in Natura 2000 site Salzachauen (Austria), service provider: University of Salzburg, Z_GIS; (c) Freshwater habitat mapping (1310) in Natura 2000 site Axios delta (Greece), service provider: National Observatory of Athens.

A public access web platform showcases to the user community what can be offered by MS.MONINA. Thisincludes an online service portfolio with specifics on the offered services and further information on the MS.MONINAservice cases, an OGC-conform geoportal with all geospatial information products being delivered and a tools repository listing and cataloguing the methodological components and algorithms utilized by the partners for the image/geospatial analysis tasks.

As a conclusion: from research to information services

Targets for the NATURA 2000 network are tough and reaching its ambitious goal will require extensive knowledge based on systematic and continuous data collection. However, many Member States are still lacking the ability to provide such information in a regular and routine fashion. Therefore, MS.MONINA will prepare the ground for establishing services to support a successful implementation of the Habitats Directive on all levels(LANG et al. 2012).It will follow four important suitability criteria for such services as identified by VANDENBORRE et al. 2011: (1) multi-scale, i.e. addressing multiple scales on all levels of implementation; (2) versatile, with algorithms tailored to the habitat type of interest and differentimage types; (3) user-friendly, allowing integration of theproducts into existing workflows; (4) cost-efficient, providing reliable and reproducible products at an affordable cost, compared to traditional field methods.

MS.MONINA as a 3-years project aimsatpre-operational services that shouldstimulate the further development of GMES/Copernicus services in new emergingtarget areas such Biodiversity.These 'focus areas' can be considered areas of community concern, which dohave a strong policy-related, though less commercial motivation. Due to the fact that NATURA 2000 is already anchored in national legislation withspecific requirements, there are already companies (especially SMEs) which concentrate on marketstrategies in this context. Also, there are projects funded on national and supra-national scale, andresearch institutions have developed, together with users, concept and solutions for utilizing EOtechnology to support these requirements.

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The Impact of Alien Plant Species on the Conservation Success of a Protected Natura 2000 Area within the Ecological Restoration of the River Traisen, Lower Austria

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Abstract

The invasion of alien plant species into protected areas has a serious negative impact on the abundance and diversity of the native flora as well as on natural ecosystem processes. For protected areas in particular, the ongoing distribution of invasive species has become a major issue. The objective of this study was to examine the development of invasive species in a riparian ecosystem, namely the planned floodplain restoration area at the mouth of the river Traisen in Lower Austria. The territory for the study lies within a Natura 2000 area, where the regulated riverbed will be revitalized as part of the LIFE+ project "Traisen". Nine invasive plant species were recorded. During the last two years of study the distribution of the species *Bunias orientalis, Impatiens parviflora, Impatiens glandulifera,* and *Solidago gigantea* increased massively. The development was evaluated using a grid of 142 recording sites. In the riparian forests in particular, the proportion of invasive species to native species in the overall species composition increased during the recording period. The Shannon diversity index showed different developments for specific riparian plant communities. Furthermore, the seed bank and phenology were analysed in order to create a monitoring concept for the planned ecological restoration of the floodplain. The goal of this monitoring is to reduce the occurrence of invasive species in protected riparian areas focused on the protection of endangered native species.

Keywords

invasive alien species, riparian, restoration, biological invasion;

Introduction

Riparian areas are important habitats for various ecological functions and European plant diversity (GREGORY *et al.* 1991, NAIMAN & DECAMPS 1997, PFADENHAUER 1997, HOOD & NAIMAN 2000). In the past decades, European riparian zones have been strongly affected by biological invasion (PYŠEK et al. 1994, ESSL et al. 2002, SCHMITZ & LÖSCH 2005). The increasing number of scientific studies in this area emphasizes the importance of the ongoing ecological changes and consequences of biological invasions (LOHMEYER & SUKOPP 1992, RICHARDSON & PYŠEK 2006). The issue of invasive alien species is regularly discussed in several international conventions and nature conservancy programs (CLOUT & WILLIAMS 2009).

The entire area was regulated in the 19th century in order to reduce the number of floodings and increase the available land area for cultivation. During the construction of the Danube power plant Altenwörth in the 1970s, the outfall of the river Traisen was relocated. Although the relocation had a negative influence on the ecological situation, the species richness of the project area was calculated to be very high. The occurrence of species of the fauna-flora-habitat directives is similarly high. Therefore the area was incorporated into the EU-wide network of Natura 2000 sites, a network of nature protection areas established under the Habitats Directive and Birds Directive (1979). Since 2004, the area has been part of the Natura 2000 FFH site 16 "*Tullnerfelder Donau-Auen*" (www.noe.gv.at). The site covers a total area of 19,483 ha (ELLMAUER et al. 1999). One of main foci of this Natura 2000 site is the protection and support of riparian vegetation. The ecological function of riparian forests, broadleaved alder forests, transitory phytocoenoses and dry grasslands of the riparian areas in particular are among the important protected and supported entities in the "*Tullnerfelder Donau-Auen*" (www.noe.gv.at/natura2000). The aim of the Habitats Directive (1992) is to assure the long-term survival of Europe's most valuable and threatened species and habitats (ec.europe.eu). Human activities are not excluded from the management of Natura 2000 sites, as long as the management is ecologically and economically sustainable (SHARPSTON 2010). The Natura 2000 site "*Tullnerfelder Donau-Auen*" constitutes one of the largest connected riparian ecosystems in Austria. But the ecological structure and function of the riparian area are strongly endangered due to the construction of the Danube power plants Altenwörth and Greifenstein. The installation of these power plants caused noticeable changes in the Danube's hydrology. Most of its abandoned meanders were disconnected from the main stream; but without these important cross-links to the main stream, the ecosystem is highly endangered. Furthermore, the reduction of river flooding leads to massive disturbances within gallery forests (www.noe.gv.at/natura2000). The ecological restoration of the river Traisen is now planned.

The main goal of the project Life+ Traisen is the improvement of the hydro-ecological condition of the downstream section and the outlet of the river Traisen. The planning of the project follows specifications of the European Water Framework Directive. Besides hydrological and hydrobiological objectives, one purpose of Life+ Traisen is to create natural riparian habitats with characteristic vegetation structures. In keeping with the objective of the restoration project, the main focus of experiments and analysis for this study was placed on invasive species within the herb layer.

In summary, the objectives of this study is a contribution to the analysis of the development of biological invasion of alien plant species on the one hand; and on the other hand, the discussion of challenges, interdependence and perspectives of restoration programs within the conservation targets of a Natura 2000 site in general.

Methods

The studied alien species were selected according to the time of their introduction and establishment. Non-native species introduced to Europe after 1492 are classified as alien species (SUKOPP 1969, ADLER & FISCHER 1994).The vegetation sampling includes all occurring vascular plant species. To assess the quality of plant diversity as well as vegetation coverage and development, a grid of coordinates was placed over the research area. Within these random localized coordinates, a grid of 142 recording areas (10m X 20m) was selected. The parameters habitat characteristics, occurrence and number of species, and abundance and dominance (BRAUN-BLANQUET 1964) were recorded for each site in the years 2011, 2012 and 2013..The seed bank analysis was performed on 89 random sites (October 2011). Within each of these sites, 3 plots were randomly taken using a soil cutter with a diameter of 2.6 cm and a depth of 20cm. The plots were collected separately for the soil layers 0-5cm, 5-10cm and 10-20cm. A germination test was then done using the rising method. The detected seeds of each sample were put in Petri dishes filled with absorbent papers, and kept for 40 days in a greenhouse without artificial day-night-control (temperature: 20 – 25°C; humidity: 60-90%). A seed was regarded as germinated if it produced a radicula (BERNHARDT et al. 2008).For a representative observation of the phenological characteristics of invasive plant species in the riparian area, 8 sites were selected. A vegetative and a generative scale were used to detect phenological development (DIERSCHKE 1994). Statistical computing and graphics "R" (32-bit) were applied (R Core Team, 2012), and the Shannon diversity index was chosen to calculate the influence of the occurrence and development of invasive alien plants on the native diversity (MAGURRAN 1988, PINHEIRO et al. 2010).

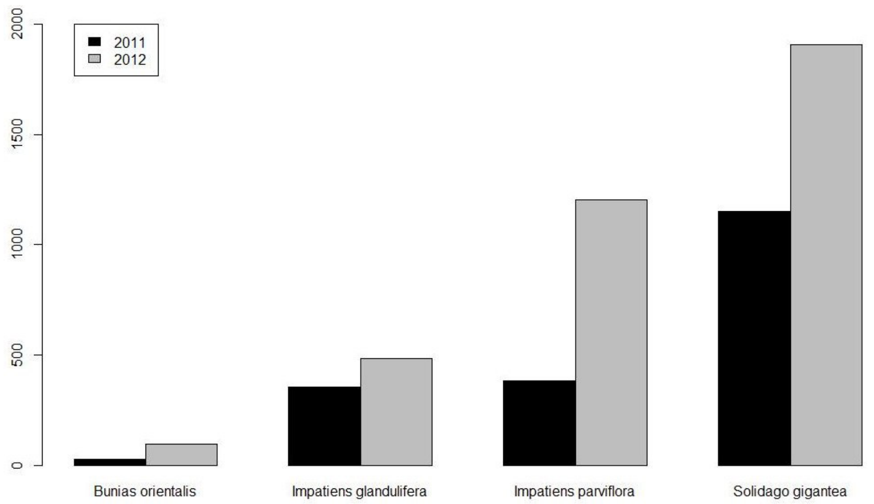

Figure 1: comparison of the total number of detected seeds and the total number of germinated seeds of *Impatiens glandulifera*, *Impatiens parviflora*, *Solidago gigantea* and *Bunias orientalis* for all samples of all layers.

Results

The vegetation sampling of 142 recording surfaces documented the occurrence of 9 invasive alien plant species. *Acer negundo, Ailanthus altissima, Bunias orientalis, Fallopia japonica, Robinia pseudoacacia, Rudbeckia laciniata, Impatiens glandulifera, Impatiens parviflora, Solidago gigantea* were recorded within four different vegetation layers and regarded as invasive alien plant species (ESSL et al. 2002). The comparison of the results of 2011 and 2012 show a significant increase of invasive alien plants (Fig. 1). 23 species included in the IUCN Red List were also recorded (KURMANN & BERHARDT 2013). A total number of 89 plots were analysed using combined sampling of the aboveground vegetation coverage and the underground density of seeds of invasive alien plants. In total, 163 seeds of the species *Impatiens glandulifera*, 83 seeds of *Impatiens parviflora*, 438 seeds of *Solidago gigantea* and 34 seeds of *Bunias orientalis* were detected. The majority of invasive plant seeds (n=499) were detected in the samples from the upper layer (0-5cm). The results of the germination test showed that of the 717 total seeds found, 396 (55%) germinated. The percentage of germinated seeds decreased with the depth at which they were found. The highest germination rate was that of the species *Solidago gigantea*,with a total of 68% of seedsgerminated. Analysis of the germination results showed that 80% of all germinable seeds germinated within the first 10 days.

Invasive alien plant species *Bunias orientalis, Impatiens glandulifera, Impatiens parviflora* and *Solidago gigantea* comprised an average of 71% (2011) and 84% (2012) (n=89 sites) of the total coverage of the herb layer.

An average of 1.8 seeds of *Bunias orientalis*,0.9 seeds of *Impatiens glandulifera*,4.9 seeds of *Impatiens parviflora* and 0.4 seeds of *Solidago gigantea* were detected. *Solidago gigantea* was the most abundant invasive species. Overall species richness (Shannon index) decreased as the occurrence of seeds of invasive alien species in the seed bank increased. The species diversity of each plot showed a significant negative relationship with seed density of *Impatiens glandulifera* ($p=0.03$, $r^2=0.05262$) (Fig.2). The occurrence of seeds of *Solidago gigantea* show a positive (though not significant) relationship to the total aboveground cover of the herb layer($p=0.6537$, $r^2=0.00232$). While the results represent the presence of seeds of invasive species in the seed bank, the spreading of invasive alien plants sampled aboveground into previously not invaded areas is not related to the occurrence of their seeds in the seed bank.

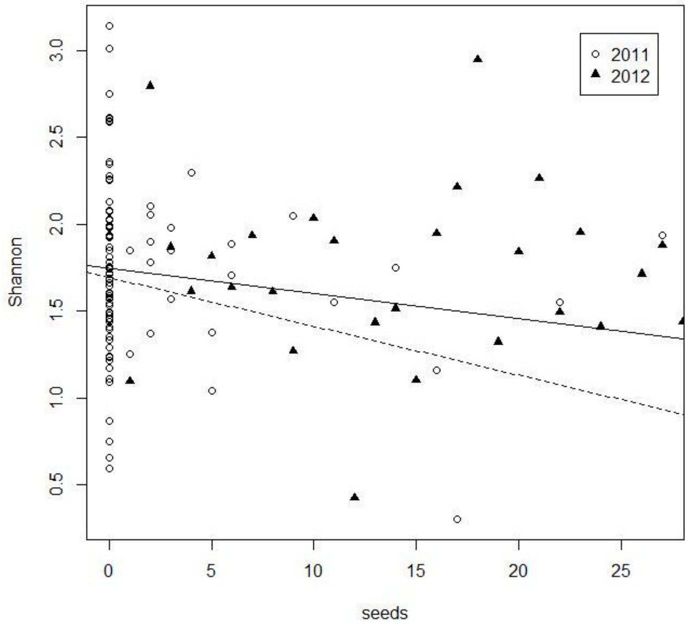

Figure 2: Regression analysis of the relationship between mean seed density of *Impatines glandulifera* and mean Shannon diversity index of aboveground plant species composition in the study year 2011 and 2012.

Discussion

The high level of species richness and diversity of habitats in the study area can primarily be seen as the remains of the natural riparian ecosystem that was destroyed by various human interventions (Ellmauer et al. 1999). Immediately following the regulation of the river Danube and the artificial relocation of the river Traisen, species richness decreased noticeably. The restoration of the river Traisen within the project Life+ Traisen aims to construct new typical riverine habitats and improve the ecological conditions of the study area's diversity (Eberstaller et al. 2000).

The new re-naturalised downstream section of the river Traisen is not merely an opportunity to improve the ecological situation, but also a challenge to reap the benefits of diversity without supporting the ongoing invasion by alien plant species. The characteristic vegetation structure of natural riparian habitats includes, among others, forests with populations of *Salix alba, Salix purpurea* and *Salix virminalis* (Pfadenhauer 1997). The construction of the new riverbed profile of the river Traisen primarily supports the FFH habitat types of softwood forests. The result of seed bank analysis and vegetation development sampling show that areas with high human disturbance are greatly affected. In order to achieve the restoration´s goals of improving diversity in the area, a concrete concept for invasive species management needs to be developed. The vegetation sampling showed a high percentage of invasive plant species in the herb layer in sites with naturally low species richness and sites with low total cover. However, the planned restoration will create large areas of such uncovered and open ground. The restoration plans therefore need to be considered carefully in order to achieve their goals (Suding et al. 2004, Richardson et al. 2007). The objective of the monitoring is to observe the construction processes from their earliest stages and implement measures as soon as possible. One possible method of reducing the expected spreading of *Impatiens glandulifera* in the constitution area, which will be tested in 2013, is to support the desired growth of *Salix alba, Salix purpurea* and *Salix virminalis.*

The plant diversity of the Natura 2000 site "*Tullnerfelder Donau-Auen*" in the study area is highly endangered due to the construction of two Danube power plants and the regulation of the river Danube. A significant number of species on the IUCN Red List (Schratt 1990)(Niklfeld & Schratt-Ehrendorfer 1999) were recorded during the vegetation sampling drives of 2011 and 2012 (Kurmann & Bernhardt 2013) , and the documented diversity is still high. However, the increase in the total number of invasive plant species is endangering the general objectives and specific targets of protection. This biological invasion must be discussed and reflected in terms of the management and land-use programs of the area.

The (in some areas massive) dominance of invasive species renders removal of these invaders economically unaffordable and in most cases also ineffective, and therefore undesirable (Del Tredici 2004). With respect to ecosystem services, the removal of alien plants from massively invaded river embankments is potentially counter-productive (Richardson et al. 2007). Studies have shown that the situation of conservation management and restoration in riparian ecosystems is extraordinary complex (Hager et al. 2007, Didham et al. 2005, Clout & Williams 2009). Open and dynamic hydrological structures create individual riparian vegetation compositions. A successful conservation management of invasive species and ecological restoration of riparian vegetation calls for participative solutions including human land-use concepts and natural ecosystem services. Small-scale and long-term restorations are recommended (Sweeney et al. 2002, Richardson et al. 2007). Analysis of the seed bank and the phenological development of invasive plant species help to specify monitoring measures. The goal of achieving conservation targets requires active monitoring measures to protect hitherto non-invaded areas from biological invasion in order to maintain the integrity of protected natural areas for the protection of native flora.

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Opportunities and limits of the ecosystem services framework in capturing the cultural dimension of sustainable regional and landscape development in protected areas

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Abstract

With regard to protected areas, the concepts of ecosystem services and the cultural dimension of sustainable development (SD) are increasingly under debate. This contribution analyses the role of cultural aspects within the ecosystem services framework using the Millennium Ecosystem Assessment classification as a reference. The limits of the ecosystem services framework in capturing the cultural dimension are highlighted. Potential ways of strengthening the position of cultural values within this framework are discussed.

Keywords

Ecosystem services, sustainable regional development, cultural services, cultural values, nonmaterial benefits, cultural landscape, cultural landscape research, protected areas, Millennium Ecosystem Assessment

Introduction

In sustainable regional and landscape development (SRLD) research, cultural aspects are rarely or only selectively and unsystematically analysed. Thus far, the cultural dimension has not been discussed in depth. However, cultural aspects are of great practical relevance in SRLD, particularly in protected areas, where the biodiversity now found is largely due to diverse patterns of use that have been adapted to environmental conditions, particularly in agriculture and forestry. Past human activity has markedly contributed to the diversity which we today consider worth protecting. Culture drives ecosystem change through both traditional and new uses in order to maintain multi-functionality. Cultural factors, such as a sense of place and belonging and the desire to protect the region in which one lives and finds valuable and aesthetically pleasing, are common incentives that have led to the establishment of protected areas (Daniel et al. 2012). According to Rodewald et al (2003), it is only because of their particular aesthetic and socio-cultural qualities that we perceive of and name our surroundings as 'landscape'.

There are various discourses that deal with cultural aspects and their significance in the context of SRLD. Since the ecosystem services framework is important in order to know, evaluate and communicate the manifold services which ecosystems deliver, this contribution analyses its opportunities and limits in capturing the cultural dimension of SRLD in protected areas.

The ultimate aim of this contribution is to reflect on the cultural dimension of the millennium ecosystem services framework. The significance of cultural aspects is analysed and reasons for their relevance within this framework are discussed. Furthermore, this contribution aims to increase the relevance of the cultural dimension, thereby promoting SRLD and reinforcing arguments for preserving diversity in protected areas.

This contribution focuses on the following questions:

- What are the aims of ecosystem services frameworks? How are ecosystem services defined? What is the millennium ecosystem assessment and which cultural aspects are considered in its classification of ecosystem services?
- To what extent does research on ecosystem services consider cultural aspects and what are the reasons for this?
- What are the potential advantages of increasing the emphasis on cultural services within the ecosystem services framework?
- What are the opportunities and limits of the ecosystem services framework in capturing the cultural dimension?
- What can be done to increase the significance of cultural services within the ecosystem services framework?

Cultural aspects are inherent facets of the development of protected areas. Culture shapes the perception of a protected area, both materially and tangibly as well as nonmaterially and intangibly. Lived culture shapes the way of life in protected areas through factors such as human desires, aesthetic perceptions and values, as well as ecosystem use and social structures, through cultural tangibles (e.g. buildings) and intangible heritage (e.g. use). The development of ecosystems is influenced by cultural factors that are subject to change and interpretation over time. As previously mentioned, understanding the establishment of protected areas cannot be separated from cultural aspects. Human ideas, perceptions, values and goals are always the starting point for initiating the protection of an area, which is then undertaken through personal engagement and motivating public support (DANIEL et al. 2012, DE GROOT 1992, FROHN 2012). Aesthetic arguments in particular are often of central importance here.

Methods

The research methodology applied included systematic literature searches in data banks and libraries. The data thus gathered was evaluated through systematic analysis of the chosen discourses on the ecosystem services framework according to defined criteria.

Results

Ecosystem services frameworks were expanded upon to systematically identify and describe the state of ecosystems, the services and benefits they deliver, and to reveal and communicate their connection to and relevance for human wellbeing. It is hoped that the results of these findings will increase motivation to prevent further degradation and and promote further protection and preservation.

Ecosystem services can be defined as the services and benefits that humans receive from ecosystems and which contribute to wellbeing. This implies that ecosystem services do not exist on their own, but that humans must first acknowledge their benefits and value. Therefore, the concept is anthropogenic (LOFT & LUX 2010).

There are different classification systems that capture the many functions, goods and services delivered by ecosystems (e.g. MA 2005, DE GROOT et al. 2002). We refer to the Millennium Ecosystem Assessment classification system (MA 2005), which is the best known in the field of research into ecosystem services and their contributions to human wellbeing (LOFT & LUX 2010). The Millennium Ecosystem Assessment has significantly contributed towards promoting concepts focusing on the benefits of ecosystems for humans (KIENAST 2010). Since the publication of the Millennium Ecosystem Assessment, the number of publications on ecosystem services has increased considerably (OTEROS-ROZAS et al. 2012, FISHER et al. 2009). In the Millennium Ecosystem Assessment, ecosystem services are defined as the benefits obtained from ecosystems that contribute to human wellbeing and subdivided into four categories. These include:

- provisioning services (e.g. food)
- regulating services (e.g. regulation of drought)
- supporting services (e.g. climate regulation)
- cultural services (e.g. aesthetic values, sense of place).

Conceptual frameworks focusing on the functions ecosystems deliver, which capture cultural services in the Millennium Ecosystem Assessment as information functions (e.g. DE GROOT et al. 2002) are not discussed here.

Cultural services are “nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences” (MA 2005b: 40). These include cultural diversity, spiritual and religious values, knowledge systems, educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values, recreation and ecotourism (Ebd.). Many of these aspects overlap. This is also the case for cultural aspects with services from other categories, which underlines the importance of cultural aspects (DANIEL et al. 2012). Cultural aspects and their perception and value depend to a great extent on individual experience (e.g. the appreciation of scenery) and cannot be measured without integrating individual points of view (DE GROOT 1992). The interpretation and attribution of value to the perception of landscape is shaped by individual notions of culture, which have been learned and experienced (GRÊT-REGAMEY et al. 2012).

Although amongst other ecosystem services cultural aspects are an important part of the ecosystem services framework, research activities are very different. An analysis of recent literature on ecosystem services reveals that there is much concentration on provisioning and regulating services (KIENAST et al. 2009). The number of publications focusing on the cultural dimension in the field of ecosystem research is much smaller (SCHAICH et al. 2010).

One reason for the intensive examination of provisioning und regulation services is that databases are extensive and appropriate valuation methods easy to achieve (BOLLIGER & KIENAST 2010). According to WILLEMEN et al. (2008), the situation regarding cultural services has neither sufficient, appropriate data nor valuation methods. SCHAICH et al. (2010) refer to a 2009 publication (REY BENAYAS et al. 2009) that lists the number of indicators for biodiversity and ecosystem services used in worldwide ecological restoration projects. This publication reveals that not a single study had explicitly measured cultural services. Particularly those cultural services that are closely linked to wellbeing and quality of life are only roughly defined and as yet neither quantifiable nor assessable (PLIENINGER et al. 2010). Another problem lies with the aesthetic aspect, which is of relevance in the cultural dimension but cannot be directly measured (RODEWALD et al. 2003).

A central problem regarding the appropriate integration of cultural aspects in the ecosystem services framework is that they are often judged as intangible, subjective, difficult to quantify, and therefore difficult to translate into monetary value (DANIEL et al. 2012, SCHAICH et al. 2010), which is an important aim of the ecosystem services framework (COSTANZA et al. 1997).

Tradeoffs and synergies are central motivations for better integrating cultural services into the ecosystem services framework and strengthening their role. Because ecosystems support many services, tradeoffs and synergies can be a natural result. An example of a tradeoff is a recreational service such as mountainbiking, which can damage soil structure. Synergies can emerge if, for example, places of spiritual significance arouse motivation to support protection initiatives.

As long as knowledge about these services and their potential effects does not exist, tradeoffs and synergies cannot be included in planning and management processes and decisions remain arbitrary (DANIEL et al. 2012). DE GROOT (2006) maintains that "economists, ecologists and social scientists need to collaborate more to obtain better insights in the tradeoffs involved in land use change decisions". As cultural aspects are associated with more than cultural services, information about them should be expanded.

While the ecosystem services framework is useful for quantifying and evaluating many of the listed services, cultural services have been neglected (SCHAICH et al. 2010), particularly in evaluation and planning, as GRUNEWALD & NAUMANN (2012) illustrate with their example of a case study on the assessment of ecosystem services in the Jahna river basin in Saxony, Germany. If the relevance of the cultural dimension within the ecosystem services framework is to be increased, adequate means must be developed.

Discussion

There is fundamental criticism regarding including cultural services in the ecosystem services framework: KIRCHHOFF (2012) appraises the notion of 'service' as being inadequate in combination with 'culture' because many cultural values cannot be appropriately described. Kirchhoff also criticizes the integration of cultural values into the ecosystem services framework as such. While instrumental values adhere to ecosystems, cultural values of nature adhere to aesthetic-symbolic objects. His example is of the shimmering surface of a lake that invites contemplation and is not an ecological object but an entity with symbolic meaning and therefore a product of a specific way of seeing. Thus, fundamental cultural values of the environment refer to the unique character of the area, which cannot be captured within the parameters of descriptions of ecosystems (Ebd.). This point of view contrasts with others claiming that the provision of cultural services such as aesthetic values and sense of place is based on the performance of ecological structures, processes and functions (MÜLLER et al. 2010). These conflicting positions reveal how much assessments regarding the value of integrating cultural aspects into the ecosystem services framework differ and that much work still has to be done to clarify the role and assessment of cultural aspects within this framework.

Conclusion

An important limit of the ecosystem services framework with regard to the cultural dimension is that, compared to other services, it is neglected and so appears to be only of secondary consequence. One possibility of enhancing the relevance of the cultural dimension within the ecosystem services framework lies in integrating cultural aspects into the monetary system. We are not convinced about this possibility because not all services, especially many cultural aspects, can be assigned monetary value (GRUNEWALD & BASTIAN 2010). We propose approaching the question from another angle: DANIEL et al. (2012) state that cultural ecosystem services are not yet adequately integrated into the ecosystem services framework but that, according to social and behavioural sciences findings, there is potential for defining cultural services in terms of socio-ecological models to enable a better fit into the ecosystem services framework (Ebd.).

From our point of view, a promising effort appears to be integrating methods and results from cultural landscape research (SCHAICH et al. 2010) and increasing application of cultural aspects on cultural landscapes with their respective manifold history of use and settlement (PLIENINGER et al. 2010). Databases could thereby be improved whilst facilitating their application to protected areas. Protected areas could thereby contribute to improving databases of cultural services whilst benefiting from a better-developed ecosystem services framework that is enriched by cultural landscape research. This could assist management of protected areas to pay more attention to cultural aspects and to better integrate them into management processes, thereby better fulfilling their task of contributing to SRLD.

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Architecture
A main factor of development and protection of the mountain environment

Estelle Lépine

Abstract

The objective of this contribution is to show architecture as a major factor of development of the mountain environment against both environmental and human risks caused by the severe overcrowding of the routes leading to the main Alpine summits.

The choice between new buildings and the rehabilitation of existing refuges is currently a subject of debate in the Alps. The conference will focus on the Mont-Blanc area. Empirical *in situ* observations and confrontation between architectural and environmental considerations have raised specific issues. Nevertheless, this approach is applicable to other summits.

In a theoretical contribution, architecture will be put forward as a main factor in the development of the mountain environment. The definitions of walking, landscape and territorial scale will be seen as an integral part of the architectural project, contributing to the choice of the site, shape and integration. In order to consider the design of the spaces, we will look into the right level of comfort, appropriate materials and atmosphere, and the human and environmental risks at high altitude and in extreme environments.

Particular attention will be given to the Aiguille du Goûter refuge as a case study. As the overcrowding of the Mont-Blanc has considerable consequences on the environment and on human health, the architectural reflexions are aimed at answering the issue of environmental protection. The conclusion will evoke the limits of the project.

The originality and interest of this contribution is to use architecture (implementation, typology and material) to address these issues and to examine site-specific solutions in order to protect a given environment.

Keywords

Refuges, Alpine Architecture, Landscape, Risks, Comfort, Mont-Blanc, Alpinism, Walking

Introduction

The human impact in the Alps is still developing; the major part of the summits is suffering from an overcrowding that has environmental and human consequences. The extreme conditions of the high altitude threaten mountaineers by natural risks, which are easily hidden behind the mass of people. On the other hand, the popularity of the Alps increases the menace of pollution and alteration of the landscape. Nowadays, most of the refuges need to be replaced or renovated, which is why the research was aimed at finding the capabilities of architecture to take part in the protection of the mountain area. The Mont-Blanc could be considered as one of the most visited summits of the Alps. In order to propose a new academic project to replace the Goûter refuge, which has been obsolete for years, this example is a suitable case study to illustrate our hypothesis. The refuge is now condemned to disappear given the fact that the French Alpine Club has built new accommodation a few meters away. Voluntarily, the new proposition won't be discussed because this study took place at the same time as the design process.

Method

In order to analyse the particular case of the Aiguille du Goûter refuge, two scales were confronted. The first analysed scalewas that of *territory* considered through the process of walking. It allows for the interpretation of the ascent as one route from the valley to the mountaintop with all its mutual risks both for the environment as for the mountaineers. The tools that we used were mainly the map at a1/25 000 scale (source: IGN 3531 ET, St-Gervais-les-Bains, Massif du Mont-Blanc) and a virtual section of the climbing process to the summit (source: Estelle Lépine). The second scale was that of the *building*, considering different concepts in relation to landscape, shape and space, in order to determine the definition of the refuge. We used mainly architectural plans, primary literature sources and personal drawings of architectural surveys.

Finally, a refuge has been designed by the present author, presented with models and drawings (source: Estelle Lépine), in order to illustrate both approaches to scale and to provide theoretical answers applicable to summits suffering from similar dilemmas.

Results

Rebecca Solnit defines high mountains as the environment above the forest level generated by natural forces and characterized by a harsh and freezing climate, where life does not exist anymore or is reduced to a minimum (SOLNIT 2002). Ice and glaciers are omnipresent and impose significant challenges to human beings who want to venture into those conditions. Special equipment and techniques are required to go up and appreciate silence and peace. However, hidden dangers lie under the beauty of the icy whiteness. The sound of falling ice keeps mountaineers alert to the reality of the surroundings and leads them to behave carefully.

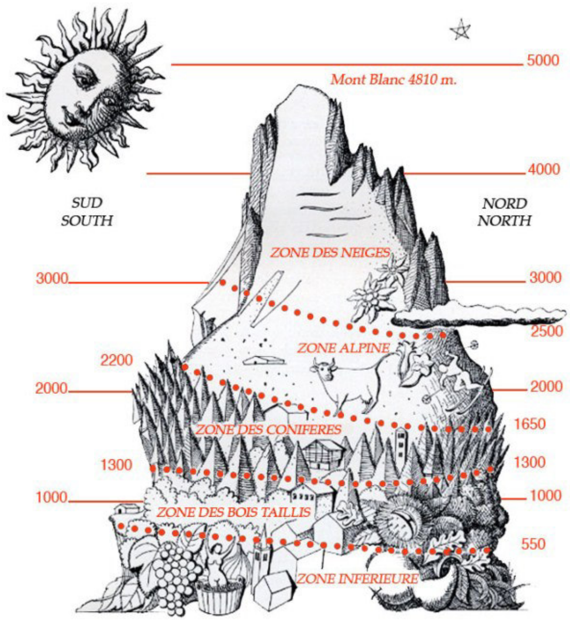

Image n°1: Source : Cereghini, M. 1956. Costruire in Montana. Milano

At high altitude, mountaineers are vulnerable to risks. The key issue is to characterize and understand the effects that this exposure has on them. "*Le risque est le dommage dont on peut évaluer la probabilité d'occurrence*" (PERRETI-WATTEL 2000). In other words, it is a notion of consequence multiplied by a presumption. Risk depends on hazards. It is not danger but it forestalls it. It is a paradox because it is real and unreal at the same time. It is objective and rational as a probability can be numbered. Simultaneously, risk is also subjective. The perception depends on the personality, the situation and the context. Anyone who is exposed to danger will react differently. In any situation, if the reason of danger is known, to be removed from it will reduce risk. On the other hand, it becomes much more complicated to avoid multiple sources of danger, as is the case in a mountain environment. As a result, it can be stated that zero risk does not exist, especially in alpinism (PERETTI-WATTEL 2000).

Risk perception has changed throughout the evolution of society; priorities are no longer the same (Anthony GIDDENS 1994). Education teaches us to respect science and technology without questioning daily life evidence. Complications emerge only when we enter into science ourselves. In fact, we learned to put our trust in expert systems or specialists. We believe in the functioning of our equipment more than the equipment itself. Trust and risk cannot be separated, because faith represents a conscious act of the human being in the unknown. Human mass, for instance, is a factor of trust, increasing with the number. That amount hides the truth and, sometimes, distorts the perception. Mountaineers progress in a reinforced safe feeling. Thus generalizing access to summits and refuges decreases limits of risk acceptance and perception, making an extreme environment accessible for all. If risks are visible within architecture, can we think that it will make the extreme environment more evident and that it will lead to more responsible behaviour towards the mountains? The approach chosen by the architects Devanthéry and Lamunière in their project "Alpine Ensemble" incorporates a protection against avalanches in the renovation of a small woodhouse. From the outside, the presence of the concrete wall appears to be omnipresent, reminding us of the presence of danger. It highlights the issue of the risks to which we are exposed (LAMUNIÈRE 2006).

At high altitude, alpinism is not a common experience. It requires physical investment. Rebecca Solnit relates it to pilgrimage,"*le voyage sans point de destination aurait quelque chose d'aussi inachevé que l'arrivée non précédée d'un voyage*" (SOLNIT 2002). Summit glory and ascension seem inseparable; they are both important. Walking is the most appropriate way to feel and appreciate the mountains. It is a mechanical process based on the personal and physical abilities of the body. Connecting *space* and *time*, it opens the mind to the path followed and the exercise provided (SOLNIT 2002).Architects have already been confronted with these issues (REICHLIN 1998). Eduard Krüger, for example, designed a refuge of commemoration"Schliffkopfhaus". Along the walk through the forest, the building is visible through the treetops and is regarded as an objective. Added to the meaning of the construction, the spirit of the site highlights the importance of reaching the refuge towards the place of memory. Eduard Krüger emphasized the effect through the shape and implantation of the refuge which induce an ongoing movement from the outside to the inside memorial room, demonstrating the possibilities of integrating walking within architectural projects. This suggests that the approach to a refuge is important, but nevertheless that the position could be even more significant for an ascent.

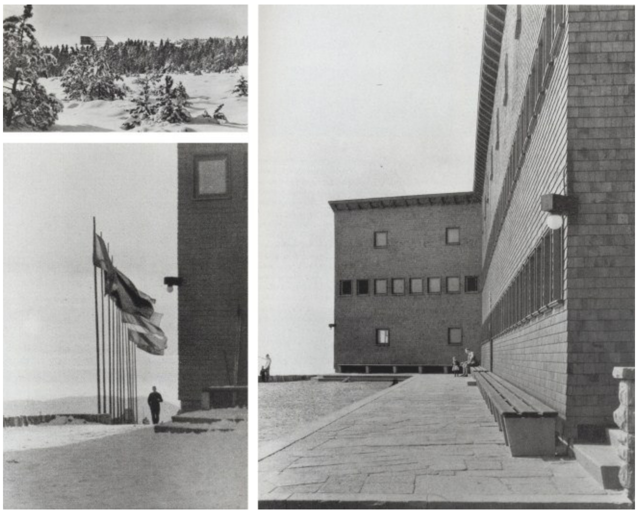

Image n°2: Source : Mayr Fingerle, C. (dir.) 1996. Neues Bauen in den Alpen: Architekturpreis. Basel.

Modernists have studied the qualities of the mountains through the relationship between site, scenery and nature. Regarding different examples, we can define three ways of questioning the parallel between landscape and architecture.

Discretion in architecture is explained by Theodor Fisher not as a work of contrast but as a harmony with nature. Everything must be valued (REICHLIN 1998). The qualities of the surroundings remain untouched despite the intervention. As for the extension of the wood house Truog "Gugalun", Peter Zumthor modified everything but at the same time he respected the original context(MAYR FINGERLE 1996).In that case, time is a consequential factor of success (REICHLIN 1998).

Mimetism is modeling nature through shapes and materials. Inspired by the form and inclination of ridges, slopes or summits, the works of Franz Baumann or Hans Leuzinger are typical. Their projects integrate the surrounding within the building through the choice of dimensions, shapes and materials (REICHLIN 1998). More recently, the main façade of the Monte Rosa Hütte project coincides with the summits in the background (ETH ZURICH 2010).

The geography and scenery of a site can also be integrated within a project as a tool of *composition*. Places can inspire the program because of their outstanding features. A number of architects use it as a conception tool. Lois Welzenbacher studied the relation between architecture, landscape and mountains for every mountain house he designed (REICHLIN 1998). Landscape is a physical site element (REICHLIN 1998).The entire architectural project is based on physical evolution influencing implantation and form. The Böhler house of Heinrich Tessenow demonstrates the possibility of composing the plan through the movement from the access road to the main terrace (BOESCH 2008). Adding section dimensions by height variations underlines the close relationship between the interior and the exterior. He emphasized the connection with the surroundings.

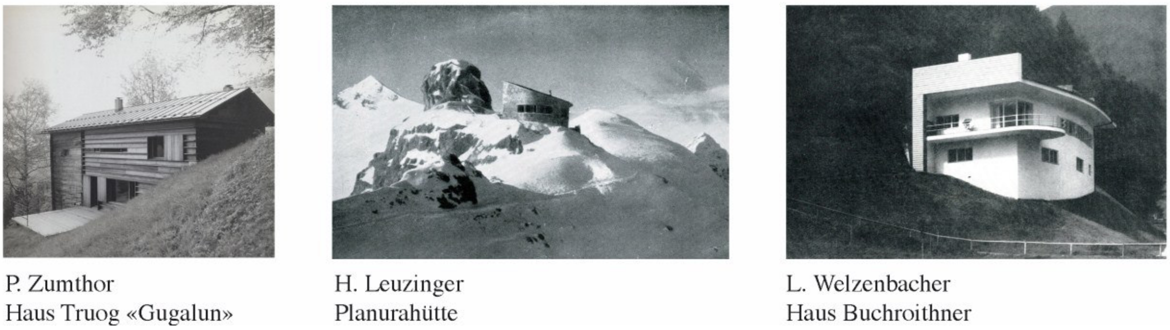

Image n°3: Source : Mayr Fingerle, C. (dir.) 1996. Neues Bauen in den Alpen: Architekturpreis. Basel.

Specifically thinking of refuges, the work of Jakob Eschenmoser (1908-1993) is difficult to avoid. He conceived several projects, offering a maximum of efficiencyfor the interior spaceswhileproposing a minimalfaçade. He consideredthe latter as the weakness of any building because of the extreme climatic conditionsin mountain environment.To address these conditions, he succeededinreducingthe external surfacesbystudyingthe dimensions of the fundamental component of the refuge: the bed. Takinghumanproportions as a base, he optimized the size of a mattress, reducing mostly the width at thefoot end. In consequence, he obtaineda trapezoid planand a multiplication of the sloped roof. He used that shape as an opportunity to integrate theconstructionsin harmony with the surroundings in response to the difficult conditions (Flückiger-Seiler 2009; Eschenmoser 1973). His reflections have had an impact on the morphological evolution of Alpine refuges. The choice of separating the sleeping and common roomswas the first stepin the direction of space efficiency and modern comfort.

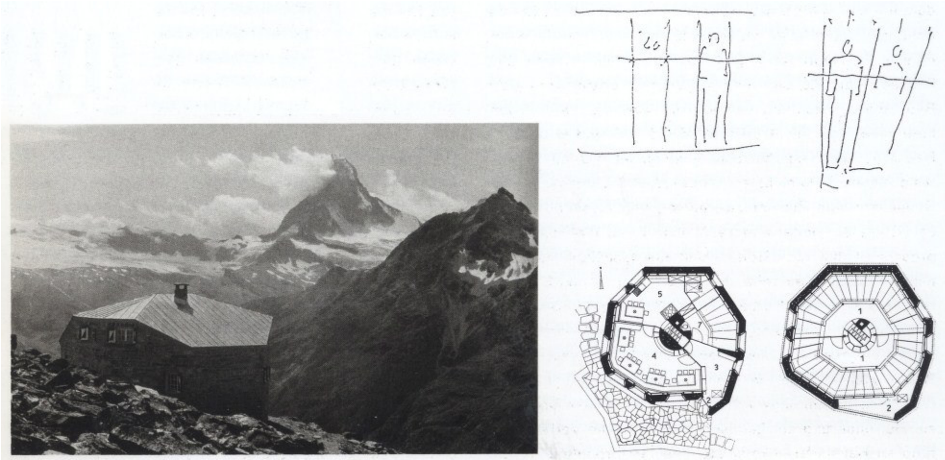

Image n°4: Source : Mayr Fingerle, C. (dir.) 1996. Neues Bauen in den Alpen: Architekturpreis. Basel.

Nowadays, comfort has evolved and is defined as the appreciation of the relationship between one's body and its physical environment in terms ofspace, temperature, light and sound (Crowley 1999). Elizabeth Shove gives us three different definitions (Shove 2003). "State of mind" qualifies the desire of access to social recognition. "Attribute" means a standard fixed by the close relationship between scientists and producers. Finally, "achievement" is a concept reachedthrough the self-will of the one who wants it. The lastone seems more accurate forcomfortat high altitudes, following the reflections of Elisabeth Shove when she points out the strangeness of making effort to control nature instead of constructing the best conditions for the natural needs of the human body (Shove 2003).Affording technical supplies is an evidentsource of difficulties in extreme environments. As users are supposed to wear adequate equipment, we could question the level of comfort currently offered in arefuge.Gaston Bachelard stated that we feel the warmth inside because of the cold outside (Bachelard 1957). The idea that feeling comfortable comes from the contrast between two opposed situations can be easily experienced in the project of arefugeespecially when the purpose of the building is to open themind to the surroundings.

With these theoretical contributions and studies on both scales, thenext objective of the author was to illustrate, through an academic project, what could be the architectural answer to the issues encountered on the particular case of the Mont-Blanc.

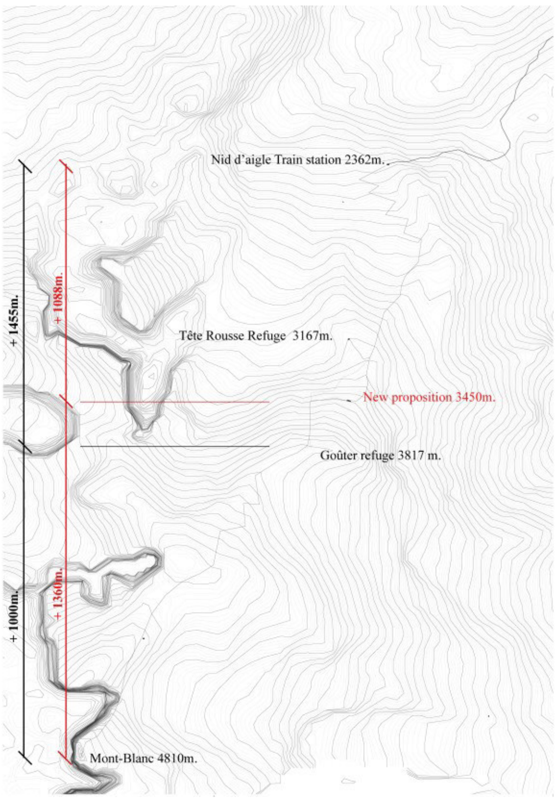

Image n°5: © Estelle Lépine

First of all, the concentration has been put on the choice of the site implantation. The preference was given to a lower position, compared to the ancient existing building and the new project now realized, in order to increase the difficulties on the way up. On the contrary of what happens now with an ascent divided into two equal parts, most of the climb would have to be done on the second day. The intention is toinduce a selection of who is capable of making that sort of effort with a potential reduction of mountaineers. In a secured area from falling rocks at the foot of the face, the refuge is not a simple place to sleepanymore. It acquires higher status as a threshold to the highest European summit, a special symbolic meaning. Whilst maintaining the goal of testing the surroundings in order to stimulate the sensations of the climbers, it gives the opportunity to play with the different scales between the refuge and the terrain along the approach. The ubiquity of the steep face will erase any human reference. The last steps, under the building, make its dimension even more difficult to define. And when our vision and footsteps reach the door, it will look appealing because of its protective appearance. The need and definition of a refuge grow obvious in the mind.

Image n°6: © Estelle Lépine

Then the path doesn't stop but continues inside. The ascent remains the main source of imagination of the internal spatial composition. In fact, inside, the guests have to follow up the main staircaseto the welcome desk and the common room. Every floor has been imagined as a step. Through the levels, limited size openingsbrighten upeach landingand provide directed eye contact with the landscape. Going up means that the view will change along the floors. Beginning at the lower entrance, the link is assured with the immediate ground. Thenone floor at a time, it will belost becausethe last windows only open to the sky. This process is in order to rhythm and lead the move inside and to emphasize the main view from the common room where the apertures are wider and unrestricting to the magnificence of the full surroundings.

Image n°7: © Estelle Lépine

The main staircase is carved in the rock, a reminder of the Goûter face, to confront people with the hurdle that has to be overcome the next day. The same idea is for the dormitories. Hanging on to the rock to keep its presence stronger, they have been designed in wood. As a protective shell, the rooms have been developed to the exact dimension of the beds. Adding ten mattressesto each room (average number we consider acceptable for one room), we have obtained the dimension of one dormitory.It is mainly conceived for restingtime, which is the basic offer of a refuge. It permits personal reflection, to have a moment to be conscious of where we are. The only extra space is for a minimum capacity for personal belongings storage. To preserve the sleeping areasfrom noise, the corridors have been specially measured to offer enough room for packing and preparing the equipment. Attention has been particularly given to the natural and artificial lighting and furniture convenience to facilitate movement and specific activities and equipment associatedwith alpinism, especially in the early hours.

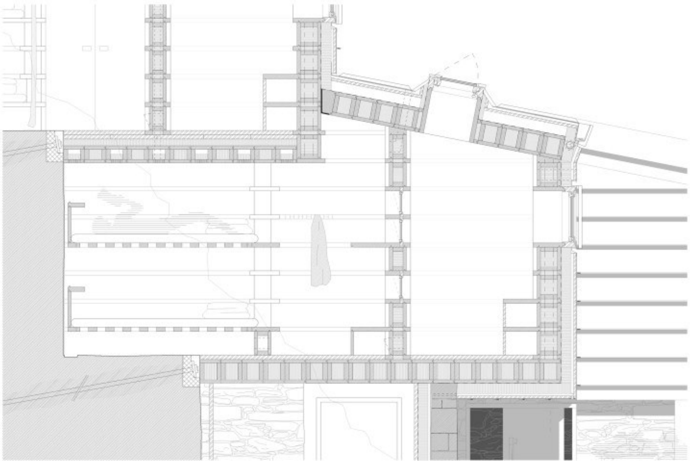

Image n°8: © Estelle Lépine

Thus, the reflection on level of comfort has been concentrated mainly on spatial considerations: space efficiency, materialselection, dimensioning and best lighting and view. The consideration of the technical aspects (shower, heating and electricity) has been deliberately reduced to a minimum, refusing to offer guests sanitary standards equal in thevalley. This is in order to have the smallest impact on the environment and minimize the effort to produce energy. Whilst keeping the purpose of designing the refuge to the context and as a sensitizer of the surroundings, comfort level isparticularly adapted to reduce the consequences of human presence at high altitude.

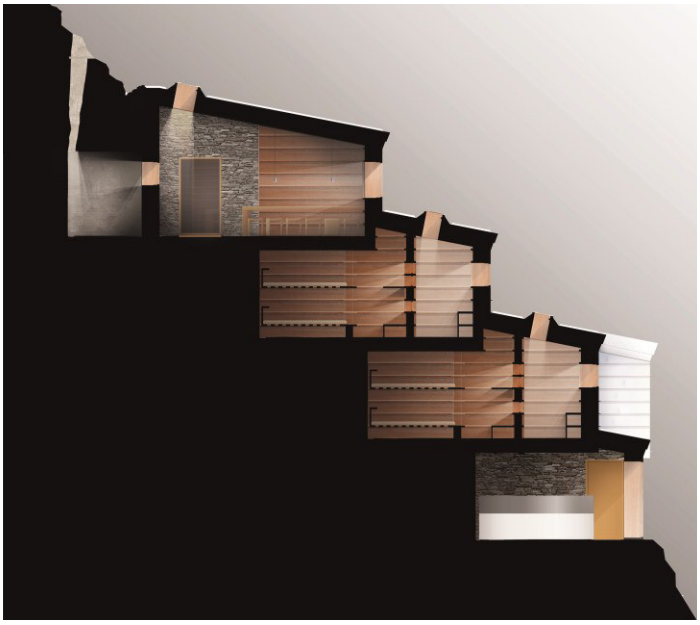

Image n°9: © Estelle Lépine

Nowadays the new projects of refuge are designed to offer comfort as we can expect in any accommodation linked to infrastructures in the valley. In order to protect the Alps, we assume that architects and designers must question themselves to make sure that the refuge is not putting the environment at risk. Consequently,a clear positionmust be adoptedin order to take decisions toinfluence the users and their behaviour. First of all, the *location* is very important because in some case it creates a natural barrier able to reduce the number of mountaineers. Then, the *integration*in the context is a source of awarenessofthe surroundings. And finally, the *space* must be designed to give the right level of comfortin order not to erase or hide the presence of the extreme environment.

The reflectionshave been specifically made for the Mont-Blanc, however, they can be applied widely to the entire Alps area. They will be adapted to the new summit or context taken into consideration.

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Monitoring and Modelling of Sediment and Habitat at the Alluvial Zone National Park of the Austrian Danube

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Abstract

Within the scope of a large restoration project at the Alluvial Zone National Park, extensive monitoring was performed over four years. Innovative bed load transport measurement methods were applied, including an adapted basket sampler and a new methodology for coded radio acoustic tracer stones. Numerous bed load transport measurements were conducted by lowering a heavy-load basket sampler along a cross section to the river bed over the entire discharge spectrum, thereby covering low flows as well as a 15-year flood event. Additionally simulations were performed using a newly developed integrated numerical sediment transport and morphology model called iSed, which was specifically designed to suit the needs of large gravel bed rivers. Moreover, a new conceptual mesohabitat evaluation model MEM was developed and applied, using a functional linkage of three parameters (velocity, depth and bottom shear stress) to distinguish six different mesohabitat types (riffle, fast run, run, pool, backwater and shallow water) based on 2-D depth-averaged and 3-D hydrodynamic numerical modelling.

As result of the multi-discipline activities, substantial progress was achieved in describing sediment transport patterns at a large gravel bed river, thus facilitating the evaluation of a restoration project within a protected area. The linkage to biotic research was strengthened by validating the habitat model considering river morphodynamics on various scales.

Keywords

bed load, advanced field measurements, tracer stones, sediment transport modelling, habitat modelling, Danube River

Introduction

Rivers are the lifelines of our landscape and as such often subject to conflicting demands. They are serving mankind for basic needs such as water and food supply, transport ways, natural borders and recreation. Ecology is increasingly important not only because of the Water Framework Directive, requiring good ecological status for European Rivers by 2015 but also because of a paradigm shift in society cherishing nature and its treasures. The Danube to the East of Vienna additionally is part of the Alluvial Zone National Park and therefore particularly deserving protection. Hence River restoration is an issue there – but with the prerequisite of extremely well elaborated measures, gentle human impact and a comprehensive monitoring to evaluate the changes. Innovative measures – as planned within the National Park - demand an even better process understanding and thus sampled data, as they are planned on the limit of technical feasibility. Especially a new method called granulometric bed improvement (allowance of larger gravel sizes within the natural grain size spectrum) which is tested at the Austrian Danube (HABERSACK et al. 2008) has to be subject to extensive monitoring.

Regarding the restoration project at the National Park, a comprehensive monitoring concept was elaborated, connecting the parameters of numerous abiotic and biotic subjects. The integrative monitoring is performed by several work groups of different Austrian Universities. Within this broad field of investigations, this paper concentrates on computer-aided river monitoring and modelling of sediment and habitat which forms an essential basis for understanding river-related processes and predicting effects and impacts of river engineering measures (HABERSACK et al. 2012). As especially regarding sediment transport the need for accurate and applicable systems is still high (HASSAN et al. 2009), a number of new methods were elaborated to gain insights to the transport processes of the gravel. Knowledge of distribution and dynamics of bedload transport is crucial for the understanding and prediction of morphological changes (RENNIE & MILLAR 2004).

Measurements with a specially adapted basked sampler form the basis for determining the yearly load, additionally radio acoustic, active tracer stones were used for determining transport paths and lengths. Based on the results of river monitoring, numerical models solving the fundamental equations of fluid motion can be properly calibrated and validated. The application of these models allows for the prediction of water depths, the flow field and other corresponding flow properties such as bed shear stress or patterns of turbulence (HABERSACK et al. 2008). Furthermore the models allow for an upscaling of spatially limited measurements to a broader scale.Habitat modelling tools are designed for an integrated interpretation of abiotic and biotic monitoring results concerning river restoration and therefore are the linkage of the two. The applied Habitat-Evaluation-Model (HEM) allows quantitative analyses on different scales (micro / meso) based on various measured and/or modelled parameters.

This contribution aims for describing the innovative monitoring and modelling methods used at the Alluvial Zone National Park and some interesting results.

Study reach

The Austrian Danube River is affected by several severe, conflicting processes and influences. Caused by the retention of bedload in the catchment (e.g. torrent control) and reservoirs of hydropower plants almost no bedload is entering the reach downstream of Vienna, leading to a deficit of bedload and consequently - in combination with prevented side erosion - to river bed degradation amounting to about 2.5 cm per year (DONAUCONSULT 2006; HABERSACK et al. 2008). Furthermore during low flow periods the constraint of minimum water depth for navigation is not met, especially in specific areas of fords. Additionally, the free flowing Danube downstream of Vienna is part of a National Park, which in the long term is endangered by the lowering of the groundwater table in the Aue area. Due to channelization and bank protection measures the former morphodynamics have been prohibited and entail ecological deficits. These problems led to arestoration project which intends to solve them by implementing a mix of measures including the allowance of larger gravel sizes within the natural grain size spectrum (granulometric bed improvement). It is planned to reduce sediment discharge to about 10% of the current amount by superimposing a layer of 25 cm width, but not to stop it entirely. It is expected for the added material to mix with the normal load subsequently (DONAUCONSULT 2006; HABERSACK et al. 2012). Furthermore seven huge sidearm systems will be reconnected and about 30% of the bank protection will be removed in order to improve the ecological situation.

Within a 3 km long test reach (river-km 1884.50 to 1887.50) near the municipality of Bad Deutsch Altenburg(Figure 1; flow direction is from left to right), the described measures are currently tested and monitored.

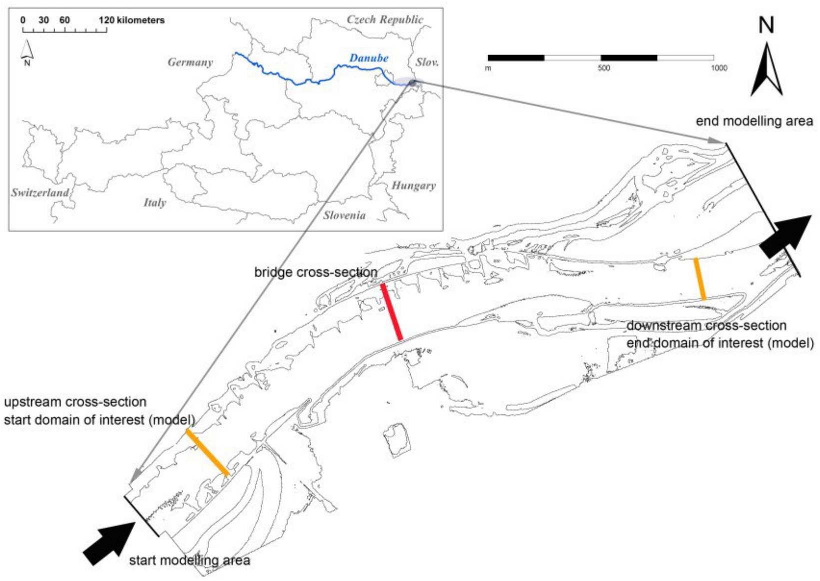

Figure 1: Map of the study reach near Bad Deutsch Altenburg; cross-sections with bedload transport measurements; upstream and downstream boundary of the model and of the domain of interest.

Regulated low flow (RNQ; 94% duration of exceedance) lies at 915 m^3s^{-1}, the annual mean flow (MQ) at 1930 m^3s^{-1}, bankfull discharge (1% duration of exceedance, approximately equal to a 1-year flood event) at 5060 m^3s^{-1} and a 15-years flood at 8000 m^3s^{-1}. The Danube east of Vienna is classified as gravel bed river with an average bed slope of about 0.0004. The average arithmetic mean sediment diameter is found at d_m = 27.5 mm. Other characteristic values are: d_{50} = 21.2 mm, d_{90} = 59.9 mm.

Methodology

Tracer Stones

For sediment transport characterisation, a new methodology of the tracer stone assembly had to be developed - in order to be applicable at a large river - and a tracer study was performed at the study reach (LIEDERMANN et al. in press). A total of 40 artificial tracer stones with three different sizes were used for the experiment characterised by the ratio of their axes: The three sizes represent the arithmetic mean diameter of the current bed material (b-axis = 27.5 mm; 20 stones), the lower limit of the projected granulometric bed material (b-axis = 40 mm; equivalent to the d_{75} of the current bed material; 10 stones) and the upper limit of the allowance material (b-axis: 70 mm; equivalent to the d_{95} of the current bed material; 10 stones). Due to the high water depths at the Danube reach (up to 10 m at mean flow conditions), formerly used systems of inserting the transmitters into either artificial or natural gravel particles (Ergenzinger et al. 1989; Habersack 2001) could not be used (Liedermann et al. in press). For the presented study transmitters with strong signals and a 0.5 m long antenna were used. In order to achieve maximum signal power the transmitter were worked into a two component epoxy-based mass. In the last layer the antenna was placed in several circles around the stone without any lead balls, and pressed into the mould of the model stone (Figure 2).

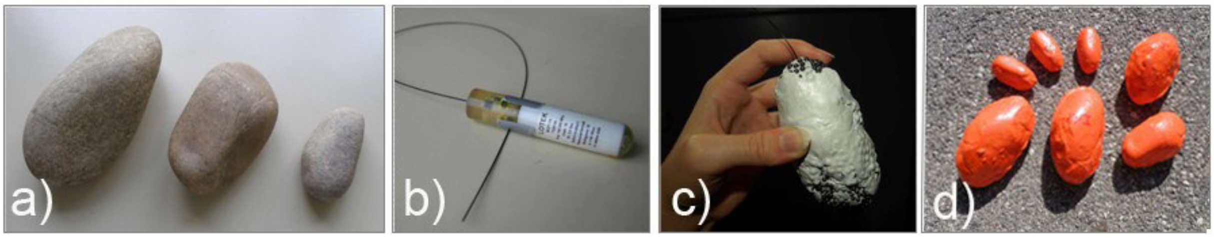

Figure 2: Tracer stone assembly; a) prototypes; b) transmitter produced by LOTEK-wireless ©; c) transmitter incorporated into resin material and lead balls before applying the external layer containing the antenna; d) finished tracer stones. (Liedermann et al., in press)

The artificial tracer stones were dumped into the river, and their positions were determined individually approximately every week over an entire year, including a 15-year flood event, with a longitudinal and lateral position accuracy of about 10 to 15 m. Each particle transmits its own ID by using a unique code allowing for the different stones to be differentiated. Hence a total of over 1000 detections were performed leading to statistically significant results.

Basket Sampler

For the determination of the bedload transport a Basket Samplers was used. The high flow velocities and turbulences at the Danube River impede the utilisation of frequently used basket samplers. Thus a sampler developed by the BfG in Koblenz, was adapted to be applicable at the Danube. The sampler is characterised by a mesh size of 1 mm, an orifice size of 160 x 80 mm and a device weight of about 200 kg (Figure 3).

Figure 3: Adapted Basket sampler (based on the sampler of BfG, Koblenz, Germany).

Measurements were performed at three different cross-sections (all depicted in Figure 1) but mostly at the bridge cross-section, as thence it is possible to carry out measurements over the whole discharge spectrum. Over the last 5 years, a number of 37 measurements covering the entire discharge spectrum (between regulated low flow and a 15 years flood event) were performed.

In order to represent the spatial variability of bedload transport, for each measurement, 7-12 locations across the section were sampled. At each location, 3 consecutive single deployments of the sampler were performed to represent the temporal variability the transport. The transport over the cross section is calculated by integrating the medium loads for each location.

Sediment transport model iSed

Sediment transport patterns were also simulated using iSed, specifically designed to suit the needs of large gravel bed rivers (Tritthart et al. 2011).The model was coupled with the river simulation model RSim-3D, a three-dimensional hydrodynamic model to obtain the flow field and bed shear stress patterns as a prerequisite for deriving sediment transport processes. The model is capable of independently calculating both suspended and bedload transport. A nonuniform formulation of the Meyer-Peter/Müller equation featuring a hiding-exposure correction was selected for the presented study. Resulting bed level differences are derived by solving the Exner equation for every node of the computation mesh based on the sediment balance. All equations are evaluated for an unlimited number of sediment size fractions, allowing for the consideration of sorting processes.

Calibration and validation of the model were conducted using separate data sets of velocity and turbulence measurements obtained from ADCP and ADV instrumentation, bed grain size distributions from over 100 samples, gauge hydrographs and officially published water surface elevations. Further details of the model validation results for the pilot reach at the Danube River east of Vienna are given in TRITTHART et al. (2009).

Habitat Model

Habitat modelling tools were used to allow an integrated interpretation of abiotic and biotic monitoring results concerning the success of river restoration measures. The newly designed Habitat-Evaluation-Model (HEM) was selected for quantitative analyses on different scales (micro / meso) based on various measured and/or modelled parameters. Within the HEM-framework the Microhabitat-Suitability-Model (MSM) was applied to evaluate instream habitats by multiplying suitability- or preference indices of single target (fish) species. The necessary database for deriving the microhabitatmodelling based on preference curves was delivered by a biotic work group (KECKEIS 2012). For the integrative evaluation microhabitat-maps for the Danube have been generated especially for those fish species and life stages (e.g. juvenile cyprinids).Moreover, related to thehigh number of fish species within the monitoring section (n=61) and the lack of data concerning habitat preferences (for various life stages of fish) the Danube habitats were additionally modelled on a meso-scale approach (hydro-morphological units). The used MEM module (Mesohabitat-Evaluation-Model) combines a more general biological model (e.g. fish guilds) with hydro-morphological classes (e.g. pools, backwaters) (HAUER et al. 2008) in order to evaluate the impact of morphodynamic processes and/or restoration measures on aquatic ecology (e.g. fish).

Results

Major progress was achieved regarding the process understanding of sediment transport at the Danube within the National Park. Position data obtained from the observation of the 40 tracer stones over one year was analysed and a set of essential results was found. The analysis of the data showed size selective transport of the pebbles – thus the smaller sizes were transported more often and farther than the larger sizes. Surprisingly the difference between the medium and the large sizes was not as large as expected. Also the differences between the small sizes and the other pebbles were not particularly large – especially at lower flow conditions. 18.7 % of the tracer stones characterised by the mean diameter of the current bed material were moved in average during discharges smaller than medium flow. The stones sized at the upper limit of the material that will be added in the future (b-axis: 70 mm) were moved at a transport probability of 6.3% for the same discharge range (Figure 4a).

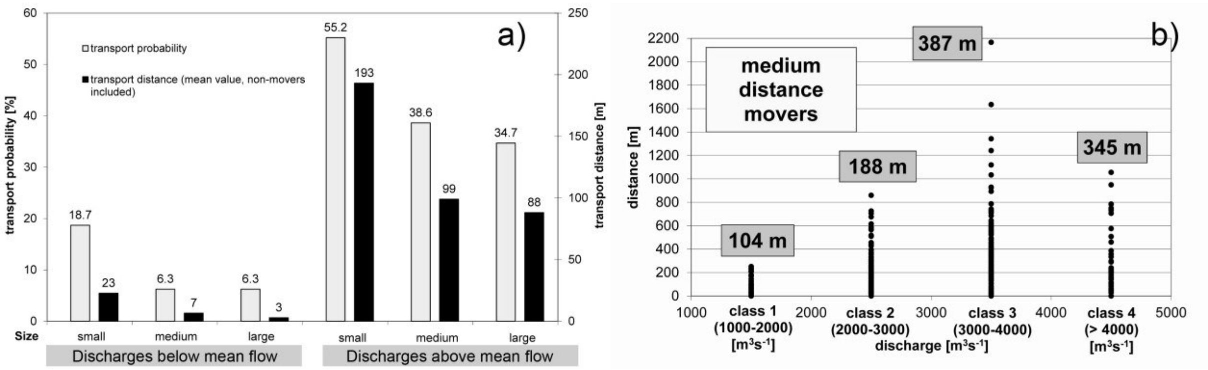

Figure 4: (a) transport probability and transport distance for the different sizes and discharges below medium flow (left) and above medium flow (right); (b) medium distance movers for 4 different discharge classes.

Additionally the mean transport velocity was calculated from the data. For the current bed material it was found to be 10.6 m per day, leading to a yearly transport length of about 3 km. When plotting the transport distance forfour different discharge classes (Figure 4b), it becomes apparent that travel distances increase with rising discharge but unexpectedly reach a maximum value at around bankfull discharge. This observation also goes along with the findings from the basket sampler measurements, but it is contrary to the calculated transport when applying commonly used uniform bedload transport formulae. Contradicting data was also found when looking at the incipient motion. Both tracer data and the results of the basket sampler measurements showed that relevant transport starts at discharges around regulated low flow (915 m^3s^{-1}), while uniform bedload transport formulae predict initiation of motion at around 3.000 m^3s^{-1} (LIEDERMANN et al. 2012).

Figure 5 depicts examples of the bedload transport rate plotted over the cross-section, and the calculated bedload transport for each measurement compared to the Danube discharge. The determination of a function describing the bedload transport – discharge relationship is a current research issue. When deriving a rough estimation from the gained data, the yearly load lies at around 320.000 m^3, which corresponds to the values gained by analyzing consecutive bathymetric data of the section (transported load by calculating height differences between consecutive years lies at 360.000 m^3) (TRITTHART et al. 2012b).

Bedload transport is strongly affected by the movement of gravel sheets, which were detected by bathymetry analysis. The medium distance between the dune crests lies at 10 m, the medium dune height is strongly dependent on Danube discharge history and varies between 5-7 cm (determined for March 2007) and 9-26 cm (determined for April 2006) (ACKERL 2010).

The hydrodynamic numerical model could also reproduce the movement of the gravel sheets. Sorting processes lead to a high variability in sediment transport influenced by the transport of the gravel sheets. The variability in sediment transport, the mean grain diameters and the gravel sheets are depicted in Figure 6.

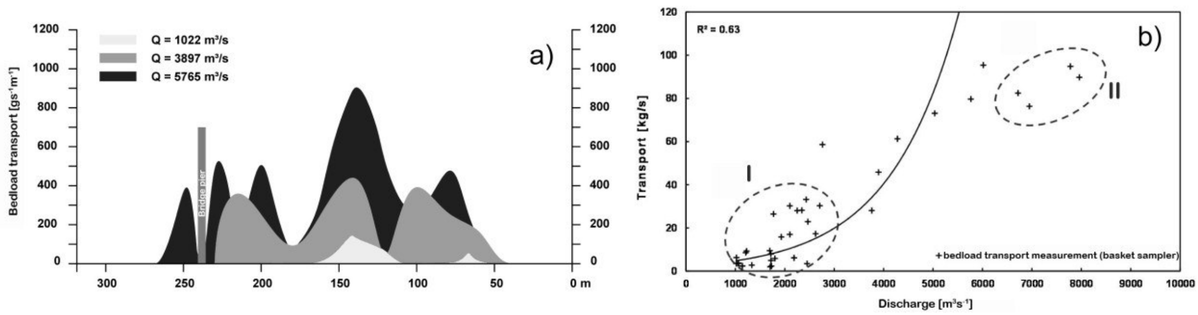

Figure 5: (a) Examples for bedload transport measurements and (b) sediment transport - discharge relationship showing (I) significant transport at low flows and the slower increase above bankfull discharge (II) (modified from LIEDERMANN et al. 2012).

A sensitivity analysis regarding the used time steps in the calculation, showed that gravel sheets occur no matter which parameter is chosen and therefore reflect a real phenomenon (TRITTHART et al. 2011). Also the suspended sediment transport and the bedload transport rates at different discharge stages were well reflected by the sediment transport model, which is remarkable as spatial and temporal bedload variability was until now rarely reflected by numerical models (TRITTHART et al. 2012a).

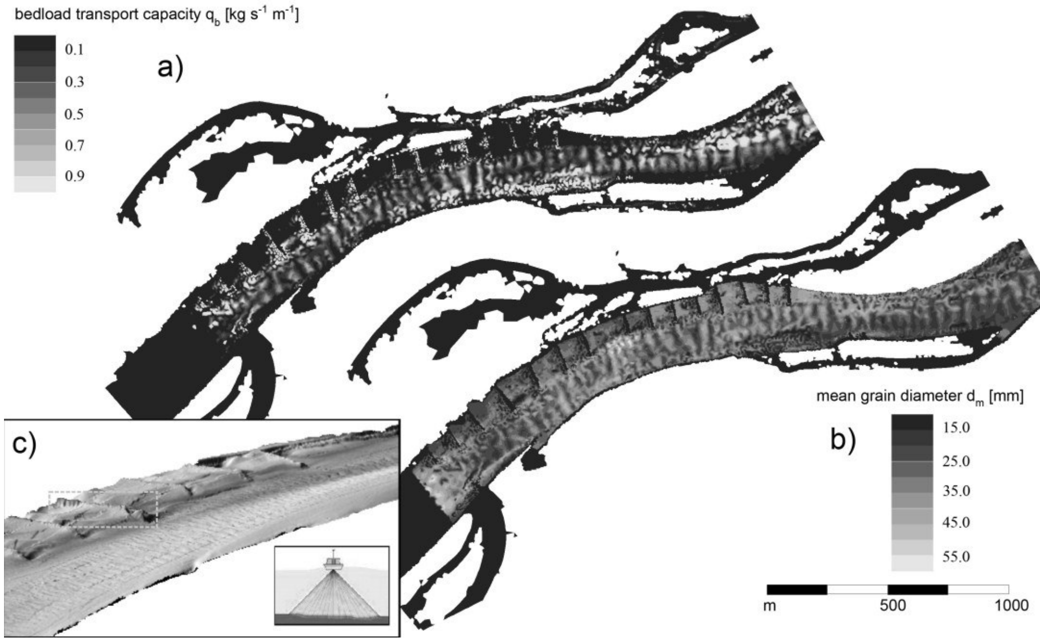

Figure 6: (a) modelled bedload transport capacity, (b) modelled mean grain diameter and (c)measured gravel sheets (modified from TRITTHART et al. 2012a).

Habitat modeling serves as a linkage between changing abiotic parameters and biotic effects and enables a quantification of a changing environment for target species (fish, invertebrates).The integrative habitat modelling analysis has been applied to evaluate changes in river bathymetry over the monitoring period. Hence, it was possible to quantify habitat shifts, which have been related to morphodynamic processes under high flow conditions. The results showed on both, the meso- and the microscale, that for characteristic discharges (e.g. mean annual low flow) those changes were only minor compared to the possible impacts on habitat distribution due to flow variation. Moreover, it was found, based on the habitat modelling on various scales that flow variation, its magnitude and the differences in each of the monitoring years is one of the trigger parameters for the Danube fish fauna. On the macro-scale, which is related to the morphological and hydrological features of the entire study reach, the connectivity to secondary channels is crucial for reproduction of many of the Danube fish species. The connectivity was given in spring 2006, however, in spring 2007 the lateral movement was not possible due to low discharges. Additionally the HEM-application allowed the modelling of the entire life circle of Danube target fish species (Figure 6), like the rheophilic cyprindis nase and barbel, in which fluctuations of flow have to be seen once more as crucial and possible bottleneck features.

The larvae and juvenile habitats, however, had to be modelled on the microscale, due to the fact, that shallow water habitats (mesoscale) at the Danube have been classified with water depths < 1 m and thus overestimating the depth sensitive zones of the functional larvae habitats. Moreover, the stability analysis of gravel spawning sites allowed a quantitative estimation, if there are possible impacts of high flows on the reproduction success of target fish species at the investigated Danube reach. Hence, for the presented case study it has to be stated, that microhabitat- and mesohabitatmodelling is complementary and important to evaluate instream habitat dynamics in the investigated large river system (HABERSACK et al. in press).

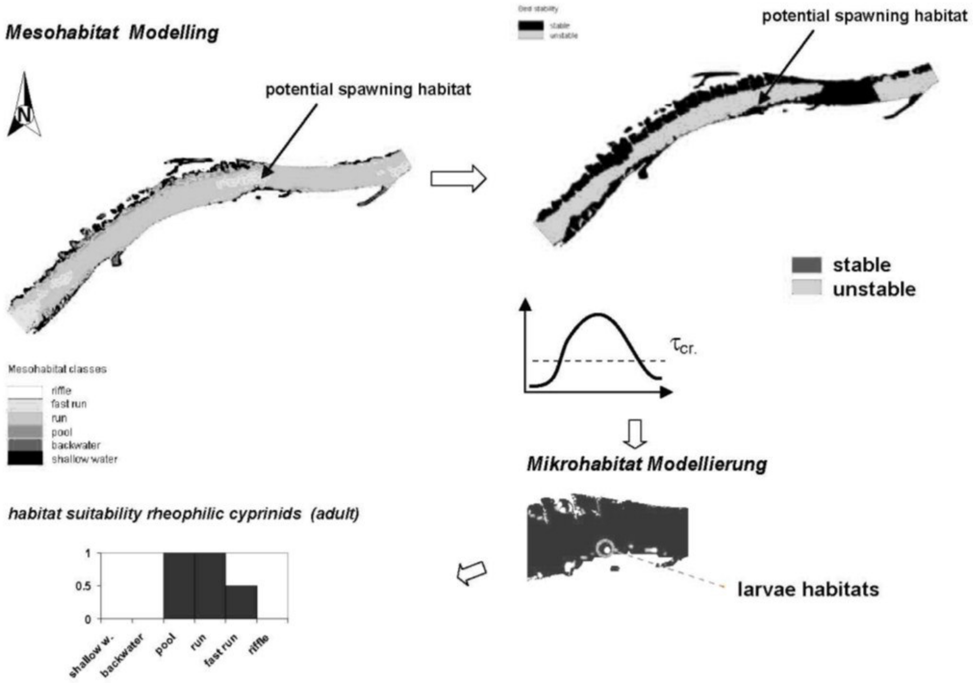

Figure 7: Analysis of the entire life circle of Danube target fish species based on HEM-Model application considering various river scales (meso- / micro-units) (HAUER et al. 2012).

Conclusions

In the study reach within the Alluvial Zone National Park at the Austrian Danube, major progress was achieved in the understanding of sediment transport behaviour due to innovative monitoring and modelling techniques. Applying different methodologies (tracer pebbles, basket sampler measurements, iSed) it was shown that incipient motion starts at low flow conditions, bedload transport increases less or even stays constant after reaching bankfull discharge and that gravel sheets significantly influence bedload transport at the Danube River. All these findings are unique and partly contrasting to previous believes rooted on uniform bedload transport formulae. Additionally, the tracer experiment showed a significant size-selective behaviour, but to a smaller extent than expected. The mean transport velocity for the current bed material was detected at 10 m per day. The 3D numerical models helped confirming the findings by providing hydraulic data such as bed shear stresses for all discharge stages and by extrapolating measured data to the entire reach. Using the MEM, a specific evaluation tool was adapted and improved which allows the assessment of river engineering measures in future, already before their implementation and to determine their potential impacts on the ecological conditions. For the presented analysis especially the variability in modelling different scales has to be seen as important issue in addressing the instream habitats of large rivers. Mesohabitat modelling has been identified as useful tool to identify possible spawning habitats (e.g. riffles) and/or addressing the suitable habitats of adult species.

The presented research answers – at least partly – relevant research questions of the National Park and helps optimizing and minimizing human impact in protected areas.

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Low genetic diversity of the reintroduced bearded vulture (*Gypaetus barbatus*) population in the Alps calls for further releases

Nationalparks Austria Science Award 2013

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Abstract

Reintroductions are a valuable tool to reestablish locally extirpated species. A difficult decision facing all reintroduction projects iswhen to stop further releases, both from a demographic and genetic viewpoint. Here we address this question in the case of the reintroduction of bearded vultures (*Gypaetus barbatus*) in the Alps, which wereexterminated in the early 20th century mainly due to human hunting. To investigate the genetic diversity present in today's reintroduced Alpine bearded vulture population, we reconstructed a pedigree, spanning the entire reintroduction program since the beginning of the captive breeding (1973-2010). We found that not every founder bird was equally well represented in the wild population and that founder genome equivalents were low (13). Moreover, wildborn bearded vultures showed a relatively high mean inbreeding coefficient compared to the captive birds and the effective population size was estimated to be only 28. Overall, this suggests that there is not enough genetic diversity in the wild Alpine bearded vulture population to ensure its longterm sustainability. Therefore further releases are recommended.

Keywords

Bearded vulture, conservation, genetics, reintroduction, pedigree, captive breeding

Introduction

With the current rate of population extinction, reintroductions are becoming an increasingly importantconservation tool (IUCN 1996). A difficult decision facing every reintroduction programme is when to call the project a success and stop further releases.Quantitative demographic evaluations of the success of reintroduction projects are rare (Evans et al. 2009; Meretsky et al. 2000; Sarrazin & Barbault 1996), but exist (e.g. Schaub et al. 2009). Even more scarce are combinations of demographic and genetic evaluations of the reintroduction success in a species (Alexandre et al. 2007; Lande 1988).

The reintroduction of the Alpine bearded vulture (*Gypaetus barbatus*) offers an excellent opportunity to investigate both demographic and genetic aspects of the reintroduction and to ask when to stop the release of individuals from captivity into the wild.Bearded vultures are large scavenging raptors which lived in mountain areas throughout Europe, Asia and Africa. They went extinct in the Alps in the early 20th century. Population size decreased due to changes in agricultural management, and reduced numbers of wild ungulates. Human hunting and poisoning were additional factors leading to the total extirpation in the whole Alpine range (Mingozzi & Esteve 1997).

In 1978, an international reintroduction project was launched with the aim to rebuild a self-sustainable population of bearded vultures in the Alps. In 1986 the first bearded vultures were released from a captive breeding program into the wild. Until 2010 a total of 179 birdswere released in four Alpine countries (Austria, France, Italy, and Switzerland).In 1997 the first wild pair consisting of reintroduced birds bred successfully in the French Alps. Until 2010, 69 wildborn birds fledged in the Alps, with the population estimated at 150-160 individuals in 2010(IBM 2010).

Given the current population size and the reproductive success in the wild it is time to ask when to stop the release of individuals from captivity into the wild. Schaub and colleagues (2009) performed a demographic analysis, which suggested that it would be possible to stop the release at once and shift the reintroduction effort to other regions and populations outside the Alps. However, no assessment from a genetic point of view has been carried out.Demographic and genetic considerations need not to lead to the same conclusion because demographic self-sustainability does not automatically mean long-term persistence (Seddon 1999). For a population to persist in the long-term, both a positive population growth and adequate genetic diversity is crucial.

Here, we analyse the genetic diversity present in the Alpine bearded vulture population using pedigree data and ask how much genetic diversity has already been transferred from captivity into the wild. Furthermore, we will discuss how the different management possibilities have influenced inbreeding, founder contribution, and founder genome equivalents in the captive population, where managers have control of matings and in the wild populations where managers can only influence the number and composition of released birds.

Materials & Methods

To investigate the genetic diversity present in today's bearded vulture population, we reconstructed a pedigree spanning the entire reintroduction program from 1973 to 2010. We divided the whole Alpine population into twodifferent groups that differ in the options available to the managers: the captive birds, which were born in captivity and remained there, and the wild group, which consists of the released and the wildborn birds.

We quantified genetic diversity using a variety of pedigree-based measures: effective population size (N_e), founder contribution, and founder genome equivalents (f_{ge}).Bearded vultures have overlapping generations, therefore we used the increase in coancestry to calculate the effective population size (CERVANTES et al. 2011).Founder genome equivalents are “the number of equally represented founders that would produce the same level of gene diversity as that observed in the current population, assuming no loss of alleles” (LACY 1989, p.115). Both unequal founder contribution and genetic drift reduce f_{ge} and are reflected in both the number of alleles and the heterozygosity present in the descendant population. Founder contribution is defined as the proportion of genes derived from each founder and present in the living descendants. It is calculated with Monte Carlo methods following the “gene drop” method from MACCLUER et al. (1986).For all calculations we used ENDOG 4.8 (GUTIERREZ & GOYACHE 2005).

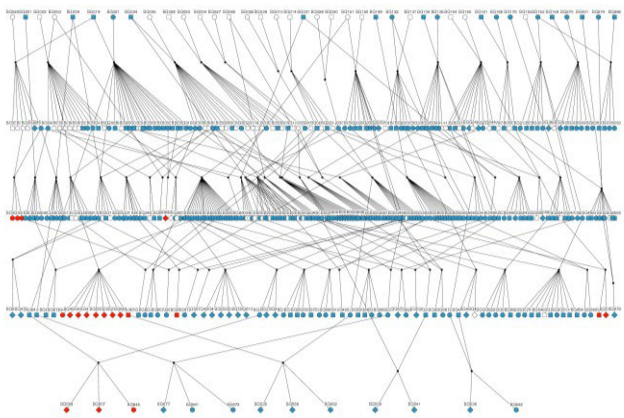

Figure 1: Pedigree of all bearded vultures in the Alpine reintroduction project. Circles are females, squares males, and diamonds are birds of unknown sex. In blue are the birds which are still alive, in white the ones that already died, and in red those which are inbred. At the top are all founder birds which reproduced.

Results

The whole pedigree of the bearded vultures includes five generations (Fig. 1). Although the number of individuals increased steadily since the beginning of the captive breeding and the reintroduction project, this is not the case for genetic diversity (Fig. 2). Both effective population size (N_e) and founder genome equivalents (f_{ge})level off around 2004, although the total number of birds alive continued to increase. The temporal pattern observed in the development of f_{ge} is similar to the one in N_e(Fig. 2), reflecting the effects of genetic drift on both measures. Founder genome equivalents in 2010 were low (maximum of 21.2 in the captive and 14 in the wild group) and the effective population size was estimated to be only 37.9 in captivity and 28.7 in the wild.

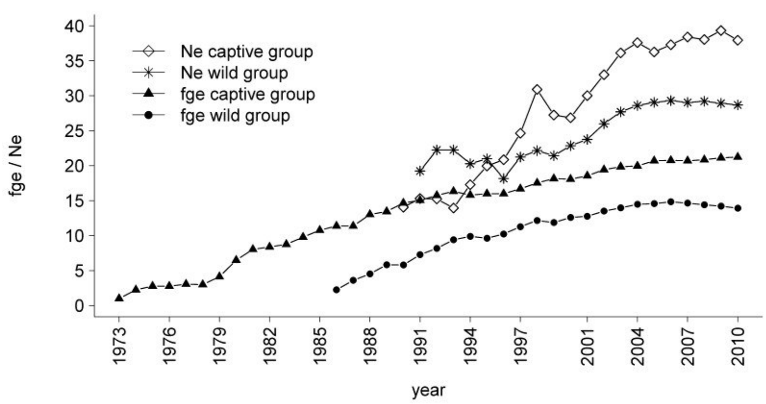

Figure 2: Founder genome equivalents (fge) and effective population size (Ne) of the captive and the wild bearded vulture group between 1973 and 2010.

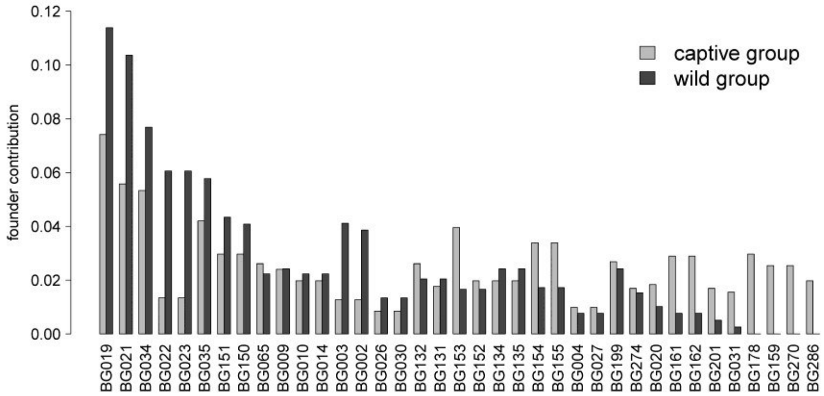

Figure 3: Contribution of the 37 founders to the two bearded vulture groups in 2010. The different founder individuals are listed on the X-axis and the Y-axis represents their relative contribution to the captive (light grey) and the wild (black bars) groups. Additional 10 founders lived in the captive population which did not reproduced so far.

The current population was founded by 37 individuals (Fig. 3).The three most successful founders in all four groups were BG019, BG021, and BG034. Together they contribute 18.3% to the captive and 29.4% to the wild individuals (Fig. 3). In both groups the founder contribution was skewed, but it was more skewed in the wild group. Fourfounders were only represented in the captive birds, and an ten additional birds lived in captivity but did not reproduce so far.

Among both, the captive and the wild pairs, mating of relatives occurred. In captivity the kinship coefficient under random mating was larger than the kinship coefficient of the existing pairs ($p = 0.05$) while the opposite was true among wild pairs, albeit not significantly ($p = 0.44$). This means, that inbreeding was avoided in the captive group. In the wild neither inbreeding avoidance nor preference was observed.

Only five inbred ($F > 0.125$) birds fledged in captivity, two of them remained in the captive breeding program, three were released into the wild. From the wild breeding pairs 16 inbred offspring fledged ($F > 0.0625$). Both the kinship coefficient and the inbreeding coefficient were higher in the wild than in the captive group. In 2010 the parents of the five fledglings with sufficient pedigree information were on average more related to each other than first-cousins (mean inbreeding coefficient >0.07).

Additionally we found some evidence for inbreeding depression among pairs breeding in the wild: the reproductive success of pairs with a kinship coefficient of 0.25 was on average reduced by 57% compared to pairs with a kinship coefficient of zero ($p=0.03$). However, this result was strongly affected by one breeding pair with very poor breeding success.

Discussion

We showed that, compared to the captive breeding population, there is little genetic variation and substantial inbreeding in the wild Alpine bearded vultures. In fact, the effective population size in the wild is so small, that levels of genetic variation have stopped to increase since 2004 despite continued releases (Fig. 2). This suggests that there is not enough genetic diversity in the wild Alpine bearded vulture population to justify stopping the release of birds from captivity. However, as there is still more genetic variation and a very low level of inbreeding in captivity, it is possible to increase the genetic variation and decrease inbreeding in the wild with further releases of birds from captivity.

The low effective population size (N_e) in the wild means that inbreeding will increase and heterozygosity decrease in the future. With no change in N_e, the expected mean inbreeding coefficient will increase to approximately 0.15 over the next 100 years and less than 90% of the heterozygosity will remain. One goal which is often defined for a long-term persistence of a population, is to maintain 90-95% of the initial heterozygosity for 100-200 years (e.g. MILLER et al. 2009; SOULE et al. 1986). Hence with no increase in N_e in the near future, the wild bearded vultures will fall below this limit.

Founder genome equivalents (f_{ge}) are a direct measure of founder contribution and the effects of genetic drift a population experienced. A population with 20 f_{ge} would contain about 97.5% of the genetic variability initially present in the population from where the founders were captured (LACY 1989). This is the case in the captive bearded vultures where f_{ge} exceeded 20. The 13 f_{ge} observed in wild individuals in 2010 (Fig. 2) indicate that the genetic diversity is equal to one of a population founded by 13 equally represented founders with no loss of alleles due to genetic drift. Both a more equal founder contribution and an increase in population size would enhance f_{ge} (LACY 1989). This could be achieved with the 14 birds already living in captivity but not reproducing so far.

A highly skewed founder contribution, as it was observed in both the captive and the wild group of the Alpine bearded vulture (Fig. 3), reduces genetic diversity. Furthermore, the risk to lose alleles of underrepresented founders is high, because some founders are only represented in just a small number of birds. A more equal founder representation would enlarge the genetic variation and is therefore worth pursuing. This skewed founder representation is due to differences in reproductive success and survival among founders or their descendants. The underlying cause may be biological but it may also reflect differences in management between breeding facilities. It might be possible to reduce the differences in reproductive success among the facilities with translocations of birds from underrepresented founder lines to facilities where birds have on average a higher reproductive output.

The smaller kinship coefficient among the captive pairs compared to the random mating expectations is a consequence of the good management of the captive population, which in all but six pairs avoided mating of relatives. Hence, compared to other studies, the frequency of close to moderate inbreeding in the captive birds is relatively small (8.8%). However, in the wild no clear pattern for preference or avoidance of mating with relatives was apparent, leading to much more inbreeding in the wild. The observed kinship coefficient was even higher in the wild pairs, but not significantly so.

The reintroduction project of bearded vultures in the Alps is on its way to be successful. The first wildborn offspring hatched in 1997 and since then the number of fledglings increased steadily. Further even without the release of further young birds from captivity the population would have a positive population growth rate (SCHAUB et al. 2009). Nevertheless we showed that the genetic diversity present today in the wild is still low. Therefore, to ensure the long-term persistence of this species it would be wise to increase the genetic variability in the wild population(LOERCHER 2011). There are several ways to achieve this goal: This could be realised by specific releases of juveniles from underrepresented founder lines. Thereby, the pairing of descendants from two underrepresented founders should be preferred over the mating of descendants between under- and overrepresented founders in the breeding stock. With this management strategy it will be possible to favour an underrepresented founder without increasing the contribution of an already overrepresented founder at the same time (BALLOU & FOOSE 1996).Furthermore, it is recommended to recruit new founder birds from other populations. However, this might have negative consequences for the source populations. Therefore, careful evaluation of these consequences and the potential for the Alpine bearded vultures should be performed prior to action. Additionallyconnecting the Alpine and the Pyrenean population to a metapopulation would substantially improve the genetic diversity.

To summarize, we recommend continuing the release of birds in the Alps for now, and recommend releasing these birds in the near future (Fig. 4). Birds for release should be chosen carefully with respect to their genetic lineages. We recommend continuing the releases of birds from captivity until approximately 20 founder genome equivalents are present in the wild population.

Figure 4: A young Bearded vulture (BG665) who was released in 2011 in Switzerland. This individual originates from a rare genetic line and was deliberately chosen to increase the genetic diversity in the reintroduced Alpine population. © Franziska Lörcher

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Conference Volume	5th Symposium for Research in Protected Areas 10 to 12 June 2013, Mittersill	pages 479 - 482

The birds atlas of the Paklenica National Park, Croatia

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Abstract

The Paklenica NP covers 9.500 ha in southern part of the Velebit mountain. Velebit is the greatest Croatian Nature park and covers 22.000 ha. The birds of the area of Paklenica National Park and its surroundings were observed in the plots of 1x1 km² during the period of 1996 till 2012. Totally 175 investigated plots were established in the area. The results show the precise spread area and their distribution for 250 birds species and 111 breeding birds species. Moreover, the distribution and number of breeding pairs in isolated nesting places of some rare and endangered species were found.

The sea coast alongside the National Park is of main importance for the wintering and migrating birds f.e. Divers, Grebes, Cormorants, Herons, Waders, Gulls and Terns. The tidal mudflats inlet Modrič is of especial important. This bay has a great importance notably for Ducks, Herons and Waders in winter, and during the spring or autumn migrations.

Some resident birds from mountain forest and peaks, undertake altitudinal movments and spent a winter at the coast (Woodpeckers, Tits, Nuthatch, Alpine Accentor, Robin, Alpine Cough, etc). As a part of the Dinaric Alps on the east Adriatic flyway, Paklenica National Park is an important resting place for many species on their flight from Europe to Africa (Dotterel, Honey Buzzard, Icterin Warbler, Wood Warbler, etc).

Keywords

Birds atlas, plots, breeding pairs, distribution, endangered species

Introduction

This paper compares the spread of some birds species in area of National Park, between 1996 and 2012, especially in Canyons of Velika and Mala Paklenica. The Park covers an area of 9500 ha, but the most interesting area to visitors is the Canyon of Velika Paklenica. Closely to the Velika Paklenica Canyon is the other, smaller Canyon of Mala Paklenica (Lukač 2002). The difference between these two areas is in the size and ecological characteristics, number of visitors, especially in the number of climbers. Up until now 250 bird species have been noted in the National Park and their surroundings. This research was focused on 74 species noted in this two canyons, and especially on 23 of them that are known to bee breeding birds in petrophilous habitats of both canyons. Five endangered species were sorted out: *Aquila chrysaetos, Falco peregrinus, Alectoris graeca, Bubo bubo* and *Corvus corax*. These species disappeared from the climbing zone in period of tourist season.

Methods

The ornithofauna of Paklenica National park was investigated in two periods. During the first period of 297 field days 193 birds species were recorded. In the second period of more than 2000 field days 57 species were recorded in the area of National park and its surrounding. The mappig method was done on the basis of plots 1 x 1 km (Bibby et al. 1992, Flade 1994). Total 175 plots in area of National park and their surrounding was investigated between 1996 and 2012.

The number of visitors passing through the Velika Paklenica is considerable (500-800 per day; maximum in some days of Mai and August 1.700-2.000 per day, total 118.000 in 2011), and relatively small in Mala Paklenica (20-50 per day, 2500-3000 in 5 months of season). After all, the Velika Paklenica canyon is the most famous climbing zone in Croatia and surroundings area with 34.000 of climbers entrances per year. The Mala Paklenica is forbidden climbing zone.

Results

During the study period, 74 breeding bird species were noted in two canyons. Of these, 23 petrophilous bird species were selected in the analyses of climber impact, and another 42 species for hiker impact. The number of breeding petrophilous bird species varied each year and shows a slowly decreasing tendency in Velika Paklenica Canyon. Two bird species have become extinct (Lukač et al. 2003) from this area over the past century, the Egyptian vulture (*Neophron percnopetrus*) and Griffon vulture (*Gyps fulvus*). Three bird species no longer breed in the recreational zone of Velika Paklenica Canyon: *Aquila chrysaetos, Falco peregrinus* and *Corvus corax*. These three species have moved from the recreational zone. The Peregrine falcon moved from the recreational zone in Velika Paklenica more inland into the park in 2002, to areas without climber activity. Other pairs breed in the no climbing area of the adjacent Mala Paklenica Canyon. The Golden eagle and Raven show the same tendency. Two other species, *Bubo bubo* and *Alectoris graeca,* are occasionally found in the recreational zone, usually outside the peak tourism periods in autumn and winter, when there are no rock climbers. It is likely that *B. bubo* occasionally nests in the climbing zone. Other species *Columba livia, Apus melba, Phoenicurus ochruros, Monticola solitarius, M. saxatilis, Otus scops* and *Sitta neumayer* were included as unaffected and stable species. The adaptive species, bred without interruption in the cracks of climbing routes in the climbing zone. Adaptive species were *Parus major* and *Falco tinnunculus*.

Discussion and conclusion

The most threatened birds in area of Paklenica National Park are the birds of rocks and cliffs, i.e. petrophilous species. Their numbers and number of nesting pairs vary by season, indicating the negative impact of climbers on this specific bird community. In order to achieve stability of the nesting bird fauna in Paklenica National Park, management should keep the climbing zone in the existing framework, to carry out regulation between climbing routes and to ban climbing during nesting season if one of the threatened species is present in that zone, i.e. *F. peregrinus, B. bubo, C. corax, M. saxatilis* or species, such as *O. hispanica, C. gallicus* and *P. rupestris*. In the future period, all climbing should continue to be prohibited with Mala Paklenica Canyon. Such a protection regime in the most heavily visited areas of the part can contribute to maintaining stability and enriching the nesting bird community in the canyon areas of the park. This can only be confirmed through an additional ten-year monitoring programme, which is imperative with such a regime and high visitor intensity. The Golden eagle moved to inaccessible areas of Mala Paklenica Canyon. Birds of prey are very sensitive to climber impacts (MEBS & SCHMIDT 2006). In individual protected areas, there are bans or regulations on climbing sites, particularly in national parks (HAMANN et al. 1999). In other cases, a certain buffer zone is applied during nesting season, and is specific for each species. However, not only birds of prey are vulnerable to increasing numbers of climber, as the Eagle owl has also been found to be sensitive to these impacts (MEBS & SCHERZINGER 2000). This species moved out of the recreational zone in Velika Paklenica Canyon at the beginning of every season, to areas without climbers (LUKAČ & HRŠAK 2005). The Rock partridge show the same tendency. This bird is very sensitive to climber disturbances (LUKAČ & HRŠAK 2005). The Raven regularly breeds in the area of Paklenica National Park, but outside of the climbing zone (LUKAČ 2011). This bird is very sensitive to the increasing number of climbers, but also to other negative influences, in neighbouring area of the national park.

The number of sensitive species varied in the number of their pairs in Velika Paklenica every year. Three species were included in this category, *Ptyonoprogne rupestris* and *Oenanthe hispanica*, whose numbers varied, and can be attributed to negative climber impacts, and *Circaetus gallicus* which nested for 6 years at the edge of the climbing zone, thereby qualifying as a potentially sensitive species. Other petrophilous species were included in groups of stable species, including *Columba livia, Apus melba, D. urbica, Phoenicurus ochruros* and *Sitta neumayer* (LUKAČ & HRŠAK 2005). It cannot be excluded that these species will not experience a decrease in the number of mating pairs over the next ten years. The main reason could be increased number of climbers, and more climbing activities during the breeding season. This will only be possible to say after other ten-year monitoring period.

It can be said that the abundance of certain petrophilous nesting birds is not directly dependent on the number of climbers, as nesting niches in rock fissures still represent good nesting protection, and not all rock faces are equally suitable for climbers (RICHARDSON 2000). As such, additional monitoring is required for the species *Columba livia, Otus scops, Phoenicurus ochruros, Apus melba* and *Sitta neumayer*. However, the same author holds that a constant increase in the number of climbers will negatively impact the nesting bird community, in this case, the American petrophilous species *Catherpes mexicana* and *Aeronautes saxitalis*. Birds of prey and Owls simply move their nesting habitats deeper into the canyon where there are no climbing areas or climbers, and are thereby directly impacted in the increasing number of climbers. Of course, some species show fluctuations in the number of breeding pairs depending of ecological factors, such as food supply, predator-prey interactions and the like, such as *A. melba, C. livia* and *D. urbica* (LUKAČ & HRŠAK 2005). This is also the case when there are sudden climatic changes during the nesting season in the Velika Paklenica Canyon (personal observation). It is also necessary to recognize the differences in the abundance and the qualitative composition of species on rocks and cliffs with southern and northern expositions (MATHERSON & LARSON 1998).

Hikers account for virtually two-thirds of all park visitors. They primarily move along marked trails and paths and, for the most part, do not directly impact nesting bird fauna. The abundance of bird species of forest groves and shrubs is stable and unchanging; these include the species *L. megarhynchos, S. atricapilla, T. merula, P. collybita, O. oriolus.*

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An outline of research for systemic governance of protected areas: building partnerships for sustainable management

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Keywords

Categories of protected areas, socio-economic-ecological systems, systemic governance, partnerships

Protected areas as socio-ecological-economic systems

Protected areas are embedded within a system of various socio-economic-ecological interactions and conditions on international, national, regional and local geographical, political, value-ethical and cultural scales (figure 1).

The category or classification of a protected area is influenced by the regional political and cultural differentiation in the place as well as by the acceptance of the local population and the visitors, respectively tourists. The category has an influence on how the population is affected or can benefit from the protection of an area and what kind of visitors are coming or even engaging in the protected area. Category groups have a decisive and inverse influence on the visitor management and protected area governance, which itself is also steered by political and cultural characteristics. The regional differentiations concern all aspects of protected areas in their social, ecological and economic interactions (figure 1).

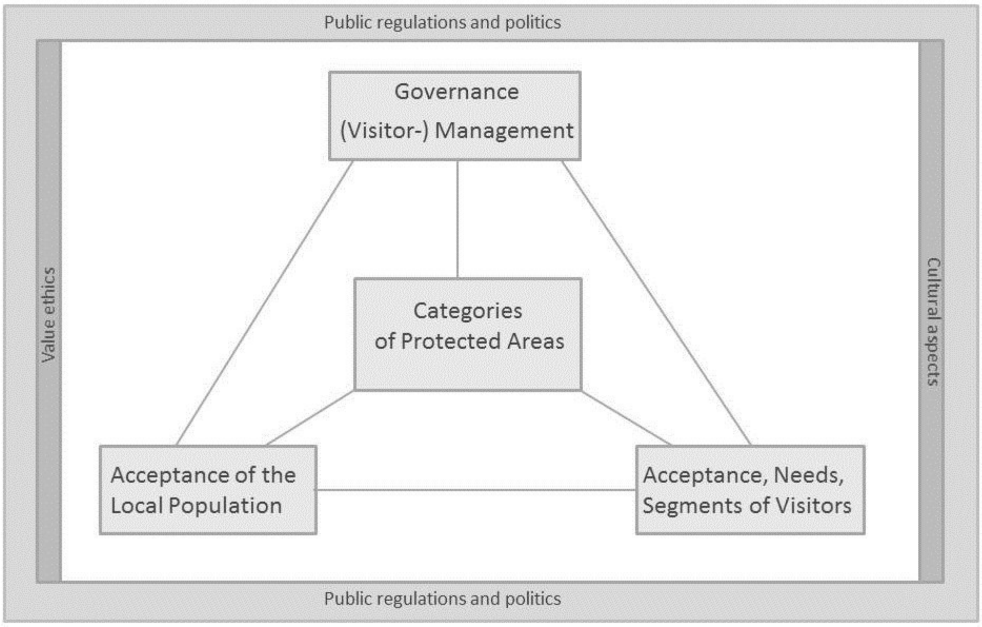

Figure 1: Categories of protected areas are defined and shaped by the interaction of the protected areas governance model, part of it being the visitor management, by the acceptance and the support of the local population, and by the demand and needs of different visitor segments. There is also a reverse influence of a chosen category to the governing body, and to the acceptance of the population and the visitors. Cultural aspects and value ethics influence this triangular relational network, while public regulations and politics define the regulatory frame.

Categories of protected Areas

With the World Parks Congress in South Africa in September 2003, a new paradigm of protected areas and its management emerged (PHILLIPS 2003). "The opening plenary sessions at the Congress featured several speakers who advocated for IUCN protected area categories V (protected landscape) and VI (managed resource areas) as the main focus for protected area activity in the future" (LOCKE & DEARDEN 2005: 1). The definition of new categories, such as category V Protected Areas (IUCN 1994: 22) had the aim to open the categories to land, "where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity". While not explicitly stated, the definition also incorporates notions of well-being: "contentment, satisfaction, or happiness derived from optimal functioning" (MCDOWELL 2010). Natural ecosystems perform both fundamental life-support services and services that enhance our subjective happiness. The UN Millenium Ecosystem Assessment (2005), for instance, emphasizes the significance of ecosystem services for human wellbeing and as a wider research program presents case studies for a number of different ecosystems as a way to understand the complex social-ecological system. The importance of material and non-material ecosystem services for human well-being is increasingly being accepted and is used as an argument for protecting cultural and natural landscapes.

The new categories including cultural landscapes respond to the fact that in Europe and in developing countries we can find many cultural humanized landscapes with a high biodiversity, depending on extensive non-industrial land use, which are also important for ecosystem services and well-being in the society. As in National Parks, preserving and protecting the health of the ecosystems and therefore the ecological integrity is the main goal, the idea of strict protection is stronger based in societies in North America and Scandinavia than in central Europe, even though there are some differences in the public and cultural understanding of wilderness between North America and Scandinavia. For example, in Scandinavia maintaining a wilderness character also means protecting the Sami culture and livelihoods and therefore e.g. the possibilities of hunting in protected areas (SAARINEN 2007).

The new category areas focus on sustainable development and consider conservation of wild biodiversity to a lesser extent (LOCKE & DEARDEN 2005). "The focus of management of category V areas is not conservation per se, but about guiding human processes so that the area and its resources are protected, managed and capable of evolving in a sustainable way" (PHILLIPS 2002: 10).

As the management from categories V and VI can make sense in distinct areas in Europe it poses some problems for areas with a higher percentage of wild areas: LOCKE & DEARDEN (2003) criticize this new paradigm as protected areas are being recast as tools for social planning and income generation instead of strict conservation. These new categories are especially a problem for the North American and Scandinavian protected areas; for example, the USA named all its National Forests, including areas that were heavily logged and used for mining and oil and gas extraction, as category VI areas. As a result the US has almost 40% of its forest area classified as 'protected', which does not reflect reality (BISHOP et al. 2004; LOCKE & DEARDEN 2005). On the other hand, many of the sites worldwide designated to meet the Convention on Biological Diversity 'Aichi Target 11' will be located within IUCN's categories V (Protected Landscapes/Seascapes) and VI (Protected Area with Sustainable Use of Natural Resources) (MCCOOL et al. 2012).

Actual discussions about the 'sustainable' production of energy in protected areas in Europe (e.g. at the 'Rheinfall' or in the 'Naturpärke' in Europe) show, that there are differing ideas on the aims of protected areas in different societies and on what visitors expect from a protected area. The discussion between conservation of landscapes and the use of renewable energies shows that sustainability is interpreted very differently by different stakeholders. In Iceland e.g. actual power plant development reduces the naturalness of places, which affects nature conservation and the development of nature based tourism (SÆÞÓRSDÓTTIR 2010). This discussion seems to be different in North America where the conservation in protected areas is more important.

Also the remoteness and population density plays a major role in protected areas categories, as building up new accessibilities can lead to more intensive use of areas (VOLL et al. 2011, VOLL 2012).

These regional natural contexts and the regional social contexts strongly influence the existence of different categories of protected areas. To strengthen protected areas in their different kinds and for future developments, more research has to be done on the relations within these different categories and their systemic governance (including visitor management), the needs, segments and acceptance of tourists, the acceptance of the local population, and the reciprocal influences in different political, cultural and ethical contexts.

Acceptance, needs and segments of visitors to protected areas

Visitor management in the context of changing demands, values and expectations of tourists, but also of the public, the affected population and other stakeholders has become a new challenge for the management of protected areas. In general tourism, visitors have traditionally been understood as customers, while the literature calls for a visitor-management partnership, where tourists are seen as partners in designing joint services (e.g. FUCHS 2004, MICHEL 2001). More recent trends in adopting such an understanding can be observed, for example Parks Canada who implemented a new approach for visitor management: "Instead of viewing the issue as a dichotomy of people versus parks, a cohesive management approach integrates three elements. From here the Agency can achieve its expressed objective of ensuring that Parks Canada programs are representative of and relevant to Canadians" (JAGER et al. 2006: 19).

Questions arise, such as what are the current expectations of park visitors on infrastructure, on the level of protection, categories of parks, and (how) do they differ from other tourists to unprotected destinations? How can the visitor become integrated as a partner in meeting the complex and overlapping objectives of protected areas - for ecological preservation, social wellbeing, cultural integration, but also integrated in an economic business model, dependent on the willingness-to-pay of visitors. In meeting the needs of a worldwide increase in tourism to protected areas, protected area managers must correspondingly pay an increasing attention to the type and quality of visitor experience offered and at the same time protect the ecological integrity of the park (PRISKIN & MCCOOL 2006).

Respecting the needs of park visitors is important for funding and acceptance in society as well as for a successful park management. Especially as "domestic and international funding for protected areas development has been declining since the 1990s. The global financial crisis that started in 2007 has resulted in increasing public debt and austerity measures in even the more developed countries, with forecasted adverse impacts on protected areas staffing and operations" (MCCOOL et al. 2012: 98f.). Besides the financial aspects in the staffing and operations of protected areas, also the aspect of cultural change in society and changing visitor needs seems to play a more and more important role in the demand of nature based tourism in protected areas. In Canada e.g. from 2001 to 2005 visits to national parks dropped by 3% while the overall Canadian population grew by almost 4% and visiting historical and cultural attractions is one of the fastest growing niche tourism markets (JAGER et al. 2006). It is therefore clear that underpinning any attempt at developing a park's tourism potential must be a greater appreciation of tourists' characteristics (COCHRANE 2006). COCHRANE (2006) developed therefore a typology of national respectively international protected area visitors and on demographic and behavioral characteristics respectively preferences for facilities and experiences. To find out more about the acceptance of parks by tourists and the needs of tourists is substantial for the management and marketing of protected areas as the largest challenge related to the visitor experience in protected areas is linked to the management of expectations: "Visitors to protected areas have expectations about what they will see and the level of infrastructures, such as the trails and information facilities, that often have no link to reality. Visitors tend to develop the same expectations about the quality of services available, particularly in relation to education and viewing opportunities no matter which protected area they visit, from a national park in the USA to a small protected area in a mountain region in Asia. In the visitors' imagination a 'protected area' is one type of recreation product" (CARBONE 2006: 56). "While the science of identifying what visitors seek has strong conceptual foundations, the art of managing these opportunities is less well developed. One of the challenges for the future is for closer collaboration involving social scientists and protected area managers" (PRISKIN & MCCOOL 2006: 9).

A study about a potentially existing 'green tourist' in the Swiss National Park found for example that tourists are visiting the national park mainly due to their interest for nature, while considering social and ecological aspects both in holiday and in daily life behavior more; about 75% of the Park visitors in this study have a higher willingness-to-pay for sustainable tourism services, in accordance with their general social and ecological behavior during holidays and at home. This 'green tourist' is above average age, educated, is visiting the National Park more frequently and is staying longer than tourists not showing their level of integrated sustainability demand and behavior. At the same time visitors do not completely understand the concept of sustainability, but are willing to pay more for sustainable service offers, such as a visit to a protected area (LUTHE et al. 2012). This opens new opportunities for governing protected areas which lead from sheer acceptance of a visitor to a real partnership if the relation of the management with visitors is increasingly understood as a joint partnership for sustaining a park as well in an economic context.

Acceptance of the local population

Besides better integrating the needs and expectations of tourists in forms of a partnership with the management, there should be a similar focus on the needs and expectations of the local population. Especially in regions with a strict conservation mandate the regional development aims can be fulfilled almost only by integration of the population in the tourism industry. But also in protected areas with a stronger orientation towards sustainable development, the local population has to be integrated in use and protection strategies. In realizing new protected areas there are still exist fears from the local population that the local economy could be negatively affected, especially in Europe (MOSE & WEIXLBAUMER 2003). Therefore WEIXLBAUMER (2009) refers to two processes which integration is a main success factor for a protected area: The participation of the local population into the management even after a protected area has been established, and at the same time a regional based governance model which is independent from community politics. FORSTER & SIEGRIST (2009) name e.g. besides the integration of the local tourism industry the participation of other stakeholders from agriculture, forestry, nature, landscape and local culture as being critical for a touristic conception of a protected area. Therefore professional touristic potentials should include the ideas and needs of the local population (FORSTER & SIEGRIST 2009). The research on the acceptance of the local population for protected areas in Europe is a relatively new research field as the foundation of most national parks and other protected areas in Central Europe only started in the last decades (MOSE 2009; JOB 1996).

Governance and Visitor Management

The interaction between the needs of tourists and the local population and the categories of protected areas is more or less determined by the status and regulations of the single protection category. But there is space for progress by involving the visitors, the local population and other stakeholders in the management of a protected area within their mandate, organized and facilitated by a systemic governance approach. The needs and expectations of visitors and the local population must be aligned with management standards of protected areas such as 'limits of acceptable change', 'visitor impact management' or the 'visitor activity management process'. For example, in Finland the protected area authority of Metsähallitus Natural Heritage Services applied the concept of 'Limits of Acceptable Change', and at the same time created two progressive quality programs in tourism: Green Destination Quality Net (Green DQN™) and Green Destination Management Net (Green DMN®), which effectively bring together local actors from the tourism industry and the nature conservation field to promote sustainable tourism (TAPANINEN 2010).

The state-of-the-art in visitor experience management yet concentrated on helping managers to make decisions in management frameworks as 'Recreation Opportunity Spectrum' or 'Tourism Opportunity Spectrum' or 'Limits of Acceptable Change' (MCCOOL 2006). Implementing a successful management requires first a regular monitoring of visitor experiences and a careful interpretation of the resulting data which must be set against specific management and performance indicators and objectives. The findings should be then integrated with other strategic site planning information (CESSFORD & MUHAR 2003; BUSHELL & GRIFFIN 2006). "Routine monitoring of such things as visitor characteristics, expectations, satisfaction and experiences can contribute to this understanding. Management decisions can then be based on tangible information, not rough judgment" (BUSHELL

& GRIFFIN 2006: 31). Ideally, this information should be collected in a consistent way over time, comparable with other sites and service providers so that benchmarking is possible, easily and efficiently collected, readily and conveniently analyzed so that the data is current and reliable, with clear implications for planning and management; and physically and intellectually accessible to all parks agency staff whose management roles could be enhanced by this knowledge about visitors (BUSHELL & GRIFFIN 2006). Globally there is also a need to integrate this data with the UN List of Protected Areas (SHEPPARD 2006).

On the other side the purpose of a 'contemporary' visitor experience management are benefits for the society: "These benefits may involve reduced family divisiveness, greater worker productivity, increased personal incomes or reduced crime. Benefits from experiencing a high quality opportunity might also include additional support for a protected area, increased labour income in the local area or an accelerating interest in conservation" (MCCOOL 2006: 4-5).

But even today only one quarter of existing protected areas are managed with a high degree of effectiveness (MCCOOL et al. 2012) There are many actors involved in managing tourism in protected areas: local businesses, community and destination marketing, organizations that promote the protected area, planners, architects, engineers and construction workers, scientists and management which holds the legal responsibility to protect an area's natural heritage (MCCOOL et al. 2012). As for example SIEGRIST (2004) shows, nature park protagonists and tourist protagonists in nature park tourism in the Alps are suspicious to each other regarding their individual aims for protection. Therefore governance plays a key role since through governance processes public interests can be identified, debated and legislated upon (MCCOOL et al. 2012). By integrating the stakeholders in governance processes of protected areas it could be especially promising to include the visitors in governance as well, in order to manage protected areas more adjusted to particular needs of visitors in each regional context, thus developing a partnership with tourists (LUTHE et al. 2012).

Participatory and multi-level, scale-adapted governance are current responses to lacking effectiveness of environmental policy in Europe and other modern democracies (NEWIG & FRITSCH 2008). DEARDEN & BENNETT (2005) found that the management of IUCN protected areas categories I-III has become more participatory and that the middle and low developed countries have made more progress than the high developed ones in ensuring decentralized and participative protected areas management (DEARDEN & BENETT 2005). But it is important to consider, that "[…] improved governance can follow multiple pathways. The challenge is to understand the particular context of the protected area systems, globally, nationally, and locally and the various pathways and their advantages and disadvantages. Every situation is unique yet has commonalities that can be better understood through a structured series of case studies at the national and regional levels" (DEARDEN & BENETT 2005: 98f.).

In terms of protected areas management and governance, EAGLES (2009: 244) made a comparison of different protected area management models and governance criteria: "[…] according to standard governance criteria, the combination of government ownership of the resources and nonprofit management comes close to the ideals of good governance." But this management concept is often related to a certain financial configuration: "In wealthy localities, with a public that accepts the principle of paying higher taxes in order to gain equity in public services, the national park model prevails. All of Scandinavia fits into this situation. Conversely, in countries where the ability of government to use tax income for conservation is restricted, a parastatal model or the public for-profit model predominates. Most of Africa fits into this situation. This indicates that financial efficiency may be a pivotal criterion, one that underlies all the others. Unless one has financial efficiency, the fulfillment of the other criteria is problematic" (EAGLES 2009: 243). When implementing governance structures in national parks and protected areas it is at the same time necessary that they are established on the two over-arching, intertwined and well-recognized goals which are conservation of natural and cultural resources and the provision of education and recreation services (EAGLES & MCCOOL 2002).

An outline for future research

Recent trends in outdoor recreation in the United States and worldwide show, that public interest in nature based recreation and appreciation of natural areas continues to grow. "Participation in most outdoor activities has increased significantly since 1960, with activities such as camping, bicycling, canoeing and skiing increasing as much as tenfold during this time" (CHRISTOPHER et al. 2009: 1).

In awareness of the actual challenges and chances in protected areas management and recreation tourism described above, it shows that more research has to be done on what visitors expect in different regions from protected areas and how these expectations can be met by giving the visitor more influence in terms of governance and management, while also giving more influence to the local population and at the same time respecting the goals of protected area categories within their mandate on the regional/national level. The interactions in this systematic approach are manifold. A first step would be to find out more about visitor needs and characteristics in differing cultural and ethical contexts in case studies of different protected areas such as North America, Scandinavia, Middle and Eastern Europe, Africa, Oceania, and Asia. In a study on demand and willingness-to-pay of tourists in the Swiss National Park, LUTHE et al. (2012) found out more about the aims and the structure of so called 'green tourists', willing to pay more for ecological and social sustainable services and products, both in their holidays and their daily life. Especially the demand and the willingness-to-pay for sustainable tourism, the protected areas tourism as such and the changing understanding and demand of what visitors expect in protected areas has to be interpreted in a multicultural context and in various political and value-ethical surroundings, reflecting also the different categories of protection. Another promising line of research should analyze how these findings from different cultural and regional contexts could be implemented better in a systemic governance model, in which the visitor and the local population are playing an active engaging role in the form of a partnership, but at the same time respecting the overall goals of the particular protected area category.

The discussed socio-economic-ecological elements of protected areas governance are intertwined in a complex way, and the goal of developing a contemporary governance model where population and visitors are integrated in a strategic partnership call for a systemic transdisciplinary research program, identifying systemic leverage points for intervention, mapping dynamics of developments in a geographical context, and integrating cultural and ethical differences, while embracing their complexity.

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Changes in soil macrofauna composition in undisturbed areas: using altitudinal gradients as a proxy for climate change

Anton P. Mahringer, Martin Zimmer

Keywords

Climate change, soil food web, space-for-time approach

Abstract

In most terrestrial ecosystems, >80 % of the annually produced plant biomass is recycled through detrital breakdown (e.g., ZIMMER 2008, for an overview on detritus-processing). In addition to climatic conditions, numerous interactions of soil animals govern these decomposition processes, including potential top-down pressures from predators preying on detritivores (c.f., DUFFY et al. 2007; GESSNER et al. 2010). However, little is known on the importance of predator/detritivore interactions in the field, or on how their relevance depends on environmental conditions: In addition to horizontal biodiversity (e.g., within the guild of detritivores), vertical diversity (here: predators versus detritivores) may play a significant role in controlling decomposition processes and hence nutrient cycling.

In a space-for-time approach that used altitude as a proxy for changing climatic conditions, we aimed at shedding light on changes in soil food web structure along a climatic (altitudinal) gradient, in order to set the basis for detailed understanding of top-down effects of predators on decomposition processes. By making use of the natural change in climatic conditions (temperature, moisture) within spatially small scales along altitudinal gradients, we analysed the surface-dwelling soil macro-fauna in two replicate valleys at the south slope of Großglockner (Austria, National Park "Hohe Tauern") and their trophic interactions from subalpine (2000 m a.s.l.) to alpine (2800 m) altitudes. According to the well-accepted prediction of a shift of altitudinal levels by ca 500 m upon climate change (BLANKINSHIP et al. 2011; BOYERO et al. 2011), such a gradient allows for a first estimation of effects of climate change on soil food webs (and in further steps on decomposition and nutrient cycling) in the alpine environment. The particular status of a protected area appears particularly suited for such studies, owing to the lack of external influences (except for tourism and/or extensive land-use) on the soil system that might override (micro-)climatic effects.

For long-term capture of motile surface-dwelling soil invertebrates, we implemented a total of 54 pitfall traps, covering an altitudinal range from 2000 m to 2800 m in incremental steps of 100 m (3 replicate traps at each altitudinal station) at Ködnitztal and Teischnitztal, in July 2011 (during the "Tag der Artenvielfalt"). Traps were filled with 100 mL ethylene glycol. In August and September, catches were emptied and traps re-installed. In addition, hand-samplings of soil macro-invertebrates were performed at each other altitudinal station (2 persons, 15 min. each) for subsequent analysis of their tissue for stable isotope signatures (see below).

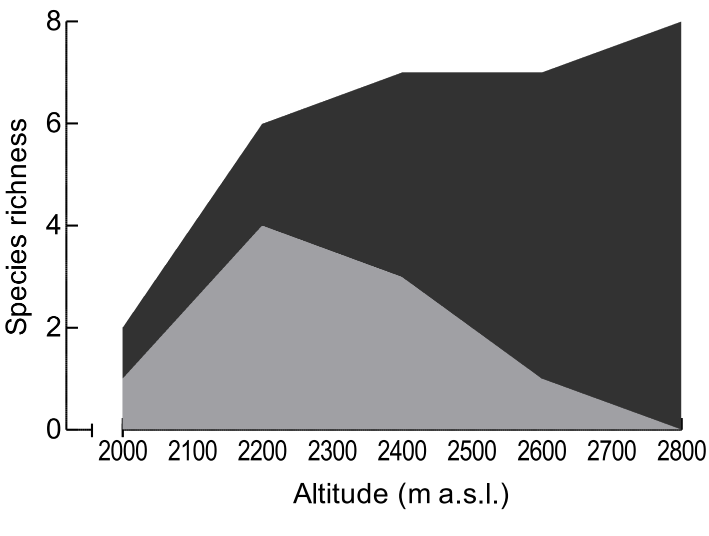

Figure 1: Altitudinal distribution of species richness of macro-detritivores (light grey) *versus* macro-predators (dark grey) along altitudinal gradients in Ködnitztal and Teischnitztal, Großglockner.

In the laboratory, captured invertebrates were determined to species level. Of representatives of common (present at at least 4 altitudes) and predacious soil invertebrates, the gut was dissected, and DNA extracted (QIAGEN DNeasy: ZARZOSO-LACOSTE et al. 2013; N = 3, for each altitude). Partial sequence of CO1 was amplified using universal invertebrate CO1-primers (FOLMER et al. 1994), before primers specific for potential prey taxa (e.g., Isopoda, Diplopoda, Diptera, Acari, Collembola, Nematoda; based on consensus sequences according to the BLAST database) were used to determine the prey spectrum of common predators.

In addition to this qualitative approach, a semi-quantitative approach aimed at estimating the relative contribution of different prey taxa to the nutrition of different predators at different altitudes. Gut-free tissues of hand-captured (see above) predators and their potential prey, having been stored frozen (-20 °C), were freeze-dried and ground for stable isotope analysis of $\delta^{13}C$ and $\delta^{15}N$.

Procedural details of PCR and stable isotope analysis will be published in an extended paper as soon as the final data will be available. The full set of data will be used for the estimation of above-ground soil food web structure at different altitudes (serving as proxy for changing climatic conditions).

None of the traps (having been implemented from July to September 2011) yielded more than a total of eight species of surface-dwelling predacious and detritivorous macro-invertebrates. The overall most common and abundant (predacious) species in our traps was the daddy-long-leg *Mitopus morio*, occurring at all altitudes (2000-2800 m a.s.l.) and being accompanied by its congeneric *M. glacialis* at 2600 and 2800 m. At lower altitudes (2000-2400 m), predators were represented mostly by lycosid spiders (e.g., *Acantholycosa pedestris*) and centipedes (e.g., *Lithobius erytrocephalus*), whereas carabid beetles (e.g., *Oreonebria atrata*, accompanied by *O. austriaca*) predominated at altitudes above 2400 m a.s.l. The most common and abundant macro-detritivore was the millipede *Allajulus fulviceps* that occurred from 2000 to 2600 m a.s.l. (albeit in decreasing numbers with increasing altitude), whereas the isopod *Trachelipus ratzeburgii* was restricted to 2000-2200 m a.s.l. The same altitudinal pattern was observed for the snails *Arianta arbustorum* and *Deroceras agreste*, respectively.

No macro-detritivores were captured at 2800 m, but the detritivorous surface-dwelling soil fauna at this altitude was solely represented by Collembola and Acari (meso-fauna). According to this finding, we hypothesize a shift in the food sources of macro-predators from macro-detritivores in the subalpine region to meso-detritivores in the alpine region. Until stable isotope data and PCR-results are available, however, we can but speculate on soil food web structure at different altitudes and potential consequences of climate change for soil food webs and ecosystem processes in the alpine environment.

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Constraints and Challenges in the Creation and Public Use of the Protected Areas within the City. Case Study: Lake Vacaresti – Bucharest City

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Abstract

The area that made the subject of the case study overlaps a "sui generis" landscape unit lying inside the built up area of the Romanian capital: Lake Văcăreşti. This territory could become in the near future an urban protected area. Named by specialists the "Capital's Delta" or the "Delta showroom", it occupies about 180 hectares, inside the 4th district of Bucharest, stretching on a former marsh, suggestively called in the past, the Wailing Valley. During the communist period, the wetlands reclamation and landscaping have begun; thus, from the vast area of the dirty Wailing Valley remained only the Văcăreşti Pit, despite the Ceausescu's intention to transform it into a lake. After 1990, the abandoning of this project has allowed the emergence of a unique ecosystem in the lake basin of the former Văcăreşti pit, which now serves about 100 species of birds, reptiles and mammals. Accidentally discovered by photography enthusiasts, biologists, ecologists and geographers, this space has recently come to the attention of the NGOs and the Ministry of Environment, which make efforts to turn this territory into a protected area. **The aim** of the study lies in anticipating / identifying the human-environment conflict situations that the future nature reserve and the urban planning of the Văcăreşti Lake will generate in the first phase, consisting in the implementation of the statutory protection and conservation measures. The **research methodology** is based on the mapping method, the direct and indirect observation and media monitoring. The authors' intention is that the results would support the efforts to create the Lake Văcăreşti Natural Urban Park.

Keywords

lake Văcăreşti, natural urban park, constraints, protected area

Introduction

The setting up of a protected area generates multiple conflicts of interests, especially when the respective territories lie in the proximity or, even more important, in the perimeter of human settlements. Under the circumstances, in order to prevent the failure of the protection and conservation measures required by the creation of a protected area, it is compulsory to identify all possible conflicts that may divide the stakeholders, both in the designing phase and in the operational one.

The natural parks and the nature reserves must be seen as a complementary form of anthropogenic intervention on the environment, oriented towards the restoring of its balance, by removing the visible causes of its degradation. In this category, one may include the landscapes resulted either from a traditional practice of territorial planning, implemented by a socio-cultural group, or from other practices of preserving the natural and semi-natural landscapes surrounding the cities (Manea 2003). At the same time, however, one must also take into account the semi-natural urban quarters, whose initial function was abandoned, but which should be preserved as such in the interest of the people, for leisure and tourism activities.

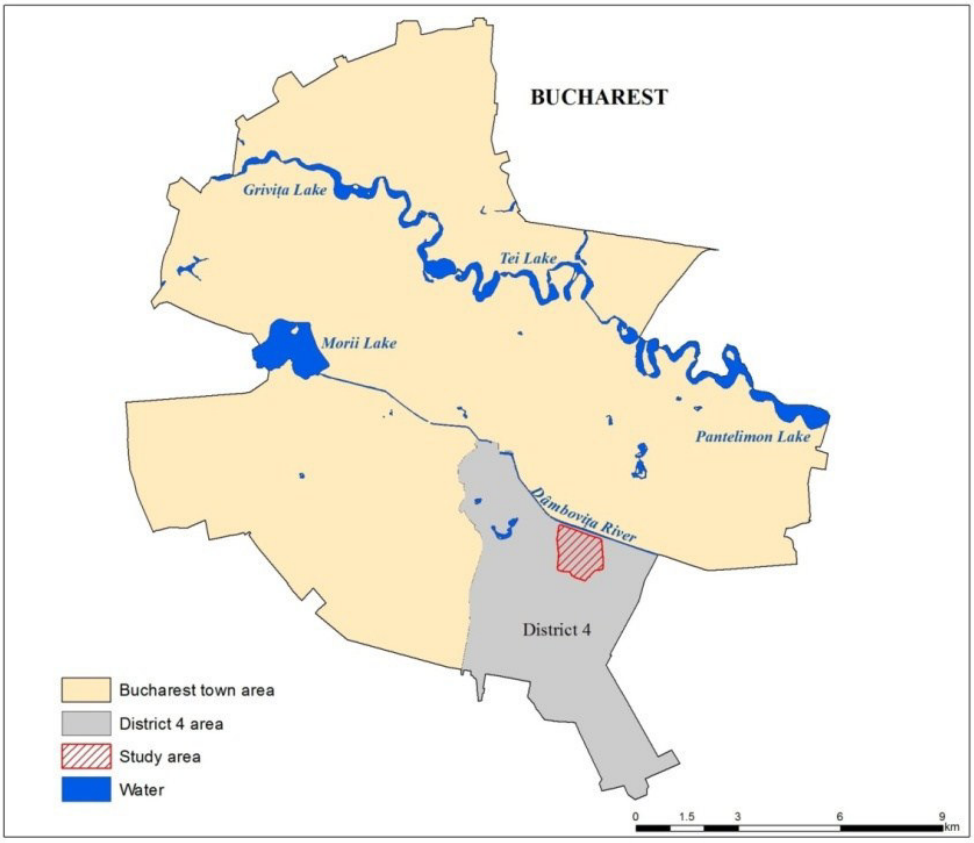
According to the German ecologist Michael Succow (quoted by Depraz 2008), the urban natural parks must be "objective parks", allowing a gradual riddance of the landscapes from the human pressure. The purpose is to achieve on a medium term a condition as close as possible to the natural one (renaturalization, ecological restructuring of the environment).

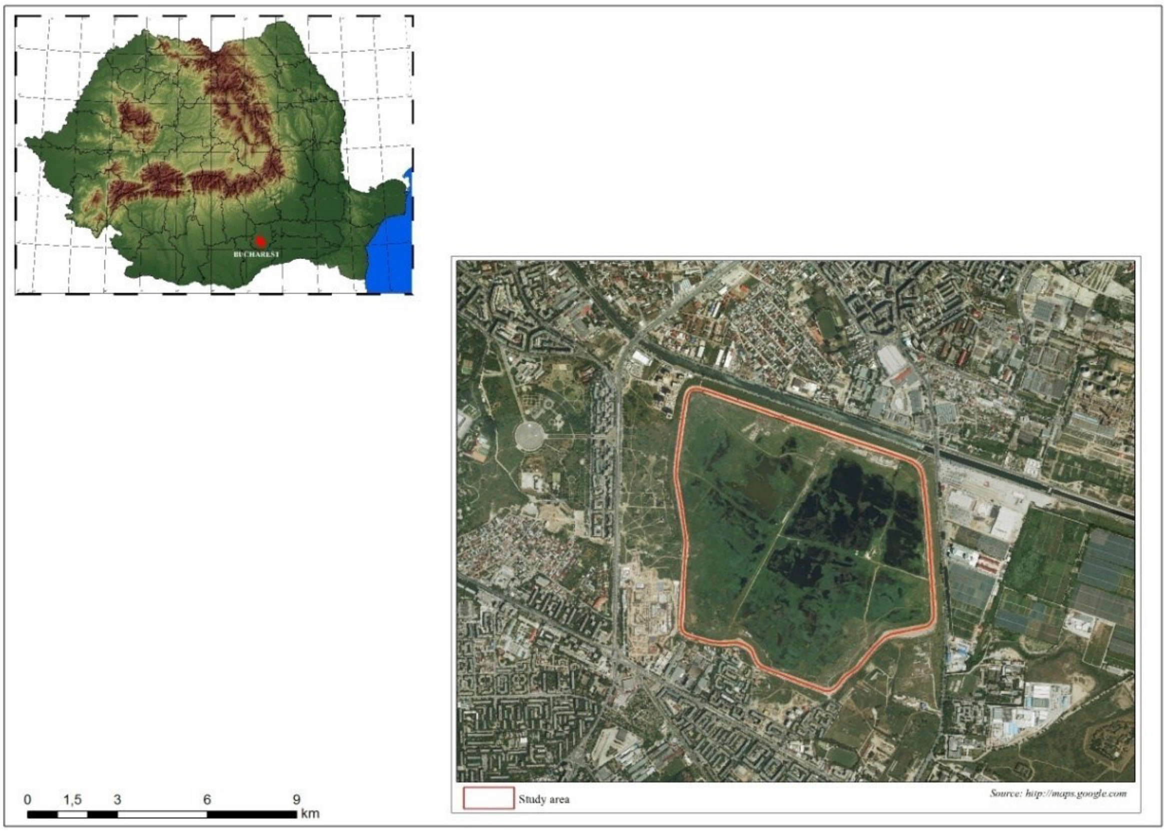
The aim of the study is to anticipate/identify the conflict situations that may occur between man and environment in the design and implementation of Lake Văcăreşti Urban Natural Park, and also to assess the opportunity of its capitalization through sustainable tourism. The paper is inspired by the media conflict that burst among the various stakeholders involved in the creation of the Lake Văcăreşti protected area, namely the local authorities, the government, the NGOs, the landowners, the residents living nearby, and the residents of Bucharest as a whole.

Study area

The investigated territory overlaps a "sui-generis" landscape division lying in the built up area of the Romanian Plain, a place that might become in the near future an urban natural protected area. This realm that occupies about 180 hectares in the southern part of Bucharest City overlies a former dirty swamp, suggestively called in the past the Wailing Valley.

Geographically speaking, Lake Văcăreşti overlaps the Cotroceni-Berceni field, which is a subdivision of the Bucharest Plain. The Cotroceni-Berceni field is delimited to the north by the Dambovita Valley, while to the south it stretches up to the River Sabar. From the altitudinal point of view, the hypsometric steps of 70-80 m and 80-90 m are prevailing (COCOS 2006) (fig. 1 and 2).





Figures 1,2: Geographical location of the study area (Designed by Roxana Cuculici, 2013)

The reclaiming works and the improvement of the swampy areas began during the communist period. Consequently, from the vast and dirty Wailing Valley only the Văcăreşti Pit survived. In the 1980s, President Ceausescu was willing to turn it into a recreational lake and sports grounds. In the last 20 years, the project was abandoned, which led to the formation of a novel ecosystem in the sink of the former Văcăreşti Pit (fig. 4), which presently shelters about 100 species of birds (hawks, wild ducks, and pheasants), reptiles (water snakes, newts, water turtles), and mammals (foxes, ferrets, otters and muskrats). Haphazardly discovered by photography enthusiasts, this space has recently caught the attention of the NGOs and the Ministry of Environment, which initiated the procedure of declaring this territory a protected area.

The research methodology was based both on collecting historical data, with the purpose of performing a diachronic analysis, and in monitoring the media articles and the opinions expressed on the social networks, in order to get the perception of the local authorities, the scientific community, the residents living nearby, and the landowners, with regard to the future destiny of Lake Văcăreşti.

Figure 3: Wildlife on Văcăreşti Lake

Figure 4: Văcăreşti Swamp

Source: http://arhivadegeografie.wordpress.com/2012/03/30/explorare-urbana-in-lacul-vacaresti, accessed on 17.03.2013); Iuliana Vijulie, 09. 2012

Results and discussion

The direct observations performed in the field during the interval August-September 2012, the analysis of cartographic documents (topographic maps, edition 2001, of scale 1:50000, aerial images of Bucharest City, edition 2008, resolution 0.5 m, scale 1:5000, maps in Stereo70 projection posted at *http://geoportal.ancpi.ro/imggis/services*), the monitoring of the media articles and the discussions on the social networks, as well as the talks with civil society representatives, all allowed us to identify the constraints that the creation of the protected area in the investigated perimeter must take into account. Likewise, we were able to understand the advantages that such an urban protected area would bring both to the environment and to Bucharest residents.

The constraints to this approach come, on the one hand, from the civil society (especially the landowners and the skeptics - some of them even in the academia) and on the other hand, from the entrepreneurs and real estate investors, who are attracted by the lower price of the land in comparison with Bucharest real estate market (MATEI 2007). But the positive aspect of improving the environmental quality is highly appreciated by the NGOs, the people in the proximity, the representatives of the central environmental authority and most academics.

At present, the situation identified in the field is dramatic, inasmuch as the vacant land status of the study area worsens the conflict situations between man and environment. For the time being, the "real" users of the territory adjacent to Lake Văcăreşti are the homeless people, who built their *favelas*-type shacks on the lake banks. These inhabitants harvest the nearby trees and bushes for fuel and even hunt with slings the bird species (according to eyewitness testimonials).

The stray dogs and the ones bread in the improvised households are a threat for the bird species. Besides, the so-called tourists, priers and anglers negatively impact the biotope and biocenosis in the study area, through the fragmentation of herbaceous cover, the accidental or intentional burning of stud and read (in order to create access trails to the pools) and the destruction of hydrophilous and hygrophilous species.

The comments made in virtual environment with respect to the future functional role of the vacant land adjacent to Lake Văcăreşti are virulent, their authors standing on both sides of the fence. The most active ones are the landowners, who are reluctant to agree that the land adjacent to Lake Văcăreşti be turned into an urban protected area. These people seek to obtain short-term benefits by selling the land to the potential real estate investors. As a matter of fact, part of the land was already sold prior to the real estate crisis and now the respective area is occupied by the "Asmita Garden" residential complex (fig. 5 and 7).

Figure 5: Lake Vacaresti (Romania) Figure 6: Costanera Sur (Argentina)

Source: Gabriela Manea, 09. 2012; blog.birdingbuenosaires.com/2010/11, accessed on 15.09.2012

The urban environment, characterized by the prevalence of artificial and artificialized natural components, by a high density of population and constructions and by a high degree of chemical, physical, biological, and even moral pollution, may and should include representative samples of city quarters reintegrated in the surrounding nature, either through the agency of urban regeneration actions or through the ecological reconstruction of the degraded landscapes. In reality, besides the well-known functions (industrial, commercial, administrative, services etc.), the urban ecosystems may also serve valuable ecological functions. These may be put forward by declaring/creating urban protected areas, as models of sustainable ecological management, capable of lending economic value to the protected areas (MUNASINGHE & MCNEELY 1994). Examples in this respect are rather numerous. We can mention here the Ekoparken Urban Natural Park in Stockholm, which has been criticized from the perspective of the city sprawl, because it hinders some urban development works (industrial and/or residential projects). For this reason, Ekoparken is one of a kind in Sweden. Other examples are the urban natural parks Hämeenlinna (2001), Heinola (2002), Pori (2002) and Hanko (2008) in Finland, as well as the urban protected areas lying in the hinterland of Buenos Aires (Costanera Sur, Vicente Lopez) (fig. 6). In Bucharest City, the future Lake Văcăreşti Urban Natural Park (fig. 3,4,5,7) might fulfill a double function: protection and enhancement of the landscape through sustainable tourism.

Conclusions

If Lake Văcăreşti were turned into a protected area, Bucharest would have the following advantages:

- Urban regeneration of a territory that is now nonfunctional and unhealthy;
- Ecological reconstruction of a semi-natural biotope;
- Creation of a leisure space for nature enthusiasts and an open air laboratory for scientists and students;
- Diversification of tourist offer for the city's residents;
- Better ecosystem services;
- Higher quality of life;
- Light tourist infrastructure;
- Higher tourist atractivity;
- Improvement of metropolis brand;
- Implementation of organic urbanism or bio-urbanism concept;
- Social-economic benefits

If the present status-quo is maintained, the risks are the following:

- Lack of interest for protection and conservation on behalf of the authorities;
- Real estate transactions meant to support the building of residential complexes;
- Extinction of aquatic ecosystem

Recommendations

- Organizing workshops with the target groups involved in the management and scientific assessment of the investigated perimeter, as well as with people from abroad, who are dealing with the creation and management of the urban natural parks from other countries;
- Raising the awareness of local population by presenting examples of good practice;
- Involving the authorities (the Ministry of Environment, Bucharest Town Hall and the Town Hall of the 4th sector of the capital) in solving the litigations with the landowners, in order to identify the sustainable planning practices for the study area

Figure 7 – Lake Văcăreşti
Source: http://4.bp.blogspot.com/ DSC_8951pp.jpg,accessed on 28.03.2013

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Carabid beetles (Coleoptera, Carabidae) in the Thaya valley

Theresia Markut

Abstract

In the year 2010, ground beetles (Coleoptera, Carabidae) of open habitats were methodically assessed for the first time in the Austrian part of the National Park (Thayatal). During the European Territorial Cooperation (ETZ) project "Nature without borders - Priroda bez Hranic" at the Thaya valley (Lower Austria and South Moravia) 20 different sites of open habitats, including dry grasslands of different size, geology, vegetation cover and exposition as well as meadows of different management, were sampled using pitfall traps. The survey contributes to basic data of the invertebrate inventory in the National Park. Moreover it adds to existing data from standardised samples in the forests of the Austrian part of the National Park taken in 2005 as well as sporadic collections since 1988 in different habitats of the Czech part of the National Park (Podyjí).

Within the project, carabid species richness increased by 30 species in the Austrian part, including 5 species, which were new for both National Parks along the border river Thaya. In total, one third of the Eastern-Austrian Carabids (124 species) were listed in the Austrian part and 243 species have been listed in the Czech part of the National Park.

The carabid species compositions of open habitats in National Park Thaya valley differ in dry grassland and meadows. Moreover the different xerothermophilous species compositions on different dry grassland sites reflect the typical small-scale distribution of diverse habitat-varieties in the National Park.

For a better understanding of dynamic processes over space and time, further research is necessary concerning connectivity or disjunction of fragmented small scale habitats and their mobile (threatened) fauna elements. Research synergies between arthropods and other taxa are possible.

Keywords

Thaya, carabidae, meadow, grassland

Introduction

The Inter-National Park Thayatal-Podvjí protects the Thaya chasm near Hardegg in the north-eastern region called “Waldviertel”, which is a colline zone in Lower Austria. The National Park Podyjí was established on the Czech side of the river in 1991 and is nearly 5 times larger than the Austrian part at the southern (right) river side. With a size of 1330 hectares, the National Park Thaya Valley is the smallest of the Austrian national parks, but due to its high biodiversity, it is a conservation area of international importance.

The huge number of plants, animals and habitats results from a special geology and geomorphology of the Thaya Valley. The high biodiversity in the small area of the national park is also due to its location at a climatic border between the harsh, humid climate in the west and the pannonian continental climate from in the east (drier and warmer).

Since the establishment of the National Park Thaya Valley in the year 2000, scientific research boosted in the area (Wurth-Waitzbauer & Übl 2010) and was initially focussed on flora and vegetation (Wrbka et al 2001a, 2001b, 2006a, 2006b, 2010). Considering the huge diversity of evertebrates, only few taxa have been studied on the Austrian riverside, which are so far land snails (Reischütz 2010), crayfish (Wurth-Waitzbauer & Pekny 2010), spiders (Markut et al. 2011, 2012), caddisflies-mayflies-stoneflies (Holovsky 2011), grasshoppers (Sachslehner, in prep.), bugs (Rabitsch 2005), cicadas (Kunz 2010), wild bees (Neumayer 2010) and ants (Harl 2010).

Within the large group of beetles, the carbabid beetles were selected as areliable bio-indicator for terrestrial habitats. The carabids of the forests had been surveyed from Waitzbauer et al. 2010. The aim of the presented study was to add basic inventory data and to analyse carabid communities of different open habitats in terms of conservation biology and zoogeography.

Methods

From April to October 2010, 20 sites were sampled (Table 1) using 3 pitfall traps on each site (plastic cups; 7cm diameter; half-filled with ethylene glycol used as trapping and conservation liquid; sheltered with a transparent plastic foil fixed with long nails). The selected sampling sites were dry grasslands (DG) and meadows (ME) within the area of the Austrian part of the National Park Thaya Valley. They differ concerning geology, vegetation, exposition, slope inclination, management, surrounding vegetation, distance to other open habitats and size. The

Carabids were determined (MÜLLER-MOTZFELD 2004b) and ecological preferences as well as geographical distributions of the species were taken from HURKA 1996, MÜLLER-MOTZFELD 2004a, 2004b, MARGGI 1992 and GAC 2009.

Table 1: Characteristics of the sampling sites. [1]DG: dry grassland; ME: meadows (extensive use); [2]Geologische Bundesanstalt Wien (2004); [3]STEJSKAL 2011; [4]WRBKA et al. 2001a, 2001b

site number	type[1]	field name	geology[2]	slope inclination [°]	exposition	base of topsoil	site code[3]	field code vegetation[4]
1	DG	Schwalbenfelsen	Bitter gneiss	12-24	SW-SSW(-S)	shallow	A3	TV01
2	DG	Fugnitztal Nord	marble	25-33	SSE-S-SSW	shallow	A8	TD09
3	DG	Hadl	marble	18-20	SW	medium	A14	TC02
4	DG	Kreuzmaiß	marble	22-24	SW-WSW	shallow	A14	TC08
5	DG	Reginafelsen	calc-silicate gneiss	21-32	SW(-WSW)	medium	A7	TU04
6	DG	Meixnersteig	calc-silicate gneiss	27-35	SSE	shallow	A7	TU10
7	DG	Burgberg	calc-silicate gneiss	25-30	SSW	very shallow	A44	TU01
8	DG	Einsiedler_TR	marble	0-10	WSW-W	shallow	A17	TF07
9	DG	Ochsengraben	calc-silicate gneiss	20-35	SSE	shallow to medium	A16	TG01
10	DG	Umlaufberg TR	orthogneiss	25-35	SSW	medium	A23	TI06
11	DG	Steinerne Wand	biotite to two-mica granite	18-30	ESE	shallow	A35	TN16
12	ME	Rosenthal	higher fluviatile sediments	±0	right riverbank of Fugnitz (slip-off slope)	deep	A12	WE01
13	ME	Fugnitzsee	water logging, half-bog	±0	former meander of the river Fugnitz	deep	A9	WD10
14	ME	Fugnitzbrache	higher fluviatile sediments	±0	left riverbank of Fugnitz (NO bank)	deep	A11	WD01
15	ME	Fugnitzwiesen	higher fluviatile sediments	±0	right riverbank of Fugnitz (NO bank)	medium	A10	WC11
16	ME	Einsiedlerwiese	higher fluviatile sediments	±0 (3-7)	right riverbank of Thaya (S bank, slip-off slope)	shallow to medium	A18	WF08
17	ME	Untere Bärenmühle	higher fluviatile sediments	±0	right riverbank of Thaya (W bank)	shallow to medium	A19	WF10
18	ME	Große Umlaufwiese	higher fluviatile sediments	±0	right riverbank of Thaya (ONO bank)	medium	A25	WI10
19	ME	Wendlwiese	higher fluviatile sediments	±0	orographisch rechtes Thayaufer (WNW-Ufer, slip-off slope)	deep	A33	WK05
20	ME	Fugnitzsee 2	water logging, half-bog	±0	former meander of the river Fugnitz	deep	A9	WD13

Results

In total, 584 individuals were caught and 66 carabid species were recorded (Table 2). 30 species are new records for the Austrian part of the National Park, where in total 124 carabid species (+1 tiger beetle, Cicindelidae) are known so far (WAITZBAUER et al. 2010, NÁRODNÍ PARK PODYJÍ 2011, MARKUT 2012, MARKUT et al. 2011, 2012). This is approximately one third of the East-Austrian carabid fauna. In Národní Park Podyjí twice as much carabid species have been recorded continually since 1991, namely 243 species (NÁRODNÍ PARK PODYJÍ 2011). Nevertheless, 5 species are new records for the whole international park (*Agonum emarginatum*, *Harpalus luteicornis*, *Olisthopus sturmii*, *Parophonus maculicornis*, *Pterostichus ovoideus*).

Only 10 out of the 66 recorded species occur on both types of open habitats (dry grassland vs. extensive meadows) so the two types are clearly separated from each other (Table 2, Figure 1). 30% of all sampled Carabid species are xerothermic specialists and only few sites show a characteristic xerothermic coenosis (Figure 2). 12 species (=18%) of all sampled species are forest species and occur especially on dry sampling sites.

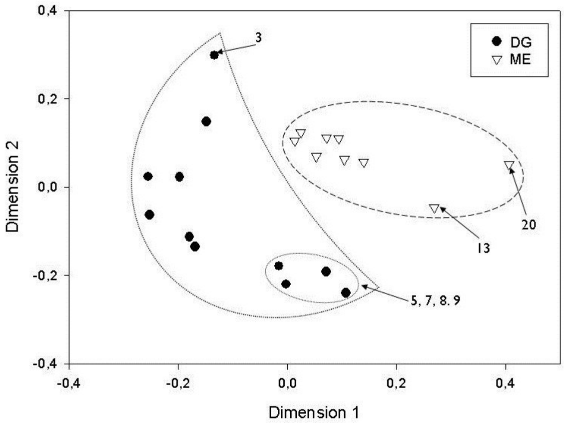

Figure 1: Non-metric multidimensional scaling of dry grassland (DG) and meadow sites (ME) with presence/ absence data. © T. Markut

Table 2: Species list of carabid beetles in open habitats. New records for the Austrian part are marked by bold letters, new records for the whole International Park are marked by *.

species	number of individuals	number of sites	occurs only at DG	occurs only at ME	occurs at DG as well as ME
Abax ovalis (Duftschmid, 1812)	2	1	x		
Abax parallelepipedus (Piller & Mitterpacher, 1783)	11	8			x
Abax parallelus (Duftschmid, 1812)	2	2		x	
Agonum emarginatum* (Gyllenhal, 1827)	2	2		x	
Agonum viduum (Panzer, 1797)	2	1		x	
Amara aenea (Degeer, 1774)	2	2		x	
Amara convexior Stephens, 1828	7	4		x	
Amara equestris (Duftschmid, 1812)	2	2			x
Amara eurynota (Panzer, 1797)	1	1		x	
Amara familiaris (Duftschmid, 1812)	4	4			x
Amara lunicollis Schiödte, 1837	37	6			x
Amara nitida Sturm, 1825	3	1	x		
Amara ovata (Fabricius, 1792)	2	2		x	
Amara plebeja (Gyllenhal, 1810)	2	2		x	
Amara similata (Gyllenhal, 1810)	2	2		x	
Amara tibialis (Paykull, 1798)	2	2		x	
Asaphidion flavipes (Linné, 1761)	2	1		x	
Badister bullatus (Schrank, 1798)	1	1		x	
Bembidion mannerheimii Sahlberg, 1827	5	3		x	
Bradycellus caucasicus (Chaudoir, 1846)	1	1		x	
Calathus cinctus Motschulsky, 1850	3	1	x		
Calathus fuscipes (Goeze, 1777)	25	3			x
Calathus melanocephalus (Linné, 1758)	14	3		x	
Carabus auronitens Fabricius, 1792	2	2		x	
Carabus cancellatus Illiger, 1798	2	1		x	
Carabus convexus Fabricius, 1775	2	2	x		
Carabus coriaceus Linné, 1758	1	1	x		
Carabus hortensis Linné, 1758	3	3	x		
Carabus intricatus Linné, 1761	6	5	x		
Carabus scheidleri Panzer, 1799	140	7			x
Carabus violaceus Linné, 1758	11	5			x
Dyschirius globosus (Herbst, 1784)	21	4		x	
Epaphius secalis (Paykull, 1790)	12	4		x	
Harpalus griseus (Panzer, 1796)	1	1		x	
Harpalus luteicornis* (Duftschmid, 1812)	2	2		x	
Harpalus pumilus Sturm, 1818	6	1	x		
Harpalus rubripes (Duftschmid, 1812)	8	5			x
Harpalus rufipalpis Sturm, 1818	5	2	x		
Harpalus rufipes (De Geer, 1774)	13	5		x	
Harpalus signaticornis (Duftschmid, 1812)	2	2	x		
Harpalus tardus (Panzer, 1796)	18	4	x		
Leistus ferrugineus Linné, 1758	2	2		x	
Microlestes minutulus (Goeze, 1777)	2	2		x	
Molops elatus (Fabricius, 1801)	13	3	x		
Nebria brevicollis (Fabricius, 1792)	1	1		x	
Notiophilus rufipes Curtis, 1829	2	2	x		
Olisthopus sturmii* (Duftschmid, 1812)	3	2			x
Ophonus azureus (Fabricius, 1775)	1	1	x		
Ophonus laticollis Mannerheim, 1825	1	1		x	
Oxypselaphus obscurus (Herbst, 1784)	2	1		x	
Panagaeus bipustulatus (Fabricius, 1775)	2	1		x	
Parophonus maculicornis* (Duftschmid, 1812)	1	1		x	
Patrobus atrorufus (Stroem, 1768)	2	1		x	
Philorhizus crucifer (Lucas, 1846)	1	1		x	
Poecilus cupreus (Linné, 1758)	52	9			x
Poecilus lepidus (Leske, 1785)	2	2		x	
Pterostichus melanarius (Illiger, 1798)	45	6		x	
Pterostichus niger (Schaller, 1783)	27	4		x	
Pterostichus ovoideus* (Sturm, 1824)	4	3		x	
Pterostichus strenuus (Panzer, 1796)	5	2		x	
Pterostichus vernalis (Panzer, 1796)	2	2		x	
Syntomus foveatus (Geoffroy, 1785)	3	2	x		
Syntomus pallipes (Dejean, 1825)	4	2	x		
Syntomus truncatellus (Linné, 1761)	7	3		x	
Synuchus vivalis (Illiger, 1798)	10	5		x	
Tachyta nana (Gyllenhal, 1810)	1	1	x		

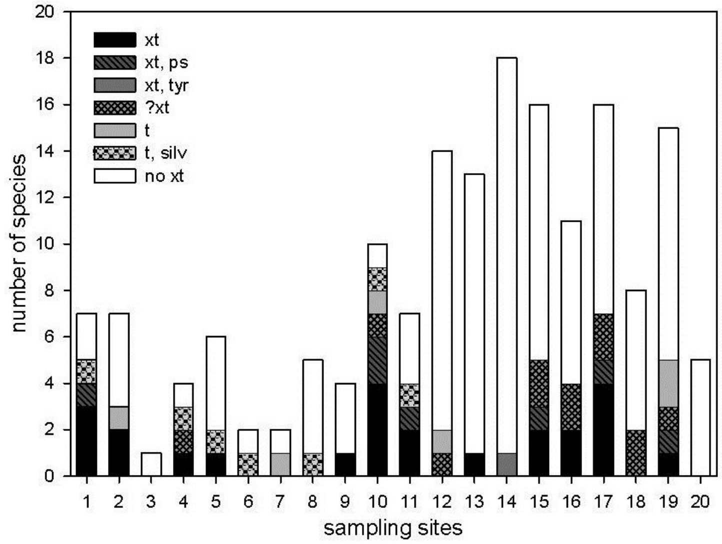

Figure 2: Xero-thermophilous preferences (after MÜLLER-MOTZFELD 2004a). t....thermophilous; xt....xero-thermophilous; ps....psammophilous; silv....silvicolous; tyr....tyrphophilous; ?....preference not sure; no tx...no xero-thermophilous preference. © T. Markut

Discussion and Conclusion

Dry grasslands, semi-natural grasslands and extensive meadows are habitats of high conservation value. In Austria the loss of dry grasslands and rock-steppes is very high (GEPP 1984) and in Europe the extent and connectivity of extensive grassland dramatically decreases (ex. g. DE VRIES et al. 2002, TSCHARNTKE et al. 2002, MAGURA & KÖDÖBÖCZ 2007). Such open biotopes of high conservation value are not substitutable with other open habitats like agricultural areas, because the composition of carabid communities differ greatly although absolute species numbers are may be equal (ex. g. TABOADA et al. 2011, TSCHARNTKE et al. 2002, SIEREN & FISCHER 2002). In consequence of habitat loss many threatened species are xerothermic species.

In the National Park Thaya Valley some rare species with additionally limited geographical distribution and mostly thermophilous preferences were recorded (ex. *Olisthopus sturmii*, *Harpalus signaticornis*, *H. pumilus*, *Amara equestris*, *A. tibialis*, *Calathus cinctus*) and some sampling sites show typical dry grassland species composition (site 1, 10). High species numbers reach the meadows near the river Thaya because of the interesting coincidence of thermophilous species and hygrophilous species at the same site (site 15, 17). Concerning environmental management of carabid beetles TABOADA et al. 2011 recommend to prioritise evaluation of assemblage composition over simple species richness, to consider a diverse set of grassland patches with variable spatial arrangements and to encourage appropriate traditional extensive farming (see also IRMLER & HOERNES 2003, GUTIÉRREZ et al. 2004, BATÁRY et al. 2007).

Ensuring habitat heterogeneity for stenotopic species, the habitat must be minimum-sized (ex. g. MAGURA & KÖDÖBÖCZ 2007, DE VRIES & DE BOER 1990). The minimum size for carabid beetles depends on geographical location, structure and the age of the fragments. Many small scaled and few larger-scaled open habitats in the Thaya valley theoretically meet the optimal requirements for durable occurrence of specialised species (TSCHARNKE et al. 2002) although the habitats are extremely small scaled in the National Park. Temporal variation of carabid species compositions, degree of fragmentation and connectivity of open habitats within the International Park as well as the surrounding landscape in Austria and Czech Republic are open questions. Research on connectivity or disjunction of fragmented habitats is of peculiar scientific interest, not only for a better understanding of the occurrence or absence of carabid species but also for distribution of other arthropods or even vertebrates.

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Epiphytic lichen communities in the National Park Kalkalpen, Austria, Upper-Austria

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Keywords

lichens, lichen communities, Nationalpark Kalkalpen, Upper Austria, Austria, *Lobaria amplissima*, *Pertusaria sommerfeltii*

Abstract

The epiphytic lichens and lichen communities were investigated in the National Park Kalkalpen (Austria, Upper-Austria) between2006 to 2010. Two hundred twenty two lichen species and 47 moss taxa were detected. To the red list of threatened lichens and mosses belong 74 lichen species and 6 moss species.

Bacidia rosella, Candelariella efflorescens, Chromatochlamys muscorum var. *muscorum, Lecanora phaeostigma, Lecanora thysanophora, Lepraria jackii, Lepraria lobificans, Lepraria rigidula, Leproloma vouauxii, Leptogium cyanescens, Mycoblastu saffinis, Pertusaria leucostoma, Pertusaria sommerfeltii, Psoroglaena stigonemoides* were found for the first time in the investigation area. The latest report of *Pertusaria sommerfeltii* in Upper Austria was published by POETSCH & SCHIEDERMAYR 1872 from the Schwarzenberg in the Böhmerwald.

A particular hot spot of a high lichen diversity is the region of Jaidhaustal – Feichtau – Haltersitz – Zwielauf. There is also a forest area in the south of the Zwielauf which has not been commercially used for a long time. In these areas great populations of *Lobaria amplissima* are present. This lichens species is very rare in Upper Austria and heavily threatened.

The following epiphytic lichen communities occur in the National Park Kalkalpen:

Chaenothecetum ferrugineae subass. chaenotecetosum chrysocephalae HOFMANN 1993

Chaenoteca chrysocephala is the differential species. This community inhabits coniferous trees with deeply fissured bark, where the microclimate is very humid.

Graphidetum scriptae HITZINGER 1925

Graphis scripta is the common species and dominates the community. It prefers deciduous trees with smooth or fine fissured bark. *Fagus sylvatica* is a frequently settled substrate. The Graphidetum scriptae occurs from the colline to the montane zone because of the preferred substrates.

Phlyctidetum argenae HILITZER 1925

The only common diagnostic species is *Phlyctis argena*, which dominates this toxitolerant community. It grows in the areas of the middle stem of different species of deciduous trees with smooth bark and prefers the eastern exposition.

Lecanoretum subfuscae HILITZER 1925

This community is rich in species. Several species of the genus *Lecanora* are the common species for this community, which is also rich in several species of other genera. It is an important pioneer community on trees with a smooth bark in the areas of the middle stem area, on *Fagus sylvatica* it is a terminal community.

Thelotremetum lepadinii HILITZER 1925

Thelotrema lepadinum is the common species together with several moss species. It is distributed in humid areas with high rainfall in the colline to montane zone.

It prefers *Fagus sylvatica* and other deciduous trees with smooth or rimulous bark.

Leprarietum incanae JAMES, HAWKSWORTH& ROSE 1977

It is composed of leprose crusts of different species and dominated by mosses. The Leprarietum incanae grows in the lower areas of the stems of deciduous and coniferous trees with deeply fissured bark. It is tolerant of air pollutants.

Pseudevernietum furfuraceae typicum HILITZER 1925

The Pseudevernietum furfuraceae is rich in species and is a hygrophilous and light demanding community on deciduous and coniferous trees in the montane to high montane zone. It is sensitive to air pollution.

Pseudevernietum furfuraceae var. Hypogymniosum physodis OCHSNER 1928

The differential species of the variety of the community Pseudevernietum furfuraceae is *Hypogymnia physodes*. It occures on sites with a higher level of air pollution. It occures on the stems of coniferous trees in the montane to high montane zone.

Pseudevernietum furfuraceae var. platismatiosum glaucae HILITZER 1925

Platismatia glauca is the differential species. This species-poor variety prefers the upper areas of the stems and branches of *Fagus sylvatica* and *Picea abies*.

Parmelietum saxatilis (HULT) SERNANDER

Parmelia saxatilis dominates the species-rich community with many changing accompanying lichen species. It grows on the upper areas of deciduous trees in the submontane to high-monate zone.

Parmeliopsidetum ambiguae HILITZER 1925 typicum

It prefers *Picea abies* with thick stems and deep fissures in the montane to high-montane zone. It is protected against extreme cold by the snow cover.

Parmeliopsidetum ambiguae subass. imshaugietosum aleuritis BARKMAN 1958

The differential species is *Imshaugia aleurites*. The subassotiation of the Parmeliopsidetum ambiguae prefers warmer sites and settels on wind exposed stems of conifers with fissures from 0,5 to 3 cm in the montane to high-montane zone.

Lobarietum pulmonariae HILITZER 1925 typicum

The Lobarietum pulmonariae is a community rich in species and dominated by mosses. According to the humidity and the degree of immission of air pollutants the species composition varies. In sheltered sites *Lobaria pulmonaria* is accompanied by the very sensitive *Lobaria amplissima*. *Fagus sylvatica* and *Acer pseudoplatanus* are settled on the whole stem. The height of distribution ranges from the montane to the high-montane zone.

Lobarietum pulmonariae leptogiosum saturnine subass. nov.

It differs from the Lobarietum pulmonariae typicum in the high amount of cyanobacterial lichens, particularly of *Leptogium saturninum*. This subassociation grows on the base of old, very thick beech trees with fissures from 1 to 7 cm in the high-montane zone with high-rainfall and low influence of air pollutants.

Melanelixia-Hypnum-Sozietät

This association is a transitional stage of the succession which starts from the Lecanoretum subfuscae. It shows a broad ecological amplitude and grows preferably on *Picea abies* und *Fagus sylvatica* in the middle regions of the stem.

Physcietum adscendentis FREY & OCHSNER 1926

The Physcietum adscendentis is a stage which follows the Lecanoretum subfuscae under high influence of nitrogen compounds. It grows on *Fagus sylvatica*, *Sambucus nigra* and on fruit-trees in the higher stem regions. The association is photophilic.

Cladonietum cenoteae FREY 1927

The acidophytic Cladonietum cenoteae grows on the base of trunks and stumps of various trees with a high degree of coverage with often dominating *Cladonia digitata*. It prefers the *Picea abies* and *Larix decidua* in submontane to high-montane zone.

Cladonietum coniocraeae DUVIGNEAUD 1942

It is similar to the Cladonietum cenoteae but it grows up to the higher areas of the stems and has a lower demand of moisture. It grows also on less acid substrata like on the bark of *Malus domestica* and *Fagus sylvatica*.

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Who is eating what?
Functional feeding-group composition in Alpine rivers

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Abstract

Alpine rivers are extreme ecosystems with harsh abiotic conditions, causing a low biodiversity of a generally well adapted fauna. This is especially the case for glacier-fed streams. In rivers, where glacial influence is low or non-existent, environmental conditions are less severe. Within the long-term program "River-Monitoring in Hohe Tauern National Park" we investigate catchment- and reach-scale conditions and their influence on the riverine fauna together with their potential to indicate climate change effects. We studied 16 river sections in four large catchments from 2009 until 2010 in Alpine spring, summer and autumn. In this study, we explored the composition of Functional Feeding-Groups along a glacial/non-glacial gradient in order to see, if they follow a specific pattern. All abiotic parameters and biotic samples were collected and processed according to developed protocols, the definition of feeding relationships were based on a solid taxonomy. We applied cluster and redundancy analysis to evaluate the results. Nearly all river sections show a dominance of the detritivore feeding guild, somewhat less dominant are grazers. Also in glacier-fed rivers autochthonous primary-production obviously is adequate for grazers to dominate second. In lower sections shredders do not gain importance, although organic-matter availability as their optimal food resource was high. Underlying factors for the functional structure in research sites are (i) glaciation in catchment, (ii) pasture, and (iii) moss as microhabitat. It seems that in extreme environments autochthonous processes are more important for the fauna than allochthonous ones. But in lower regions, where glacial conditions are less severe, the allochthonous influence came to the fore.

Keywords

Aquatic insects, Ephemeroptera, Plecoptera, indicators, environmental influence

Introduction

Alpine river ecosystems are characterized by high discharge, high channel dynamics, and harsh environmental conditions including low water temperatures (e.g. Füreder et al. 2001; Füreder 2012). Therefore macroinvertebrates living in Alpine streams have to be specialists with adaptations to constantly changing environmental conditions. This is especially relevant for glacier-fed streams (Brittain & Milner 2001, Burgherr & Ward 2001, Füreder et al. 2001, Füreder 2007). On the other hand they have to be generalists in their nutrition because of the limited availability of food resources in these extreme habitats (Zah et al. 2001, Füreder et al. 2003a, 2003b, Robinson et al. 2008).

For exploring the feeding ecology of stream invertebrates and functional structure of ecosystems the classification concept of Functional Feeding-Groups (FFG) generally is used (e.g. Merrit & Cummins 2006, Compin & Céréghino 2007, Von Fumetti & Nagel 2011). This method is based on the (i) morphology of mouthparts, (ii) feeding habits, and (iii) the use of similar food classes (Cummins & Klug 1979, Merrit & Cummins 2006). Main food items are benthic organic matter (coarse or fine particulate), periphyton, and prey; functional classes, divided by feeding mechanisms, are scrapers/grazers (herbivores), shredders (herbivores or detritivores), gatherers (detritivores), filterers (detritivores), and predators (carnivores). Following a longitudinal gradient from headwater to downstream, the composition of FFGs demonstrates different terms of organic-matter distribution and energy flow (Vannote et al. 1980). As the food resources are limited in Alpine glacier- and spring-fed streams, most benthic invertebrates are detritivores (Mihuc & Toetz 1994, Zah et al 2001, Füreder et al. 2003a, 2003b, Robinson et al. 2008).

This study is integral part of the "River Monitoring Program" (River Monitoring Hohe Tauern National Park, project leader: Prof. Dr. L. Füreder) of the working group "River Ecology and Invertebrate Biology" at the Institute of Ecology (University of Innsbruck). Herein we investigate reach- and catchment-scale conditions and their influence on the riverine fauna together with their potential to indicate climate change effects. The understanding of ecosystem function and its modifications caused by environmental conditions is essential for predicting effects from climate change (Parmesan & Yohe 2003, Beniston 2005). Particularly food resources are expected to depend on climate/environmental factors and occurring taxa portrait potential links between climate and biodiversity (Brown et al. 2007) in their feeding mode (Hershey et al. 2006).

In this presentation, we were interested in the functional relationship of key species in Alpine headwaters and compared functional communities by means of FFGs along a glacial/non-glacial gradient in order to see, if they follow a specific pattern.

Methods

Study Area

The study sites were situated in the Hohe Tauern National Park, which is characterized by a wide range of typical high Alpine stream types (FÜREDER 2007). Furthermore, the conservation status of this protected area guarantees for low human impact. Four glacier- and four spring-fed streams were sampled above the timberline, another four glacier- and four spring-fed streams below. These 16 sites were investigated September 2009 and July, August, September 2010 (Table 1).

Table 1: General characteristics of the studied catchments in Hohe Tauern National Park (Austria).

Catchments	Innergschlöß (Tyrol)	Seebach Valley (Carinthia)	Anlauf Valley (Salzburg)	Krimmler Achen Valley (Salzburg)
Catchment area (ha)	3362	1837	2193	5062
Highest point (m a.s.l.)	3666	3360	3252	3499
Mean gradient (°)	25	31	33	28
Glacier area (ha)	1449	82	84	710

Physico-Chemical Parameters

Conductivity, Oxygen saturation/concentration, pH and water temperature were measured by the portable measurement equipment WTW (Wissenschaftlich-Technische Werkstätten GmbH, Austria) in the field. Additionally water samples were taken to analyse conductivity, pH, alkalinity, Na+, K+, Ca2+, Mg2+, NH4+, NO3±, Cl± , SO42±, total phosphorus, and dissolved organic carbon in the laboratory. Discharge was derived from a calibrated water-level gauge (depth±velocity±transects; JENS 1968).

Macroinvertebrate Taxa and Functional Groups

For each study site, three replicate benthic samples were collected by kick sampling with a Surber sampler (sampling area 0.09 m^2, 100 µm mesh) and preserved in 75 % ethanol. Invertebrates were sorted in the laboratory and identified to species level, where possible, using current taxonomic identification keys. The definition to FFGs is based on MOOG (1995) and SCHMIDT-KLOIBER & HERING (2012).

Organic Matter in Substratum

Benthic organic matter was expressed as ash-free dry matter (g m^{-2}) of the pooled material, remaining from the benthic samples after the invertebrates had been removed. The substrate material had three grain sizes: Coarse Particulate Organic Matter (CPOM) > 1 mm, Fine Particulate Organic Matter (FPOM) < 1mm to >500 µm, and < 500 µm to > 100 µm. The substrate material has been dried at 60° for 24 h and ashed in a muffle furnace at 450° C for 2 h (WALLACE et al. 2006).

Data Analysis

For statistics we used the software packages PC-ORD 6 (Cluster Analysis; distance measure: relative Euclidean, group linkage method: Ward's method) and Canoco for Windows 5 (Redundancy Analysis). For normal distribution benthic invertebrate data were log (x + 1) transformed.

Results

All river sections show a dominance of detritivorous invertebrates (gatherers, filterers); somewhat less dominant are grazers (Fig. 1a-c). Also in glacier-fed rivers, with their high discharge dynamics and turbidity, autochthonous primary-production obviously is adequate for grazers to (nearly) dominate the feeding guilds (Fig. 1a, b). In lower river sections shredders do not gain importance (Fig. 1b, d), despite the high organic matter input as optimal food resource.

First results in cluster analysis and ordinations (RDA) demonstrate the environmental factors (i) glaciation in catchment, (ii) pasture, and (iii) moss as microhabitat to be the underlying factors for FFG composition in research sites.

Discussion

The particular aim of this work was, to compare functional communities by means of FFGs along a glacial/non-glacial gradient in order to see, if they follow a specific pattern. It seems that in extreme environments autochthonous processes are more important for the fauna than allochthonous ones. But in lower regions, where glacial conditions are less severe, the allochthonous influence (e.g. pasture) gets more important.

In the RCC canopied headwaters are dominated by shredders and canopy-free river sections by the grazer feeding-guild (VANNOTE et al. 1980). In our study the proportion of the detritivore and herbivore feeding-guild in headwaters goes along with the RCC. But most downstream sections are still dominated by gatherers and grazers, despite the high degree of canopy cover.

Earlier investigations of stable isotope analyses (SIA) proofed the classification of taxa into general FFGs in Alpine river-ecosystems (FÜREDER et al. 2003a). As the food resources are limited in Alpine glacier- and spring-fed streams, most benthic invertebrates are omnivorous, while detritivores dominate in spring food webs (Robinson et al. 2008). This was also supported by Mihuc & Toetz (1994) and Füreder et al. (2003a), who detected most taxa being detritivores in high Alpine streams. Mayfly species considered as detritivorous, such as *Rhithrogena* sp., or grazers like *Ecdyonurus* sp. seem to be highly omnivorous in these systems (Zah et al. 2001). With the application of SIA, Füreder et al. (2003b) defined several Ephemeropteran and Plecopteran species being extreme opportunistic and omnivorous in Alpine streams. Opportunistic and omnivorous feeding seems to be an adaptation on these harsh environmental conditions.

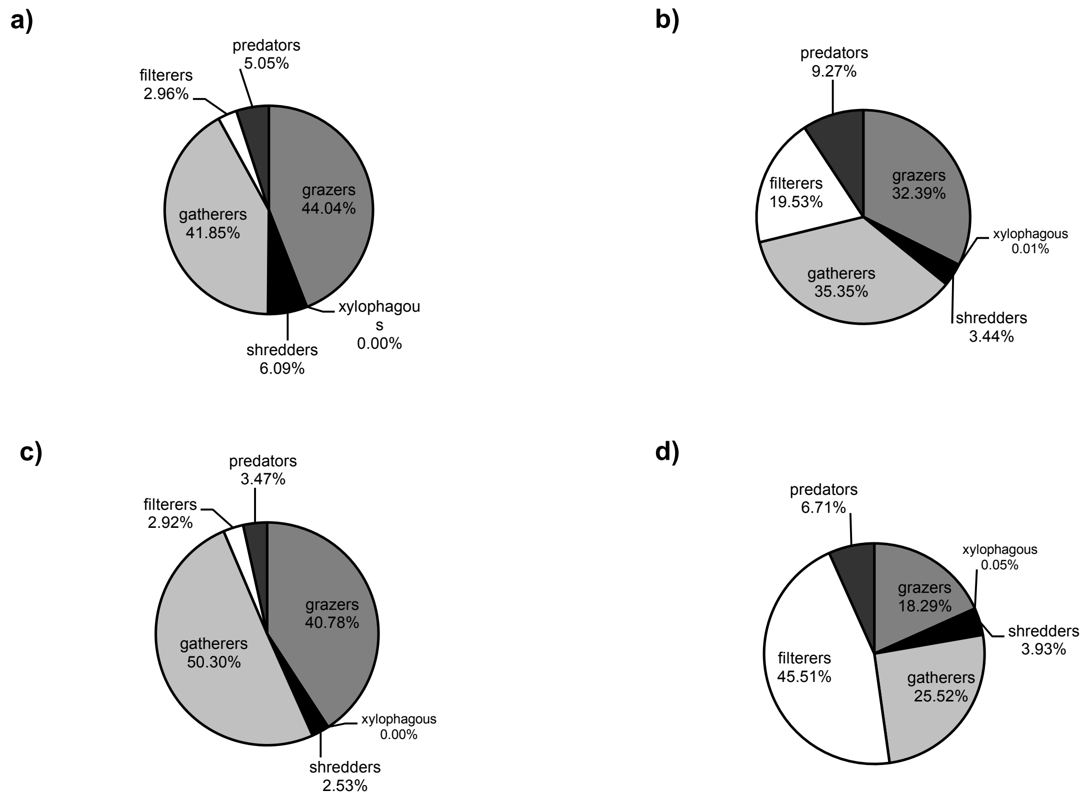

Figure 1: Functional Feeding-Group composition of macroinvertebrates along a glacial/non-glacial gradient: a) kryon (n=49), b) glacio-rhithral (n=44), c) krenon (n=41), and d) rhithral stream sections (n=33).

Furthermore our results confirm that food webs and their interactions reflect environmental conditions in riverine landscapes (Compin & Céréghino 2007, Von Fumetti & Nagel 2011). Based on FFG composition, Compin & Céréghino (2007) defined major clusters of anthropogenically modified and natural areas in south western France. In Swiss Jura Mountains Von Fumetti & Nagel (2011) developed a classification system to characterize crenic springs by their FFG composition. The FFG composition in our study underlies above all the influence of glaciation in the catchment.

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Monitoring of autochthonous brown trout *(Salmo trutta* f. *fario* L.*)* populations in different brooks of the National Park Hohe Tauern

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Abstract

Autochthonous fish species are severely threatened due to habitat deterioration and a wrong fishery management in European freshwaters. Sophisticated measures are needed for the support and conservation of the native fish populations in the Alps. In several projects we focused on the native brown trout with the aim of exploring its ability to survive and reproduce in these harsh environments. In the National Park Hohe Tauern, isolated rivers were chosen for the stocking of newly discovered brown trout of Danubian origin. Offspring fingerlings were marked by cutting the adipose fin and subsequently released. Different types of high mountain brooks, glacially influenced and spring-fed waters in altitudes ranging from 1300m to 2000m a. s. l. were chosen for long-term experiments. Barriers in the streams separate the stocked fish from downstream populations. Results include information about survival, age, growth, maturation, spawning time, preferred habitat structures and moving behaviour. From these results we gained important new insights about fish in such extreme environments. In particular, we conclude reasons and circumstances that influence life cycle components (survival of eggs, larvae and fingerlings) of this species and its performance in establishing self-reproducing populations in sensitive and harsh alpine environments.

Keywords

brown trout, autochthon, alpine streams, high altitude, population, stock, surviving, reproduction, discharge, floodwater, temperature

Introduction

Autochthonous fish species are severely threatened due to habitat deterioration and a false fishery management in European freshwaters. This work is focused on the native brown trout in the Alps with the aim of exploring their ability to survive and reproduce in these harsh environments.

Some data of this presentation is based on the Austria–Italia Interreg IIIA project "Trout Exam Invest", see: http://c719-71-22.uibk.ac.at/TroutExamInvest/. Although this project ended in 2007, the outdoor experiments in the National Park Hohe Tauern are still being continued. The results of an eight year monitoring period in these outdoor experiments are shown.

Methods

Different types of high mountain brooks, glacially affected and spring-fed waters in altitudes ranging from 1300m to 2000m a.s.l. were chosen for long-term experiments to establish self-reproducing autochthonous brown trout populations.

The streams showed high structural diversity and fulfilled all requirements that brown trout need to thrive in their life.

Artificial reproduction of autochthonous brown trout was performed; their offspring was marked and stocked for the experiments.

Barriers in the streams separate the stocked fish from downstream populations to keep the autochthonous population pure.

Monitoring of the brown trout populations was performed by annual electro-fishing in autumn.

Table 1: Basic characteristics of the three experimental water-bodies

Waterbody	Stream-type	Stream-order	River-basin	Geology*	Temp. (°C)	Conduct.	Coordinates		Altitude
	epirhithral	(Strahler)			min-max	(µS/cm)	Latitude	Longitude	(m a.s.l.)
Trojer Almbach	sprig fed	3	Drave	ACR	0° - 9,5°	133	46° 57´N	12° 17´E	1960 - 2010
Windbach	sprig fed	3, 4	Salzach	PCG	0° - 15°	24	47° 07´N	12° 11´E	1840 - 1950
Anlaufbach	glacial affected	3, 4	Salzach	PCG	0,5° - 10,5°	68	47° 10´N	13° 54´E	1320 - 1400

*According to: Geologische Übersichtskarte der Republik Österreich (map scale 1: 2 000 000), Geologische Bundesanstalt Wien, Austria, 1999.
ACR Austroalpne Crystallines, PCG Penninic Central Gneiss

Layout and site-specific results

Trojer Almbach

In the Trojer Almbach the allochthonous population of stocked rainbow trout, brook trout and brown trout of Atlantic origin was removed by several electro-fishing attempts in 2005. Within this fish-population only offspring of brook trout were noticed. Therefore it was very interesting to see if autochthonous brown trout can survive and establish a reproducing population in this extreme altitude at 2000 meters.

An initial stock with 450 marked two-year-old and a second stock with 400 one-year- old local brown trout of Danubian origin was performed. By annual monitoring, a good growth, but a steady slight decline of the population was observed. We interpret this fact as a natural decrease but also as due to negative effects of annual monitoring by means of electro-fishing. Most dubious was the fact that we never caught juveniles, although we observed spawning. By analysing this negative development, we conclude that a combination of several facts may result in losses during the sensitive stages of eggs, larvae or fry.

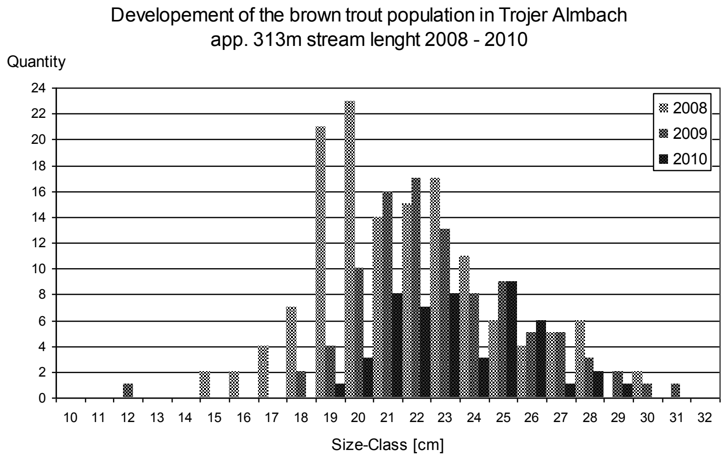

Figure 1: The length-frequency shows a steady shrinking of the population, individual growth, but no reproduction.

Reasons:

- Long lasting deep temperatures and low water levels in winter may lead to a freezing of spawning ground and loss of eggs.
- Deep temperatures result in delayed development of eggs and larvae, thus hatching may occur during times of high water levels with little chance of survival.
- Temperature-related slow growth implies that juveniles remain at a suitable prey size for larger fish for a longer time (cannibalism).
- Slow growth also implies that females will mature at a smaller body size. Small trout produce fewer eggs.
- Extraordinary flooding events
- Barriers impede compensative migration after floodwaters
- Low reproduction results in little survival for the sensitive larval and juvenile stages in harsh environments.

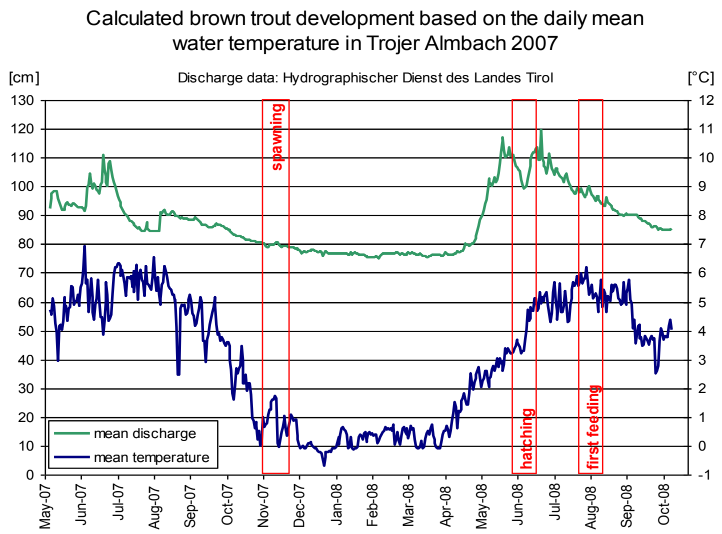

Figure 2: Observed spawning of brown trout in the middle of November. Hatching and first feeding was calculated using continuous temperature measurements. Both events take place in times of floodwater with little survival for larvae and juveniles.

Windbach

In 2005 an indigenous brown trout population was discovered in Windbach. The former stocked fish, originating from Anraser See, were removed by several electro fishing attempts and a new stocking with 2100 original Windbach offspring was conducted in 2007.

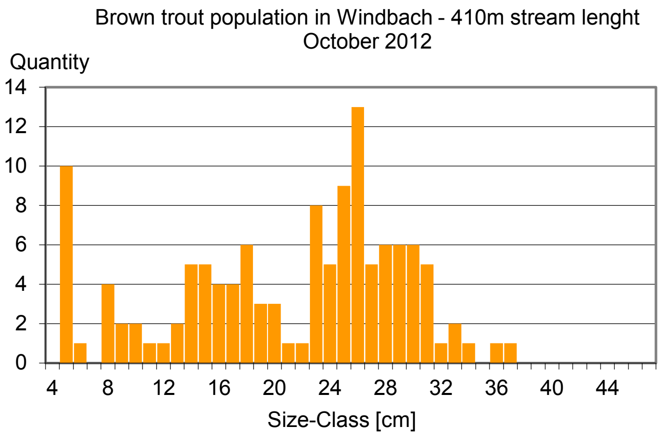

Figure 3: The length-frequency of the brown trout in Windbach indicates a self-reproducing population.

Five years after stocking an excellent brown trout population was observed. The initial stock from 2007 is represented in the size-class from 23cm to 30cm. Most of the smallest fish are their offspring, while the size-class between 12cm and 22cm descend from the original stock (Fig. 3).

Anlaufbach

In 2005 brown trout of Danubian origin were detected in the Anlaufbach. In this glacier-affected alpine stream annual floodwaters lead to a selected, highly adapted, but small population. To reinforce this endangered stock, marked offspring from the same population was stocked twice. A stable stock was observed for several years. In summer 2012 an extreme floodwater destroyed almost the entire brown trout population. Hardly ten percent of the population survived.

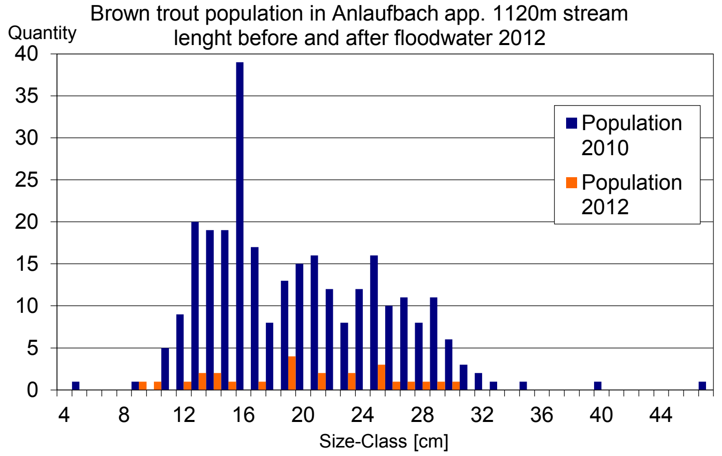

Figure 4: Brown trout population in the Anlaufbach before and after the high floodwater. Survival of all size-classes (orange) indicates a high adaptation of this indigenous species to floodwater situations.

General results

Survival

- Brown trout can survive in epirhithral streams up to 2000m a.s.l.
- Population survival depends on the survival rate of eggs, larvae, fry or juveniles.
- The continuity of a brown trout population depends on the dimension of several factors in their environment. Main negative events are floodwaters, suspended sediments, bed load, drift, low water, freezing, predation, barriers etc.

Growth

- Fish are poikilotherm organisms and therefore a long-lasting cold situation in high-lying streams leads to a delayed development and slow growth.
- Growth is a function of nutrition, temperature, genes, water-body, habitat and stress.

Maturation

- Brown trout males normally mature in the second and females in the third year of their life. Due to low temperatures, a one or two year delayed maturation of brown trout in comparison to low land brooks was observed.

Spawning time

- In our experimental sites, brown trout started spawning in the middle of November.
- Within the shortened day length in autumn, a rapid water temperature decrease seems to be a trigger for spawning.

Moving behaviour

- Through annual electro-fishing we noticed a high local constancy of naturally occurring and stocked brown trout in high alpine streams.

Discussion

Each stream has its own characteristics based on physical and chemical parameters. Apparently, suitable fish-streams are often wrongly appreciated. Alpine streams occasionally show their colour in interactions of discharge and temperature in time of the year. Temperature, discharge and floodwaters mainly manage the survival-rate of the sensitive development stages of fish.

The Windbach and the Trojer Almbach, which share similar physical characteristics, show how very slight differences in these extreme environments may decide whether stocked brown trout populations will persist or only exist temporarily. Against all expectations, the Windbach with the lowest conductivity, with high daily temperature fluctuations in summer and long lasting low temperatures in winter seems to be the most suitable stream for brown trout in our investigations.

In high altitudes, a temperature-dependent delayed development of the eggs may cause hatching to coincide with summer floodwaters resulting in lower survival rates of larvae. This seems to be the main reason for the absence of brown trout offspring in Trojer Almbach, although spawning was observed. In this high alpine stream the allochthonous brook trout can survive. This species is well adapted to harsh environments and hatching starts long before floodwaters arise. If only few brown trout offspring are able to survive in Trojer Almbach, an extinction of this population can be expected.

The Anlaufbach with glacially affected discharge represents a widespread type of alpine brown trout streams. Most of these show low production and small populations. A management of some of these alpine brown trout streams with very sensitive populations should be reconsidered and sometimes these streams are best left alone.

We do not know how strongly global warming will affect the alpine regions in the future, but there is a noticeable tendency towards more or heavier precipitations, resulting in high floodwaters. That might have a negative effect on many water bound organisms in alpine streams. The loss of some of these heavily affected streams as habitat for brown trout seems obvious.

Conclusion

This poster depicts an eight year monitoring period in three streams and shows expected and unexpected results. To prevent negative effects during monitoring, electro-fishing should only be randomly and cautiously executed in highly sensitive environments. Lacking any comparable long-time experiments in these harsh environments at altitudes between 1300 and 2000 meters a.s.l., this data makes no claim to be complete. The results underline the ability of autochthonous brown trout to adapt and show their limits as water-bound creatures in an extreme and quickly alternating climate.

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Erasing a biodiversity hot-spot: Open woodlands, veteran trees and mature forests succumb to forestry intensification, logging, and succession in Lower Morava UNESCO Biosphere Reserve

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Keywords

forest management, land use/land cover change, Lower Morava UNESCO Biosphere Reserve, pasture woodlands, Natura 2000, oak savanna, canopy closure, biodiversity

Aims

Open woodlands are biologically the richest habitat of temperate Europe that, however, nearly dissappaered from the continent. Their original cover and magnitude of their loss remain unknown. Here, we quantify the loss of open woodlands and assess the potential for their restoration in an internationally protected biodiversity hot-spot.

Location

Floodplain woodlands of lower Thaya and March rivers, Dolní Morava UNESCO Biosphere Reserve, Czech Republic, EU.

Methods

Aerial photographs from years 1938 and 2009 were used to analyze changes in forest canopy closure for the area of 146 km². Forestry maps and aerial photographs were used to analyze changes in forest age structure.

Results

Between 1938 and 2009, expansion of closed-canopy forest reduced open woodlands cover from 41% to 5.7% of total wooded area, or 68.5% to 14.1% in the state reserves respectively. Logging has led to a decrease in mature forest cover from 45% to 26% between 1990 and 2009. State reserves prevented logging, but not open woodlands loss.

Main conclusions

The magnitude of open woodlands loss parallels that of tropical habitats, but has gone unabated by nature conservation. Chances to restore open woodlands and conserve associated biodiversity in the internationally protected (e.g. UNESCO, Natura 2000), mostly state-owned, woodlands are being compromised by rapid logging. The logging eased neither after the UNESCO biosphere reserve declaration in 2003, nor after the adoption of EU legislation in 2004. The current intensity of logging within the UNESCO biosphere reserve and Natura 2000 sites surpasses that practiced during war times. It, however, lasts for decades, and slows down only when nothing to log remains. Our results point to the low ability of post-communist EU-members to conserve their biodiversity.

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Priorities for Research, Planning and Management of Sustainable Spatial Development and Protection in Serbia

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Abstract

This paper analyzes the problems in the tourism development and management of tourism in protected areas in Serbia. Practice in the EU suggests that the development and protection of the natural values, directs and achieves spatial definition and alignment mode using these zones and tourism potential. Managing spatial development of Serbia, according to the relevant principles and standards in the EU, based on the integrated spatial planning, environmental, economic, social and cultural factors of sustainable development. Presented with experience in design and features to improve the management and direction of sustainable development in Serbia, for instance priroitetnih mountain tourist destinations (Nature Park Stara Planina and Kopaonik National Park) and the most attractive part of the Danube corridor (National Park Đerdap). Addressed two questions: what are the possibilities for minimizing existing conflicts or those that may occur in the future, and what are the possibilities effectiveness of protected areas. Existing arrangements for protected areas in Serbia did not provide effective protection of natural and cultural heritage, tourism and local communities.

Keywords

mountain areas, Nature Park Stara planina, National Park Đerdap, research and spatial planning, sustainable development, management

Introduction

The area of nature conservation in Serbia is legally regulated by the Law on Nature Conservation and other legal acts which are either directly or indirectly related to nature. In addition, by-laws, particularly decisions on protected natural resources, the Law on Planning and Construction, as well as the Law on Tourism are also relevant for normative regulation of the area concerned. By adopting Spatial Plan of the Republic of Serbia – SPRS (in 1996 and 2010) and several spatial plans for the special purpose area (for protected natural resources Stara planina, Kopaonik, Djerdap, etc.), the system of spatial planning which enables harmonization of conflicting interests of tourism development and nature conservation has been established. Protected areas currently cover 5221 km^2 (i.e. 5,9%) with the tendency of increasing to 10% by 2015, that is to say 12% of the territory by 2012 (Figure 1). In the process of harmonization of legislative regulations related to the area of environmental protection, nature conservation and planning with the similar legislation of the European Union, it is necessary to take into account and apply the principles of international conventions signed by Serbia.

Sustainable tourism, according to the World Tourism Organisation (UNTWO), enables the management of resources which satisfies economic, social and esthetic needs, cherishes cultural integrity, essential ecological processes and biological diversity. Attracting tourists and investors in tourism contributes to economic development and social stability of local communities. However, mismanaged tourism development may result in permanent negative consequences on the environment, especially in economically vulnerable areas. For the purposes of promoting sustainable tourism, the Guidelines on Biodiversity and Tourism Development (CBD Secretariat, 2004) in protected areas, including fragile riparian and mountain ecosystems, have been defined. According to these Guidelines, sustainable tourism development requires a coordinated process of policy making, planning and management, based on the participatory approach. The precondition is development of institutional capacities and continual educational activities regarding the impact of tourism on biodiversity and good practice (*IBID*).

Sustainable development, protection and management of tourist areas in the Republic of Serbia rely upon the following principles (POPOVIĆ et al. 2012):

- Development: economic sustainability ; social and cultural appropriateness; ecological acceptability;
- Protection: organisation, planning and use of tourist areas with the application of standards of environmental protection and nature conservation; providing protection, presentation and integrated management of natural and cultural resources to the advantage of sustainable tourism; conservation and revitalisation of nature by means of income from tourism; and
- Planning: valorisation of natural and man-made tourist resources classified on the basis of their value and content.

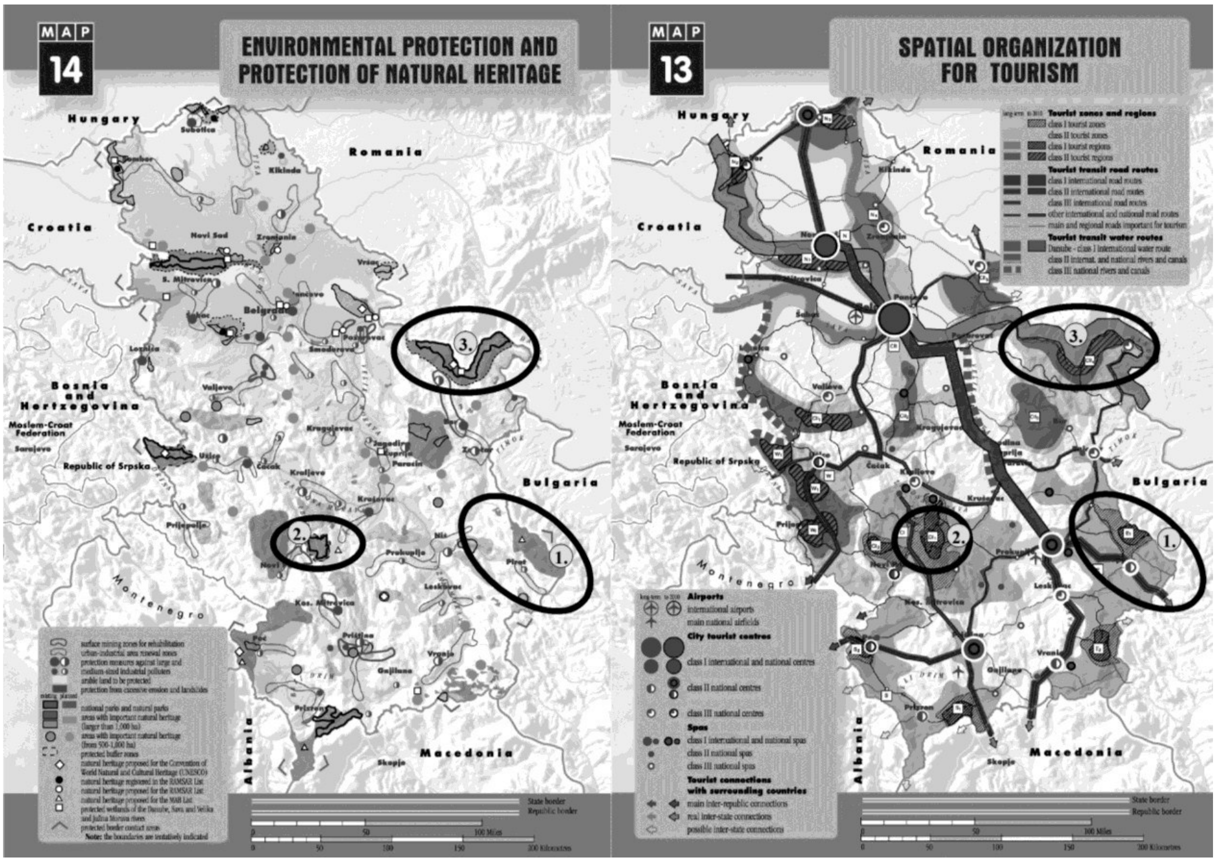

Figure 1: Areas planned for integral protection of nature and tourism development in Serbia: 1. Nature Park and tourist region Stara planina Mt., 2. National Park „Kopaonik“, and 3. National Park „Đerdap“ (Source: IAUS, Documentation of SPRS, 1996-2010)

In accordance with the mentioned principles, the main aim of tourism spatial development in Serbia has been defined, with the focus on spatial and ecological support to the realization of the concept of sustainable development, by compromise integration of planning and programme documents connected with tourism development and protection of areas and fulfillment of national and local level requirements as well as the market interests and conditions of cross-border and international cooperation. Cross-border cooperation, realised in the area of nature conservation and tourism development on: Stara planina with Bulgaria, Gornje Podunavlje with Hungary and Croatia, Donje Podunavlje with Romania and Bulgaria, Gornja Tisa with Hungary and the Tara river with BIH needs to be finalised. It is necessary to establish cross-border cooperation (within Euroregion) in the area of protection and development in new contact areas.

Examples of Sustainable Development and Protection of Areas

The most important parts of protected natural resources in Serbia, mountains and river banks, are at the same time planned for tourism development. The basic problem of tourism development lies not so much in the limitations of potential, as in the limitation arising from some other factors (infrastructural facilities, lack of compliance of laws, etc.). The processes of integration of development and protection ni Serbia have been decelerated by unresolved economic and system mechanisms, in addition to social and political issues (Maksin et al. 2011). Political, declarative support of market economy proved not to have created necessary stability and favourable business conditions, and to have slowed down development and protection. Unlike European practices, apart from realisation of economic and social justification and environmental appropriateness, the crucial issue in Serbia seems to be finding the manner in which tourism development will make it possible for local communities to survive in protected areas in order to avoid complete depopulation of these areas. This imposes the obligation of recognising previous errors and reconsidering the approach to development and protection along with the application of positive European practices.

The concept of development and protection of mountain regions in Serbia is based on previous accomplishments in the field of spatial planning and design and standards which are being enforced in the countries with higher level of development. This, first of all, refers to good case studies in the development and protection of the Alps tourist region. The activation of development resulted in the construction of attractive tourist places with efforts made to avoid irrepairable ecological damage in the course of their construction and exploitation. The process of development of mountain regions inevitably involves conditional degradation of the area parts due to the building of infrastructure and stationary facilities, and although this is impossible to avoid, but it can be managed by spatial plans. So far over 600 mountain resorts, equipped to meet the highest standards in terms of infrastructure, have been built in the European mountain regions. Development of mountain tourist destinations must be based on integral planning, with particular attention to economic restrictions with respect to financial support, and natural limitations, especially concerning ecological protection and climate changes.

Mountain region od Serbia, which implies the height of 600 m or more, covers 34% of the area, i.e. approximately 29.850 km² (Figure 2.). Regarding development potentials, high mountain areas lead the way (over 1500m) with surrounding areas (1000-1500m), which account for about 11% of the area, i.e. 9680 km². High mountain regions of national importance include: Kopaonik, Stara planina, Krajište with the Vlasina river, Golija, Šar-planina and Prokletije.

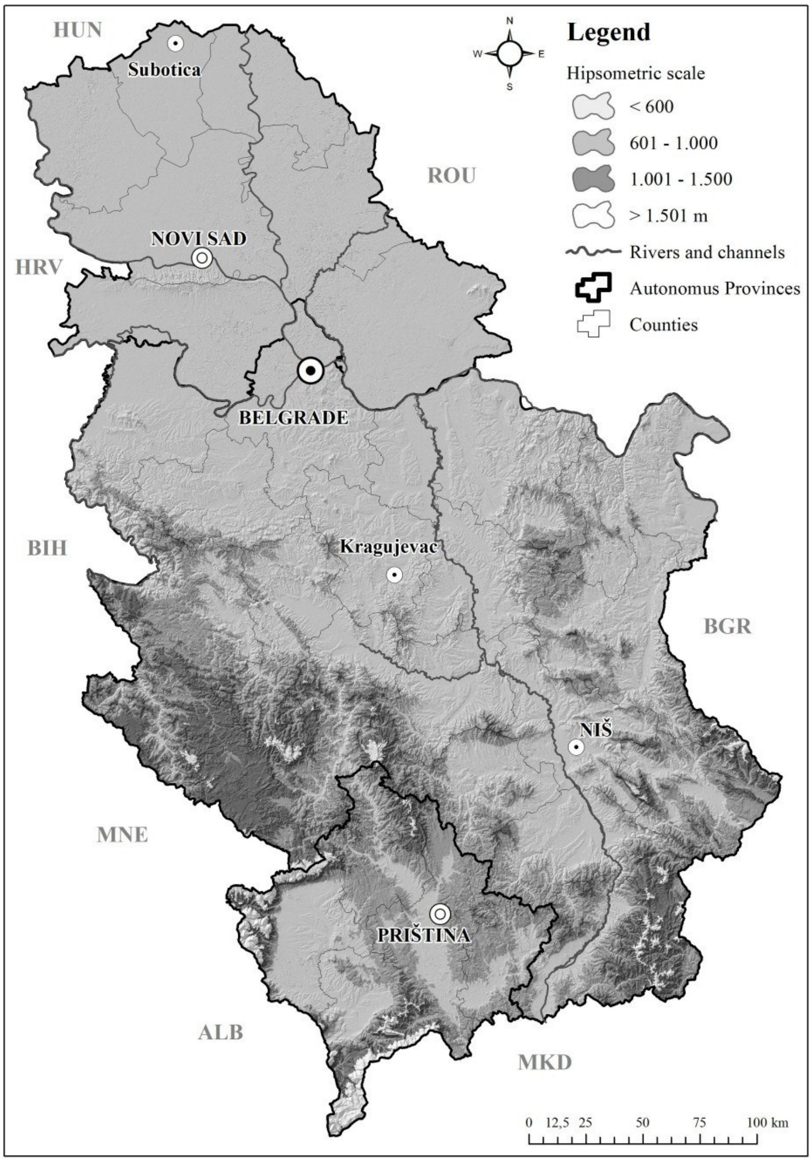

Figure 2: Mountain areas of Serbia

The Republic of Serbia has great potential for the development of mountain regions a part of which has been activated. Whereas in the countries with higher level of development mountains represent the areas not lagging behind other parts and there are special funds for development programmes of mountain communities, use and protection of resources, Serbian mountains are characterised as undeveloped areas, with severe issues.

Spatial and environmental limitations

of sustainable development involve: peripheral geographical location and unfavourable transport connections; inadequate infrastructure, insufficient nature protection and similar. The key problems include: the space characterised by disbalance between tourist capacities and infrastructural facilities; disappearance of agriculture and depopulation of mountain villages; the appearance of unplanned exploitation of forests; threats for ecosystems and biodiversity caused by negative influences of climate changes. Part of the problem is provoked by one-sided interpretation of sustainable development in the form of placing priority on nature conservation in protected areas. Coordination of protection and use of resources poses a particularly serious challenge for sustainable development of mountain regions of Serbia (Krunić et al. 2010). All important mountains enjoy some status of protected natural resources:

- national parks: Kopaonik, Šar-planina and Golija;
- nature parks: Stara planina and Golija;
- special nature reserves: Goč-Gvozdac, Peštersko polje; certain locations on Mokra Gora – Tutin, etc.;
- araes planned for protection: Valjevske planine, Kučajske planine, Zlatibor, Jadovnik, etc.

Limitations in the management of sustainable development

are consequences of unadapted legal basis for planning, inadequate organisation of institutions and administrative and economic division of mountain region. This results in uncoordinated development. A special problem lies in individual views and decisions on development, ranging from municipalities interested in the development of their part of a mountain to various industrial branches whose particular interests are usually not in line with other activities and nature protection.

The SPRS (1996) regards mountains as tourist places and areas with natural heritage and resources, which sets strategic framework for sustainable development and protection. The new SPRS (2010) confirmed the continuation of planned and development treatment of tourist areas, with emphasis on high mountain areas (Stara planina, Kopaonik, etc.) and river corridors (The Danube, the Sava, the Drina, etc.).

Special features of Stara planina which had an impact on the creation of spatial plan include: Nature park (with Bulgarian part of the mountain it is a candidate for UNESCO MaB); high mountain region with potentials for development of tourism throughout the year, etc. Simultaneously with making of plans, the activities on the preparation of the Regulation on Protection of Nature Park, Master Plan of Tourism and construction of ski tourist centre were performed. Adoption of Spatial Plan in 2008 provided planned basis for: the protection of Nature park by means of defining nature conservation regimes; reserving space for tourism development, improving transport connections; enhancing the quality of life in local communities, etc.

During the preparation of Spatial Plan, conflicting interests of protection of natural resources on one side, and tourism development on the other, were prominent. In the process of harmonization, a compromise solution for nature protection and tourism development was reached thanks to cooperation and coordination of activities of IAUS and competent institutions for protection of natural heritage. By this, the requirements of nature conservation were fulfilled and the construction of tourist and recreational infrastructure at heights from 1100-2169m, which is a key tourist zone for the development of ski centres was enabled.

By concept of dispersive development and construction which has been applied in most parts of Stara planina, planning solutions will not have an unfavourable influence on the environment which cannot be kept under control (MAKSIN-MIĆIĆ et al. 2009). However, in one part of Stara planina the applied concept of excessive construction in the tourist resort "Jabučko Ravnište" may have an adverse effect on nature, especially when it comes to water supply, disposal of waste waters etc.

A similar approach to tourism planning and nature conservation was used in case of National park "Kopaonik". Main goals were: harmonization with limited capacity of space and natural resources for hosting visitors; preservation of natural resources and reduction of waste production, realisation of new development potentials of tourism with preservation and improvement of natural and cultural heritage; and enforcement of the principle of responsibility in case of caused damage and provision of appropriate compensation.

In terms of tourism, the most attractive part of the Danube flow through Serbia is Donje Podunavlje, i.e. National park "Djerdap", spatial plan for which has also been made. Tourist, natural and cultural potentials of Djerdap make it the leading protected area of the Danube river basin in Europe. It can be networked with other attractive tourist areas, especially on the Romanian side of the river bank zone. Exceptional natural heritage, common history and tradition, valuable cultural heritage are all reflections of intercultural influences and connections of different communities in the Djerdap region and its regional and transborder surroundings (MAKSIN et al. 2012).

National park "Djerdap" has been pronounced as IBA (Important Bird Areas), IPA (Important Plant Areas) and PBA (Prime Butterfly Areas). It is a part of the EMERALD network of areas (Emerald Network of Areas of Special Conservation Interest – AsCI) in Serbia, and potentially the NATURA 2000 network. The area is listed on the Tentaive List of UNESCO World Heritage (WHC 2011), the list of Carphatian areas and has been included in the programme of European Green Belt Project. It has been nominated for the biosphere reserve of UNESCO MaB, and the flow of Danube and its riverbank zone for the Ramsar area. The initiative for establishing of common natural resource of cross-border area of Djerdap has been started and it will include National park "Djerdap" on Serbian and Nature park "Portile de Fier" on Romanian side.

Due to terrain configuration and peripheral position, no big urban centres have been formed nor has there been significant industrial development in the Djerdap part of the Danube area. The construction of dams Djerdap I and Djerdap II and formation of the lake have influenced the changes of seaworthiness on the river and contributed to the improvement of availability, infrastructural facilities, development of new industrial branches (power supply, tourism, etc.). The tourist offer is not sufficiently developed and improved, not to mention connected. Spatial plan includes integral concept of protection and development. Tourism will represent the basic and alternative branch of economy and a kind of compensation to local inhabitants for various development limitations imposed by regimes of protection of natural and cultural heritage and resources. Presentation and promotion of natural and cultural values of Djerdap, development of Danube aquatorium with the most attractive section of the nautical waterway, tourist settlements in the river bank zone and hilly and mountainous zones all have extreme importance for the tourism development of the mentioned area.

Concluding Remarks

Tourism, spatial development and management of protected araes in Serbia faces several challenges. The most important parts of mountains and river banks in Serbia have certain kind of status of protected natural resources or they are in the process of gaining one. The problem arises due to potential or manifested conflict, most frequently between nature conservation and tourism development. Prevention and relativisation of this conflict is formally obtained by means of spatial differentiation of protected zones from the ones planned for development and, in particular, balansing activation od tourist potential and nature conservation regimes.

In line with the EU trends, tourism represents one of the most dynamic areas of development, especially in ecologically preserved and economically underdeveloped areas. Priorities of tourism as a branch of industry are aimed at preservation and improvement of natural and cultural heritage, that is to say at defining common interest with regard to rational use and space management, which is a precondition of sustainable development. Continuation and further enhancement of the already started process of tourism development in the instances of mountain regions and Podunavlje in Serbia do not appear to be the antithesis of protection; on the contrary, they are complementary activities.

Regarding the elements of management system in protected areas in Serbia, there exist Spatial Plan of the Republic of Serbia, a set of spatial plans for the special purpose area and various programmes of development and protection which cannot adequately function on their own without the elements of development guidance, system conditions or correlation with them. The application of planning documents will depend on and require government support and private initiative, efficiency in the management of development and protection as well as giving equal consideration to economic, spatial, ecological and social factors of development. The establishing of cooperation with the Institute for Nature Conservation of Serbia during which harmonization of planning solutions for the areas of protected natural resources with the areas of tourism development was done, had special relevance in the process of making spatial plans for protected areas of Serbia (Stara planina, Kopaonik, Djerdap, etc).

Aknowledgements

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Conference Volume | 5th Symposium for Research in Protected Areas | 10 to 12 June 2013, Mittersill | pages 521 - 522

Characterization of the six recent woodpecker species in the Nationalpark Kalkalpen and the development of a habitat-model in GIS to evaluate the living space of woodpeckers in the area of the Nationalpark

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Abstract

The objective of the diploma thesis was to develop a habitat-model of 6 woodpecker species that recently occur in the Nationalpark Kalkalpen in Upper Austria. The modelis based on expert knowledge and literature review. The model, vicarious for the Three-toed Woodpecker (*Picoides tridactylus*) and the Black Woodpecker (*Dryocopus martius*), has been developed with a Geographic Information System (GIS) and has been evaluated with real woodpecker detections in the investigation area. The habitat model supplies a forecast quality of 94,34% with a total of 107 Three-toed Woodpecker records as potential breeding and foraging habitats in the Nationalpark area. In case of the Black Woodpecker with 362 records in potential breeding and foraging areas, the model delivers a forecast quality of 91,99%.

Also, the model should serve as an extrapolation tool in a Natura-2000 birdmapping in the Nationalpark, to determine the population density of the investigated species.

Keywords

Geographic Information System (GIS), habitat-model, Nationalpark OÖ Kalkalpen, woodpeckers;

Introduction

Many woodpeckers are called "keystone species" for their crucial role in creating habitats that suit other woodland wildlife. Abandoned woodpecker nest-holes become important nests or roosts for many birds, small mammals and invertebrates. In general, woodpeckers are bio-indicators of natural forests. Six out of ten breeding woodpeckers in Austria inhabit the Nationalpark Kalkalpen and therefore they represent an important flagship species for the institution.

Data & Methods

The basis for the model construction has been established upon data research of the six current woodpecker occurrences in the Nationalpark, a characterization and evaluation of the limited habitat factors by literature research, and additionally through to the knowledge of an expert. The used data were gathered out of the Nationalpark data pool (BioOffice) and the ZOBODAT (Zoological Botanical Database Linz). The used habitat suitability modeling technique is based on literature review and an expert opinion (Beier et al. 2001), and generally follows the ideas found in the 1980 U.S. Fish and Wildlife Service publication "Habitat Evaluation Procedures Handbook" (U.S. Fish and Wildlife Service 1980). Unlike statistic-based models this method is relatively easy to create, doesn't require costly new collections of detailed field data for all species in the investigation area and can be applied to multiple study areas. The habitat model is based on several factors like elevation, slope, topographic conditions, stand age and the tree species composition. These factors are raster layers with the same resolution (25metres), whereby within each factor several categories are classified. Multiple habitat factors are combined into an overall habitat suitability score for each raster pixel. An important step is to assign weights to each habitat factor that reflect their relative importance for a species. The result is a score per pixel from 0 (absolute non-habitat) up to 10 (best habitat, highest survival and reproductive success).

Result & Discussion

The results of the raw data research in the Nationalpark data pool and the ZOBODAT prove 1435 woodpecker records from 1982 – 2008. According to these results, the most frequent observed woodpecker taxon in the Nationalpark is the Black Woodpecker with 658 records, followed by the Three-toed Woodpecker (n=250), the Grey-headed Woodpecker (n=195), the Great Spotted Woodpecker (n=155) and the White-backed Woodpecker with 124 records. The Green Woodpecker (n=51) plays a subordinated role in the Nationalpark area.

The habitat model supplies a forecast quality of 94,34% with a total of 107 Three-toed Woodpecker records as potential breeding and foraging habitats in the Nationalpark area. In case of the Black Woodpecker with 362 proofs in potential breeding and foraging areas the model delivers a forecast quality of 91,99%. With the highest breeding respectively survival success (habitat class 9-10),24% of the Nationalpark surface can be allocated as potential optimal habitats for the Three-toed Woodpecker. 58% of the Nationalpark area are allocated as potential Black Woodpecker habitats with high to highest breeding respectively survival success. Including the usable, but suboptimal habitats, the potential dispersion of the Black Woodpecker increases up to 16.700 hectares (80%) of the Nationalpark surface.

The Three-toed Woodpecker and the Black Woodpecker require very different demands on their habitat. The Three-toed Woodpecker habitat map shows a hot-spot distribution which results from a high degree of specialization on the living-space. It needs old, autochthonous coniferous forests with deadwood. The Black Woodpecker is a generalist and the habitat map shows a homogeneous distribution among the Nationalpark area, except the karst plateaus of the Sengsengebirge and Größtenberg.

In 2011 the habitat model was applied in practice within the Natura-2000 birdmapping project (WEIßMAIR 2011) in the Nationalpark Kalkalpen. The model should serve as an extrapolation tool to determine the population density of the investigated species. Habitat models were created for all flycatchers, owls and woodpeckers that are currently living in the Nationalpark area. Compared to the results of the diploma thesis, the forecast quality of the Three-toed Woodpecker fell by 2,45% to 91,89%.

Conclusion and Future Work

A model tries to estimate the nature but it is not able to represent it. Every habitat model is as good as the input data it uses. The discussed habitat model also shows some weak points. The data quality of the stand age and the tree species composition has its deficits in some areas. A data layer with the information of deadwood could improve the forecast quality of the model. Furthermore, the model doesn't consider any competition for resources, such as food or breeding caves, between the different Woodpecker taxa. In the future the evaluated habitat model should serve the Nationalpark institution as planning base for further management decisions, e.g. monitoring.

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A Perspective on Ecological Corridor for Maintaining Healthy Ecological Processes in the Caucasus

Cristian S. Montalvo Mancheno, Giorgi Nakhutsrishvili & Nugzar Zazanashvili

Abstract

Unless changes in the current "island spatial structure" of protected area systems are thought over, it is quite likely that protected areas will fail in fulfilling their objectives. This is because they will not be able to respond well just by themselves to threats such as a rapid change of climate, increment in habitat destruction and fragmentation due to population growth, etc. Hence, governments have committed not just to further increasing protected area territories but also to create networks of protected areas, which should be integrated into the wider landscape.

This approach to biodiversity conservation has been widely recognized by conservationists and scientists. Many approaches for planning and managing conservation of biodiversity at a regional and landscape levels have been developed to fulfill this recommendation (e.g., Natura 2000, Emerald Network, etc.); and corridors have been recognized as a key element in all of them. Nevertheless, use of corridors has been much contested, even among members of the same group who called for them. Hence, the purpose of this paper was to outline a perspective on ecological corridors based on current understanding on this conservation measure.

Its conceptualization was driven by the goal of developing a measure that could serve to conserve biodiversity patterns and processes in the Caucasus.

Keywords

Caucasus, protected areas, ecological corridors, landscape planning

Introduction

The Caucasus is distinguished by its uniqueness and high level of biodiversity. However, biodiversity of the Caucasus region is under strong human impact, which poses a threat not only to species but also to ecological processes. For example, tree line vegetation has been strongly degraded and lowered (at an average of 200–400 m.) in the Central part of the Greater Caucasus because of long-term overgrazing, tree cutting, etc. (Nakhutsrishvili 1999). As a result, the Caucasus region was identified as one of the 34 Earth's biologically richest and most endangered biodiversity hotspots (Zazanashvili et al. 2004).

There is a long tradition of nature conservation in the Caucasus. The first strict nature reserve in the region was created in 1912 in Lagodekhi gorge on the south-eastern slopes of the Greater Caucasus. Strict protection was the approach used during Soviet time. For instance, after the collapse of the Soviet Union the protected areas system of Georgia consisted poorly of 15 strict nature reserves, which covered 2.4 per cent of the country. Fortunately and thanks to support from international organization (e.g., World Wildlife Fund - WWF and German Bank for Reconstruction and Development - KfW), more comprehensive protected area systems have been developing in the countries of the Caucasus.

In the Caucasus, conservation efforts have been driven by the Ecological Conservation Plan since 2001. This strategic document recognized the importance of establishing ecological networks to ensure the conservation of Caucasus' biodiversity. Its development has primarily focused on ensuring that high valuable biodiversity areas are well conserved by improving the management of existing protected areas (PAs), setting aside new PAs and restoring deteriorated habitats (Montalvo Mancheno 2012). Although the implementation of these activities has been successful for the past 12 years and has also considered more urgent and complex conservation issues (e.g., developing a strategic document for responding to impacts of global climate change on forests in the Southern Caucasus (Zazanashvili et al. 2011)), all components of an ecological network still need to be thought through for the Caucasus. Hence, ecological corridor has been put forward as the next conservation measure that needs to be developed.

A perspective on ecological corridor for the Caucasus

Driven by the goal of developing a conservation measure that will help conserve biodiversity patterns and processes, we believe that the purpose of ecological corridors for the Caucasus must be to maintain or increase connectivity. In order to achieve this, planning and design of ecological corridors must be at a landscape level and considered the different structural components of an ecological network.

When thinking about connectivity, we concur with KROSBY et al. (2010) that it refers to management actions that facilitate or enhance the flow of organisms and ecological processes. Based on this understanding, we assume that connectivity is an attribute of an entire landscape that is influence by the spatial arrangement of different physical elements and the features associated with their layout in a landscape, and by the behavioral responses of species and processes to those elements in the landscape (i.e., structural component and functional component, respectively). Although both definitions are the main functional aspects of the landscapes (JONGMAN et al. 2004), it does not necessarily mean that conserving structural connectivity ensures functional connectivity (TISCHENDORF & FAHRIG 2000). Nevertheless, we agree with CHETKIEWICZ et al. (2006) that using biodiversity patterns as surrogates for biodiversity processes seems like a reasonable mapping approach to design a suitable conservation measure (i.e., ecological corridor) in an area where uncertainty exists.

In the Caucasus, a regional approach was firstly used to identify important areas where urgent conservation actions are needed. Nevertheless, conservation efforts have reached a tipping point where more detailed information is necessary to ensure persistence of biodiversity (MONTALVO MANCHENO 2012). Consequently, landscape has been thought of as the scale for developing ecological corridors.

Landscape was selected as planning level because it represents a kilometers-wide cluster of repeated spatial elements (i.e., a mosaic)–including local ecosystems and land uses–that manifests an ecological unity (FORMAN 1995). As a mosaic, our perspective on ecological corridor goes away from the artificial dichotomy of habitat and non-habitat (CHETKIEWICZ et al. 2006; MCINTYRE & HOBBS 1999). Instead, planning of ecological corridors is perceived as a spectrum of habitats occupied by organism and where ecological processes can persist. This perception is supported by FISCHER & LINDENMAYER (2007), who stated that even though landscape connectivity is a human perception of connectedness, it might translate into habitat connectivity, and it tends to positively facilitate some ecological processes. Movement–not restricted to animals but extended to processes (e.g., pollination)–also happens in a mosaic of habitats with different levels of suitability (MCINTYRE & BARRETT 1992). Therefore, we agree with MCINTYRE & HOBBS (1999) that a particular landscape should be analyzed along a continuum of its alteration, in which destruction defines the state of landscape and modification describes the state of lasting habitat.

All the discussed above about the purpose of ecological corridors and the landscape planning approach needed shows that our perspective on ecological corridors for the Caucasus have to include the habitat function in addition to the movement function, as argued by BERGÉS et al. (2011). In addition, this constant shifting mosaic of habitats with varying suitability will require a range of management actions. Hence, to keep a guiding picture when planning ecological corridors, we adopt the structural configuration of ecological networks proposed by BENNETT & JO MULONGOY (2006) (i.e., core areas, different types of connectivity mechanisms, buffer zones, and sustainable-use areas) but add rehabilitation areas, as another management action to be considered.

Because in our perspective on ecological corridors host a varying degree of human use related to biodiversity, which in turn affects biodiversity patterns and processes (HANSEN & DEFRIES 2007; MCINTYRE & HOBBS 1999), we agree with VAN DER WINDT & SWART (2008) that the so-called social robustness comes to play an important role when planning and designing large-scale conservation measures. Therefore, socio-economic and land-use pattern analyses have to be carried out in the whole extend of any ecological corridor to ensure that efforts to conserve biodiversity patterns and processes does not compete with but supports local population needs and desires.

Discussion and Conclusion

Even a hard preservation such as Aldo Leopold recognized that the sole action of keeping PAs free of development is not enough for achieving conservation of biodiversity. In the Caucasus, PAs has significantly increased since 2001, which concur with KROSBY et al. (2010) recommendation that establishing and strengthening PAs should be the first conservation action before developing large-scale efforts to maintain or increase landscape connectivity. Moreover, decision and policy makers from the Caucasus perceive that there is no more space for setting aside new territories under legal protection. Hence, in our perspective on ecological corridors we have embraced that it is not and will not be possible to set aside new PAs for all natural lands.

Based on this understanding, efforts and resources have to be allocated to maintain least modified habitat (i.e., existing natural corridors) rather than to restore degraded territories (BERGÉS et al. 2011; MCINTYRE & HOBBS 1999). This approach could be applied in the Caucasus because although the forming Soviet planning system has contributed to the serve degradation of certain areas in Eastern Europe, it has at the same time helped conserve others (JONGMAN et al. 2004).

The success of our perspective on ecological corridors, as for any large-scale conservation effort, has to do a lot with its implementation. This implies to carry out a processes where the whole spectrum of stakeholders (i.e., from policy makers at national levels to local farmers) are actively involved. We believe that this can be achieved in the region, because the transitional process facing Eastern European countries has not just resulted in challenges, but also in opportunities for changes within states' functioning at the economic, institutional, legislative and administrative levels (JONGMAN et al. 2004).

Even in a complete favorable environment, implementation needs a logic structure. Hence, when implementing ecological corridors, it will be essential to frame the whole process. There exists various theoretical frameworks, but based on the success in a similar topic and biome there are two that stand out: Ecological Sustainable Land Management (KNIGHT & COWLING 2003) and Adaptive Collaborative Management (PRABHU et al. 2007). Likewise, there is an ongoing work, leaded by IUCN Environmental Law Centre and Global Programme on Protected Areas, for advancing connectivity conservation through law; and therefore, their lessons learned and expertise should be kept in mind when seeking to incorporate ecological corridor and connectivity conservation into the legislation of the countries in the Caucasus region

We believe that acknowledging shortcomings/limitations of our perspective on ecological corridors is also important, because it will help us keep in mind that there is space for improvement. In other words, we acknowledge that our perspective is not the final answer to long-term conservation of biodiversity in the Caucasus or anywhere else.

Like similar conservation measures, our perspective will not be able to encompass all ecological processes functioning in the pilot area because its limits are based on a human perception of unity (i.e., landscape). Lack of information will become an important barrier to overcome in the Caucasus. Information for all species does not exist, and for those species that information does exist, mainly large mammals and some threatened species, either its reliability is questionable (e.g., species distribution points) or it is outdated (e.g., pasture conditions). There are no studies on the biological and evolutionary processes in the pilot area or even for the Caucasus region. Likewise, land-use patterns and socio-economic data are outdated and even in some cases hard to access due to bureaucratic procedures. These constraints highlight the importance of having a truly participatory process for designing and setting on the ground ecological corridors in the Caucasus.

For us, an ecological corridor is not just a measure that can help ensure persistence of biodiversity, which has been acknowledged as an important aspect for achieving long-term conservation and has proved to be even more challenging under any climate change scenery, but also a strategy that could help balance the need between natural resource use and conservation. The challenge will be to keep ecosystems' rates, scales and intensities of change within historic ranges in a world increasingly dominated by human activities. Our perspective is the first attempt of such effort in the Caucasus. Therefore, our perspective on ecological corridors needs to be piloted, and like similar conservation measures implemented in other parts of the world it will have to be evaluated during and after implementation. This will allow us to gain insight on the planning process for developing similar conservation measure in the Caucasus region, primarily, but maybe also be useful for other regions.

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Societal research perspectives on protected areas in Europe: priorities for future research[1]

Ingo Mose

Keywords

Large protected areas, paradigm change, societal challenges, conceptualization of research

Abstract

Large protected areas across Europe have experienced a far reaching change of paradigm over recent years. This has been widely discussed and recognized of crucial importance. Accordingly managed large protected areas today are faced with a multitude of tasks many of which go well beyond conservation and landscape protection, especially societal demands for regional development and an active role of protected areas in shaping the future of their regions. As a result, protected areas research actually needs to focus much more on the involvement of protected areas in regional development and the societal challenges that are connected with the new demands arising.

Drawing on the results of a European expert workshop held in cooperation with ALPARC and ISCAR in St. Pierre de Chartreuse, France in October 2011, the author is going to reflect on the current state of research, point out some obvious research gaps and neglected issues, and, finally, present six priority areas that have been identified for future societal research on protected areas: first, the material and immaterial benefits of protected areas; second, tourism and recreation; third, innovations in regional economy geared towards conservation and landscape protection goals; fourth, images and regional identities; fifth, handling regional and global change; and sixth, participation and governance.

The research areas listed above give clear indication for the far-reaching consequences the paradigm change holds out for conceptualizing protected areas research. What is especially required for future research is a stronger orientation on interdisciplinarity, more comparative analyses on European scale, and greater involvement of researchers in transdisciplinary networks at the interface of research and practice to provide "products" that can be used by protected areas management.

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Conference Volume	5th Symposium **for Research in Protected Areas** 10 to 12 June 2013, Mittersill	pages 529 - 530

Prioritization of river protection measures and strategies

S. Muhar, M. Poppe, S. Preis, M. Jungwirth, S. Schmutz

Keywords

river, conservation, protection, prioritization, criteria, scale, planning instrument

Abstract

The use of running waters is further being intensified on both global and national levels. This process is affecting increasingly aquatic ecosystems and is threatening those ecosystems of running water bodies, which are still intact although already substantially reduced in number and size.

In contrast to modern legislative and policy strategies at both the international and national level, which provide at least theoretically a useful framework for conservation and restoration there are still great shortcomings in addressing conservation in a systematic manner. Protecting biota and their habitats requires controlling upstream river sections and catchments, the surrounding land, and, concerning migrating aquatic fauna, downstream reaches. Accordingly, beyond the traditional criteria that represent 'rarity' or 'naturalness', adequate criteria must be chosen to capture freshwater dynamics, processes and threats at a catchment scale.

Consequently, first priority in freshwater conservation has to be dedicated to the assessment of conservation value and protection in the form of a comprehensive, adequate and representative network of conservation areas and the identification of threatening processes and protection against these. New approaches are being discussed for the first time both on the European and national levels to develop supra regional and interdisciplinary pre-planning instruments for this coordination and the subsequent prioritization process. The aim is to identify river sections where the maintenance and protection of ecological sensitive river stretches takes priority.

In this presentation we discuss protection values and criteria for running waters following the principles mentioned above. The process of prioritizing river protection measures and strategies is exemplified by the help of case studies.

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Owls in Floodplain Forests in Eastern Austria: Habitat Use and Population Density

Christina Nagl, Karl Reiter & Christian H. Schulze

Abstract

Due to their trophic position owls represent important indicator species for an intact environment. However, little is known about the population density and habitat preferences of owls in European floodplain forest ecosystems. Therefore, we mapped owl territories and analyzed the habitat use of the Tawny Owl in the largest remaining floodplain forests in Central Europe, located along Danube River and Morava River in Eastern Austria. The studied floodplain forests are embedded in an agricultural landscape matrix and are characterized by different flood dynamics, forest structure and forest management measures. Using a point-count methodology, owls were surveyed in March-May 2012 in an area covering approximately 100 km² along the Danube River east of Vienna (the largest part of this area belongs to the Donau-Auen National Park) and in an area of approx. 10 km² along Morava River, Lower Austria. The 188 observation points were located at a distance of >0.5 km from each other and covered the entire study area. Three owl species, Tawny Owl (*Strix aluco*), Long-Eared Owl (*Asio otus*) and Eagle Owl (*Bubo bubo*), were recorded in the surveyed floodplain forests with at total of 99, 7 and 5 identified territories, respectively. In regard to the Tawny Owl, the likelihood of occurrence at census points increased significantly with the increase of deciduous forest coverage (within a 200 m radius around census points). Apparently, the occurrence of Tawny Owl was not affected by flooding regime and the proximity of Eagle Owl territories. The high territory densities of Tawny Owl in the Nature Reserve March floodplain (1.6 territories/km²) and the Donau-Auen National Park (1.0 territories/km²) indicate a high habitat quality of the studied floodplain forests for owls.

Keywords

Tawny Owl, Long-Eared Owl, Eagle Owl, habitat use, habitat quality, population density, floodplain ecosystem

Introduction

The floodplain forests along Danube River and Morava River in Eastern Austria represent one of the largest remaining floodplain ecosystems in Central Europe and are characterized by one of the region's last free-flowing river stretches (MANZANO 2000). In this study we investigated the importance of this ecosystem for owls. Three owl species are known to breed in the region's floodplain forests: The Tawny Owl (*Strix aluco*), the Long-Eared Owl (*Asio otus*) and the Eagle Owl (*Bubo bubo*) (ZUNA-KRATKY et al. 2000). The Tawny Owl, a cavity-nesting and hence forest-dependent species, has a low ecological specialization (HIRONS 1985, MEBS & SCHERZINGER 2008). Long-Eared Owls prefer forest edge habitats and small woods surrounded by open country (MARTINEZ & ZUBEROGOITIA 2004, MEBS & SCHERZINGER 2008). They can strongly depend on old corvine nests for breeding and thereby avoiding Tawny Owl's territories (SCHUSTER 1996). After having almost vanished from large parts of its former distribution area due to the hunting and persecution by humans, the Eagle Owl has during the last decades successfully re-colonized in the Pannonian region, which includes the lowland floodplain forests along the Danube and Morava River (GRÜLL et al. 2010). Watercourses and an irregular topography combined with a heterogeneous landscape composition are preferred, whereas the species avoid areas with a high extent of human disturbance (ORTEGO 2007). The colonization of the Danube-Morava floodplains by Eagle Owls may lead to an increased intraguild predation on smaller predatory birds such as the Tawny Owl, which is frequently recorded as Eagle Owl prey (e.g. SERGIO et al. 2007).

The high hydrological dynamic of floodplain ecosystems creates a broad spectrum of habitats and has significant effects on the abundance of small mammals (WIJNHOVEN et al. 2005). Both most likely affect the value of floodplains as breeding and hunting habitats for owls. Beside natural flood dynamics, varied forest management measures affect forest structure, tree species composition and the availability of tree-cavities, which represent important nesting sites for tree hole-breeding owls. Due to their special breeding and food requirements high densities of owls can indicate high habitat quality (MEBS & SCHERZINGER 2008).

Due to a lack of information on their occurrence and population density in Central European floodplain forests, we made extensive owl surveys in two protected areas along Danube and Morava River in Eastern Austria, where all three owl species occur. The Tawny Owl is the most abundant owl species in Austria (BERG 1992), followed by the Long-Eared Owl (MEBS & SCHERZINGER 2008). The Eagle Owl is continuously colonizing lowland floodplain forests in Eastern Austria (ZUNA-KRATKY 2000). Besides estimating the population densities for all three owl species in floodplain forests, we assessed the effects of landscape composition and flooding regime on the habitat use of the most abundant species, the Tawny Owl.

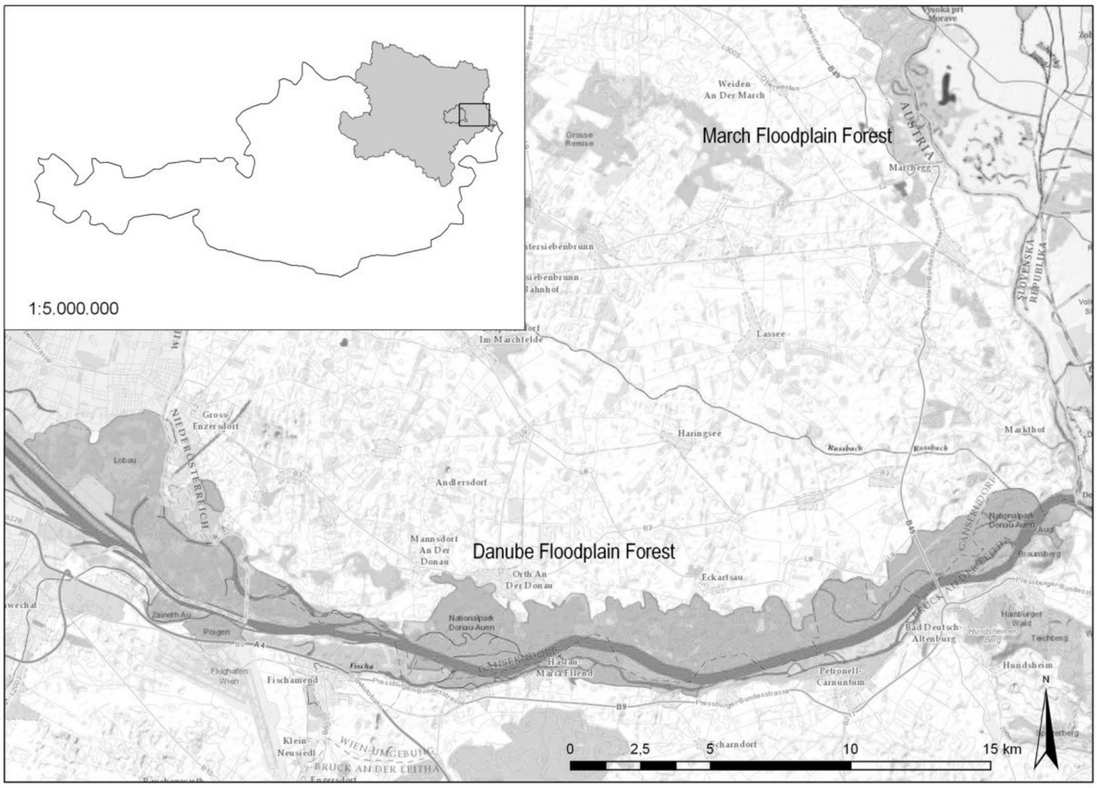

Figure 1: Study area along Danube and Morava River. Floodplain forest areas are marked dark grey. Source: Esri.

Methods

Study area

The present study was conducted in lowland floodplain forests in Eastern Austria along the Danube and the Morava River (Figure 1). The study area covers 109 km². The largest part of 93 km² belongs to the Donau-Auen National Park and a further 6 km² of non-protected forest at Petronell-Carnuntum are attached to the southern margin of the national park. The remaining area of 10 km² is located in the WWF-Nature Reserve March-Auen. A detailed description of the tree species composition of the floodplain forests along the rivers Danube and Morava can be found in TIEFENBACH et al. (1998) and BAUMGARTNER et al. (1999), respectively. The Danube-Morava-floodplain is characterized by two different flooding regimes: spring floods along the river Morava and summer floods along the river Danube (ZUNA-KRATKY et al. 2000, TIEFENBACH et al. 1998).

Owl surveys

We used a point-count methodology to survey the owls in our study area. The 188 census points were located at a minimum distance of 0.5 km from each other and were more-or-less equally distributed over the total study area. All observation points were visited once between 1 March and 5 May 2012. Playbacks (duration: 1 min.; repeated 2-3 times) of male owls were used to stimulate the calling of territorial birds. The observation time at each census point was 30 minutes (REDPATH 1994).

Habitat variables

For each observation point the habitat composition was quantified within a radius of 200 m. A total of six habitat types were classified: deciduous forest, mixed forest, coniferous forest, grassland, agricultural area and area of water bodies. For each habitat type the percentage of area covered within the radius of 200 m around census points was measured. Therefore, we used landscape classifications according to WRBKA et al. (2003). For each observation point habitat diversity was quantified by the Shannon-Wiener index.

Data analysis

All owl records were plotted on maps of the study area to allow for a preliminary visual evaluation of the spatial distribution of the three owl species in our study area. Subsequently, population densities were calculated for the entire study area and, separately, for floodplain forests along Danube and Morava River. For the Danube floodplain system which was divided into flooded and non-flooded forest areas by a levee, we tested for differences in the occurrence frequency of Tawny Owl in both forest types by using a chi-square test.

Only the Tawny Owl was abundant enough to evaluate the importance of habitat composition on the species' occurrence. Due to strong multi-collinearity of habitat variables, we calculated a principal component analysis (PCA) on all variables. A generalized linear mixed model (GLMM) was calculated to evaluate the potential of our landscape variables (factors 1-3 of the calculated PCA), region (Danube and Morava floodplain forest), flooding regime and the presence of Eagle Owls for predicting the occurrence of Tawny Owls at census points. Occurrence probability predicted by the GLMM was then plotted against potentially important habitat variables. Furthermore, their effect on the occurrence of Tawny Owl was described by logistic regression functions.

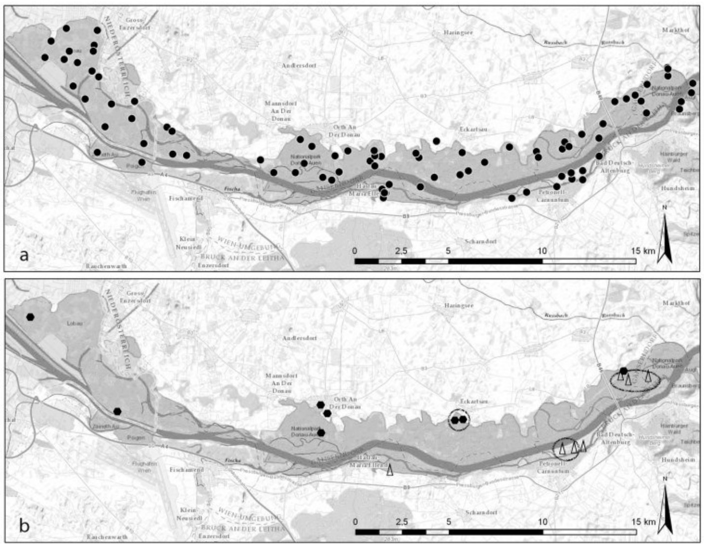

Figure 2: Occurrence of (a) *S. aluco* (●), (b) *A. otus* (⬣) and *B. bubo* (Δ) in the study area along Danube River in spring 2012. Circles merge observations most likely referring to one territory.

Results

<u>Population densities</u>

The most abundant owl species *S. aluco* was recorded in the whole study area at 56.7 % of all observation points (Figure 2a, 3a). The frequency of occurrence at census points was significantly higher at the Moravian than at the Danube floodplains (Chi-square test: χ^2 = 8.38, df = 1, p = 0.004). In the Morava floodplain the Tawny Owl was recorded at 88.9 % of all observation points (N = 18), in the Danube floodplain it was found at 53.2 % of all observation points (N = 156). The density of territories estimated for the Nature Reserve March floodplain was 1.6 territories/km^2 (Table 1, Figure 3a), for the Vienna and Lower Austrian parts of the Donau-Auen National Park a density of 1.0 and 0.9 territories/km^2, respectively, was calculated (Table 1).

Table 1: Number of recorded territories and territory density of *S. aluco* in different parts of our study area.

Location	Area (km^2)	Territories	Territory density/km^2
WWF-Nature Reserve March-Auen	10	16	1.6
Donau-Auen National Park Vienna (Lobau)	22	22	1.0
Donau-Auen National Park Lower Austria	71	61	0.9

The Long-Eared Owl could not be recorded in the Nature Reserve March-Auen. In the Donau-Auen National Park a total of <0.1 territories/km^2 were found. A total of five Eagle Owl territories were recorded in the entire study area: one territory in the Nature Reserve March-Auen and four territories in the Danube floodplain forest (Figure 2b, 3b).

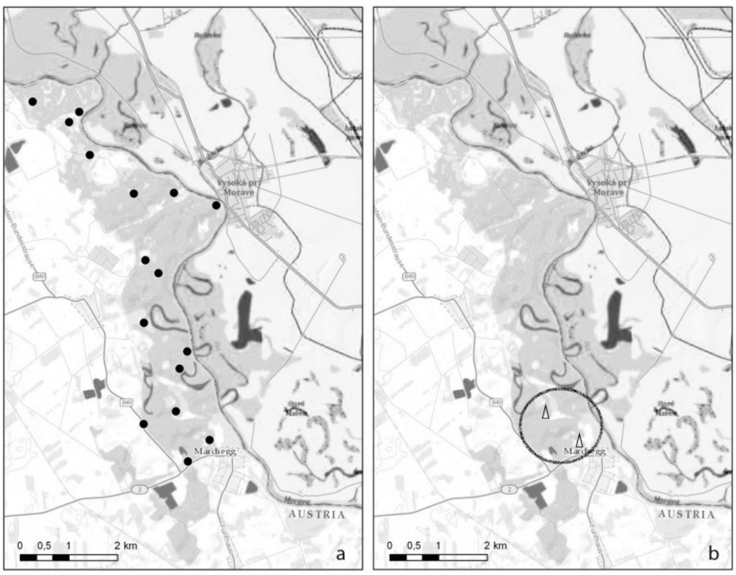

Figure 3: Occurrence of (a) *S. aluco* (●) and (b) *B. bubo* (Δ) in the WWF Reserve March-Auen in spring 2012. Circles merge observations most likely referring to one territory

Habitat use of Tawny Owl

The occurrence frequency of Tawny Owl in our study area did not differ between census points located in flooded forest areas, non-flooded forest areas and the transition zone between both forest types (Chi-square test: $\chi^2 = 1.70$, df = 2, $p = 0.427$). Also no significant differences were found when only comparing flooded and non-flooded forest areas and only considering the census points located in the Danube floodplain (Chi-square test: $\chi^2 = 1.40$, df = 1, p = 0.237).

Due to the strong multi-collinearity of landscape variables, we calculated a principal component analysis. The first three factors PC1, PC2 and PC 3 explained 39.15%, 25.48% and 14.23% of the total variance. PC1 predominantly represents the proportion of deciduous forest and habitat diversity. Habitat diversity has a negative factor loading, the deciduous forest cover is positively related to the PC1 values (Table 2) because habitat diversity declines when most of the area is covered by deciduous forest ($r = -0.84$, $p < 0.001$). The PC2 is highly related to variance in the cover of human-modified habitats (grassland, agricultural area, coniferous forest) and the area of water bodies. The proportion of mixed forest is the only variable with a high PC3 loading (Table 2).

Table 2: The first three factors (PC1-4) of a principal component analyses on seven habitat variables showing factor loadings.

Variables	PC1	PC2	PC3
Proportion deciduous forest	**0.95**	-0.22	0.03
Proportion mixed forest	-0.36	-0.01	**0.91**
Proportion coniferous forest	-0.56	**-0.65**	<-0.01
Proportion grassland	-0.24	**0.70**	-0.23
Proportion agricultural area	-0.47	**0.62**	-0.05
Proportion water area	-0.52	**-0.65**	-0.32
Shannon habitat diversity	**-0.92**	0.043	-0.06

To evaluate the importance of different subsets of habitat variables (PC1-3), region, flooding regime and the presence of Eagle Owls for the occurrence of Tawny Owls at census points, a GLMM was calculated. The resulting model only indicated a significant effect of PC1 on Tawny Owl occurrence (Table 3).

Table 3: Results of GLMM testing for effects of PCs combining habitat area and diversity variables, region, flooding regime and the occurrence of Eagle Owls on the occurrence of Tawny Owl. Significant effects are printed bold.

Variable	*F*	*P*
PC1	**11.54**	**0.001**
PC2	2.36	0.126
PC3	0.78	0.781
Region	1.13	0.339
Flooding regime	0.89	0.415
Eagle Owl territory	2.25	0.114

The likelihood of occurrence increased with increasing PC1, which explained predominantly the variance in deciduous forest cover and habitat diversity. Indeed, both variables are strongly related to the predicted probability of Tawny Owl occurrence, which increases with increasing forest cover (Figure 4a) and decreasing landscape diversity (Figure 4b).

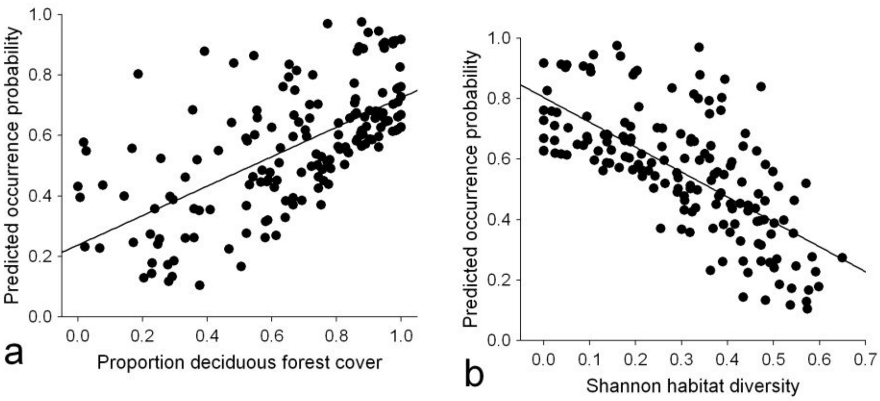

Figure 4: Relationships between the probability of Tawny Owls occurrence at census points and (a) the proportion of deciduous forest cover and (b) the habitat diversity. Probability occurrences were estimated by a GLMM evaluating effects of different habitat variables, region, flooding regime and the presence of Eagle Owls on the presence of Tawny Owls at census points.

Discussion

In lowland forests of Central Europe, the Tawny Owl usually represents by far the most abundant owl species. Its regional density varies, depending on the forest cover, between <0.2 and 2.75 breeding pairs/10 km². When considering only forest areas, higher densities between 5 and 10(16) pairs/10 km² can be found. Even higher densities are only reached in small forest fragments (GLUTZ VON BLOTZHEIM 1987). In Central European floodplain forests, the reported territory densities range between 8 and 11 territories/10 km². Our study documents an even higher density of 16 territories/10 km² for the WWF Reserve March-Auen (Table 4).

A total of five Eagle Owl territories were found in our study area in 2012; four of them in the Donau-Auen National Park, one in the WWF Reserve March-Auen. A slightly higher number of territories (6-7 calling males) were found in the Danube floodplains in 2004/2005 (THOBY 2006). The breeding pair in the WWF Reserve near Marchegg has been continuously recorded since 1998 (ZUNA-KRATKY et al. 2000). During breeding season, Eagle Owls defend a territory of a size of 9-12 km², and during post-breeding season they use a home range of up to 100 km² (LEDITZNIG 1992, LEDITZNIG 1996). Therefore, the territory density documented for our study area most likely had already approached its summit.

The recorded density of 1 Long-Eared Owl territories/10 km² in our study area is almost certainly an underestimation. Due to its low territoriality and hence low response-probability to playbacks, a higher survey effort would have been necessary for assessing the species' territory density.

The fact that only forest cover proved to positively affect the occurrence of the Tawny Owl in our study area emphasizes its tolerance against other environmental factors. The remarkably high territory density in floodplain forests, not only in Eastern Austria, indicates the high habitat quality of this forest type for the Tawny Owl. In the studied floodplain forests along Danube and Morava River, forest management measures have decreased significantly during the last decades. This may have resulted in an increased density of available tree cavities (CARLSON et al. 1998) providing important nesting sites for *S. aluco* (SALVATI et al. 2002).

The Tawny Owl has a preference for old forests composed of large trees and a sparsely developed undergrowth layer, facilitating easy access to prey dwelling on the forest floor (GSTIR 2012). Besides infrequently feeding on birds, amphibians and insects, forest rodents are the main prey of Tawny Owls (JEDRZEJEWSKA et al. 1994), which should reach lower densities in regularly flooded forest areas (WIJNHOVEN et al. 2005). However, in our study area no differences in occurrence frequency of the Tawny Owl were found between regularly flooded and non-flooded parts of the forest.

Table 4: Territory densities of Tawny Owl in different forest types in Central Europe.

Study area	Landscape type	Study area (km²)	Territories/10 km²	Source
Bayrischer Wald (Germany)	mixed woodland	13.0	1.7	Mebs & Scherzinger (2008)
Grunewald West Berlin (Germany)	mixed woodland	31.0	6.0	Wendland (1972)
Badische Rheinebene (Germany)	floodplain forest	23.0	11.3	Glutz von Blotzheim (1987)
Fürstenwald/Ringelsdorf (Austria)	floodplain forest	8.5	8.2-9.4	Zuna-Kratky et al. (2000)
WWF-Nature Reserve March-Auen (Austria)	floodplain forest	93.0	9.0-10.0	present study
Danube floodplain east of Vienna (Austria)	floodplain forest	10.0	16.0	present study

Besides an underestimation of the density of Long-Eared Owl in our study area due to methodological reasons, the availability of suitable habitats may be limited. The species depends on open areas for hunting (SCHUSTER 1996, MARTINEZ & ZUBEROGOITIA 2004). Hence, large parts of the Donau-Auen National Park with a total meadow cover of <10 % (MANZANO 2000) may not fulfil the species' habitat requirements. Furthermore, Long-Eared Owls seem to avoid *S. aluco* territories (SCHUSTER 1996), which are densely distributed over most of our study area.

Conclusion

Our study confirms the high habitat quality of floodplain forests for owls, particularly for the Tawny Owl. Further studies will have to evaluate which resources (availability of nesting sites, abundance of prey etc.) are most important in explaining the high population densities of the Tawny Owl in floodplain forests.

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Spatial and temporal variations in chironomid assemblages in glaciated catchments of the Hohe Tauern NP

Georg Niedrist & Leopold Füreder

Abstract

Alpine river ecosystems represent harsh environments (e.g. low temperatures, high dynamics, steep gradients, low nutrient availability) and will be affected by climate change and increasing anthropogenic impacts. Hydrological changes (e.g. melting glaciers and shrinking snow cover) will affect the invertebrate fauna in different types of alpine rivers (glacier-fed, spring-fed), and can even effect important food sources for fish and other vertebrates at lower elevations. Within the project 'Long-Term River Monitoring in the Hohe Tauern NP' we investigated over a three year time period pattern and processes of alpine river hydrology and morphology and their relationships to the benthic invertebrate assemblages. In this study the chironomid assemblages were investigated as these organisms are ubiquitous and most abundant in alpine river systems and most species are known to react sensitively to environmental gradients. We found different temporal and spatial patterns when non-glacial and glacial rivers as well as reaches above and below the tree line were compared, both in terms of structure and functional organization, respectively. Additionally, we elucidated correlations of abundant chironomid species with environmental key variables such as maximum water temperature, oxygen concentration and conductivity. This study demonstrates that in order to interpret and simulate future shifts in biodiversity and ecosystem structure, and function, knowledge about the ecological preferences of the noumerous alpine chironomid species is crucial.

Keywords

Chironomidae, high alpine, climate change, species preferences, indicator

Introduction

Alpine rivers represent extreme environments with low temperatures, high dynamics in discharge, low nutrient availability and increased ultraviolet radiation (Füreder 1999; Häder et al. 2007). These ecosystems traditionally have been usually regarded as pristine and clean systems of high biological integrity. Nowadays, these precious resources seem to become rare in the densely populated areas of the Alps. Besides various anthropogenic impacts of water use (irrigation, snow generation, power generation) and pollution, alterations due to climate change will affect those river ecosystems concerning hydrological (Zierl & Bugmann 2005) and biological (Jacobsen et al. 2012; Füreder 2012) aspects.

For this presentation, we focused on spatial and temporal variations in chironomid (non-biting midges) assemblages, regarding taxa richness, community composition, diversity and evenness in pristine alpine running waters with and without glacial influence. The results provide insight into the larval development in such extreme environments, as well as into the distribution of specialized taxa in alpine rivers. Whereas temporal variations in chironomid populations at lower altitudes seem to depend on the quantity of available food (Wright 1978; Drake 1982), abiotic parameters seem to be crucial for the formation of chironomid communities in high altitudes, especially during snow free periods (Füreder et al., 2001). As suggested by Füreder (2007), the biota of alpine running waters (esp. glacier-fed rivers) may serve as model to examine the impact of the proceeding climate change. Therefore, a precise knowledge of species preferences concerning a set of hydrological, thermal and biotic variables is needed.

Among stream invertebrates, chironomids represent the majority of invertebrate species in lotic habitats (Cranston 1995). They are known to be well adapted to a variety of extreme conditions (anoxic, dried or frozen habitats)(Oliver 1968; Danks & Oliver 1972), and consequently they form the dominant dipteran family in high elevated headwater ecosystems(Füreder 1999), making them suitable as potential indicators for corresponding variables. Highly resolving species identification is a prerequisite because many genera include species with different ecological demands (Rossaro & Mietto 1998). The main aims of the present study were: (1) to investigate Chironomid taxa assemblages at microhabitat scale in four different running water ecosystems, (2) to define species preferences for certain environmental parameters and (3) to detect the main community-regulating factors during the snow-free season in different river types.

Study Area, Methods

The study streams are located in the Hohe Tauern NP in Austria in the AnlaufValley near Böckstein, Salzburg. The glacial Anlaufbach is the main river in the AnlaufValley, where several spring-fed rivers discharge into it. Four sampling sites, defined among the monitoring sites of the project 'Long-Term River Monitoring in the Hohe Tauern NP', were chosen for this study: two above (1770 m a.s.l.) and two below the treeline (1360 m a.s.l.). At both altitudes, the glacier-fed Anlaufbach and a spring-fed tributary were sampled, respecitively.

A highly resolving set of physicochemical data at various scales (reach and site) was obtained by installing monitoring instruments at each study site and conducting point measurements. Quantitative samples of benthic invertebrates were obtained using a Surber-sampler; mesh size 100 µm. Six substrate-specific benthic samples were taken at every sampling site and date.

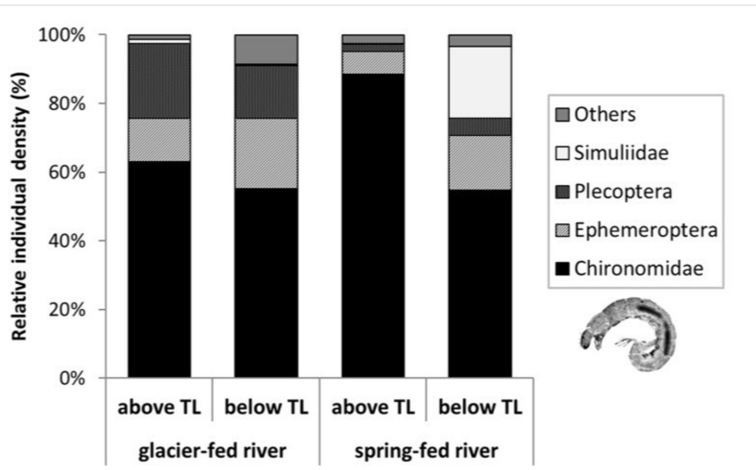

Figure 1: Relative abundance of stream invertebrates in four selected river reaches in the Anlauf Valley in summer 2011 (June, August, September). TL = tree line. (Georg Niedrist)

Results & Discussion

The results of this study confirm prior reports that chironomids are dominating rigorous alpine stream habitats in terms of individual densities (Fig. 1) and taxa number above and even below the tree line. Whereas the glacier-fed river site above the tree line is mainly colonized by *Diamesa* species, krenal assemblages showed a very diverse pattern with much more species. These more stable ecosystems provide suitable conditions for a more diverse chironomid community. Generally,with decreasing glacial influence, the diversity, species richness and abundance were increasing. We were able to conduct a spatial categorization of chironomids regarding their occurrence, whether they live only in glacier-fed, only in spring-fed, or in both habitats (Fig. 2). The majority of taxa (30) were found in both, glacier-fed and spring-fed rivers. However, both river types represent unique habitats for specialized taxa: we detected eleven taxa restricted to glacier-fed rivers and ten taxa living only in spring-fed rivers. *Larsia* sp., the unique taxa belonging to the subfamily Tanytarsinae, was only sampled in glacier-fed rivers.

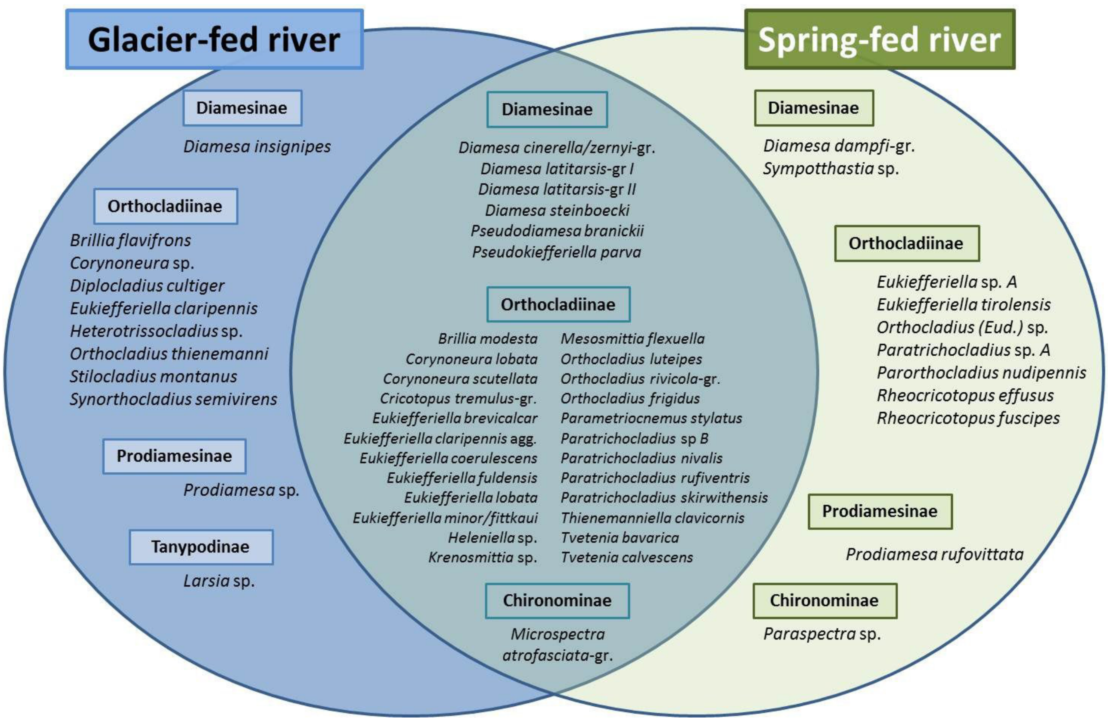

Figure 2: Spatial occurrence (only in glacier-fed rivers, only in spring-fed rivers, or in both river types) of all found chironomid taxa in the Anlauf Valley in summer 2011. (Georg Niedrist)

Correlation analyses highlighted several relationships of abundant taxa with environmental variables (Fig. 3). For example, *Diamesa cinerella/zernyi*-gr. showed a positive correlation with oxygen concentration (r_s = 0.710; p <0.001) and conductivity (r_s = 0.641; p <0.001), and a negative correlation with maximum water temperature (r_s = -0.644; p <0.001.). The taxa Diamesa latitarsis I showed negative correlations with chlorophyll a content in water (r_s = -0.504; p <0.001.). Although combined effects of important factors should not be neglected, dependencies of taxa to single factors could be shown. *Diamesacinerella/zernyi*-gr can be characterized as krypophil taxa preferring high oxygen concentrations. Our results allow the expansion of autecological knowledge of several alpine chironomid species due to preference analyses. Further work will be conducted to evaluate the indicator value and tolerances of such species. Research activities, targeting autecological knowledge for the identification of potential indicator species, have to be carried out in pristine or near-pristine ecosystems to get an uninfluenced reference status of ecological preferences and responses of species to natural environmental factors and changes. That is why protected areas as the national park Hohe Tauern provide optimal study areas with minimized anthropological influence on the ecosystem.

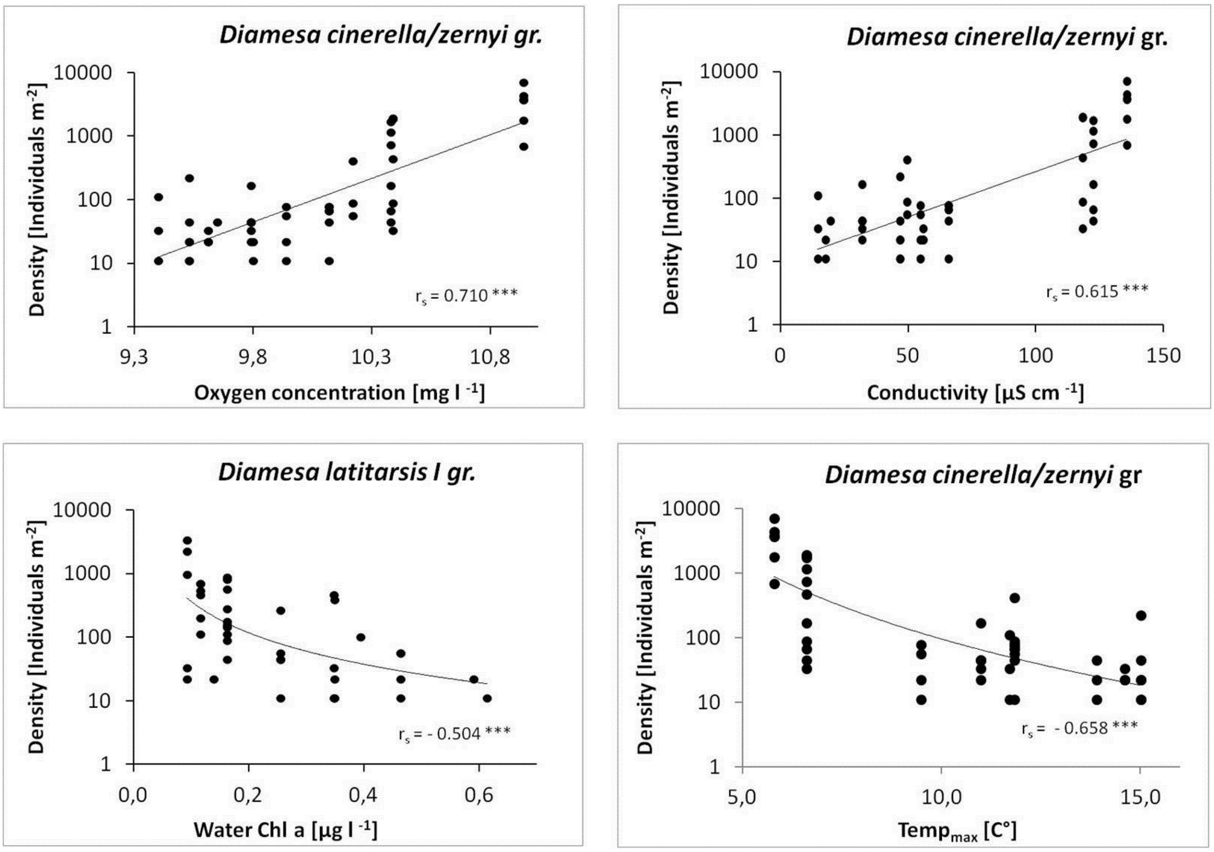

Figure 3: Best correlation of most abundant chironomid species (Individuals m^{-2}) and environmental factors with indication of Spearman correlation coefficient (r_s) and signifinance (*p <0,05; **<0.01; ***<0,001). $Temp_{max}$ represents the maximum water temperature of the past 3 months at each site. (Georg Niedrist)

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Labels of protected areas: best practices for a sustainable regional development. The case study of the Italian Alpine protected areas.

Andrea Omizzolo & Serena Frittoli

Abstract

Tourism can be considered as an important tool thanks to which the authorities of protected areas (PA) can reach the goal of an active environmental protection. In the last few years, the Italian PA stood out for its commitment to the development of a new and sustainable touristic model, based on: the enhancement of the environment, the particular regional and local resources and the promotion of qualities. This is one of the few models not affected by the current crisis. In fact, it has a steady increase of visitors, local products and services. This good result is also given by: the involvement of local operators in good environmental practices and large number of products and services that have one or more quality certifications recognized at European, national and local levels. Many of these PA have been active in granting their brand, with very different methods and results. The present study investigates in Italy the role of quality certifications and PA's trademarks for regional and local development. In particular, the research considers the main PA of the Italian alpine ridge. First of all the complex framework of certifications has been defined; subsequently were analysed and interpreted data of products and services. The Research highlights the economic and social added value and the potential contribution of PA's quality brands to the solution of complex and multi-functional problems of italian and european mountain economy.

Keywords

Labels, Alpine Protected Areas, Italy

Introduction

According to data of Italian Ministry for Environment, Territory and Sea (MATTM), Italy boasts Europe's largest natural, landscape and cultural heritage with a total of 871 protected natural areas and 2564 sites of the Natura 2000 network covering a total of 21% of the national territory (MATTM 2010). The territory of the Italian Alps, within the perimeter of the Alpine Convention, contributes to this network of nature protection areas with 4 national parks, 34 regional parks, 31 regional nature reserves, several other protected areas and about one-fifth of Italy's Natura 2000 sites. Needless to say, these protected areas are governed by applicable European and Italian laws including legislation concerning the trade mark system and quality certifications intended to help protect and promote local quality products and services offered. Certifications also help protect the work of operators and manufacturers, improve consumer confidence in the products and associated services and, above all, preserve and enhance the territorial heritage.

Methods

For the purposes of this study, after an initial examination of the leading scientific and popular publications in the field, more in-depth research was carried out using national and international scientific metasearch engines. The websites of sector-specific ministries and agencies were surveyed and data were acquired from the main public and private databases of Eurac partners. In particular, the databases belonging to the following entities were considered: Italian Ministry for the Environment, Land and Sea; Italian Ministry of Agriculture and Forestry; the European Union; Italy's statistical office Istat; other government bodies or offices in charge of providing public services and the Italian Federation of Parks and Nature Reserves. Missing data were sought and partly found in press releases or publications by other research centres and universities. Collected data were classified and suitably processed to identify areas suffering from a lack of information and requiring further research. Informal contacts with other researchers and research networks were used to fill in the gaps and boost information and data gathering. Relevant data were used to provide an overview of the sector: a catalogue of updated basic information was created, organized and systematized in order to document the entire set of spatial knowledge available at different levels. Some considerations were presented for discussion and conclusions were drawn on the opportunity to quantify protected areas' assets to better exploit their added value.

Results

The IX Ecotur Report on Nature Tourism (ECOTUR 2012) has made it very clear that one of the few forms of tourism to record a positive trend in the current economic crisis - that has hit also the tourism industry - is in fact nature tourism, that is travel or vacationing to natural areas with a focus on the observation and appreciation of the outdoors, wildlife and traditional culture. In particular, the best performing segments of nature tourism are parks and reserves with a market share of over 35 %, followed by the mountains (23 %), rural tourism (18 %), lake tourism, the network of the most beautiful villages of Italy (*Borghi più belli d'Italia*), marine reserves and agritourism. Altogether, the nature tourism sector grosses over 10 billion euro a year. This profitable performance results primarily from the good practices implemented in recent years in the Italian nature protection areas, proving that business and environmental protection can get on well together. Italian companies can be successful in Europe just by tapping into the international markets' strong demand for environmental quality and origin certification, especially for high-end products. Certification in fact is a good tool to promote a region, as shown in Tables no. 1 and no. 2 which provides an overview of the complex system of regional quality / specificity / typicality labels for products, producers and services in the Alpine regions and the way in which such labels are recognised and perceived.

Table no. 1: European and Italian Quality Labels in the Italian Alpine Protected Areas. Data source: parks.it.

Acronym	Title	Type	Area / Initiative	Logo
DOP	Denominazione d'Origine Protetta	Marchio di Qualità Europeo	UE	
IGP	Indicazione Geografica Protetta	Marchio di Qualità Europeo	UE	
STG	Specialità Tradizionale Garantita	Marchio di Qualità Europeo	UE	
BIO	Agricoltura Biologica	Marchio di Qualità Europeo	UE	
PDM	Prodotto di montagna	Marchio di Qualità Europeo	UE	NO LOGO
PDI	Prodotto delle Isole	Marchio di Qualità Europeo	UE	NO LOGO
PSF	Presidi Slow Food	Marchio privato riconosciuto globalmente	Int	
AdG	Arca del Gusto	Marchio privato riconosciuto globalmente	Int	NO LOGO
PAT	Prodotti Agroalimentari Tradizionali	Marchio di Qualità Italiano	IT	
DOCG	Denominazione di Origine Controllata e Garantita	Marchio di Qualità Italiano	IT	D.O.C.G.
DOC	Denominazione di Origine Controllata	Marchio di Qualità Italiano	IT	D.O.C.
IGT	Indicazione Geografica Tipica	Marchio di Qualità Italiano	IT	I.G.T.
IG	Indicazione Geografica	Marchio di Qualità Italiano	IT	NO LOGO
De.C.O.	Denominazione Comunale d'Origine	Marchio di Qualità Comunale	IT	NO LOGO
De.Co.	Denominazione Comunale	Marchio di Qualità Comunale	IT	NO LOGO
De.C.P.	Denominazione Comunale di Provenienza	Marchio di Qualità Comunale	IT	NO LOGO

Another aspect to consider is the branding of protected areas, which is a powerful tool for sharing information, engaging interested parties and fostering the growth and sustainable development of protected areas. Formalized in 1991 by Article 14 of Italy's Framework Act on Protected Areas, branding proves a powerful strategy both for the tourism industry and the agro-food production industry, not to mention the extraordinary opportunities offered by the interaction of the two sectors. The Italian Alpine protected areas are among the main promoters of area-specific brands and their activities are often identified as best practices at national and European level. Table no. 3 shows the most popular brands associated with the main protected areas in the Italian Alps. Initial data from the ongoing in-depth survey of individual protected areas in the Alps highlight and testify to the great work done by the management authorities. *Carta Qualità* (Quality card), for example, groups together all of the companies that make use of the Dolomiti Bellunesi National Park logo, i.e. more than 210 enterprises from very diverse sectors: farms growing traditional food products, hospitality facilities, restaurants serving local food, craftspeople versed in woodworking and many other businesses closely tied to the local area and the traditions of the Park. Similarly, just over two years after the beginning of the project, there are already more than fifty operators using the quality mark of the Gran Paradiso National Park.

Discussion

Article 14 of Italy's Framework Act on Protected Areas lays down that said areas can grant the right to use their trademark. Despite having been interpreted in different ways because of its generality, said article makes it clear that the right to use the trademark may be granted only to entities who promote the conservation of the protected area through good practices. The law therefore focuses on the producers rather than on products. In fact, product quality certification would imply issues of monitoring and control which go beyond the tasks and responsibilities of the protected area's management authorities, as reaffirmed in 2004 by an inter-ministerial working group of experts. However, a recent survey conducted by Federparchi, Italy's Federation of Parks and Nature Reserves, has shown that, even without common guidelines and procedures, all management authorities of protected areas in Italy recognise that trademark licensing to third parties plays an important role in bringing together, under the same logo, services and production activities respectful of the (natural, social and cultural) environment (BOSCAGLI 2011).

Table no. 2: International labels and regional certifications. Data source: parks.it

Acronym	Title	Type	Area / Initiative	Logo
QI	Ospitalità Italiana	Marchio di Qualità	IT Private	
ECOLABEL	Certificazione Ambientale Europea	Marchio di qualità	Europe	
CETS	Carta Europea Turismo Sostenibile	Marchio di Qualità	Europe	
DEAP	Diploma Europeo delle Aree Protette	Riconoscimento specificità	Europe	
WHS	Patrimonio Mondiale dell'Umanità	Riconoscimento Specificità	Internazionale	
GEO	Rete dei Geoparchi	Riconoscimento specificità	Europe	
MAB	Riserva della Biosfera	Riconoscimento specificità	Internazional	
Fattorie del Panda	Qualità ambientale	Marchio di qualità	Privata	
Parchi Attivi	Qualità ambientale	Marchio di qualità	Regionale	
Parchicard Lombardia	Qualità ambientale	Marchio promozionale	Regionale	
RELACS	Energia pulita per il turismo	Marchio di qualità	Privata	
Eco-Cluster	Qualità ambientale	Marchio di qualità	Privata	
VIVA	VIVA, il viaggio nella natura	Marchio di qualità	Regionale	
SAVEURS DU VAL D'AOSTE	Sapori della Valle d'Aosta	Marchio di qualità	Regionale	
ALTO ADIGE	Marchio territoriale ombrello	Marchio d'area	Regionale	
	Qualità produttiva	Marchio di qualità	Regionale	
TRENTINO	Marchio di Qualità	Marchio di qualità	Regionale	
	Marchio Territoriale	Marchio d'area	Regionale	
VENETO	Marchio di Qualità	Marchio di qualità	Regionale	
LOMBARDIA	Qualità dei servizi	Marchio di Qualità	Regionale	

The decisions taken by certain management authorities echo the debate that has recently led the European Union to legislate on the creation of so-called "territorial brands". According to our survey, that is a further opportunity for the future. One way forward might be the creation of a common "umbrella brand" for the national system of protected areas, a strong brand able to sell well internationally that could be "customised" locally to encompass and improve all those certification systems and brands that have rendered great service to the area until now.

Conclusion

In a situation of widespread economic crisis which seems to spare only the industry linked to nature tourism and the supply of quality products and services, the moment looks propitious to push the industry further and propose new strategies for the socio-economic development of protected areas and surrounding regions. The time seems ripe for reviewing and "standardizing" the brands of Italy's protected areas as well as the criteria for granting the right to use such brands and related promotion strategies. Finally, building on the provisions of the national Framework Act on Protected Areas, brands should be governed by a single instrument at national level. This is a valuable opportunity especially for mountain protected areas, particularly in the Alps, because at the end of 2012 they were given the right to use two additional powerful tools recognized at European level, namely the geographical collective mark and the recognition of mountain specificities. In addition, the combination, simultaneous presence and interaction of various certifications and trademarks open interesting scenarios and opportunities with beneficial effects on the territory, as exemplified by the case of food and wine tourism and ecotourism (COLDIRETTI 2012).

Table no. 3: Brands of the main Italian Alpine protected areas

Name	Objective	Type	Logo
Marchio Qualità Parco	Qualità ambientale	Marchio AP	
Marchio Qualità Gran Paradiso	Qualità ambientale	Marchio AP	
Marchio Ecoturismo in Marittime	Qualità ambientale	Marchio AP	
Marchio di Qualità ambientale	Qualità ambientale	Marchio AP	
Marchio collettivo del Parco	Qualità ambientale	Marchio AP	
Il marchio del Parco delle Prealpi Giulie	Qualità ambientale	Marchio AP	
Carta Qualità, "Parco Dolomiti Bellunesi"	Qualità Ambientale	Marchio AP	
Marchio del Parco Naturale Regionale della Lessinia	Qualità Ambientale	Marchio AP	
Marchio di Qualità del Parco	Qualità Ambientale	Marchio AP	

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Forest disturbance monitoring system based on high spatial resolution satellite images in the Kalkalpen National Park

Antonia Osberger, Dirk Tiede & Stefan Lang

Abstract

Major storm events in many parts of Austria repeatedly led to the destruction of forest areas in recent years. Moreover, the windfall zones in conjunction with particularly very hot and dry summers provided ideal conditions for a progressive and continual infestation of spruce bark beetles. Therefore there is a strong need to support the estimation of forest disturbance in a cost-efficient manner. Remote sensing enables to extract valuable information to detect and analysis forest dynamics even from areas difficult to access.

The Kalkalpen National Park has initiated a pilot study together with the Interfaculty Department of Geoinformatics – Z_GIS (Salzburg University)to establish an operational framework for automated extraction of affected forest areas. Based on satellite imagery the analysis was complemented by available in-situ datahelp to identify area-effective by stressors such as storms and bark beetle attacks that result in deadwood. The spatial variability and dynamic of the forest ecosystem can be investigated and visualized. Data integration, data analyses and change detection were performed by an object-based image analysis (OBIA) methodology.

Keywords

Coarse woody debris;Object-based image analysis (OBIA);Change detection; Rapid Eye

Introduction

EO-based monitoring of forest disturbance

Major storm events in many parts of Austria led to the destruction of forest areas in recent years (e.g. Kyrill, January 2007; Paula, January 2008; Emma, March 2008). Moreover, the windfall zones in conjunction with given suitable environmental settings – particularly very hot and dry summers – provided ideal conditions for a progressive infestation of spruce bark beetles (*Ipstypographus*) over large regions. The beetle's population has exploded and the infestation of forests e.g. in the Austrian Kalkalpen National Park has continued. These forest disturbances triggered by abiotic (storm) and biotic (insect pests) factors result in a patchy distribution of coarse woody debris.

Nowadays scientific research emphasises the importanceof deadwood presencefor the health and functioning of a forest ecosystem at a variety of scales. Deadwood contributes positivelyto the nutrient cycling, long term storage for carbon dioxide as well as habitat provision in terms of ecological niches and biodiversity pools (LOUMAN et al. 2009; MÜLLER &BÜTLER 2010; RADU 2007). That's why in protected areas forest authorities require spatially explicitinformation on those deadwood areas and their changes over time to maintain forest management and conservation objectives and to contribute to habitat maintenance.

There is a strong need to support the estimation of forest disturbance on a regular and continuous basis in a cost-efficient and area-extensive manner. Here we focus on the potential of Earth observation (EO) to provide such information mainly from remote sensing data that also enable to detect forest change even from areas difficult to access.High resolution satellite imagery and reproducible methods for semi-automated feature extraction should support traditional techniques of large scale forest inventory through field surveys and aerial photo interpretation(DESCLÉE et al. 2006; WULDER et al. 2008; COOPS et al. 2010; MARX 2010;KOCH 2011).

The research conducted was part of a feasibility study initiated by the Kalkalpen National Park. The objective was to establish an operational framework to (semi)-automatically extract and monitor forest disturbances that result in coarse woody debris across an alpine forest habitat. Such a forest monitoring system should address the information needs of forest managers concerning their annual reporting tasks on the assessment of deadwood to the national forest authority. Specifically, the project aimed to examine the potential and limits of high spatial resolution multispectral remotely sensed data such as RapidEyeimagery with a ground resolution of up to 5m.

The approach should not only capture forest disturbances triggered in particular by storm events and insect pests for any given year, but also allow assessing and visualizing the spatial variability and dynamic of the forest ecosystem at regional scale. The role and performance of such an 'information service' is currently tested in a European (FP-7 SPACE) project called MS.MONINA (www.ms-monina.eu), which offers scale adaptive monitoring services for the implementation of the EU Habitats Directive.

Research objectives

Based on the objectives outlined above, the following research questions arise:

1. Is it possible to identify small-scale disturbances (as small groups of trees) within healthy forest stands?
2. Is multi-date RapidEye imagery a suitable data source for the detection of coarse woody debris caused by storm and bark beetle attacks in an alpine forest ecosystem?
3. What classification accuracy can be achieved for forest disturbance detection with (semi)-automated methods?

Data integration, data analyses and change detection were performed by an object-based image analysis (OBIA) methodology. The approach and the obtained results of this study are discussed in the following sections. A detailed validation of the extracted forest disturbances and the change assessment in cooperation with the national park authorities are still in progress.

Methods

Study area

The study area is situated in the Kalkalpen National Park in the federal country of Upper Austria, Austria.

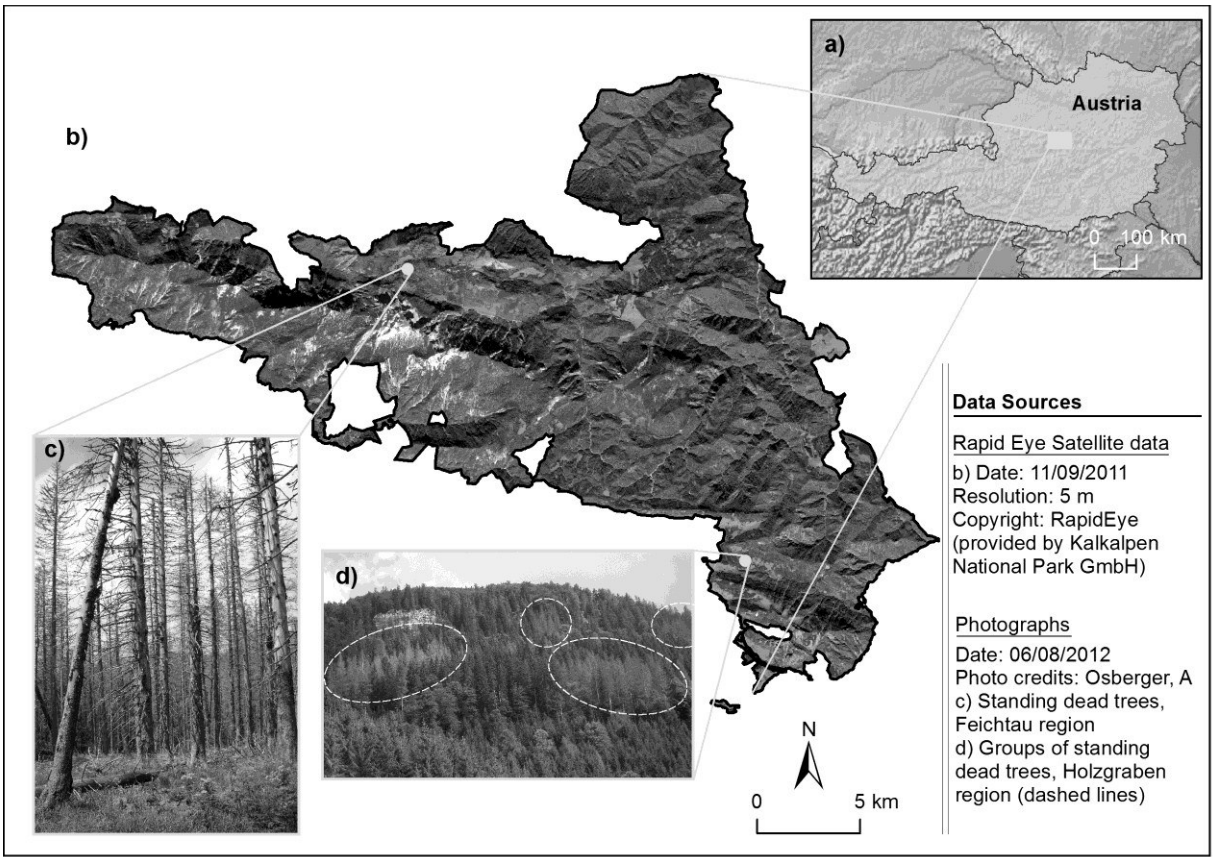

Figure 1: Kalkalpen National Park, Upper Austria

The national park covers an area of 208.5 km² andis Austria's largest closed protected forest area. Itwas established in 1997 and belongs tothe six national parks in Austria that are internationally recognized by the IUCN (International Union for the Conservation of Nature) under category II (national park). The regionisboth a European protected site in the network of NATURA 2000, according to the European Birds (79/409/EEC) and Habitats Directives (92/43/EEC), and a Ramsar site through the Ramsar Convention to protect wetlands due to the extended creek ecosystem in this area.

Forests represent four fifths of the national park area and are primarily allowed to develop naturally. The most common forest types are spruce-fir-beech forests. In recent years especially the Norway spruce stands (*Piceaabies*) faced progressive infestation of spruce bark beetles.

Data and pre-processing

Remotely sensed data

The decision to use RapidEye (www.rapideye.com)data for the annual forest monitoringwas based on the spatially and timely high coverage and the multispectral capacity.The RapidEye constellation includes five identical small satellites, which are calibrated equally one to another. They provide multispectral high-resolution imagery in five optical bands (440-850 nm). In addition to the visual bands and a near infrared (NIR) band, the sensor contains also the red-edge spectrum (690-730 nm), which is spectrally located between the Red and the NIR band without overlap. The corresponding part of theelectromagnetic spectrum is particularly sensitive for vegetation chlorophyll content because of the sudden increase of reflectance caused by vegetation.

Due to the high temporal and spatial coverage it was possible to acquire archived,radiometrically and geometrically corrected images of different years,covering the national park area nearly free of clouds or haze. The time series comprises three different dates t_1 = 19 Sept 2009, t_2 = 23 Aug 2010 and t_3 = 11 Sept 2011.The timing of the images in the late summer seasonal window is closely connected with the biologicalcycle of deciduous trees. In view of the fact that the process of discoloration of leaves and leaf fall starts in autumn, it is necessary to use images when forest vegetation is stable to distinguish properlycoarse woody debrisfrom vital trees. Then it is more likely that changes in spectral reflectance can be assigned to bark beetle attacks. The image data t_2 (RapidEye Level 1B) were orthorectified by combining a 10 m Digital Elevation Model (DEM) and precise ground control points (GCPs) selected from a set of digital orthophotosacquired in the years 2008 and 2009. Theorthorectified RapidEye scenet_2 served as the reference image to geo-correctdata t_1 and t_3 (RapidEye Level 3A) to minimise geometric offsets.

Auxiliary information

In addition to the remotely sensed imagery,silvicultural- and other geo-data, provided by the Kalkalpen National Park, were integrated in GIS vector formatto give useful input for the classification process. These included the topographic (e.g. bodies of water, avalanches), the vegetation (e.g. mountain pine stands, alpine pasture, grassland), the management (administrative boundaries) and the infrastructure (e.g. forest roads, paths) domain. With these layers we created a coarse forest mask to exclude non-forest areas for the subsequent change assessment. The reference data to evaluate the provided forest disturbance layer consists of deadwood areas (downed as well as standing dead trees) available as point and polygon features mapped by the national park authorities. Beyond taking these samples a detailed field validation in two small national park regions was carried out in August 2012.

Object-based image analysis for vegetation conditions

The advances in sensor technology along with the increasing spatial resolution of remote sensing data justify the object-based image analysismethodology for a spatially explicit and intelligent information extraction workflow (BLASCHKE 2010; LANG 2008). A shift has been recognized in the commonly accepted assumptions from discrete single pixels (picture element) as basic entities to meaningful spatially contiguous geographic image objectsas homogeneous regions by grouping neighbouring pixels. The feature space, beside spectral characteristics, is extended to make use of additional spatial (such as size, texture, shape, and neighbourhood), structural, hierarchical, and contextual information. The extended feature space in conjunction with a scaled object-hierarchycould be used to address the complexity of natural phenomena like forest ecosystemsin a more appropriate way (BLASCHKE &STROBL 2001; HAY et al. 2005; BLASCHKE 2010).

The method applied consists of two conjoined elements that aim at characterizing and classifying relevant changes (disturbances) in forest vegetation units. On the one hand, it is built on multi-scale image segmentation, partitioning the images into homogenous image objects on different scale levels.In addition, a class modelling approach – established as a rule-based system – is applied, which integrates expert knowledgeto modify and classify objects in the object-hierarchy based on the extended feature space (TIEDE et al. 2010; LANG 2008).

The method proposed for the alpine forest monitoring system consists of two main steps. An initial forest mask that reflects the current condition of the forest stands. In reference to this base layer forest change detection can be applied. The expert rule-sets for these two components were written within the eCognition object-based image analysis software framework (Trimble Geospatial Imaging). The modular programming language CNL (Cognition Network Language) allows the coding of rule-sets to address and process image objects in a vertical and horizontal hierarchy in a region-specific manner at any time in the rule-set(TIEDE et al. 2010).

Generating of a forest mask

The forest change detection needed as an initial step a forest/non-forest mask to exclude irrelevant features and focus the subsequent monitoring task only on forest stands. Furthermore all areas of forest disturbances had to be detected as well to represent the status quo on the amount of coarse woody debris before a specific year. Based on this status quo layer it is possible to calculate or recalculate the increase of deadwood on an annual base. Image$t_2$of the satellite image series acted as base to perform an object-based forest/non-forest mask. Auxiliary datasets helped to better delineate both healthy forest stands and areas of forest disturbance in the year t_2. Non-forest objects mainly correspond to mountain pine stands, alpine pasture, grassland,water bodies, forest roads, debris, and rocks.

To address the complex natural appearance of forest stands and forest disturbance regarding the varying spectral response patterns fuzzy-based rules by means of membership functions were used. In addition the algorithm also focused on relational features as for instance the NDVI (Normalized Difference Vegetation Index) to differentiate between healthy forest stands and coarse woody debris. Such rules were mainly used to distinguish coarse woody debris from riversides, embankments and roadsides due to similar spectral values and from rock formations at a certain altitude. For the southern face of the Sensengebirge(western part of the national park; cf. Fig. 2) a specific refinement was necessary due to different vegetation composition and sparser vegetation in higher altitudes as compared to the rest of the national park area. For that region adjusted rulescould be applied within the same rule-set (region-based processing).Finally minor manual refinementwas performed to correct an insignificant amount of small objects that where wronglyassigned between the categories deadwood and rocks or debris due to spectral similarities.

Forest change detection

In order to identify forest disturbance areas in the images t_1 and t_3, a change detection approach was applied on the generated forest mask of image t_2. It focused primarily on the statistical analysis of the image objects avoiding therefore to some degree the dependence of atmospheric corrected imagery. For the object-specific change indication attime slott$_1$ mainly the normalisedNDVI per image objectwas used. The same algorithm for the change detection was applied on image t_3 enhanced through a combination of two additional feature characteristics (mean intensity value of the red band and absolute brightness to avoid confusions of forest disturbance and rock formations).

Results

The detected forest disturbances are provided in a GIS layer format for the national park authority.

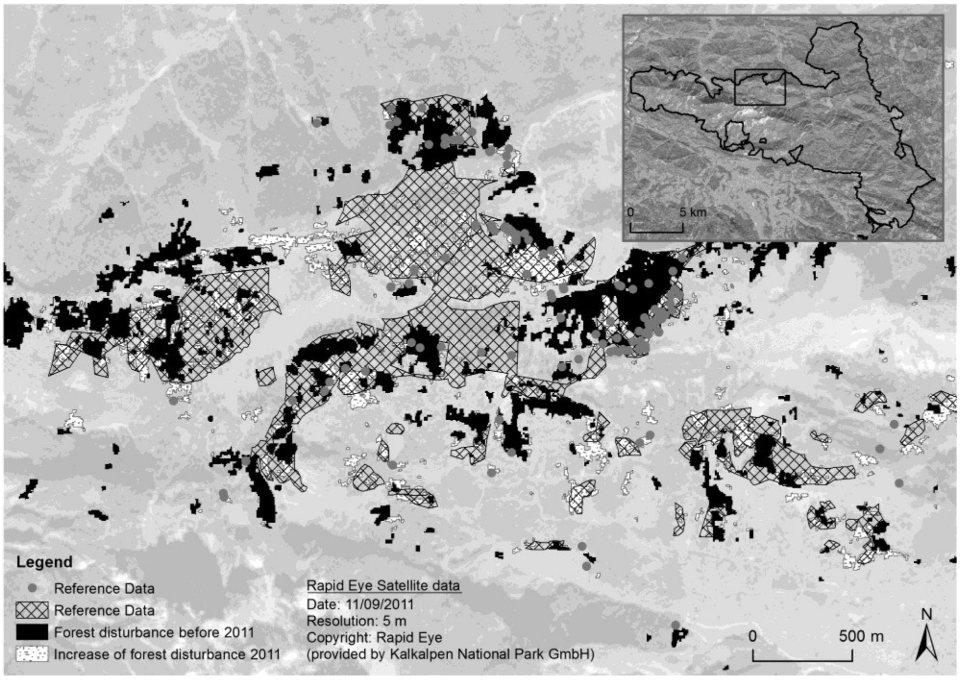

Figure 2: Forest disturbance up to 2011, Kalkalpen National Park

An initial statistical evaluation showed that the amount of deadwood extracted with the aid of remotely sensed data is about 5 to 15 % higher according to the respective reference year and region within the national park area. Reason for that is the detectionofeven fine-scaled forest disturbance areas within healthy forest stands. Also a more realistic analysis of canyons and steep slopes or in general of areas difficult to access was possible. Usually deadwood in areas difficult to access isestimated so far from the opposite hillsides only (if no recent aerial imagery is available). Primary preliminary validation with the existing reference data shows that the pattern of the forest disturbance matches quite well the pattern of the reference data.

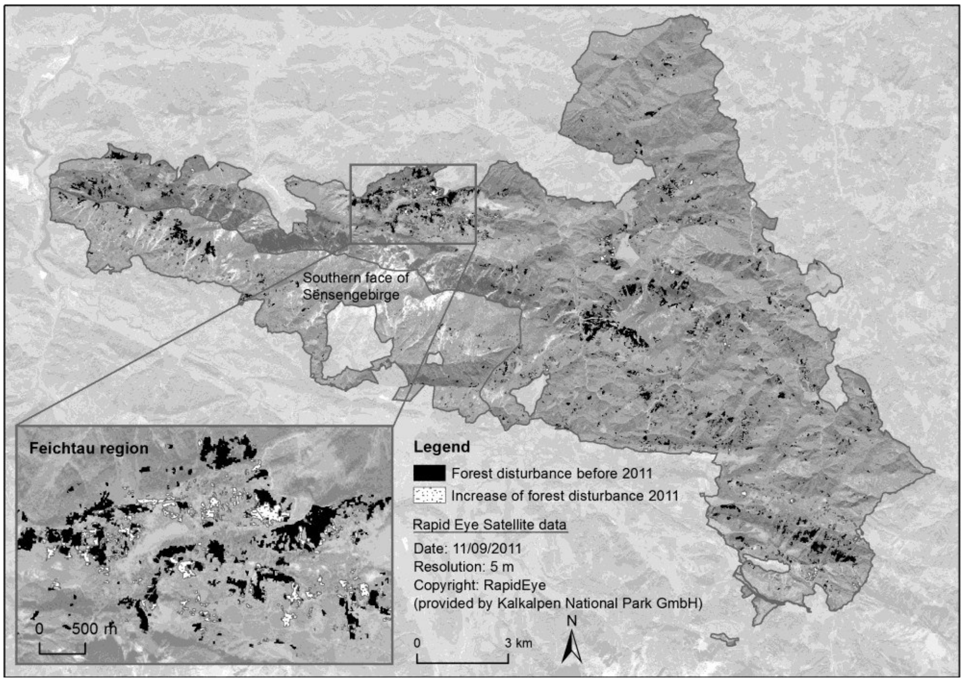

Fig. 3: Forest disturbance up to 2011, overlain by reference data, Feichtau region

In summer 2012 for the Unterlaussa region (south eastern part of the national park) acomprehensivesurvey of deadwood areas before 2011 and their increase in the year 2011 was conducted with one of the four rangers of the national park region. For the validation GPS records and photo documentation of forest disturbances of the year 2009 to 2012 was used. Consequently, it was pointed out that the forest disturbance areas as part of the (semi-)automated object-based analysis were very well captured according to the initial results of the field validation. Sometimes mistakes occurred within rock formations. The detailed accuracy assessment for the forest disturbance indication is still in processes, which also will include expert feedback of the national park administration.

Conclusion

In this research, the authors demonstrated the potential of an object-based forest disturbance monitoring approach in an operational context.In general its strength lies in the repeatability, once the rule sets for the semi-automated analysis system are established. Then it shall offer a robust and economically priced solution for a monitoring system that is likewise useful the local (i.e. site-specific) monitoring and reporting tasks as well as to support the implementation of EU biodiversity policies such as the Habitats Directive.

In terms of an optimization of seasonal aspects we found that a capturing date in September does not cover the net increase of deadwood areas in an unbiased way if the statistics should be valid for the calendar year, since bark beetle attacks are still active. The future system will therefore be based on early summer (May) imagery.

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Species Composition Changes of the Herb Layer and Epigeic Spider Communities in Oak-Hornbeam Forest in Báb after 40 Years (Slovakia)

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Abstract

Authors studied herb layer and ground living spider communities of the lowland forest in the permanent research site Báb (one of the Slovak ILTER site) during 2007-2011. This research is continuation of research realised in programmes IBP and MaB in years 1967-1974 using the same permanent plot of size 100x100 m which was divided into 100 sub-plots of size 10x10m. Typical forest species dominate in the herb layer, but quite high number of synanthrop plants and expansive spiders were recorded as well. This reflects recent disturbance when part of the research plot was cut and open space is colonised especially by ruderal invasive and expansive species. The changes of species composition and dynamics of the herb layer in the forest influenced by the clear-cut were evaluated. Also aim of the research was to assess changes of the current structure of vegetation and selected animal groups (spider) and with their structure in 1967-1974. This comparison showed big changes during studied 40 years that could be caused by the climate changes - gradual drying out of the studied locality were documented by Cunev & Šiška (2006). Authors demonstrate this fact mainly by increasing many xerotermophilous and on other hand by decreasing of the abundance or absolute disappearing of the several more hygrophilous species.

Keywords

vascular plants, spiders, Araneae, oak-hornbeam forest, diversity, climate changes

Introduction

The research site Báb near Nitra (SW Slovakia) was established in 1967 to study the production, energy and material flows of the lowland oak-hornbeam forest ecosystem in intensively used agricultural land. The site was part of the International Biological Programme (IBP). The permanent research plot (TVP) of size 1 ha was established and permanently marked with metal bars (Biskupský 1975). Part of the TVP was felled in 2006; in 2007 we renewed the research in the TVP.

In this paper we present the results of a study of herb layer of the forest community in the TVP and results of the study of epigeic spiders. Apart from the spiders studied in frame of the project, our research also included other invertebrate communities namely harvestmen (Mihál &Gajdoš 2010), neuroproid insects (Vidlička 2010), beetles (Majzlan 2010; Cunev & Šiška 2010), etc.

Material and methods

Study area

The study was carried out at the permanent research site Báb which is partly located in the National Natural Reserve Báb. The locality is situated approximately 15 km from Nitra city (south western Slovakia). It represents the fragment of natural Pannonia oak - hornbeam forest situated in intensively used agricultural landscape. The research site is included in the list of long-term ecosystem research sites within the international network ILTER.

Sampling and study sites

The vegetation was studied in the permanent plot (TVP) of size 100x100 m that is divided into 100 sub-plots of size 10x10 m. Because of the clear-cut in 2006 in part of the permanent plots, we classified individual 10x10 m plots into 4 groups: L – forest in the Nature Reserve (41 plots); H – production forest outside Nature Reserve (17 plots), R – glades (21 plots) and forest margin (21 plots). The phytosociological records of the herb layer were taken in each sub-plot in spring and early summer using standard phytosociological methods, the species abundance was recorded in the 9-member ordinal scale (Westhof & van der Maarel 1978). We analysed the proportion of native and non-native plant taxa using the classification of Halada (1996). The native taxa included proantopophytes (native taxa living exclusively in natural and semi-natural communities) and apophytes (native taxa, penetrating synanthrop communities). Archaeophytes (non-native immigrants before 1500) and neophytes (non-native immigrants since 1500) were classified as non-native taxa.

In 2007 we launched monitoring epigeic fauna. For this purpose we installed 5 pitfall traps in 3 study areas in the permanent plot (TVP) from 1967 (clear-cut, edge of oak-hornbeam forest and clear-cut and oak-hornbeam forest, in total 15, on April 4, 2007). The traps were emptied monthly during warm seasons and once or two times during the winter period. Each pitfall trap consisted of a 0.7-litre jar (diameter 10 cm) with an antifreeze substance Fridex as a conservation medium. The trapping period was until April 4, 2010. When research was repeated the traps were placed approximately to same position and type of habitat as was used earlier in 1967-1971.

Results and discussion

Vegetation

We documented 69 taxa of vascular plants by spring record; this number included 48 herbs and 21 woody plants (seedlings and juveniles). Spring geophytes *Anemone ranunculoides, Corydalis solida* and *Gage lutea* dominated, abundant were also other species of the spring ephemerals Fic*aria bulbifera* and *Pulmonaria officinalis*. From other herbs, high frequency had *Mercurialis perennis, Polygonatum multiflorum, Melica uniflora, Galium odoratum, G. aparine* and *Galeobdolon luteum*. Abundant was also a liana *Hedera helix*. The listed species document that mainly the native species of forest communities form the spring aspect of the herb layer. *Corydalis cava, Dentaria bulbifera, Arum alpinum, Brachypodium sylvaticum,* and *Campanula rapunculoides* occurred only in plots located in the Nature Reserve while *Cirsium arvense* occurred only in the glade.

In the early summer we recorded 130 taxa of vascular plants: 104 herbs and 26 woody species. The abundance of herb layer varied from 25 to 100%. The time of recording in early summer is reflected in the frequency of individual species. The geophyte *Anemone ranunculoides* remained dominant followed by species *Viola odorata, Melica uniflora, Ficaria bulbifera, Galium aparine, Mercurialis perennis* and *Pulmonaria officinalis*. High frequency (over 80%) had taxa *Galium odoratum, Geum urbanum, Hedera helix, galeobdolon luteum, Glechoma hirsuta, Polygonatum multiflorum, Alliaria petiolata* and *Impatiens parviflora*.

Only in a forest plots we observed species *Anthriscus cerefolium, Campanula rapunculoides, Corydalis cava, Dentaria bulbifera, Lathyrus niger, L. vernus, Melica nutans*, and *Lithospermum purpurocaeruleum*. For the forest margins were typical species *Dactylis polygama, Chenopodium album agg., Sanicula europaea, Stenactis annua and Urtica dioica*. Quite a number of taxa (24) were recorded only in a glade: *Achillea millefolium, Aster lanceolatus, Astragalus glycyphyllos, Capsella bursa-pastoris, Dactylis glomerata, Echinops sphaerocephalus, Epilobium lamyi, Gnaphalium sp., Hypericum perforatum, Lamium amplexicaule, Lathyrus pisiformis, Lythrum salicaria, Myosotis sp., Plantago major, Polygonum aviculare, Rumex obtusifolius, Sambucus ebulus, Silene dioica, Solidago sp., Sonchus arvensis, Trifolium pratense, Tripleurospermum perforatum, Tussilago farfara* and *Veronica chamaedrys* as well as the woody plants *Ailanthus altissima, Humulus lupulus* and *Lonicera tatari*ca. As can be seen from this list, there is a high proportion of synathrop taxa observed in glades only. This confirmed also the Figure 1 showing distribution of non-native taxa on the permanent plot.

The data presented here can be used for monitoring of further development of the herb layer structure in the permanent because after the felling the significant changes in the community structure during secondary succession are expected. The possibilities for comparison of the species composition in TVP with the first research period (70's and 80's of the 20th century – JURKO & DUDA 1970) are limited, since published data (e.g. KUBÍČEK & BRECHTL 1970) are related to the whole forest complex Bábsky les, not to permanent research plots.

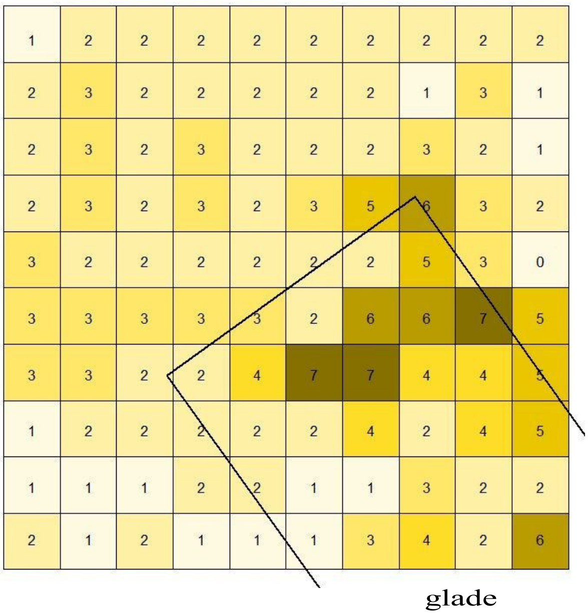

Figure 1: Distribution of the non-native taxa in the permanent plot. (Author: L. Halada)

Epigeic spider communities

We compared changes in the composition of the epigeic spider communities in oak-hornbeam forest located in Báb research plot in long time horizon of nearly 40 years. In past the research of the epigeic spider fauna in this locality was realised by Žitňanská in 1967-1971 (ŽITŇANSKÁ 1970, 1973, 1981). Repeated research was done on the same study area from April 2007 to April 2010. Žitňanská found out 45 spider species belonging to 16 families. During our research in 2007-2010 there were documented 103 spider species belonging to 24 families.

We recorded only 30 species that were found in both periods of study. From them only 15 ones were occurring in the same categories of dominance in both studied periods (expect *Pardosa hortensis* all ones are recedent occurring species). Dominances of other common species in the epigeic communities were different. In present the eudominant species *Pardosa alacris* (D-40.53%) has shown the greatest change in its abundance. In 1971 this species was presented in category as subdominant (D=2-5%). Similarly, presently dominant species *Trochosa terricola* (D-7.48%) was occurring in past as recedent (D until 2%). On other hand dominant species in 1971 as *Pisaura mirabilis* and *Microneta viaria* were documented during current research as subrecedent (D-0.24% and D-0,08%). Also abundance other dominant sowbug-eating spiders *Dysdera erythrina* and *Harpactea rubicunda* from 1971 were markedly lower in 2007-2011 (recedent representation- D- 1.46% and 1.98%). Last dominant species from 1971 crab spider *Ozyptila blackwalli* was documented as subdominant in 2007-2010 (D-3.21%). From 73 species captured only during current research *Urocoras longispinus* (D-11,01%), *Drassyllus villicus* (D-5.21%), *Tenuiphantes flavipes* (D-4,43%), *Scotina celans* (D-4.38%), *Ozyptila praticola* (D-2.72%), *Diplostyla concolor* (D-1,62%) and *Ceratinella brevis* (D-1,22%). Totally 15 species were not confirmed after 40 years. From them species *Entelecara acuminata* was occurring in the samples from 1971 as dominant and other 5 species (*Robertus lividus*, *Dicymbium nigrum brevisetosum*, *Pardosa amentata*, *Agelena labyrinthica* and *Drassodes lapidosus*) were subdominant.

Also we compared the occurrence of threatened species in spider communities in 1967-73 and in the current research. Within the identified species we recorded 6 threatened species (*Bathyphantes similis*, *Enoplognatha oelandica*, *Macrargus carpenteri Megalepthyphantes pseudocollinus*, *Metopobactrus ascitus* and *Segestria bavarica*) which are listed in the Red List of Spiders of Slovakia (Gajdoš & Svatoň 2001) in different categories of threat (Tab.1). No threatened species was documented in previous research.

Table 1: Abundance (A) and dominance (D) of the threatened species in epigeal spider communities on individual study site. RL – Red list of spiders of Slovakia (Gajdoš & Svatoň 2001). Categories of threat: CR - critically endangered, EN – endangered, LR - lower risk (nt - near threatened, DD – data deficient (Author: P. Gajdoš)

RL		Abundance	Dominance (%)
	Segestridae		
LR(nt)	*Segestria bavarica*	1	0,009
	Theridiidae		
EN	*Enoplognatha oelandica* (Thorell, 1875)	1	0,009
	Linyphiidae		
CR	*Bathyphantes similis* Kulczyński, 1894	1	0,009
EN	*Macrargus carpenteri* (O.P.-Cambridge, 1894)	4	0,035
DD	*Megalepthyphantes pseudocollinus* (L.Koch, 1872)	40	0,346
LR(nt)	*Metopobactrus ascitus*	1	0,009

On bases of results very great changes in the composition of the epigeic spider communities in the studied forest were documented in time horizon nearly 40 years. It was demonstrated mainly by increasing many xerotermophilous species (e.g. species from family Gnaphosidae) on other hand by decreasing of abundance or absolute disappearing of some hygrophilous species (e.g. *Microneta viaria*, *Pachygnatha degeerii*, *Pardosa amentata*, etc). Provided changes in species composition can be reflection on climate changes documented by Cunev & Šiška (2006) who indicated gradual drying out of the studied locality. On basis of climatologic monitoring from 1960 to 2004 realised on meteorological station close to Báb it is possible to observe increase of average annual air temperature from 9.3°C to 10.7°C. According to this trend we can observe tendency of this increase mainly in last decade of 20 century with continuation in the first years in following decade, as well as 60-ties years of the last century. According to Cunev & Šiška (2006) the atmospheric precipitation represents in our latitudes main received component of water balance in ecosystem. Amounts of precipitation in time interval 1960 – 2003 decreased from 570 mm on level of 510 mm what is more than 10%.

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Biodiversity and structure in managed and unmanaged forests: a comparison based on the strict forest reserves network in France

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Abstract

In Western Europe, the long history of forest management over the past centuries has shaped both landscape- and local-scale forest structure. As a consequence, forest biodiversity has probably been impoverished and recovery is still ongoing. In France, the strict forest reserves network was created to serve as a reference for biodiversity conservation and close-to-nature forest management and currently includes around 200 sites. However, research comparing biodiversity in managed and unmanaged forests remains strikingly poor despite the relatively large number of candidate sites.

In order to close the gap in knowledge in the French context, we studied forest structure (living and dead wood amounts) and the biodiversity of 6 taxa (vascular plants, saproxylic fungi, birds, bats, carabids and saproxylic beetles) by comparing fifteen strict forest reserves with adjacent managed forests, on a total of 213 plots.

In terms of forest structure, we showed that deadwood was the most discriminant criterion between managed and unmanaged forests in France. In terms of biodiversity, we showed that only saproxylic fungi richness responded significantly to management abandonment. For the other groups, the results were less clear, and further analyses correlating forest structure with taxa or ecological groups are programmed in the forthcoming year.

This applied research closely associated managers and researchers and is a good example of research-action involving protected areas.

Keywords

Forest management, stand structure, saproxylic species.

Introduction

In Western Europe, the long history of forest management over the past centuries has shaped both landscape- and local-scale forest structure. Except for the most northern boreal locations, "real" primeval forests are virtually inexistent in Europe; all the forests have undergone more or less intensive management until a recent past (Bengtsson et al. 2000). As a consequence, the network of strictly protected areas is made up of forests where harvesting has only quite recently stopped.

In France, the strict forest reserves network was created to serve as a reference for biodiversity conservation and close-to-nature forest management (Gilg 2004); it currently covers up to 0.3% of the national territory (core areas of national parks excluded, www.inpn.mnhn.fr), distributed over 200 sites representative of the main forest types.

Despite the extent of this network, research comparing the biodiversity between these areas and adjacent managed forests remains strikingly poor (Paillet et al. 2010). References for sustainable forest management (e.g. how much deadwood exists in French forest reserves?) as well as scientifically estimated levels of biodiversity are lacking. In this context, we sought to answer the following two questions:

- What stand structure features differ in managed forests and strict forest reserves (with a special focus on old-growth features: deadwood and large trees)?
- How does biodiversity respond to management abandonment?

This paper gives an overview of the significant results obtained to date. For forest stand structure, we focused on variables associated with old-growth forests (Bobiec 1998; Boncina 2000). Hence, we studied deadwood amount (volumes and densities), and basal areas and densities of (large) living trees. For biodiversity, we compared the total species richness of six taxa: saproxylic fungi, vascular plants, carabids, saproxylic beetles, birds and bats (further details on the project: http://gnb.irstea.fr, in French).

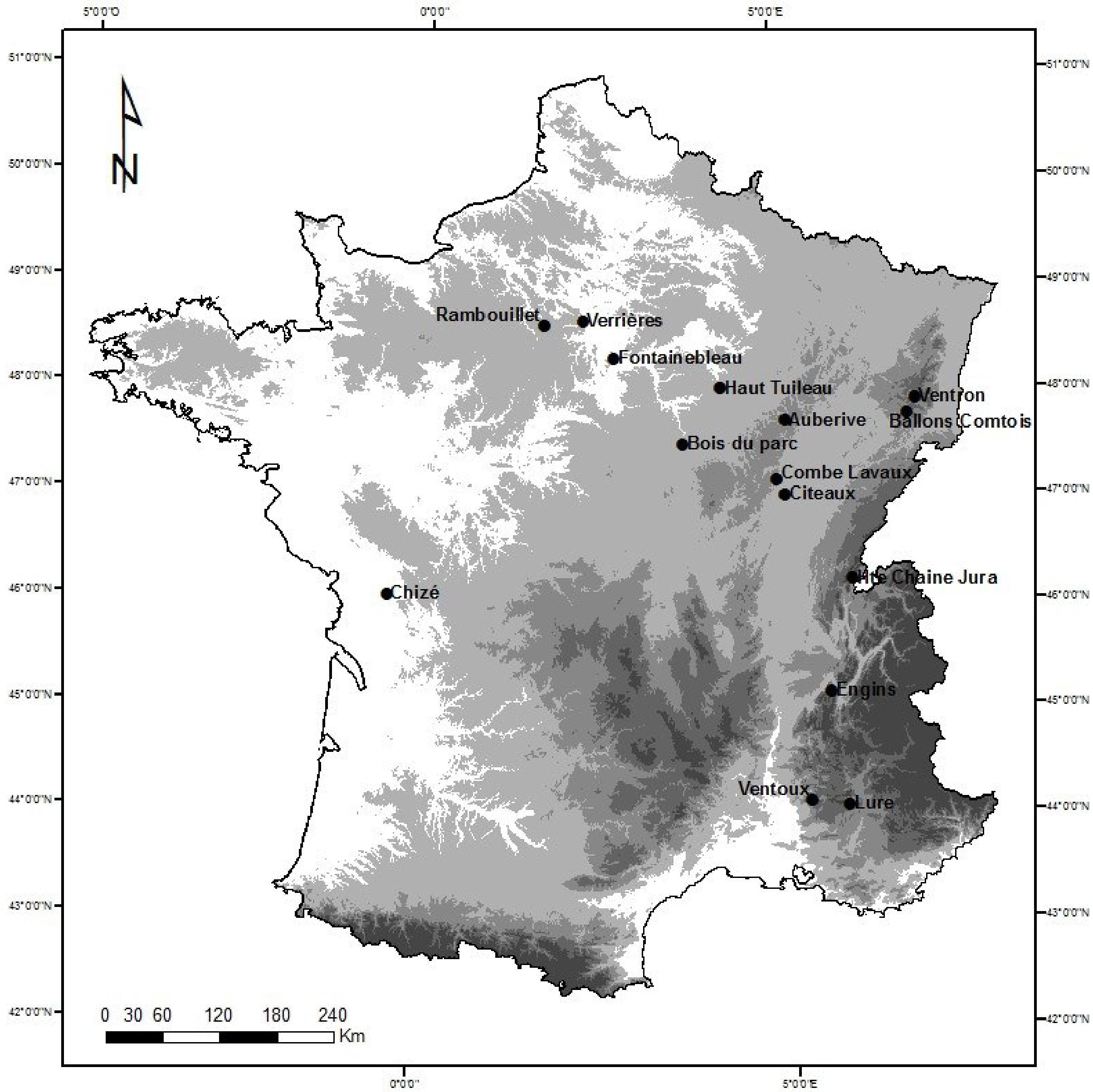

Figure 1: Map of the study sites

Materials and methods

Study sites

We compared fifteen strict forest reserves distributed across France (Figure 1) with adjacent managed forests in the same site conditions. The mean time since last harvesting was 46 years (min: 8, max: 147) for unmanaged reserves and nine years (min: 0, max: 76) for managed forests. We restricted our study to mixed lowland oak-beech-hornbeam forests and mountain beech-fir-spruce forests. These forest types represent around 40% of the total forested area in France (www.ign.fr).

At each of the fifteen locations, sample plots were randomly selected and matched according to site conditions: edaphic and topographic conditions were checked in the field so that each plot within the forest reserve had its equivalent outside the reserve. The managed plots were selected within a radius of 5km around the forest reserve boundaries and in stands composed exclusively of native tree species. The final sample had 213 plots (Table 1).

Stand structure characterisation

Forest stand structure was characterised using a combination of two sampling techniques. On each plot, for all living trees with a diameter at breast height (DBH) of more than 20cm in lowland forests and 30cm in mountain forests, we used a fixed angle plot technique to measure the trees comprised within a fixed relascopic angle of 2% (resp. 3%). Practically, this means that, in lowlands, trees with a DBH of 60cm within a maximum distance of 30m from the centre of the plot (resp. 20m in mountains) were included in the sample and accounted for a basal area of 1m²/ha (resp. 2.25m²/ha in mountains).

All other variables were measured using a fixed area plot technique. Within a fixed 10m (314m²) radius, we measured (i) the diameter of all living trees from 7.5 to 20cm DBH (resp. ≤ 30cm in mountains) and (ii) the volume of snags and stumps with a diameter ≤ 30cm. Within a 20m radius, we recorded the volume of downed deadwood (logs > 30cm) and standing dead trees (stumps with a height ≤ 1m and snags with a diameter > 30cm).

Finally, logs with a diameter < 30cm were measured using Line Intersect Sampling (LIS, Woodall & Williams 2005) on a total length of 60m.

We then used the measurements to infer densities and basal area of living trees (including very large trees with DBH ≥ 67.5 cm) and deadwood densities and volumes at the plot level.

Table 1: Number of plots comparing unmanaged strict reserves and adjacent managed forests.

	Sites	Managed forests	Unmanaged strict reserves
Lowland	Auberive	12	12
	Bois du Parc	5	5
	Chizé	12	12
	Citeaux	6	6
	Combe-Lavaux	4	4
	Fontainebleau	16	13
	Haut-Tuileau	7	7
	Rambouillet	8	8
	Verrières	4	4
	Total Lowland	74	71
Mountain	Ballons Comtois	8	8
	Engins	5	5
	Haute Chaine Jura	8	8
	Lure	4	4
	Ventron	4	4
	Ventoux	5	5
	Total Mountain	34	34
	Total	**108**	**105**

Biodiversity protocols

Due to differences in sampling dates for each taxon, all data were not available at the time of writing.

Fungi

Saproxylic fungi (i.e. species for which the sporophore grows on wood) were sampled once in autumn. We searched for fungi on all living trees and large dead trees (snags, stumps and logs with a diameter > 30cm) retained for stand structure characterization (see above), and recorded and identified all sporophores occurring to a height of 3m. In addition, six small logs intersecting the transects mentioned above were surveyed.

Vascular plants

We used the Braun-Blanquet (1932) abundance-dominance method to inventory all vascular plants within a 1000-m² circular plot once in spring. All censuses were performed by two observers. Sampling effort was limited to 35min (+/- 5min) per plot.

Saproxylic and carabid beetles

Saproxylic beetles were sampled using multidirectional Polytraps™ (EIP, Toulouse, France; Brustel 2004) placed at a height of about 1 m. Two traps were located approximately 30 m apart on each plot.

Ground beetles were sampled using pitfall traps. In each plot, three traps were set 10m from the centre point along lines radiating out in three different directions (zero, 120 and 240 degrees) to ensure the independence of the traps (see Toïgo et al. 2013 for further details).

Sampling of all traps was carried out monthly over a three-month period. All beetles were identified to species level. Total richness per plot was calculated by pooling all the species caught in all the traps during the entire sampling period.

Bats

Bats were inventoried using 30min ultrasonic point-counts. Two observers listened to bat echolocation calls during the first four hours of the night. In all, three censuses were carried out by the same observers: one in spring and two in summer. All bats were determined to species level whenever possible. All sampling periods were pooled to calculate species richness.

Birds

Breeding birds were surveyed using a standardized monitoring methodology (JIGUET et al. 2012): five-minute censuses were carried out by skilled observers during two sampling periods in spring (before and after May 8 with a 4–6 week gap in between). Every individual seen or heard was recorded. Total species richness was calculated as the sum of all species detected during the two sampling periods.

Statistical analyses

Analyses were processed in R v.2.5.1 (R Development Core Team 2007). Management type, i.e. managed forest vs. unmanaged strict reserve, was used as the explanatory variable.

For stand structure characteristics, we considered basal area, deadwood volume and living and dead tree densities. We used non-linear mixed effects models (nlme function, nlme package) with an exponential link. In practice, we obtained a multiplication coefficient between managed and unmanaged forests for each explanatory variable. This allowed us to take into account the initial values of stand characteristics. We then re-estimated coefficients using bias-corrected bootstrap confidence intervals calculated with 9999 iterations (library boot). The significance of these results was assessed using a Bayesian posterior p-value (GOSSELIN 2011).

For biodiversity data, total species richness per plot of each taxa was used as the response variable. We used generalised mixed effects models (lmer function, lme4 library) with a Poisson error distribution with site as a random effect to analyse the response of biodiversity to forest management. We also added a plot random effect to account for potential over-dispersion of the data (ELSTON et al. 2001).

Table 2: Dendrometric data comparing unmanaged (UNM) forest reserves (n = 105 plots) to adjacent managed (MAN) forests (n = 108 plots). Coef = multiplication coefficient between MAN and UNM data, Bca- and Bca+ = lower and upper values of bias-corrected bootstrap confidence intervals calculated with 9999 iterations. N = number, V = volume, DBH = Diameter at Breast Height. p = sampled posterior Bayesian p-value. ***p<0.001; **p<0.01; *p<0.05; (*) p<0.1; ns: non-significant result.

Variable	Coef	p	Mean MAN	Bca-	Bca+	Mean UNM	Bca-	Bca+
N living trees / ha	1,225	*	508,8	447,6	580,6	623,3	555	703,5
N very large trees / ha (DBH>67.5cm)	2,052	**	3,4	2	5	7	6	8,5
Total basal area (m^2/ha)	1,166	***	22,9	21,6	24,2	26,7	25,2	28,3
Total basal area of large trees (m^2/ha)	2,467	**	1,4	0,8	2,3	3,5	3	4,2
N standing deadwood / ha	-0,932	ns	84,8	62,7	108,1	79,1	55,3	115
N stumps / ha	-0,301	***	62,6	53,3	80,3	18,8	12	31,8
V standing deadwood	4,591	***	4,6	2,9	9,3	21,2	17,9	27,5
V lying deadwood	4,759	***	6,2	3,6	9,9	29,6	25,2	36,1
Total deadwood V	4,595	***	11,1	7,1	17,4	50,9	44,7	60,9

Results

Forest stand structure (Table 2)

Living trees

Living trees were significantly more numerous (by 22%) in strict reserves (623 trees/ha) than in managed forest (509 trees/ha). In particular, there were twice as many very large trees (DBH ≥ 67.5 cm) in strict reserves (7 trees/ha) than in managed forests (3.4 trees/ha). Basal area was also significantly higher (by 16%) in unmanaged reserves (26,7m^2/ha) than in managed forests (22.9m^2/ha). Similarly, the basal area of very large trees was 2.46 times higher in the reserves (3.5 vs. 1.4m^2/ha in managed sites), which indicates that very large trees are both more numerous and larger in the reserves.

Deadwood

The combined number of snags and stumps (standing deadwood) did not differ significantly between strict forest reserves and managed forests. However, the number of stumps in the reserves represented only 30% of the number in the managed forests (p<0.001). For deadwood volumes, there was 4.5 times more standing (21.2 vs. 4.6m^3/ha), lying (29.6 vs. 6.2m^3/ha) and total deadwood (50.9 vs. 11.1m^3/ha) in the reserves, and all these results were significant.

Total species richness (Table 3)

Among the 6 taxa analysed, only saproxylic fungi displayed significantly higher total species richness in unmanaged reserves than in managed forests (12.3 vs. 8.6 species). Birds showed marginally higher total species richness in unmanaged (11.9 sp.) than in managed forests (11.1 sp.). For all the other groups, the total species richness did not differ.

Table 3: Total species richness comparisons between unmanaged strict forest reserves and adjacent managed forests. The results were derived from a generalised mixed model with Poisson error distribution. The estimated mean values have been back-transformed. Please note that the number of plots differ from one taxon to another. n = number of plots, SE = estimated standard errors. ***p<0.001; **p<0.01; *p<0.05; (*) p<0.1; ns: non-significant result.

		Managed forests		Unmanaged reserves		
Taxa	n	Estimated Mean	SE	Estimated Mean	SE	p
Fungi	99	8,6	1,192	12,3	1,19	***
Flora	197	32,5	1,1	32,7	1,1	ns
Carabids	121	3,3	1,293	3,1	1,294	ns
Saproxylic beetles	169	26	2,032	24,2	2,032	ns
Birds	185	11,1	1,075	11,9	1,075	(*)
Bats	101	4,8	1,352	5,7	1,351	ns

Discussion

Strict forest reserves and managed forests differ in structure

We found that unmanaged strict forest reserves differed significantly from adjacent managed stands in terms of stem and stump number, total basal area, large tree and deadwood volumes. These latter two features are generally used as indicators of old-growth unmanaged forests (BOBIEC 1998; BONCINA 2000; GILG 2004). These results highlight the fact that forest management tends to shorten the silvigenetic cycle by eliminating the aged and senescent phases (PAILLET et al. 2010). Compared to the results obtained by BURRASCANO et al. (2013), our results showed higher differences in terms of basal area and density, but comparable results in terms of deadwood. However, BURRASCANO et al. (2013) found median deadwood volumes for old-growth forests that were much higher (157.3m^3/ha) than those we obtained in the French forest reserves; this indicates that recovery in the French reserves is still an on-going process.

Small differences in terms of biodiversity

Our multitaxa analysis revealed that only saproxylic fungi had higher species richness in the reserves than in managed forests, thus confirming the results previously observed (PAILLET et al. 2010). Birds tended to display the same pattern, but for all the other groups, forest management had no effect on species richness. Most surprisingly, saproxylic beetle species richness did not differ significantly between managed and unmanaged forests in our study, despite the differences in deadwood volumes. This supports the hypothesis that deadwood volume is probably not the main driver of saproxylic beetle richness in temperate forests (LASSAUCE et al. 2011). However, this lack of difference may also be due to several other factors, or their combination:

- the French forest reserves are probably too recent, and biodiversity is still recovering from past forest management;
- an extinction debt, notably due to centuries of deforestation in western Europe, has already been paid and potential sources of recolonisation for species have disappeared;
- current forest management in the surrounding forests is sufficiently sustainable to maintain the typical forest species;
- other factors at other time and spatial scales (especially at the landscape scale) play a greater role in biodiversity than forest management per se (see Toïgo et al. 2013 for a comparison with structural factors).

Conclusions

Although established quite recently, the French forest reserves showed higher stem densities, basal areas (especially for very large trees) and deadwood volumes. However, these structural differences were only partially reflected in terms of biodiversity. This study constitutes a first reference for French forests since research comparing structural attributes and biodiversity between managed and unmanaged temperate forests remains spectacularly scarce, and will undoubtedly serve as a basis for many other forest programs.

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Research for sustainable communities

Anthony Patt

Abstract

In recent years, scientists have increasingly focused on the role of ecosystem services in enhancing the sustainability and value of mountain areas. In this talk, I describe research into social systems that has the same objective. I focus on strands of research examining to related, but nevertheless distinct, questions.

First, how can we best manage natural resources in mountainous areas: what institutions, organizations, and strategies work better than others? The main goals for such management are the typically enhancement of value of resources, such as timber and farmland, on the one hand, and the protection of communities against risks, primarily from landslides and rockfalls, avalanches, and flash floods, on the other. Social science research has examined the preconditions for effective long-term management, achieving these goals in the face of short-term pressures to use resources unsustainably, and I summarize some interesting conclusions. With respect to risk management, I draw off of two recent studies of landslide management, one examining a single community in Austria, and a second contrasting governance approaches in mountain regions of India and Italy. Together, these studies provide important evidence concerning the respective roles of public and private institutions, and concerning the geographical level at which decisions are taken.

Second, how can we make communities in mountain areas attractive places to live? In the Alps, the track record would appear to be poor, as the region has experienced a continuous and dramatic outmigration of people, in particular younger people with valuable skills. First, I examine the evidence of whether the out-migration is a result of alpine communities become less attractive places to live, or a result of increased opportunity elsewhere. Second, and more importantly, I examine the evidence concerning the factors driving out-migration, and the types of opportunities -- economic and social -- that can be created in mountain communities, necessary and sufficient to make them attractive places to live.

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Protected areas and climate change impact research: roles, challenges, needs

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Abstract

Protected areas were originally designated to deal with regionally caused threats. Yet, they increasingly encounter potentially detrimental influences from distant sources and of globally area-covering climate change effects. By forcing organisms to shift in latitude and elevation, anthropogenic climate change may deprive nature reserves of their threatened "biotic goods". The long-lived nature of many mountain species may counter their rapid disappearance and topographically determined habitat and micro-climatic diversity may buffer against climate warming impacts. An ongoing large-scale thermophilisation of alpine vegetation and a decline of narrow-range species in fragmented cold habitats, however, call for joint efforts in observing and studying the changes as well as in developing and implementing suitable conservation measures. Both protected area managers and researchers will mutually depend on and benefit from each other in such an endeavour. High mountains hold an unsurpassed potential for large-scale comparative studies, due to their virtually global distribution and their rather natural environments. Taking advantage of this situation, the Global Observation Research Initiative in Alpine Environments (GLORIA) has started already at the turn of the millennium to build a global research programme and observation network. Rapidly expanding, it is now represented on six continents. The majority of the currently 115 study regions lie within protected areas and, thus, provide a unique opportunity for tracing human-induced impacts on the shrinking natural biosphere.

Keywords

alpine plants, climate change, conservation management, long-term monitoring, mountain protected areas, species migration

Introduction

Protected areas were usually designated in view of locally or regionally generated causes of threats to species, habitats, ecosystem services and landscapes. At least since the 1970s, however, when the dying forests syndrome and rapid lake acidification became apparent in Europe, long-distance effects of pollutants shifted into the focus of conservation concerns. Only one-and-a-half to two decades later, human-induced climate change was recognised as a by far more spatially extensive phenomenon which could have a strong impact on species distributions and survival. Even if climate change may still be outranked by other threats such as forest exploitation, industrial agriculture, construction or land use changes, it could become one of the most powerful factors of change, owing to its virtually global area-covering influence and in the view of its projected continuation or even acceleration (Sala et al. 2000).

Climate warming is expected to force many terrestrial organisms to shift in latitude and elevation. A recent meta-analysis estimated that the distributions of species have already moved to higher elevations at a median rate of 11 m per decade, and to higher latitudes at a median rate of c. 17 km per decade, but species varied greatly in their rates of change (Chen et al. 2011). Organisms living in cold environments, such as high mountain regions, are considered to be particularly prone to climate warming, because species are adapted to low-temperature conditions (Gottfried et al. 2002). By that way, even this otherwise more remote and anthropogenically undisturbed mountain biome experiences a shift from nature-dominated to human-dominated environmental changes (Messerli 2006).

Developing and implementing suitable strategies to protect high-mountain biota from the impacts arising from warmer climates, therefore, appears to be one of the greatest challenges of conservation biology and conservation management.

Mountain protected areas – effective conservation or a hopeless lag behind?

Despite the possibility that protected areas may simply become ineffective, if their threatened "biotic goods" lose their suitable habitats, all may not be lost for the endangered biota. First, most of the plants living in high mountains are slow-growing and long-lived individuals, which can counteract their rapid disappearance. Simulations using a hybrid model suggested persistence of alpine plant species over several decades, at least in form of remnant populations, in spite of the view of projected average range size reductions of 44-50% by the end of the century (Dullinger et al. 2012). In fact, extinctions or declines of species numbers were by far less commonly reported up to now, than an increase caused by an upward shift of mountain plants (Grabherr et al.

1994, WALTHER et al. 2005, KULLMAN 2010, PAULI et al. 2012, WIPF et al. 2013). Second, rugged terrain and pronounced microtopography, being typical for many high mountain environments, provide a multitude of habitat situations with marked microclimatic changes over short distances. This would allow for escape routes to nearby colder refuge sites, when temperatures continue to rise (SCHERRER & KÖRNER 2011).

At the same time, however, geographically highly restricted alpine species (endemics) often occur in moderately-high mountain ranges, where space above the forestline is limited, e.g. in the marginal ranges of the Alps (DIRNBÖCK et al. 2011) and to a much higher degree in many of the fragmented Mediterranean mountains (KAZAKIS et al. 2007, NOROOZI et al. 2011, FERNANDEZ CALZADO et al. 2012). Looking into the past, the late Quaternary climate displacement rate was high in the north, in NW-Eurasia and NE-North America in particular, when the formation of ice shields caused massive extinctions. Nowadays, these regions are populated mostly with rather widespread and more generalist species. Further south, such as in the Mediterranean, but also in parts of the Pyrenees and the Alps, the climate remained relatively stable and supported survival of many species with small range sizes, narrow ecological niches and expectedly poor dispersal abilities (ESSL et al. 2011, SANDEL et al. 2011). Narrow-range and often less mobile species constitute much if not most of Earth's biodiversity. What if accelerating climate warming pushes these less vigorous species, dwelling in long-term climatically stable habitats, into high velocities of climate change (SANDEL et al. 2011)? Recent local declines of high-mountain vascular plant species were already observed on Mediterranean mountains and were hypothesized as a consequence of decreasing precipitation in spring, combined with climate warming (PAULI et al. 2012).

Protected areas are in a role of Noah's Ark, but leaking and occasionally in heavy sea. The future role of mountain protected areas is expected to significantly gain in importance. On one side, they act as Noah's Ark for upward-moving climate refugee species. Mountains, thus, will harbour many more species than they presently do. The cold-adapted species may remain to be on board, either by re-establishing at nearby sites or in form of weakened remnant populations. A protection status, however, does not ensure that species will survive. Narrowly distributed endemics may drop out from Noah's ark, as will eventually do the shrinking population of cold-adapted species with some delay of probably several decades (ENGLER et al. 2011, DULLINGER et al. 2012). Even though species richness will increase locally on many mountains, mostly due to immigrating wider spread, more thermophilous species (GOTTFRIED et al. 2012), we are going to lose the more special to the benefit of the more common species. The large-scale picture, therefore, would show a drop of species numbers and a homogenization of species compositions (WINTER et al. 2009). Floras would become more similar to each other among mountain ranges and mountain systems.

The mutual needs of conservation management and climate change impact research

Simultaneously with the growing importance of mountain protected areas and effective conservation strategies, internationally comparative ecological research in mountain regions increasingly became a matter of attention since the 1990s, following the UNCED-Conference in Rio 1992. Between 1996 and 1998, the Mountain Research Initiative (MRI; (BECKER & BUGMANN 2001) was launched. A few years later, two research programmes and observation networks targeting on mountain biodiversity emerged: the Global Mountain Biodiversity Assessment (GMBA of DIVERSITAS; (KÖRNER & SPEHN 2002) and the Global Observation Research Initiative in Alpine Environments (GLORIA; (PAULI et al. 2009, GRABHERR et al. 2010). Linking between protected area management and research, the UNESCO MAB programme attempted to develop and/or to incorporate existing global change research and monitoring approaches within its network of mountain Biosphere Reserves (GRABHERR et al. 2005).

The generation of knowledge about past, recent and possible future changes as well as the development and implementation of suitable measures against expected biodiversity losses demands collaboration. Both protected area managers and researchers intrinsically benefit from each other from their different, but mutually dependent perspectives.

<u>The researcher's perspective:</u>

- Areas where a continued "naturalness" can be ensured are invaluable for observing and studying large-scale impacts on the biosphere in absence or at minimised background noise from direct anthropogenic impact. Legally designated protected areas have a greater chance to remain undisturbed from direct human intervention than areas without a conservation status. In an increasingly populated and globalised world, contrasts may further grow between such "set aside" near-natural or pristine areas and the expanding human-shaped land.
- Longer-term time series of semi-natural or natural vegetation from standardised permanent plot designs are still scarce, but would essentially contribute to the evaluation of predictive models and to ecological theory. A co-operation with protected area management will be of much help to filling this urgently demanded gap.
- Protected areas usually have experienced staff knowing the places and often many of the species. Although staff capacity may be limited due to other obligations, a long-lasting management could provide an ideal general setup for ecological climate impact monitoring – in particular, if service costs and expenditure of time can be kept at reasonable levels.
- Records on the recent land use history may be easier obtainable as for unprotected land. This is important information for areas where, e.g. pasturing practices ceased with a protection status, but which may continue to influence the composition of species over decades.

<u>The conservation manager's perspective:</u>

- Knowledge based on local data about recent impacts of climate change is crucial for defining and implementing targeted conservation measures.

- Large-scale phenomena such as climate change require standardised settings over many sites and across regions. Protected areas being part of such a network would benefit in the way that larger data sets enhance statistical significance and therefore an earlier detection of change.
- Internationally organised, standardised monitoring enables comparison among different protected areas and could stimulate interdisciplinary and trans-disciplinary activities in a conservation and sustainability context.
- Participation in long-term monitoring would enduringly contribute to capacity building for young generations of experienced field workers.
- Presentation to non-experts and visitors of regional results on climate change impacts combined with the large-scale dimension strengthens public awareness of conservation needs.

The Planet's mountains and their unique potential to trace climate change impacts

The world's high mountain areas represent the only terrestrial biome type which is really globally distributed from the tropics to the polar regions: i.e. the "alpine life zone" above the upper treeline. All of the globally scattered alpine areas have one thing in common – and this is low-temperature conditions (KÖRNER 2003). Alpine areas, moreover, are usually by far less influenced by human landuse than many of the lowland areas. More than half of the world's mountains are categorized as not influenced or with low influence from direct human activity. Surprisingly, 34.7 % of these little impacted mountain regions are covered by nationally designated protected areas (RODRIGUEZ-RODRIGUEZ & BOMHARD 2012). Such a worldwide configuration of cold and fairly natural ecosystems, which are legally protected from direct human intervention, offers an unrivalled opportunity for investigating and tracing the ecological and biodiversity impacts of a global human-fuelled phenomenon.

Taking advantage of this unique situation and of the indicative value of alpine organisms was one of the key-considerations in developing a globally applicable long-term monitoring approach. Already in the late 1990s, a world-wide call for participation was replied by many concerned ecologists, expressing their interest to join in. This was the actual starting point of the Global Observation Research Initiative in Alpine Environments (GLORIA; www.gloria.ac.at). GLORIA's basic monitoring approach was designed along three main principles: comparability, simplicity, and economy. Practicality as well as a large number of committed biologists led to the outstandingly fast expansion of the research and observation network, which also includes remote mountain areas. GLORIA comprises currently 115 target regions (study regions) scattered over six continents. Sites are to be established along a series of four mountain summit arranged between the treeline and the limits of plant life. The main requirement for the field observers is a very good knowledge of the regional vascular plant flora, the priority organism group of the basic approach. Dependent on the availability of experts, time, and budget, bryophytes and lichens can be included in the basic approach and suitable designs were developed for other organism groups such as arthropods, reptiles, and amphibians. Further, additional research and monitoring approaches are emerging and are already in operation is some GLORIA study regions, such as on soil variability, complete downslope transects of vascular plants, as well as on socio-economic and cultural aspects.

The world-wide coordination including the central database is located in Vienna, Austria at the Institute for Interdisciplinary Mountain Research of the Austrian Academy of Sciences and the University of Natural Resources and Life Sciences. The majority of GLORIA target regions and active observation sites lie within protected areas. In several cases, protected area authorities take the responsibility of operating the monitoring activity. Examples for the Alps are Berchtesgaden National Park, Swiss National Park (NP) or Gesäuse NP, for the Rocky Mountains, Glacier NP or Yellowstone NP. Many others are organised as joint efforts between national research institutions and the protected area management, e.g. the sites in California's Sierra Nevada national parks Yosemite and Kings Canyon and the White Mountains Reserve, Australia's Kosciuszko NP, and several national reserves in Taiwan. Others, again, are principally operated by research institutions, but supported by protected area authorities, such as many of the sites in the Andes, the Himalaya system and in Europe. A number of intergovernmental unions and organisations (e.g., European Commission, Comunidad Andina, UNESCO MAB), national governments (e.g. Austria, Germany, Taiwan), internationally operating research and development organisations and NGOs such as Missouri Botanical Garden, ICIMOD (Himalaya-Hindu Kush), CONDESAN (Andes) or The Nature Conservancy as well as private foundations such as the Swiss MAVA Foundation for Nature Conservation and the National Geographic Society provided or provide support.
Thus, a fairly large number of different ways of support and cooperation proved to work well and should be successful for a long-term operation. With every monitoring cycle, sites and data sets gain in significance and, thus, of relevance for decisions and development of conservation measures. The GLORIA program and network is continuing to expand in the number of sites as well as in the development of integrating and interdisciplinary activities. Additional sites in protected areas are most welcome and important in order to have a solid network of indicators for an uncertain future of the biota in natural habitats.

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Parks & Landscapes in Europe: Towards An Integration of Policies and Management

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Abstract

Because of the risks connected to the global change and the continuous worsening of environmental conditions, biodiversity conservation objectives assume an important role in third millennium strategies.

In particular, the current situation challenges the effectiveness of area-based nature conservation policies, such as typically those of **Protected Areas** (PAs).

The "new paradigms" for the conservation of nature proposed by IUCN (Durban 2003; Bangkok 2004; Barcelona 2008) stimulate innovative proposals about nature conservation policies.

Landscape, conceived by the European Landscape Convention as a bridge between nature and culture, can support this integration process as it invites not only to broaden the conservation action to the whole territorial context, but also to consider both natural and cultural values, looking at the quality of life and at the identity values.

This presentation will focus on the potential relationships between nature conservation policies and landscape policies - a relevant subject also due to the current need of reviving cultural and natural heritage conservation policies, today affected by a general effectiveness deficiency - starting from the outcomes of the research programme "Parks & Landscapes: a territorial research programme", that CED PPN (the European Documentation Centre on Nature Park Planning, Polytechnic of Turin, Interuniversity Department of Regional and Urban Studies and Planning) launched in the 2008. The outcomes of the research activity have been discussed on the occasion of many international meetings (IUCN WCC 2008, 2012; EUROPARC Conference 2010; EUROPARC WS Reims 2010; Federparchi-San Rossore Group 2011; Roma 3 University 2011; ISCAR et al. 2011). Two Important stepsof this work have been the surveyon the "New frontiers of conservation" (2010) and the recent initiative of a Research-book "Parks & Landscapes" that willdiscuss and suggest innovative visions about the relationships between nature policies and landscape policies.

Keywords

Nature Conservation, Protected Areas, Landscape, Policies, Planning and Management

Introduction

Globalization revives the crucial importance of integrating nature conservation policies into territorial policies. Facing the effects of global change by adaptation and mitigations strategies, trying to defend biodiversity avoiding irreversible damages to ecosystems, nature conservation policies are more and more related to issues such as cultural diversity, social and political security and economic sustainable development. Biodiversity conservation objectives have assumed a crucial role in territorial strategies. In particular, the current situation challenges the effectiveness of area-based nature conservation policies, such as typically those of **Protected Areas** (PAs).

The "new paradigms" for the conservation of nature proposed by IUCN (Durban 2003; Bangkok 2004; Barcelona 2008) stimulate innovative proposals about nature conservation policies; particularly, they ask for a better integration of PA policies into territorial policies. The "territorialization" of nature conservation policies implies that they inevitably cross landscape policies, as conceived by the European Landscape Convention (ELC) (CoE 2000). According to the conception, **Landscape**, as a bridge between nature and culture, can support this integration process, inviting not only to broaden the conservation action to the whole territorial context (beyond protected area boundaries), but also to consider both natural and cultural values, looking at the quality of life and at the identity values.

Further, ELC promotes the acknowledgement of the role played by people and local communities in building and managing landscapes and supporting PAs as effective tool for social and economic development.

In such a frame, the landscape concept is assuming a pivotal role for nature conservation and new alliances are envisaged, referring both to the cultural landscapes (as particularly the IUCN Category V – "Protected Landscapes" or the World Heritage UNESCO Cultural Sites) and to the overall policies having influence on landscape such as those concerning forestry, water management, agriculture, urban processes, infrastructure. The alliance between nature conservation policies and landscape policies is therefore a relevant subject, due to the current need of reviving cultural and natural heritage conservation policies.

But in order to improve our knowledge and understanding of the underlying relationships and interactions between nature and landscape, new cultural and scientific approaches are required. In fact, this subject is strictly linked to some important processes that are now taking place at international level, such as the revision of global strategies for biodiversity conservation (CBD Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets) and the prospects of a World Landscape Convention proposal for Rio+20 Conference (Limoges, September 2011). Itis also strictly connected to the topics of the most recent European financing programmes for research (such as Horizon 2010 -2020).

In this direction, the CED PPN lunched in 2008 an innovative research programme "Parks & Landscapes: a territorial research programme", largely based on a previous investigation on European Protected Areas. The Centre has been working on such relationship since the beginning of the 90,s and theissue has had several opportunities for discussion and debate at national and international level (IUCN WCC Barcelona 2008; Polytechnic of Turin 2009; EUROPARC Conference Pescasseroli 2010; EUROPARC WS Reims 2010; Federparchi-San Rossore Group Florence2011; Roma 3 University 2011; ISCAR et al. 2011; IUCN WCC Jeju 2012). Among the CED PPN main researches, two initiatives may be recalled , representingimportantsteps in this process:the international surveyconducted in 2010 on the topic "New frontiers of conservation" and theinitiative that is now in progress of the Research-book "Parks & Landscapes", collecting innovative reflections, on this theme. Both are shortly presented in the following pages.

New Frontiers of Conservation. Five Questions for the Experts Suggestions and Perspectives

An international survey was launched in 2010 about the topic "New frontiers of conservation: suggestions and perspectives", submitting to a group of well-known international experts some general questions as the following:

1. Which are the **new frontiers** for the international scientific communities, in view of carrying out more effective policies for the conservation and enhancement of natural and cultural heritage?
2. Which are the sense and the scope, to this end, of **landscape policies**?
3. Which role have to play the **local communities and indigenous people**, in the presence of value systems and risk factors of an over-local significance?
4. Which role can play the **normative approaches** (particularly the institution and protection of areas of specific value) towards multilateral governance strategies?
5. Which missions can be assigned to **planning**, with the aim of a more effective integration of conservation policies into the overall territorial policies?

The scope of this test is wider, as well as the cultural background of the experts, linked to different contexts (not only Europe), therefore the received answers reflect a variety of points of view and make reference to different management experiences, such as, for instance, those related to the US National Park Service, or to the implementation of the European Landscape Convention, or to the initiatives aimed at strengthening the role of indigenous people in the developing countries.

In the light of the received answers we could define some "**dominant themes**", which pervade most of the received answers: **climate change, fragmentation, landscape, governance**.

A first remark concerns (and no surprise for it) the common emphasis on the **climate change.** We can observe that this issue is strictly tied with other wider issues, first of all the ecosystem based management, aiming to ensure a friendly use of the natural resources and a strategic far-sighted perspective for adaptation and mitigation policies. To this regard, many answers underline the need for the integration of eco-management and planning in sectorial policies (for forestry, farming, energy, infrastructure, recreation, and so on), not without reminding the risk of submitting the ecological options to the sectorial ones.

> *"For natural and cultural heritage conservation, my simplistic answer is that unless we can reduce CO2 levels in atmosphere to 350 ppm there is no hope in the long run for conserving either. Thus every measure must be taken to preserve the important carbon sinks-oceans, forests, grasslands, wetlands, tundra. Formal Protected Areas have a major role, but it takes nature-friendly land management on ALL lands, to make a difference (...)" (L. Hamilton).*

> *"Science must address the issues associated with climate change and impacts on the significant international natural and cultural landscapes. I am particularly interested in effects of rapid climatic changes on forests, farms, urban areas and how protected areas managers can adapt to an uncertain and unprecedented change" (J. Di Bello).*

A second remark concerns a topic of a great momentum, particularly in Europe: how to contrast the **fragmentation** of ecosystems and the related insularization of habitats and protected areas. Most of the answers stress the need for protection policies *outside* parks and protected areas. Bio-regional management and planning, and landscape scale planning are different and complementary ways for ensuring a wider protection and an adequate connectivity in the whole territory.

> *"A very important point for safeguarding biodiversity is the topic of habitat fragmentation. The necessary paradigm shift from the static conservation of single species in specific protected areas towards a flexible protection that takes the dynamic of global change into account still needs to be implemented (...)" (A. Ullrich).*

> *"The Nature Conservancy has expanded its approach to protecting important habitats from focusing on habitats directly to advancing conservation of entire landscapes" (P. Bray).*

> *"Understanding how landscape protected areas contribute to wider conservation strategies is critical (...). Also the way in which protected areas are integrated into the wider landscape and seascape is increasingly important" (N. Dudley).*

A third remark concerns **landscape** and its role in conservation policies. There is a large consensus among the experts on the idea that landscape is the main device for taking care of the whole territory, both in spatial and in cultural terms. This idea is consistent with the ELC landscape conception, that overcomes the concept (still largely diffused) of "natural beauty" and draws the attention on the needs and perceptions of local communities. Strengthening their responsibility and reaffirming the identity values of the subjects closest to the "actual" resources is the main road for contrasting the over-pressure of the driving forces (commerce, tourism, mining, urban processes and so on) on natural and cultural heritage. To this end, landscape policies must be developed as a part of the regional planning, landscape issues must be integrated in multi-sectorial policies and Protected Landscapes (cat. V IUCN 2008) should be more spatially diffused.

> *"Landscape policies should reflect long standing cultural importance of landscape to society and the changing understanding of human linkage to landscapes in a world that is becoming ever more urbanised; landscape policies should ensure that the natural and cultural components are fully integrated and mutually reinforcing" (R. Croft).*

> *"I believe that the Category V approach is one that provides a model to which many countries can relate. We need stronger international support for the Category V model and to encourage higher standards of management. But the strength of the approach is that it links people and nature, recognises what communities have created and values the sustainable practices that underpin valued landscapes (...)" (A. Phillips).*

Last but not least, a fourth remark concerns the **governance** topic. Many suggestions stress the importance of local communities, but at the same time others underline the need for a multi-lateral governance, aiming at protecting supra-local values, with inclusive and overarching approach. While some experts stress the lessons that modern societies should learn from local communities and indigenous people (for example, for a conservative and appropriate use of the natural resources), others remind that much must be done to support them in maintaining or even recovering their traditional linkages with the earth. The complexity of the present territorial systems requires at the same time flexible and strategic policies (inside and outside the protected areas) giving space to local creativity, and a public effective regulation of local processes.

> *"The integration of local communities (including indigenous people) with their specific local knowledge is absolutely crucial. Especially when it comes to the discussion on values we have to be aware that these can only be defined in a very broad sense on an overlocal level and that the negotiation of which values are at the core of conservation and landscape protection has to be done on the local level" (A. Wallner).*

> *"In my view, the importance of the role of local and indigenous communities cannot be over-stated: it is fundamental. A few examples include: knowledge systems - local knowledge of specific places, including not only their natural features but their cultural features, not only tangible values, but also intangible values; local/indigenous management practices - including customs, rituals and celebrations; providing models of sustainable practices that can be taken up by the broader populations well as possible tools for resilience in the face of dynamic changes, such as global climate change" (J. Brown).*

> *"(...) The English landscape sets a context for peoples' lives which provides both a physical and an emotional presence. It is a meeting-ground between the past, the present and the future as well as between both natural and cultural influences. People's perceptions are an inherent part of how landscape and its character and qualities are experienced and valued" (R. Partington).*

> *"My guess this is true of many types of traditional peoples, including those in many of the cultural landscapes of Europe (...). I think the key is to look for opportunities (...) for territorial level participatory planning. The problem is the lack of institutional capacity to plan and perhaps most importantly, invest at the territorial scale" (J. Manno).*

A Research-Book Program

With reference to the international survey experience and believing that the topicality of the emerging issues could stimulate an interesting debate, the CED PPN is still developing the research-book "Parks & Landscapes", aiming at taking stock of reflections, researches and experiences that could strengthen the thesis of a mutual benefits. The aims are verifying if, and at which conditions, landscape policies may strengthen the role and effectiveness of Protected Areas and, inversely, whether PAs can be a privileged field for the application of landscape policies.

Confirming the international and interdisciplinary vision, several experts are been contacted, coming from international contexts (Europe, U.S.A.), various disciplinary backgrounds and institutional bodies.

The invited authors could contribute to the "Research-book" in different ways, which would reflect their own specific competences, suggesting innovative visions on the subject concerning the above relationships. In particular, the comparison and interaction between the different authors' papers should allow to investigate those relationships through some main topics: (i) regulations and institutional frameworks, (ii) policies, iii) actions and tools. Such investigation has pointed out the need and possibility of overcoming the traditional and still dominant separation between nature and landscape domains, in favour of more integrated approaches, requiring:

- on the one hand, that the conservation of nature, with particular reference to the IUCN "new paradigms", which should guide biodiversity and PA policies should be considered as a part of wider landscape and territorial issues and strategies;

- on the other hand, that the conservation of landscape, with particular reference to the European Landscape Convention and the international strategies for the conservation of cultural heritage (UNESCO 2011) should be considered as a part of, closely linked to nature conservation and territorial ecological issues and strategies.

Considering the whole of the reflections gathered, the scope of the research-book, is to enlight common and different author's positions, aiming to suggest innovative visions, issues and problems to be faced in order to build the alliance which is the focus of this presentation.

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Soil Crust InterNational (SCIN) – Understanding and valuing biological soil protection of disturbed and open land surfaces

Thomas Peer, Lingjuan Zheng, Burkhard Büdel

Abstract

The international SCIN-project aims to achieve both better appreciation of the functioning and importance of biological soil crusts (BSCs) in Europe including four different sites in Spain, Germany, Austria, and Sweden, and to transfer scientific output to local authorities and stakeholders in order to ensure a better territorial protection. The project lasts 3 years (2011 – 2014) and is integrated within the pan-European BiodivERsA – a network of national funding organisations (www.biodiversa.org/). Six research groups and over 15 scientists from the Universities of Madrid (Spain), Salzburg and Graz (Austria), Kaiserslautern and Kiel (Germany), and the Natural History Museum of Stockholm (Sweden) participate in this project. Coordinator is prof. Burkhard Büdel from the University of Kaiserslautern (buedel@rhrk.uni-kl.de). After one year, first results have been achieved from all research groups, and in this paper comparison of soil physiochemical properties and vegetation differences between the four sites are reported. The results illustrate the unique situation of the alpine Hochtor site (Hohe Tauern, Grossglockner, Austria) relative to the other climatically different sites in Spain, Germany and Sweden.

Keywords

Biological soil crusts, SCIN-project, soil properties, vegetation, Hochtor, Austria

Introduction

BSCs are the biologically modified soil surface that form naturally in open areas. They are typically composed of cyanobacteria, algae, micro fungi, lichens, and bryophytes in varying amounts and can be the only vegetation cover in arid and semi-arid regions such as hot and cold deserts or xerothermic steppe vegetation. They are also the first colonizers of disturbed soils and have major impacts on the soil properties through stabilization, erosion limitation, better water infiltration and facilitation of colonization by higher plants (ELDRIDGE & GREENE 1994; BELNAP et al. 2001; BELNAP & LANGE 2003).

The SCIN-project will provide a much improved understanding of BSC functionality from the severest deserts to the alpine ecosystems. Functional studies will be backed by detailed biodiversity assessments that aim to reveal the key organisms in BSC functioning over a wide latitudinal, altitudinal and climatic range. Information transfer to stakeholders will be achieved through a series of consultations and reports including highly visual material supporting their work. Key questions of the project are: How is their taxonomic composition and how diverse are the BSCs itself? How is diversity and productivity linked? What is their role in the referring ecosystems as carbon and nitrogen sequestration agent, soil stabiliser, and for enhancement of soil and vegetation succession? How unique are the key species and what is their role in BSC functioning over a wide latitudinal, altitudinal and climatic range? (see the project homepage: www.soil-crust-international.org/).

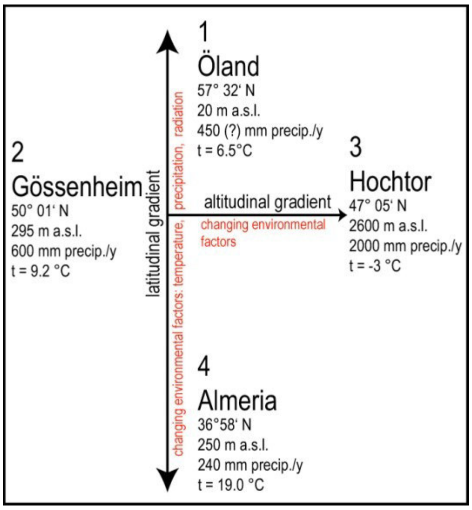

Figure 1: Coordinates, altitude, and climate of the four research sites

Material and methods

Along a latitudinal and altitudinal gradient across Europe, four sites were selected for our study (Fig. 1): i) Spain, Almeria, Tabernas basin, BSC in Mediterranean semi-arid steppe vegetation, ii) Germany, Gössenheim, nature reserve "Ruine Homburg", BSC in xerothermic steppe vegetation, iii) Austria, Hohe Tauern, Grossglockner, Hochtor, BSC in high alpine pioneer vegetation, and iv) Sweden, Island of Öland, Nature Reserve Gynge Alvar, BSC in xerothermic steppe vegetation. At each site, an area of 40 m × 40 m was defined, and equipped with a climate station to gain data about wind conditions, precipitation, air humidity, air and soil temperatures, PAR and UV-radiation, as well as the photosynthetic efficiency of some typical lichens (Moni-Da system). In these defined areas, crust types and vegetation cover were recorded in 150 randomly selected plots, using a 25 cm × 25 cm grid. At every fifth or tenth plot, 20 crust and 20 underlying soil samples were collected for analysis of soil properties. In addition, 10 control and 10 treatment plots (80 cm × 80 cm) were established for restoration experiments at each site. In treatment plots, the upper soil layer with BSC was removed. After 6, 12, 18, 24, and 30 months the speed and successional pattern of BSC recovery will be proved through species composition and alteration of relevant soil parameters.

Five work packages (WP1 to WP 5) were developed in our project. WP 1 works on identification of BSC component organisms like cyanobacteria, algae, fungi, lichens and bryophytes by means of classical and molecular methods. Primers for specific organismal groups (i.e. algae, cyanobacteria, fungi) will be used to extract DNA, and fingerprinting techniques (SSCP) will be used to assess and visualize variation among samples. To localize microorganisms in crust, light and confocal microscope technique will be applied. WP 2 looks at net carbon gain of BSCs, obtained from a model linking 3 sets of measurements: i) chlorophyll *a* fluorescence monitoring of activity at least one year data from each site (2 preferred), ii) CO_2-exchange of BSCs in the field using portable gas exchange fluorescence system (Walz GFS-3000) and Klapp-cuvette at least 14 days continuous record from each site, and iii) response of net CO_2-exchange of BSCs to environmental factors in the lab under controlled conditions. In this part, particular focus is given on lichenized fungal species and cyanobacteria, which represent key ecological indicators of soil crusts. Description of soil components (e. g. particle size distribution, pH, exchangeable nutrients, aggregate stability) and hydrological parameters (e. g. water drop penetration time test, water repellence, water infiltration) are included in WP3. Methods are described in Canton et al. (2003), Li et al. (2005), Huber et al. (2007), Contreras et al. (2008), and Peer et al. (2010). In addition, contents of organic C, total N, $\delta^{15}N$ and $\delta\,^{13}C$ in crust and underlying soil will be analyzed by elemental analyzer isotope ratio mass spectrometry (EA-IRMS) to provide insight into the N- and C-turnover. Moreover, the biological nitrogen fixation will also be investigated. WP4 focuses on vegetation analysis and recovery of BSCs. We differentiated between BSCs light, BSCs dark (represent successional development of BSC from a species-poor, light-coloured cyanobacterial BSC to a species-rich BSC community dominated by late successional lichens and dark cyanobacteria, Belnap & Eldridge 2003), cynolichens, chlorolichens, bryophytes, vascular plants, litter, open soil, stones and gravel. In WP5, crust lichens of the same species from all four sites are sampled to test whether they have the same photosynthetic CO_2-uptake properties, or they show a climatic-specific acclimation and have local photobiont populations. For further information see the project homepage (www.soil-crust-international.org/). A separate work package (WP 6, Delivery Package) should transform the science outputs into a form that is more easily understood by stakeholders and endusers, and most important, assure the awareness and appreciation of BSCs as an important component of the landscape.

Table 1: Chemical soil properties (n = 40) in crust and underlying soil at the four research sites. Values in the table represent mean values±SE.

	pH		P (ppm)		Mg (ppm)		K (ppm)		Ca (ppm)		Na (ppm)	
	Crust	Soil	Crust	Soil	Crust	Soil	Crust	Soil	Crust	Soil	Crust	Soil
Spain	7.0±0.02	7.4±0.01	89±8	60±2	127±4	93±3	259±8	216±5	2316±65	2005±67	13.7±2.3	9.6±2.1
Sweden	7.3±0.01	7.4±0.02	15±1	8±1	40±3	30±1	109±5	59±3	6129±281	4959±223	13.9±0.6	13.4±0.5
Germany	7.3±0.01	7.4±0.03	20±1	9±1	63±6	41±4	142±5	113±4	5623±353	4293±298	14.8±0.8	12.9±0.7
Austria	7.3±0.01	7.4±0.04	11±1	6±1	352±34	300±41	29±2	8±1	2189±188	1796±239	2.6±0.3	3.4±0.4

Preliminarily results on soil and vegetation

Although no conclusive results can be expected after one year of research, however, initial indications show that each research site has its own specifics based on differences in geography, climate, geology, soil, and land use. In contrast to the Hochtor, which is the unique site with a high alpine climate, means 8 to 9 months snow cover, low annual temperatures, and high precipitation (Auer et al. 2002), the climate of the other sites is generally dry (< 600 mm.y^{-1}) and more than 10 ^{0}C warmer on their mean annual temperatures than the Hochtor site. From the analyses of soil parameters and site comparison, the following first preliminarily results can be derived (Tab. 1 and 2): i) Plant available nutrients like Ca, Mg, K, Na, and P are generally higher in crust than in underlying soil (p<0.05); the Hochtor site exhibits the lowest K-, Ca- , Na- and P- amounts but the highest Mg-amount of all studied sites. ii) The pH values are generally above 7 because of the calcareous parent material at all sites - although it is of different edge and mineral composition. Crusts generally show slightly lower pH values than underlying soil. iii) The Hochtor site has the lowest amount of clay (< 3 %) in comparison to the other sites (8 – 12 %), but the highest soil penetration resistance and water storage capacity (Tab. 2). The loosest crust is found in the Alvar (Öland, Sweden). The data vary over a wide range in all study sites (high standard errors), indicating great inhomogeneity of soil at each site. Moreover, the alteration of soil parameters within the recovery plots is difficult to assess as well. After taking samples for the 2nd time, 6 months later, we couldn't find any clear indications of change in soil parameters within the treatment plots so far (data not shown); possibly the time interval of sampling was still too short.

Table 2: Soil compaction (n = 40), soil texture in crust (n=20) and water storage capacity (n=20) at the four research sites. Values in table represent mean values±SE.

	Soil compaction kg.cm^{-2}	Sand (%) in crust	Clay (%) in crust	Water storage capacity gH_2O / 100g dry weight
Spain	2.51±0.1	22.5±0.7	11.4±0.4	32.7±0.5
Sweden	1.72±0.1	55.1±1.7	8.3±0.5	39.6±1.9
Germany	3.16±0.1	20.3±0.9	10±0.6	45.6±6.9
Austria	3.84±0.1	58±1.3	2.8±0.3	48.1±5.4

Investigation of crust type, vegetation composition, and cover degree, which were done by Laura Williams and Katarina Schneider (University of Kaiserslautern), reveal that the Hochtor site has by far the highest average percentage of cyanobacteria (BSC light and BSC dark), chlorlichens and also a high proportion of vascular plants (Fig. 2). At the other sites (Gössenheim, Öland and Tabernas basin), bryophytes (mainly mosses) dominate, and Gössenheim owns the highest degree of mosses with more than 40 %.

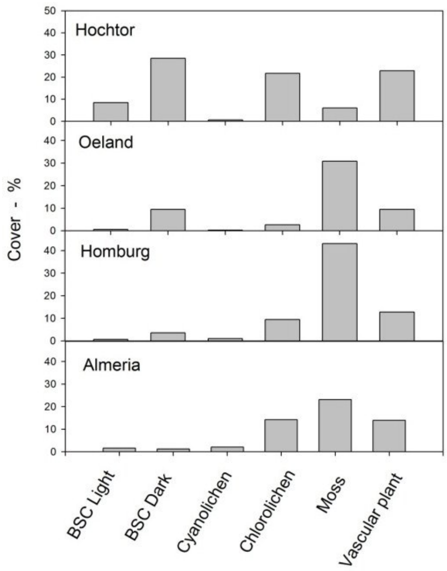

Figure 2: Mean cover degree for surveyed groups at the four research sites

Discussion

The special position of the Hochtor site was already mentioned in several papers (e. g. HUBER et al. 2007; PEER et al. 2010). Our preliminary results verified it in comparison with other research sites of the SCIN-project. Soil properties like low amount of exchangeable nutrients and low clay content could be explained by low chemical weathering and leaching processes, which are typical for alpine climate with high precipitation (BOCKHEIM & KOERNER 1997; EGLI et al. 2003). The high Mg amount probably originates from the dolomite within the Seidlwinkl Triassic formation. The high cover degree of dark crust and chlorolichens at the Hochtor site could be resulted from the humid climate and soil moisture through the whole year. Although this area is 8 to 9 months under snow cover, the conditions for growth of cyanobacteria and cynolichens seem to be excellent. The most common lichen species at the Hochtor site are *Toniniopsis obscura*, *Buellia elegans, Psora decipiens, Collema tenax, Catapyrenium cinereum, Fulgensia bracteata* ssp. *deformis,* and *Bilimbia lobulata* (R. Türk, personal communication). The lichens *Psora decipiens* and *Peltigera rufescens* occur at all four sites, and therefore they are important test organisms to study their symbiosis partners, as well as their physiological effectiveness and their adaptation and acclimation along latitudinal and altitudinal gradients. The humid climate at the Hochtor site promotes dark BSCs of 2-3 cm thickness, suggesting that the area has been undisturbed for a long time. Dark BSCs develop a relatively high surface compaction (indicated by soil penetration resistance). Therefore, they promote surface runoff (to see on small polygonal branched channels on the surface, filled with small stones), on the one hand, and they inhibit infiltration rate and establishment of seedlings (the latter has been controversially discussed, see MAESTRE et al. 2002, BELNAP et al. 2003, LI et al. 2005, LANGHANS et al. 2009), on the other hand. Cultivation experiments with crust material from the Hochtor site will show how biological soil crusts effect germination and establishment of seedlings. However, the number of vascular plants is the highest at the Hochtor site! At the drier sites, the crust layer is considerably thinner and looser, and the cover degree of mosses is more than 20 % on average (maximum 43 % in Gössenheim). It is not yet possible to interpret this. However, we have to consider life strategy, life history, and life span of plants at each site. At Tabernas, for example, ephemeres might not have been visible at the end of February, when we were there. In Gössenheim, the vegetation was recorded at the end of September, and at this time spring time plants are already decomposed. The high proportion of mosses (mainly *Rhytidium rugosum*) may be interpreted with the high proportion of shadowing pine trees. In Öland, the vegetation period is optimal in May, but here the large limestone plains with thin or no soil limit the spread of higher plants. Also at the Hochtor site, the vegetation period was on its culmination point in July/August, but here the distribution scheme of plants is very irregular (clumped), depending on small scale site conditions. It might be that despite of the randomized survey of the vegetation, especially areas with abundant vegetation were recorded.

Conclusion

Unfortunately, it is not possible within the scope of this paper to present results of all working groups. However, the taxonomic/systematic scientists around of Martin Grube (Graz, Austria), Burkhard Büdel (Kaiserslautern, Germany), Mats Wedin (Stockholm, Sweden), and Roman Türk (Salzburg, Austria), as well as the ecophysiological scientists around of Allan Green (Madrid, Spain) and Burkhard Büdel (Kaiserslautern, Germany) have been deeply penetrated into the subject of the project. Objectives like comprehensive diversity assessment of photoautotrophs, as well as fungi and heterotrophic bacteria, net carbon gain of BSCs, N- and C-turnover, recovery experiments, infiltration coefficients and water repellence values for different crust and soil types, the level of adaptability of key species, the genetic diversity of local and continental-wide distributed species, and the uniqueness of key species at the four sites, all these studies are progressing well. 2013, data collection will be continued, and we hope to come to a comprehensive understanding of BSC functionality across Europe by the cooperation. Finally we hope that our research can also offer professional options for development of improved policies and actions in land protection.

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Society and Protected Areas in Flux – more than one hundred years of nature conservation in Austria, Germany and Switzerland

Christina Pichler-Koban & Michael Jungmeier

Figure 1: Nature conservation in old and new garb
Source: Illustration by the authors

Abstract

In a research project, which was carried out from 2004 to 2007, the conceptions for nature conservation in Austria were examined. So-called "lists of events" were drawn up as a showcase for four protected areas (Hohe Tauern, Donauauen, Wienerwald, Dobratsch). Each "event" listed (e.g. the declaration of a nature conservation area or the demonstration against the construction of a power station) represents a milestone in the development of the area and was analysed from a socio-historical point of view. Four protected areas in Germany and Switzerland are now being included in the study as part of an ongoing research project. The historical and social context of different tendencies in nature conservation is examined through key events, and a chronological inventory is created of the conceptions for nature conservation occurring in the individual areas. The relevance of the identified conceptions for nature conservation to the current events in the protected areas is analysed. These conclusions will be used to attempt to forecast future trends in nature conservation activities. Similarities and differences in the three countries, as well as the influence of international and global developments, will be ascertained.

Keywords

Protected areas, history, social sciences, qualitative methods, Austria, Germany, Switzerland

Introduction

Nature conservation seeks to preserve and safeguard selected natural assets and thus represents an important segment of any comprehensive system of environment and resource protection. Measures to protect resources for economic reasons can be traced as far back as the 19th century, and this type of protection therefore has a long tradition (Erz et al. 1990). In the past 150 years, nature conservation has become established as an essential element of the value systems and activities of modern societies, and is now included across Europe in politics, international programmes, and institutions. The study "Austrian Nature Conservation Movements in the Context of Social Developments" (Pichler-Koban et al. 2006, 2007) represents the first research effort to focus specifically on social scientific dimensions, rather than only exploring the Austrian nature conservation movement using questions and methods derived from the Natural Sciences. Using the example of four Austrian protected areas, (Hohe Tauern, Donauauen, Wienerwald, Dobratsch), the nature conservation movement and nature conservation were investigated against the background of social developments. Protected areas were chosen as the objects of research, because they represent central instruments of nature conservation. The authors further assume that they serve as a projection screen for societal interests and debates. The results of this study are explored in greater depth in the follow-up study "Society and Protected Areas in Transition", a project funded by the Bristol Foundation. Furthermore, the methodology is developed further and the research area is extended to include Germany and Switzerland.

Research questions

The study seeks answers to the following questions:

1. How can different conceptions for nature conservation be explained by their social and historical context, and how can they be rationalised?
2. What influence does a changing society have on the perception of and the demands on protected areas?
3. Which similarities/differences can be noted when comparing the development of protected areas in Austria, Germany and Switzerland, and which influence do international conservation policies show in the respective country?

Initially conceived in order to conserve natural resources, today nature conservation represents a multi-layered task at the intersection of a wide variety of disciplines. This complexity becomes especially apparent in the area of nature reserves. According to their initial primary purpose, protected areas were intended for the protection and preservation of biodiversity and of natural or associated cultural resources (BLAB 2002, BLAB 2006, JUNGMEIER in print). Along with the transition and development of society over the past 150 years, the concepts behind protected areas have also changed significantly. The analysis of protected areas within their social and historical context reveals a surprising glimpse of the ideological conglomerate behind the modern understanding of nature reserves. Modern protected areas purport to being "Learning Sites for Sustainable Development" (UNESCO). The human – hitherto viewed as "enemy" and "destroyer" of nature – should no longer be largely excluded from protected areas (JUNGMEIER et al. 2009). Rather, the human is seen as part of the respective protected area, who, through economically compatible and sustainable activities, should ideally contribute to the conservation of the natural diversity of habitats (LANGE 2005). The restrictive nature protection measures carried out in nature reserves ("bell jar" nature protection) in years past, has been developed into an integrated system of spatial management, and has broadened into a transdisciplinary field, into which flow diverse elements from economics, sciences pertaining to planning, as well as the social and legal sciences (DUDLEY & MÜLLER 2011, GETZNER & JUNGMEIER 2009, MOSE & WEIXLBAUMER 2003). This development necessitates new knowledge and new practical approaches with regard to the management of protected areas. Modern nature reserves (biosphere reserves, world heritage sites, Ramsar sites, etc.) pursue an integrated approach, following the objective to integrate "the social sphere with the eco sphere" (BROGGI 2001). Today, protected areas are regarded as societal task, which must involve the relevant stakeholders (JUNGMEIER et al. 2009).

Methods

Drawing upon oral and written sources, a conceptual history of protected areas is reconstructed for Austria, Germany and Switzerland. So-called lists of events (Figure 2) illustrate the conceptual development of the protected areas. Based on key events or milestones the attempt is made to shine a light upon the historical and social context of various concepts from the sphere of nature protection.

The analysis is carried out using the example of eight protected areas.

The following protected areas are part of the study (Figure 3):

- In Austria: Wienerwald Biosphere Reserve, Donauauen National Park, Hohe Tauern National Park, Dobratsch Nature Park
- In Germany: Schorfheide-Chorin Biosphere Reserve, Berchtesgaden National Park
- In Switzerland: Parc Adula, Swiss National Park

Narrative interviews are used to question contemporary witnesses and managers with active responsibility for a protected area about the history and the milestones in the development of the protected areas, and about the issues – both past and present – that they believe are significant in relation to protected areas. The interviews are transcribed and are processed and evaluated in preparation for analysis using the QDA software Atlas.ti 7. In parallel, written sources on the history of the eight protected areas are systematically collected. Relevant passages from the texts are selected and also analysed using the QDA software. The subsequent synthesis of the results of the analysis will yield a framework of categories, which can be used to explain and understand events in nature protection. The analysis and evaluation will combine methods from qualitative content analysis in accordance with KUCKARTZ (2005), qualitative data analysis with Atlas.ti according to FRIESE (2012) and metaphor analysis according to KRUSE et al. (2011).

Year	Event
1979	- Lower Austrian Nature Conservation Union demands a national park
1980	- Citizens' initiative against hydropower plant and for a nature park
1982	- Nature Conservation Union demands impact assessment for the barrage Vienna - Donau-March-Thaya floodplains are recognized as Ramsar Sites
1983	- Public gets to know the plans for a new Danube hydropower plant - Public exchange of letters between the Minister of Environment and conservationists - International support for the opponents of the power plant project
1984	- „Press conference of the animals" against the power plant - Manifestations of power plant supporters and opponents - Construction of the plant is approved according to Nature Conservation Laws - Initiation of the Konrad-Lorenz referendum - Positive decision according to water law and approval of clearing of forests for the Hainburg power plant - Occupation of the wetlands in Hainburg - Hainburg-conflict as a political landmark of the 2nd republic - Publicist Günther Nenning takes a stand on the Hainburg Conflict - Prof. Konrad Lorenz takes a stand on the Hainburg Conflict - Trade Union president Anton Benya speaks on the Hainburg Conflict - Artists take a stand on the Hainburg Conflict - Robert Jungk speaks on the Hainburg Conflict - Open letter to minister of interior Karl Blecha - Freda Meissner-Blau takes a stand on the Hainburg Conflict - Kurt Zukrigl speaks on the ecological value of the wetlands - Media take the Hainburg Conflict into the the public sphere
1985	- Environmental government retreat in consequence of the Hainburg Conflict - 11-point programme of the Austrian Government - The Friends of Nature participate in the Hainburg Conflict - Appointment of a commission for ecology of the Federal government
1986	- Federal Forestry Company is open-minded about a national park - Field mapping of the amphibians of the Danube floodplains
1987	- Nature Conservation Union demands a qualified termination of the expansion of plants along the Danube
1989	- Public discussion event to discuss the planned Donau-Auen-National Park - Public action „Redeem Nature" - Concept for the Donau-Auen National Park

Figure 2: Extract from the "List of events Donauauen", showing period from 1979 to 1989 (Source: Illustration by the authors)

Figure 3: Overview of the study area and the selected nature reserve (Source: Illustration by the authors)

Results

Based on the Austrian data gathered during the preceding project, "The Austrian Nature Protection Movement in the Context of Social Developments" (PICHLER-KOBAN et al. 2006), three hypotheses were formulated and discussed:

Hypothesis 1: Nature protection follows in line with social debates and conflicts. Nature protection aligns itself with social interests.

- Concepts in nature conservation can be seen as consequence or as opposition to significant social movements and developments. The protection of nature is promoted by diverse social actors. Virtually every one of these actors could also appear to be an opponent of nature conservation.

Hypothesis 2: Concepts in nature conservation represent the result of value systems.

- Different social groups have different notions of nature ("views of nature"). These are implemented in different laws, organisations and actions which, in turn, have a direct impact upon nature and environment. In a feedback process these changes in nature and environment exert an influence upon society.
- Nature conservation and its various concepts build upon very specific social interests. Those interests, which are communicated most vehemently eventually determine the development of nature and of nature conservation.

Hypothesis 3: Social fragmentation is reflected in the current activities around nature protection

- In today's individualised society, everyone has their own view of nature, which is revised or adapted as required or in line with specific interests.
- As a consequence of the many different views of nature held by the different actors in society, a great number of diverse concepts exists. Despite the widely diversified content of these concepts, they are all subsumed under the umbrella term "nature conservation".
- If too many interests and objectives claim consideration, this can result in a stalemate, which effectively puts a stop to all nature protection activities and measures.

The work carried out in the present study so far supports these hypotheses. It remains to be investigated, whether they remain valid to the same extent, when applied to the development of nature protection in Germany and Switzerland.

A fourth hypothesis shall be proven or disproven by this study:

Hypothesis 4: Nature conservation concepts are moving towards the protected area of the third generation.

- Sustainability is based on the idea that only an implementation of ecological, economic and social objectives that occurs simultaneously and ensuring equal rights, can safeguard and improve the sustainability of a society (JUNGMEIER et al 2006).
- Depending on social developments, modern protected areas (biosphere reserves, world heritage sites, Ramsar sites, etc.) are pursuing this integrated approach (RUOSS in print).
- The topics, which are of relevance to modern protected areas, range from classical forms of nature conservation (natural Sciences), to issues of business management, legal and cultural matters, right up to project planning and management, education and marketing (JUNGMEIER et al. 2012).
- This new understanding of the concept of protected area is defined as protected area of the third generation by JUNGMEIER (in print).

Further initial results of the current study take the form of an extensive code list, which also acts as a catalogue of concepts of protected areas, and a system of categories, which facilitates the structured representation and analysis of all events investigated to date. At any point in time it is possible to expand the system of categories by including aspects which have not previously been recorded.

These are the main categories developed to date (Figure 4):

- Event: An occurrence that triggers resonance in the respective protected area. All further categories serve to provide more detailed descriptions of "events".
- Year: When did the event occur?
- Spatial relationship: Where does the event produce effects?
- Actors: Which persons, organisations or institutions are involved in the event?
- Attitude/position: Does the chosen passage point to an attitude of agreement, neutrality, or rejection in relation to the event?
- Threat: Which perceived threat or hazard is reflected in the event?
- Protection objective: Which protection objectives are pursued by the event?
- Instruments: What actions are set in the event, which forms of conflict and types of argument are used, in order to achieve a goal?
- Process direction: Is the process direction during the event bottom up or top down?
- Movements and trends: Which movements and trends resonate in the event?

Current research activities involve using the system of categories described above to analyse and interpret the vast amount of available material and raw data. The results of the research process will be systematically prepared and are expected to be available as a publication to all interested parties next year.

Figure 4: Categories - an overview (Source: Illustration by the authors)

Discussion and outlook

In the recent past, historians have already examined the history of selected protected areas in great detail (e.g. for the Swiss National Park cf. KUPPER 2012a, for a global perspective see GISSIBL et al. 2012). An ongoing project under the leadership of Patrick Kupper is dedicated to the history of nature conservation in the Hohe Tauern (KUPPER et al. in prep.). The project "society and protected areas in flux – more than hundred years of nature conservation in Austria, Germany and Switzerland" is intended as a contribution to gaining an understanding of the concepts and approaches used historically and today, in relation to nature protection in Europe. Concepts for nature conservation can be viewed both as consequences and as counter-movements to social trends and developments. It is not always possible to precisely assign the actors involved. The same individuals can appear both as promoters and as opponents of nature protection. The insights gained from the project shall provide support to all actors involved with protected areas, helping them to understand their own role in current events in nature protection. The objectives of nature conservation today are far more complicated and diffuse than they were in the past. At the same time there is now an opportunity for nature protection to act as the creator of new possibilities – particularly in large modern protected areas (PICHLER-KOBAN et al. 2007). It is hoped that the results of the study will encourage the involved parties to critically reflect upon current strategies in nature conservation, and to reconsider them, where necessary.

The comparison of several nations reveals where protected areas quite literally reach their borders. The project is also intended as a contribution to allowing nature conservation to be grasped and negotiated as a cross-country and cross-nation phenomenon. The authors hope to provide a significant contribution to the debate on the "dynamics and conservation in protected areas", and actively seek to enter into dialogue with all actors involved in events surrounding nature protection.

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Ways to merge conservation needs and recreational fisheries in protected areas

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Keywords

nature reserves, freshwater fisheries, best practice management

Abstract

By now a great part of Austrian salmonid populations are exposed to management practices that widely disregard natural capacities and dynamics of fish stocks. Waiving factors such as the natural productivity, stock composition and population resilience is a common practice in fisheries management, although it leads to overexploitation and degeneration of native populations.The frequently applied compensatory measure of stocking hatchery reared fish is mostly insufficient and a further cause for loss of vitality of wildlife stocks.

Recreational angling in protected areas is a widely controversially discussed issue. However, the combination of conservation and recreational needs is not necessarily exclusive. This can be seen and has been proven by a series of successful management concepts in national parks e.g. in the United States of America. Surplus values like the rising awareness for conservation demands are evident. Moreover, the possibility for conservation areas to fulfill advisory services in educating the society in sustainable use of natural resources can be perceived as a chance to set good examples. In other words, conservation areas stride ahead applying best practice.

There is common sense among fisheries scientists and ecologists that running waters in protected areas have to be managed with explicit cautiousness. Rigorousregulations have to be applied that are based on considerations reflecting current knowledge in sustainable fisheries management. Stocking of fish, for example, has to be abandoned or adequately applied.Catch/size limits need to be ascribed to the dynamics of the closely monitored fish population and fish population censuses need to result in the formulation of ever evolvingmanagement plans.

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Use of the forest canopy by bats in temperate forests in the Thayatal National Park

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Keywords

bats, canopy, forest, batcorder, Thayatal National Park

Abstract

The objective of this study is to explore the behaviour of bats in different forest strata in the area of the Thayatal National Park. Hence, the ground level activity of bats was measured and compared to the activity in the canopy level of the forest.

It is well known, that, in tropical areas, most species primarily forage in the higher canopy levels. This behaviour makes their detection from the ground with standard methods difficult. So far, very few studies had been carried out in central Europe, addressing the issue. The aim of this study was to extend our knowledge about the behaviour of forest bat species and to compare the results with pre-existing information. Furthermore, we provide guidelines for future management and monitoring of threatened forest bat species. Furthermore the data of this study were part of a full inventory project of bats the National Park from 2009- 2010. This project was performed by the Austrian Coordination Centre for Bat Conservation and Research (KFFÖ) and gives a complete overview about the actual distribution and conservation status of all bat species in the area (Hüttmeir & Reiter 2011).

Woodland is one of the most important foraging habitats for bats, and therefore, a detailed understanding about the foraging behaviour of bats is essential (Celuch & Kropil 2008). The Thayatal National Park was selected as study area because of its considerable expanse of natural forests with a low amount of human interference. Furthermore, it is known that there is a high diversity of bat species in this National Park (Hüttmeir et. al 2011). 22 out of 28 native Austrian species can be found in this area. Due to this situation, we expected to gain a vast amount of data for a wide range of bat species and to be able to generate reliable predictions about their foraging behaviour.

The standard method for sampling bats in a forest area is observation from the ground level. However, it was suspected that some bat species tend to prefer the canopy area and therefore being underrepresented in the usual sampling methods. The sampling effort spanned 48 nights in the year 2010, with automatic recording devices, one Batcorder (ecoObs, Nuremberg, Germany, www.ecoobs.de) placed in the canopy (up to 19 m) and one on the ground level. The batcorder in the canopy was mounted using a slingshot and ropes. With some experience it was possible to install the devices within 10 minutes in the canopy (depending on the forest). Batcorders are ultrasound recording devices and with it is possible to identify the different bat species and their activity in the different strata.

Results show that at least 50 % of the studied species prefer the canopy level at least during one of the three measured seasons. Especially the Bechstein´s bat (*Myotis bechsteinii*) and the Alcathoe Whiskered Bat (*Myotis alcathoe*), which are very specialized forest species, showed clear preferences for the canopy level. This results show, that species which prefer the ground level, the standard methods seems suitable. However, it is likely that for specialised forest species, which prefer old, natural forest areas, the standard monitoring methods are not sufficient underestimated their activity, and hence their conservation status is estimated incorrectly. Therefore it is important to implement the method presented in this study for future monitoring and inventory studies of these threatened species.

Due to the increase of wind energy, power plants are now also planned in forested areas. Wind turbines are a serious thread for high flying bat species. Therefore, this study presents new insights into the vertical distribution of the Austrian bat species, but further studies are required, to assess the activity level above the canopy area.

For further information see Plank et. al (2012), where this study is presented in detail.

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Conference Volume	**5th Symposium for Research in Protected Areas** 10 to 12 June 2013, Mittersill	pages 587 - 590

Linking the wilderness continuum concept to protected areas

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Abstract

In this study we present a spatially explicit wilderness model for the Austrian territory using Geographic Information System techniques combining data and information from different sources. This model uses the wilderness continuum concept, implemented by an approach developed by the Australian Heritage Commission that makes wilderness quantifiable by assigning each locality a quantitative wilderness quality index. Considering that, due to the long anthropogenic colonization, only few true pristine wilderness areas are left in Central European landscapes we identify regions that still show wilderness qualities. The result is used for a gap analysis considering established protected areas and exploring potentials to locate wild areas suited for the establishment for secondary wilderness.

Keywords

Wilderness, wild areas, protected areas, Natura 2000, Austria, wilderness continuum concept, GIS, spatial model

Introduction

The establishment of protected areas is closely connected to the idea of wilderness, areas with low impact of human society providing natural dynamics and processes as well as opportunitiesfor recreation and solitude. Beginning in the later 19th century the conservation movement in the USA, inspired by ideas of concepts of thinkers and activists like Henry David Thoreau, John Muir or Aldo Leopold, gradually imposed the implementation of National Parks. This development began with the Yellowstone National Park, which was established 1872, and led to the declaration of the Wilderness Act in 1964, which designated land as "wilderness" for the first time.

The shift in nature conservation over the last decades from an organismic-oriented point of view to a more ecosystem-oriented approach drew the attention to the importance and value of such pristine areas. This awareness led to a resolution of the European Parliament in 2009 to improve protection and funding for wilderness in Europe.In the same year a first conference on Wilderness and Large Natural Habitat Areas was organized through the Wild Europe initiative, an initiative on wilderness incorporating European environmental NGOs and European Commission. After the conference the Austrian Ministry of Environment has placed the idea of wilderness at the heart of the new strategy (endorsed in 2010), declaring that all Austrian national parks shall henceforth focus on ecological process management in their core zones (explicitly referred to as "wilderness").

But Central European landscapes have faced anthropogenic alteration for thousands of years, soonly few true pristine wilderness areas are left. On a first look this might reduce the importance of wilderness in human dominated regions. But MACKEY et al. (1998) emphasize that in the context of nature conservation, and as a consequence of protected areas, the concept of wilderness quality plays an important role besides the concept of wilderness areas. Wilderness quality is "the extent to which any specified unit area is remote from and undisturbed by the impacts and influence of modern technological society" (MACKEY et al. 1998). Many indicators reflecting the wilderness quality of an area are related to indicators reflecting the state of health of an ecosystem. So whenever conservation interests go beyond a species-based focus and integrate a perspective on ecosystems and their processes, an approach considering wilderness quality adds valuable possibilities and insights. An established concept to handle wilderness quality is the wilderness continuum, initially developed by R. Nash in the 1980s (NASH 2001). Based on this idea various methods were used to assign each locality of a study area a quantitative wilderness quality index, indicating and distinguishing wild and not wild places on a continuous scale. European cases for this approach were applied to several regions for example The United Kingdom (CARVER et al. 2002), Scotland (CARVER et al. 2012), the Alps (KAISSL 2002) and even the whole European territory (FISHER et al. 2010). These examples have proven the feasibility and utility of wilderness continuum mapping.

Despite of the lack of true wilderness areas with large extend in Austria there are still remote areas with extensive land use, so called wild areas, still keeping many aspects of wilderness. These areas have a high potential to become - by changing current land use - secondary wilderness regions (KOHLER et al. 2012). The goal of this study is to identify such areas with a high potential for wilderness for the Austrian territory by mapping the wilderness continuum described above. Further we want to estimate the wilderness quality of existing protected areas like the core zones of National Parks (and additionally of the Natura 2000 sites) and to identify areas with high wilderness quality without protection status.

Methods

To estimate the wilderness continuum we use the approach of LESSLIE et al. (1993), which distinguishes four different aspects of wilderness: (1) remoteness from settlement (remoteness from places of permanent habitation); (2) remoteness from access (remoteness from constructed vehicular access routes like roads and railways; (3) apparent naturalness (the degree to which the landscape is free from the presence of the permanent structures of modern technological society); and (4) biophysical naturalness (the degree to which the natural environment is free from biophysical disturbance caused by the influence of modern technological society).

Similar to FRITZ et al. (2000) we estimate and combine these four indicators using a multi-criteria evaluation (MCE) framework implemented in a Geographic Information System (GIS).We calculate weighted distance decay models on raster level with a spatial resolution of 100 meters using following input data sets:

1. Remoteness from settlement: based on a map of soil sealing (KOPECKY & KAHABKA 2009) as proxy for settlements we calculated a weighted pathdistance to locations with sealed soil. The pathdistance was favoured over the Euclidian distance because it considers topographical surface conditions, which were implemented by using a digital elevation model (JARVIS et al. 2008).For weighting we applied a kernel density to estimate the density of settlements.
2. Remoteness from access: we used the Open Street Map data (Geofabrik 2012) to calculate traffic-weighted pathdistance models. We distinguished between line features like roads and points representing public transport stops like railway stations. In the first case tunnelled sections were excluded.
3. Apparent naturalness: similar to the remoteness from access weighted distance-decay functions were calculated using several civilization facilities as input: skiing areas (Umweltbundesamt 2012), hydroelectric power stations (WALDER & LITSCHAUER 2010), other power stations (Geofabrik 2012), power lines (Geofabrik 2012), alpine huts and shelters (Geofabrik 2012), railway network (Geofabrik 2012) and buildings (Geofabrik 2012).
4. Biophysical naturalness: due to a lack of adequate land use data we usedthe CORINE land cover data set (EEA-ETC/LUSI 2007) as a proxy for human impact on the environment, applying weights according to the degree of naturalness of land cover. Additionally we applied the degree of hemeroby (GRABHERR et al. 1998) for wooded areas.

For the integration of all intermediate results described above we followed two different approaches. To get an overall estimation of wilderness quality we used a weighted overlay which considers all features within a certain radius at a given location. This method is suited for highly populated areaslike most European landscapes and contradicts to the Australian approach, which only takes the most important factor into account (FRITZ et al. 2000). In the Austrian case this method tends to underestimate the influence of single facilities in remote areas (like alpine huts), because they accumulate much lesser weight compared to crowded localities. To be able to consider such facilities in these sensitive areas we adapted the Australian approach and applied a so called minimum operator (which corresponds to a logical "and"). As a consequence for each locality the smallest and hence most influential distance value was taken into account.

To obtain a final spatially explicit estimation of the wilderness quality index for all of Austria we calculated the average of these two layers. In a last step we intersected the core zones of the Austrian National Parks as well as the Natura 2000 sites with the wilderness continuum map to estimate the wilderness quality for these areas.

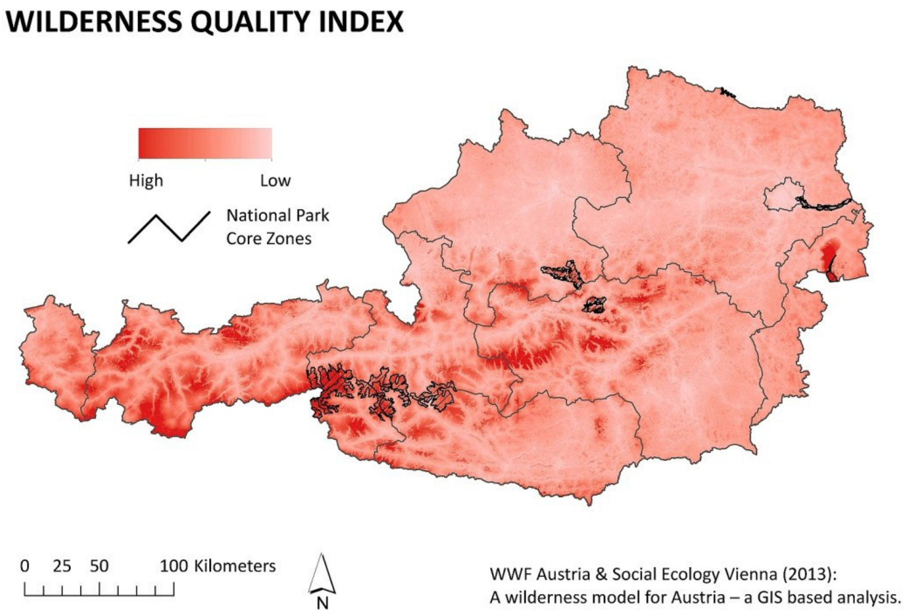

Figure 1: Map shows the wilderness quality index for all of Austria and on top the boundaries of the Austrian National Park core zones.

Results

The wilderness continuum is shown in Figure 1, together with the core zones of Austrian National Parks(but for reasons of clarity not the Natura 2000 sites). Most areas with high wilderness quality are located in mountainous regions with higher elevations,located in the western parts of Austria, for example Hohe Tauern, Niedere Tauern, Ötztaler Alpen, Lechtaler Alpen, Karwendel and Totes Gebirge. One exception is the large sheet of water of Lake Neusiedl situated in the east at the border to Hungary. As was expected the populated regions of Vienna, Lower Austria, Upper Austria, the south-western parts of Styria and the large alpine valleys show consistently low wilderness quality values.

Figure 2 shows a comparison of the wilderness quality of the core zones of Austrian National Parks (separated for each federal state[1]) as well as the Natura 2000 sites in relation to the Austrian territory.
The median of Austria's wilderness quality index is 0.14 and one of the National Parks, Donau-Auen, has a similar range of values. The part in Lower Austria has a median of 0.16 whereas the part in Vienna shows a slightly smaller median of 0.11. All other national parks as well as the Natura 2000 sites show clear higher wilderness quality values. The highest median can be found in Neusiedlersee (0.69), followed by Hohe Tauern Tyrol (0.46), Hohe Tauern Salzburg (0.39), Hohe Tauern Carinthia (0.37), Gesäuse (0.28), Kalkalpen (0.23), Thayatal (0.23) and the Natura 2000 sites (0.19).

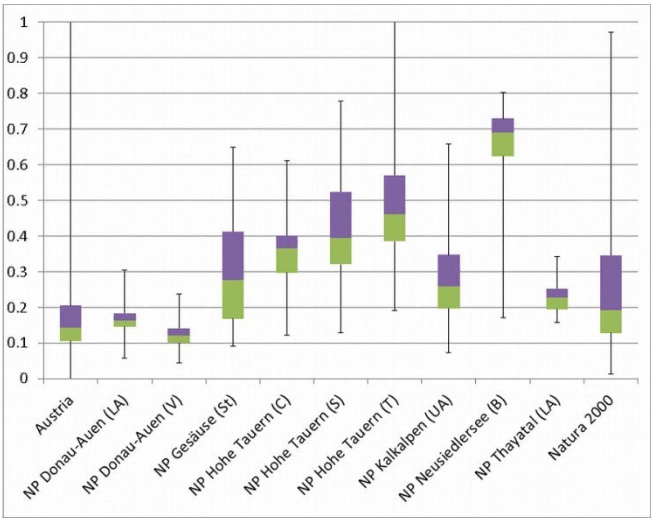

Figure 2: Box plot presents the wilderness quality index in Austrian National Parks and Natura 2000 sites, indicating minimum, 25th percentil, median, 75th percentil and maximum for each area. B: Burgenland, C: Carinthia, LA: Lower Austria, S: Salzburg, St: Styria, UA: Upper Austria, T: Tyrol, V: Vienna.

Discussion

The spatial pattern of the Austria's wilderness continuum shows that mountain ranges are favoured over lowlands. This is an expectable result since intensity of land use as well as most human activities decline with increasing altitudes. Nevertheless we are able to present this effect on a quantitative basis, underpinning the importance of alpine habitats for preserving natural processes and services on a large scale. Moreover this approach is able to provide a starting point to compare the level of naturalness for different regions and localities, considering various aspects of anthropogenic disturbances.An overlay with Austria's National Park core zones and Natura 2000 sites reveals that the vast majority of Austria's network of high level protected areas providesa wilderness index above the average, indicating high wild land quality. Given a certain minimum size, some of the core zones have the capability to establish wilderness, fulfilling the requirements of the Wild Europe initiative for wilderness and wild areas (Wild Europe 2012).Detailed local studies could offer scenarios how to protect existing aspects of wilderness as well as how to change recent management and land use to develop wilderness in a sustainable way. Candidates for such a process are the National Parks Hohe Tauern and Kalkalpen.
Although some of the areas with high wilderness quality enjoy a high status of protection, like the core zones of National Parks, and others are covered by Natura 2000 (e.g. Ötztaler Alpen, Karwendel), some have no adequate protection at all (e.g. Lechtaler Alpen, Stubaier Alpen). These areas deserve special considerations when it comes to conservation issues like connectivity of (alpine) habitats.
The high wilderness quality value for Lake Neusiedl is a consequence of the input data used. We were facing a lack of data focusing on human activities on lakes – like ferries, sailing or fishery – resultingin an underestimation of human impact in freshwater habitats. This bias has to be considered when reviewing the result and emphasizes the importance of data quality and completeness. It is clear that this assessment misses several factors, important for a full and extensive evaluation of Austria's wilderness continuum (like hunting or grazing activities). But we hope that in the long run this study will help to improve the relationship and interaction between nature conservation, protected areas and the wilderness idea in a beneficial and fruitful way.

[1]kindly provided by Amt der Burgenländischen Landesregierung; Amt der Kärntner Landesregierung; Amt der Salzburger Landesregierung, (c) SAGIS; Amt der Tiroler Landesregierung, TIRIS 2012; Amt der Steiermärkischen Landesregierung; Amt der Oberösterreichischen Landesregierung; Stadt Wien - data.wien.gv.at; Amt der Niederösterreichischen Landesregierung

Conclusion

The study presented is a first spatially explicit assessment of the wilderness quality for Austria. It shows that, despite of the long human colonization of Austria's landscapes, there are still large, unfragmentedareas left, equipped with high wilderness quality values. These regions can be considered mainly as wild land with high potential to become secondary wilderness, providing natural processes and dynamics. Looking at the whole of Austria this potential is covered partly by the Austrian network of protected areas, especially the core zones of National Parks, but also the Natura 2000 sites. The core zones show, with one exception,clear higher wilderness quality than the Austrian average and hence can be seen as important basis for the protection of large-scale natural processes. Nevertheless national studies tend to miss local or regional characteristics, last but not least because of insufficient data quality and availability. So further in detail studies, focusing on a specific region and considering its individuality, will help to improve the mapping of the wilderness continuum in Austria as well as our understanding of the meaning of wild land for nature conservation.

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Mobility patterns of alpine *Erebia* populations: Does a large road act as a dispersal barrier?

Daniela Polic & Andrea Grill

Abstract

Dispersal is a crucial feature for the preservation of butterfly metapopulations, which can be affected by habitat fragmentation. Each individual that enters the matrix takes a risk. Therefore, even winged organisms, like butterflies, are often extremely sedentary and spend their whole lifetime in a relatively small area. For such species, large roads may constitute a real obstacle for movement. We conducted a mark-release-recapture study on six alpine *Erebia* species in the Hohe Tauern National Park in order to investigate if theGroßglocknerHochalpenstraße – a large and highly frequented road in an alpine environment – acts as a barrier to movement for these relatively sedentary butterflies. We aimed at analysing which of the following variables predicts movement probability: (a) species membership, (b) ecological specialization, (c) nectar availability, (d) age or (e) patch isolation.

We marked a total of 429 individuals, of which 113 were recaptured. Our data indicates that neither body-size nor ecological specialization significantly influenced mobility patterns in these *Erebia* butterflies.Butterflies that were on a patch with a high nectar level were less likely to leave the patch. Age influenced mobility with mid-aged butterflies being most likely to change between patches. The road, however, seemed to be a barrier for dispersal. We found that butterflies that had to cross the road to get to another suitable habitat patch were less likely to leave the patch than butterflies that did not have to cross the road.

Keywords

habitat fragmentation, *Erebia*, mobility, dispersal, alpine butterflies, mark-release-recapture, metapopulation

Introduction

Numerous studies show that dispersal is a key feature for the preservation of butterfly metapopulations (e.g., Hanski et al. 2000, Hill et al. 1996). In a fragmented landscape individuals have to take the risk of entering the matrix to reach new suitable habitat patches with costs during dispersal through the matrix, for example due to an increased predation risk (Andreassen & Ims 1998, Robinson et al. 1995). This might cause individuals to stay sedentary. When species are forced to live in isolated populations, the genetic exchange is limited which may increase homozygosity and thus, in the long run, the risk of extinction (Saccheri et al. 1998). Once a population on an isolated patch is extinct, recolonization is unlikely (Heino & Hanski 2001).

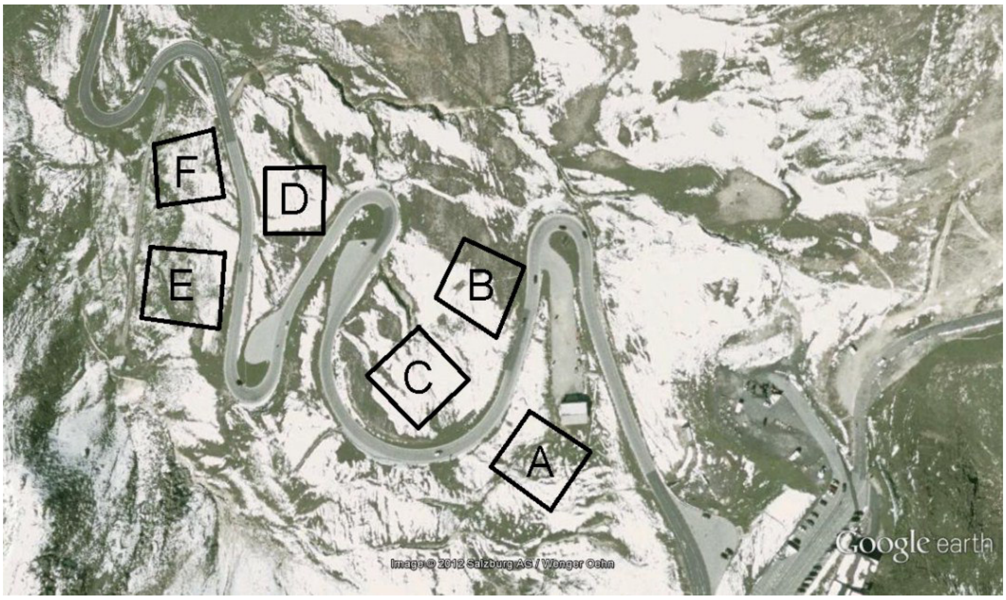

Figure 1: Map of the study area: Analysed plots in the Hohe Tauern National Park. “Upper triangle” with the plots ABC, “lower triangle” with the plots DEF. Source: Google Earth.

Habitat fragmentation might be more destructive to alpine butterfly populations as opposed to lowland conditions. The harsh climatic conditions and sudden onsets of bad weather in such environments may increase the mortality during dispersal events. Due to recent climate change, mountain butterfly species have shifted their distributions towards higher elevations (PARMESAN 1996). Hence, when distribution ranges are shifted upwards and high-altitude habitats become fragmented into smaller patches, organisms that are restricted to alpine habitats might be those most threatened. Understanding the dispersal patterns of alpine butterfly populations and what might be a barrier for dispersal is therefore fundamental for developing and adapting conservation plans. In Austria, the butterfly genus *Erebia* contains about 25 species adapted to alpine habitats, several of them occurring sympatrically (STETTMER et al. 2007).

We analysed the dispersal patterns of *Erebia* butterflies in an anthropogenically fragmented habitat in the Hohe Tauern National Park in Austria, where a large road cuts through the natural habitats of the butterflies. The genus *Erebia* (Nymphalidae: Subfamily Satyrinae) contains species adapted to alpine habitats (NEUMAYER et al. 2005), occurring on altitudes of 500 m to more than 2500 m (STETTMER et al. 2007). According to KOMONEN et al. (2004) habitat generalists are more mobile than habitat specialists. Hence, we compared a habitat generalist, like *E. pandrose* to a habitat specialist, like *E. gorge*. *E. pandrose* is relatively widespread in European mountain habitats, colonizing rocky and dry habitats as well as moist grassland, in contrast to *Erebia gorge*, which is restricted to rocky habitats such as moraines (TOLMAN & LEWINGTON 2012). BERWAERTS et al. (2002) found that the flight performance of *Parargeaegeria* butterflies was positively correlated with total body mass, forewing area and forewing length. Therefore, we compared larger butterflies to smaller butterflies.

We analysed six alpine *Erebia* species, namely *E. eriphyle, E. epiphron, E. gorge, E. pharte, E. pandrose* and *E. nivalis*. We aimed at analysing which of the following variables predicts movement probability: (a) species membership, (b) ecological specialization, (c) nectar availability, (d) age or (e) patch isolation. We asked the following questions: (1) Does a large road act as a dispersal barrier for *Erebia* butterflies in the sense that butterflies do not (or less often) fly across the road? We expected higher dispersal rates between habitat patches on the same side of the road than between patches on different sides. (2) Is there a difference in the mobility patterns between a habitat generalist like *E.pandrose* and a habitat specialist like *E. gorge*? The specialist was expected to be more affected by habitat fragmentation and to be more likely to stay on the same habitat patch. (3) Is there a difference in the mobility patterns between larger species like *E. eriphyle* with wingspans of about 4 cm and smaller species like *E. epiphron* and *E. pharte* with wingspans of less than 3 cm? We expected larger species to be more mobile and smaller species to be more likely to stay on the same patch. (4) Do nectar availability or age influence the mobility patterns? We expected nectar availability to influence mobility in the sense that if butterflies are on a patch with sufficient resource availability, they might be less likely to leave that patch. We expected the migration rate to increase with age as this has been found e.g. by KARLSSON (1994).

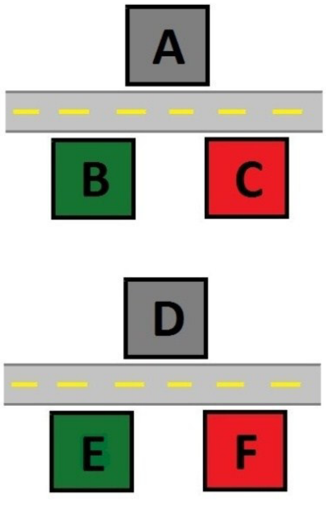

Figure 2: Schematic overview of the “upper triangle” ABC and the “lower triangle” DEF.

Material and Methods

<u>Study area</u>

We conducted our field study in the Hohe Tauern National Park in Austria, which comprises suitable alpine habitats for these butterflies like meadows or dwarf shrub heaths, hence 21species of *Erebia* occur there (HUEMER & WIESER 2008). We chose alpine meadows located at an altitude of 2300-2400 m,relatively homogenous regarding slope and resources. A large road, the “Großglockner Hochalpenstraße”, leads through the national park and cuts through these meadows. The Großglockner Hochalpenstraße is a highly frequented alpine road with about 267.000 motor vehicles per year between May and the beginning of November, according to the Großglockner Hochalpenstraßen AG. To determine whether the road has an impact on dispersal of ringlet butterflies, we examined two habitat plots on one side of the road and one plot on the other. The plots were arranged in a triangle within these meadows with no natural elements determining the borders of the plots. This setting was replicated a second time, so that we analysed six plots in total. Each plot had a size of 40 x 40 m² and the distance between plots was 40 m. The plots of the first (and upper) triangle were named A, B and C, while the plots of the second (and lower) triangle were named D, E, and F (Figure 1, Figure 2). The plots A and D will be referred to as the "separated plots" hereafter, since they were segregated from the other plots by the road.

Data collection

We conducted a mark-release-recapture study on six different *Erebia* species in the Hohe Tauern National Park between 7 July and 14 August 2012. Study sites were visited daily (if weather permitted) in a random order, usually from 9:30 a.m. to 6:00 p.m. Butterflies were captured with a hand-held net and individually marked with a consecutive number on the underside of one hind wing with a fine-point permanent marker. Sex, age, hour of capture and location was noted for every butterfly. Age was estimated by wing-wear on a scale from 1-3. The location was recorded with a GPS-device. Once a week the available nectar sources were estimated on a scale from 1-4.

Table 1: Analysed species and recapture rates for the categories "sedentary", "same side" and "cross road". Using the Fisher test for differences among these species with respect to their mobility we could not reject the null hypothesis (p = 0.11).

	E. eriphyle	*E. epiphron*	*E. pharte*
sedentary	25	24	16
same side	8	3	9
cross road	1	4	1

Data analysis

We analysed the distance covered by butterflies by measuring the distance between the site coordinates of the first and the subsequent capture using Google Earth. We classified recaptures into three categories: (1) "sedentary", if the butterfly was recaptured on the same plot; (2) "same side", if the butterfly was recaptured on a different plot but on the same side of the road; and (3) "cross road", if the butterfly was recaptured on a plot on the other side of the road. To find out if the species differ from each other with respect to their mobility patterns, we compared recapture frequencies of *E. eriphyle, E. epiphron*and *E. pharte*, and the three categories using the Fisher test (Table 1). A rejection of the null hypothesis of no difference among the species meant that the species differ from each other with respect to their mobility. The same was done for *E. pandrose* and *E. gorge*.

The impact of the road on the mobility was tested using a logit model. First, we excluded the butterflies that had only been captured once. Second, we checked if the modelling results changed if we also included the butterflies that had only been captured once. In our model, the dependent variable "same plot" took the value 1 if the butterfly was recaptured on the same plot (or was only captured once in the second case), and it took the value 0 if the butterfly came from a different plot. We constructed a dummy variable that indicated on which side of the road the butterfly had been captured. For instance, the dummy variable "plot A" took the value 1 if the butterfly had initially been captured on plot A and took the value 0 if it came from any other plot. We did the same for the variable "plot D". We expected that butterflies captured on plot A or Dwere more likely to stay on the same plots rather than to cross the road. We tested if modelling results changed if weused just one dummy variable "plot A or D". We controlled for the effect of nectar availability, age and species identity. Age enteredquadratically into the regression equation to account for possible unimodal effects. We constructed a dummy variable for each species. Information criteria (AIC, BIC) were used for model selection.

Table 2: Summary-Table. Analysed species and their respective mark and recapture rates.

Species	Marked	Recaptured
E. eriphyle	88	35
E. epiphron	75	31
E. pharte	43	26
E. gorge	49	9
E. pandrose	34	6
E. nivalis	25	6
E. euryale	1	0
E. manto	1	0

Results

We marked a total of 316 individuals, of which 113 were recaptured (Table 2). Roughly 62 % of the butterflies were recaptured within a distance of less than 30 m(Figure 3). 155 of the 429 captured butterflies were females, 211 were males and for the remaining 63 the sex could not be determined. Our data indicates that neither body-size nor ecological specialization significantly influenced the mobility in *Erebia* butterflies. The road seemed to be a barrier against dispersal.

Using the Fisher test we could not reject the null hypothesis of no difference in mobility neither between *E. eriphyle, E. epiphron* and *E. pharte* (p = 0.11) nor between *E. gorge* and *E. pandrose* (p = 0.60). According to the logit model (Table 3) butterflies captured on plot D were significantly more likely to stay on the same plot than butterflies captured on the other plots. We did not find analogous effects for plot A. If we used just one dummy variable for plots A or D, we found that butterflies captured on these plots were significantly less likely to change the plot across the road. If there was a high abundance of nectar flowers, butterflies were less likely to change the plot. We did not get this result if we included butterflies that were captured only once. We found significant evidence that very young butterflies were more likely to stay on the same plot. When they got older they were more mobile and thus, more likely to change the plot, and at the end of their flight period they were more likely to stay on the same plot (Figure 4). We found that *E. pharte* was more likely to change between plots than the other species.

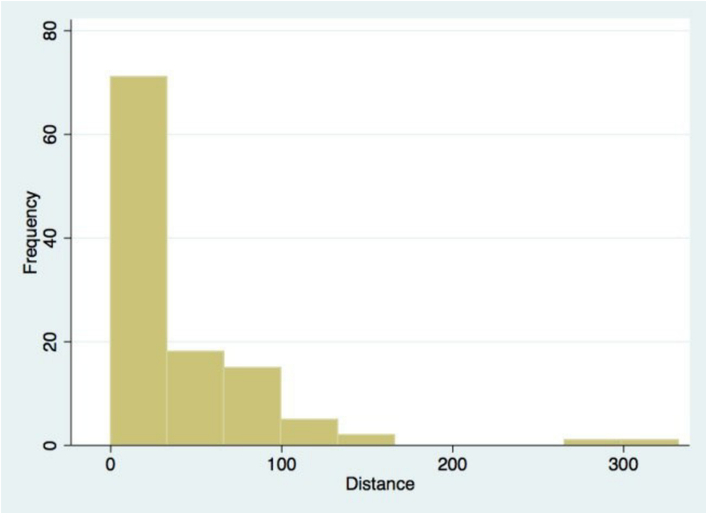

Figure 3: Histogramm of distances [m] moved by Erebia butterflies. The maximum flight distance recorded was 331,93 m (Erebia epiphron).

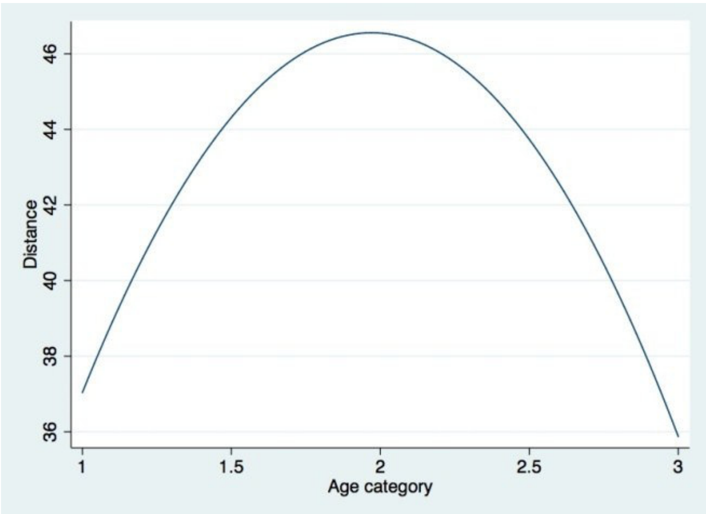

Figure 4: Graph of the prediction for Distance [m] from a linear regression of Distance on Age [categories 1-3] and Age squared.

Discussion

Most of the butterflies did not move more than 40 meters (≈ 69 %) between two capture events (Figure 3). Junker et al. (2010) suggested that a low mobility might be an adaptation of alpine butterfly species to a high elevation habitat, as limited movement distances might prevent accidental drift events, e.g. by squalls, in these high-altitude environments.Apparent sex ratios were biased towards males for all *Erebia* species except for *E. eriphyle* and *E.pandrose*. Male butterflies are more active most of the time, spending more time patrolling, presumably searching for females (Slamova et al. 2011). This makes them more likely to be observed, which can lead to a bias towards males in the number of captures.

Patch isolation. The logit model suggested that butterflies captured on plot D were less likely to change the plot than butterflies captured on the other plots. Butterflies captured on plot D had to cross the road to change the plot, which leads us to assume that the Großglockner Hochalpenstraße is a decisive factor for the lower mobility of the butterflies captured on plot D. We did not find this pattern for the upper triangle ABC, which might be due to a lower sample size. These results confirm our prediction, that a large road can hinder butterflies from dispersing from a suitable habitat patch on one side of the road to another suitable habitat patch on the other side of the road.

Table 3: Maximum Likelihood Estimation, logit model. The dependent variable is "same plot", which takes the value 1 if the butterfly was recaptured on the same plot (or was only captured once in the model that also included the butterflies that were only captured once) and takes the value 0 if the butterfly came from a different plot. The independent variable "plot A" takes the value 1 if the butterfly was captured on plot A and takes the value 0 if the butterfly was captured on another plot. The same goes for the dummy variables "plot D" and "plot A or D", respectively.

VARIABLES	(1) Logit - recaptured	(2) Logit - recaptured	(3) Logit - all	(4) Logit - all
Plot A		0.669		1.233
		(1.260)		(1.054)
Plot D		2.801**		2.301**
		(1.167)		(1.094)
Plot A or Plot D	2.135**		1.871**	
	(0.903)		(0.808)	
Nectar	0.647**	0.695**	0.262	0.284
	(0.286)	(0.289)	(0.219)	(0.221)
Age	-3.977**	-3.981**	-3.761**	-3.837**
	(1.832)	(1.839)	(1.509)	(1.513)
Age squared	0.992**	0.986**	0.861**	0.880**
	(0.465)	(0.467)	(0.380)	(0.381)
Erebia pharte	-0.754	-0.748	-0.803*	-0.804*
	(0.536)	(0.538)	(0.418)	(0.418)
Constant	2.278	2.154	5.184***	5.185***
	(1.737)	(1.751)	(1.497)	(1.500)
Observations	113	113	427	427
LR chi-squared	14.45	16.06	20.97	21.49
LR-test p-value	0.0130	0.0135	0.000820	0.00150

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Species membership. In contrast to our expectations, we did not find evidence that the *Erebia* species under study differed much from each other with respect to their mobility, neither regarding body-size – when we compared larger species like *E. eriphyle* to smaller species like *E. pharte* – nor ecological specialization – when we compared a habitat generalist like *E. pandrose* to a habitat specialist like *E. gorge*. The analysed species are rather homogeneous so that the gradient in body-size and ecological specialization among the species might not be steep enough to show a variance in the mobility. We found that *E. pharte* was more likely to change the plot than the other species. However, this weakly significant effect only emerged if we also included butterflies that were captured only once (Table 3). Hence, evidence for higher mobility in *E. pharte* remains mixed, which could be due to the small sample size.

Nectar availability. Butterflies captured on a plot with a high abundance of nectar flowers were less likely to change the plot than butterflies seen on a plot with a low nectar level. However, we only got this result when we excluded butterflies that were captured only once. We suggest that ringlet butterflies in alpine grassland tend to be sedentary when a suitable habitat patch is found and do not take the risk of entering the surrounding matrix.

Age. We found that age influenced mobility in a unimodal manner. Very young butterflies were more likely to stay on the same plot. With increasing age the butterflies were more likely to change the plot, but towards the end of their flight period the butterflies became more likely to stay on the same plot. We did not find any studies which show a similar mobility pattern with respect to age of butterflies. The decrease in the mobility at the end of the flight period found in the present study could be explained by bad weather conditions, including snow towards the end of our sampling time. After a few days of bad weather we noticed a sharp decline in captures and a few days later the *Erebia* butterflies at our study sites disappeared. At this point the butterflies were probably no longer as dispersive as they had been at the peak of their flight period.

Conclusion

As expected, the Großglockner Hochalpenstraße constrained the mobility of *Erebia* butterflies in the Hohe Tauern national park, i.e. individuals were significantly less likely to change a patch if they had to cross the road. Contrary to expectation, we found but slight differences between *Erebia* species with respect to their mobility. Only *E.pharte* seemed to be more mobile than the other five species. When butterflies were on a plot with high nectar availability, they were significantly less likely to change the plot. Age influenced mobility in a unimodal manner, i.e. mid-aged butterflies were most likely to change the plot. It would be worthwhile to further explore the genus *Erebia* with respect to mobility using data from a wider range of sites over a longer period of time and under more variable conditions.

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Monitoring breeding birds in the National Park Thayatal: point counts with distance sampling – a case study on selected songbird species

Jürgen Pollheimer & Martin Pollheimer

Abstract

Protecting endangered species and developing management measures requires knowledge about distribution and abundance of species. The national park "Thayatal" shortly after having been established in the year 2000 launched an ornithological startup project to determine the distribution and current numbers of all breeding bird species within its borders. Due to the parks steep slopes and rough terrain lacking tracks in many parts, the first goal was to find a suitable census method serving as a baseline for future monitoring. Because of the difficult terrain that makes locomotion and simultaneous census work impossible we decided to use a point count method (89 points, two visits per breeding season). Lacking any reasonable habitat information at the study's beginning, points were distributed more or less equally over the whole national park's area (with slight regard to access points). In order to obtain abundance data, distance sampling was applied. In the field, for any bird record a distance-to-observer was measured (Bushnell laser rangefinder) or estimated after a two day preparatory training and calibrating with the laser rangefinder. Census work was done by only four different, experienced ornithologists during spring and early summer of the year 2000 and 2008 for first monitoring, respectively. Abundance analysis was calculated with DISTANCE software, grouping of data and selection of the best fitting distribution model was done for each species, choosing the variant with the lowest AIC. We demonstrate the results of two selected songbird species (Wood Warbler *Phylloscopus sibilatrix* and Collared Flycatcher *Ficedula albicollis*) with emphasis of this rarely used method in continental Europe and show monitoring results for this species.

Keywords

National Park Thayatal, breeding birds, point count, distance sampling, *Ficedula albicollis, Phyloscopus sibilatrix*

Introduction

The National Park "Thayatal" shortly after having been established in the year 2000 launched an ornithological startup project to determine the distribution and current numbers of all breeding bird species within its borders. Due to the parks steep slopes and rough terrain in a closed forest lacking tracks in many parts, the first goal was to find a suitable census method in order to determine breeding densities of all widespread bird species. Furthermore, the study should serve as a baseline for a future monitoring. The chosen method fulfilling all these preliminaries was a point count with distance sampling.

References to guiding theme and to protected areas

The study demonstrates the importance of the protected area for both widespread and rare songbird species alike. Furthermore it illustrates the implementation of a baseline breeding bird survey in a rough terrain lacking habitat quality information at the beginning.

Methods

The study site covered the National Park Thayatal in Lower Austria with a total area of 1330 ha. It's situated in the north-eastern part of the Waldviertel, a part of the Bohemian Massif. The region is characterized by a Proterozoic plateau (ROETZEL 2010) with rolling hills covered with large forests and interspersed fields and meadows. It is shaped by deep incisions of a few running waters like the river Thaya. The slopes from the plateau to the river and smaller running waters are quite steep and very few tracks or paths break through this barrier in the National Park. For about four decades the area was in the proximate vicinity of the Iron Curtain at the Austrian-Czech border and therefore forestry and agriculture were quite extensive, with an almost complete lack of tourism.

Because of the difficult terrain that makes locomotion and simultaneous census work impossible we decided to use a point count method following BIBBY et al. (1995) and SÜDBECK et al. (2005). Lacking any reasonable habitat information at the beginning, 89 counting points were distributed more or less equally over the whole national park's area (with slight regard to access points). Point-distribution was made in advance in a Geographic Information System, where coordinates were generated and exported in a GPS-handheld device. In the field, each location was marked with a biodegradable tape. To cover the prolonged breeding season in a temperate forest adequately, each point was visited twice (first to second decade of April and second May-decade to first June-decade, respectively). In order to obtain abundance data, distance sampling was applied: in the field, for any bird record a distance-to-observer was measured (laser rangefinder) or estimated after a two day preparatory training and calibrating with the laser rangefinder. Simultaneous registrations were marked separately in order to determine maximum registrations for each species and counting point. To keep data variability low, census work was done by only four different, experienced ornithologists during spring and early summer of the year 2000 and 2008 for first monitoring, respectively. Analysis was conducted with species' maxima at every counting point. Abundance analysis was calculated with DISTANCE software (Thomas et al. 1998) if more than 45 registrations were gained, grouping of data and selection of the best fitting distribution model was done for each species empirically, choosing the variant with the lowest AIC (Akaike Information Criterion) and the lowest coefficient of variation (cv). If both values showed diverging developments in the final choosing section, the model with the lower cv was taken.

Two songbird species were chosen for this presentation: the Wood Warbler (*Phylloscopus sibilatrix*) and the Collared Flycatcher (*Ficedula albicollis*). The Wood Warbler is a widespread and not rare ground breeding species in many parts of Austria but shows a negative population trend in Europe (Species of European Conservation Concern, BirdLife International 2004). The cavity-nesting Collared Flycatcher prefers lower elevations in warm-summer climate outside the Alpine region in Austria and is listed in the Annex I of the European Birds Directive (Official Journal of the European Union 2009). Both species are long-distance migrants that arrive rather late in the season on their breeding grounds in central Europe.

Results

In the year 2000 the Wood Warbler showed to be under the breeding birds with highest abundances all over the study area. The abundance calculated with DISTANCE was 7,1 ± 1,2 terr./10 ha. In 2008 the Wood Warbler showed an almost unchanged breeding density of 6,7 ± 0,5 terr./10 ha. In total, 164 registrations were used for the analysis, the best fitting model (uniform, cosine) had an AIC of 466,85. In spite of a population loss of about 50% in Austria since 1998 (Teufelbauer 2010), the species remained more or less stable in the National Park Thayatal.

In the year 2000, the Collared Flycatcher was found in low numbers, widely distributed over the total area. Therefore, a calculation of its abundance using distance sampling was not possible. On many sample points the species wasn't found at all. Instead of which we followed an approach for a total count mapping all territorial males between the sample points or during other census methods in special habitats (transect count along the permanent open running waters, territory mapping on larger clearings of steppe vegetation in hilly area and meadows along the Thaya river). The total breeding density following this combination of data gathering was 0,6-0,7 terr./10 ha. In 2008 the Collared Flycatcher had shown a significant increase in distribution and abundance. In total, 106 registrations were used for the analysis, the best fitting model (negative exponential, polynomial) had an AIC of 258,62. The species reached an abundance of 3,2 ± 0,5 terr./10 ha (300-400 breeding pairs) which is one of the most important single spots for this species in Austria. Direct counts alone made up for 280 territories. Since 1998 the species had increased by 200% in Austria, which shows directly in our monitoring results.

Discussion

The results demonstrate the importance of the protected area for both widespread and rare bird species alike. Rising numbers of the Collared Flycatcher reflect at least partly a large scale increase of this species in the last 10 years after an European decline with lowest numbers in the year 2000 (http://www.ebcc.info/index.php?ID=391&result_set=Publish2010-06&one_species=13480). But facing an intensification of forestry due to rising needs for resources it's still more important to preserve unmanaged woods with large amounts of dead and dying trees with numerous tree holes as nest cavities. Quite different is the case of the Wood Warbler, a formerly widespread and numerous breeding bird in Austria. Results of the Austrian breeding birds' monitoring (Teufelbauer 2011) show a long-term and marked decline of the species as for other *Phylloscopus* Warblers in the whole country. The more surprising is the constantly high level of breeding abundance of this species in the Nationalpark Thayatal, underlining the importance of large undisturbed woods not only for Non-Passerines but even for small ground-breeding songbirds.

Conclusion

In the future, more detailed habitat information could be gained and used for habitat modeling for most of the breeding birds in the National Park. Recent studies in other protected areas in the Austrian Alps show, that recording of bird-specific habitat features improves habitat model quality (cf. Oberwalder et al. 2012, Frühauf et al. 2013).

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Abundance and habitat selection of two alpine songbird species in the National Park Hohe Tauern (Austria)

Jürgen Pollheimer & Julia Gstir

Abstract

Scientific research and management measures in protection areas often focus on rare and endangered species. In terms of financial resources and manpower this approach is reasonable in a short-term aspect. But long-term developments and processes often require formerly common and widespread species for calibration, as shown by the influence of climate change in the Swiss Alps on an alpine breeding grouse species. And birds in general are well adapted organisms in different ecosystems to indicate ecological conditions or their shift.

In the Austrian Alps, even in mountainous protection areas, knowledge about most of the common breeding bird species is rare. In the National Park Hohe Tauern in the Provinces of Kärnten and Salzburg, an ornithological project dealing with grouse, woodpeckers and owls listed in the Annex I of the European Birds' Directive was carried out from 2010 to 2012. Aside from the sometimes rare target species, some common and widespread passerines were quantitatively censused by territory mapping, too. Among them, we chose two characteristic species breeding in the alpine zone above tree line, both representing somewhat different habitat preferences regarding vegetation cover and scree to rock boulder cover, namely Water Pipit (*Anthus spinoletta*) and Wheatear (*Oenanthe oenanthe*). We present quantitative results from more than 10 different plots (each c 90 to 150 ha) to the north and south of the main chain of the Alps. Breeding abundance of both species can serve as a data baseline for future climate change research. We discuss habitat selection or preferences of both species.

Keywords

National Park Hohe Tauern, breeding birds, territory mapping, habitat selection, *Anthus spinoletta, Oenanthe oenanthe*

Introduction

In remote and often hardly accessible habitats like mountainous areas, knowledge about distribution and abundance even of widely distributed and common breeding bird species is rare. This means, that actual population size is roughly estimated for species concentrating their breeding area in these habitats. As a consequence, changes of distribution or population size triggered by altering ecological conditions are easily overlooked. Furthermore, the study should serve as a baseline for future monitoring and research on climate change in a large protection area of the eastern Alps.

Methods

The study site covered the National Park Hohe Tauern in Kärnten and Salzburg with a total area of c. 1.246 km^2 ha. It's situated in the highest part of the eastern Alps in Austria reaching from about 1000 to 3798 m at the summit of Großglockner, Austria's highest mountain. The mountains of the Hohe Tauern are buildt by plutonic rocks and characterized by steep slopes, large glaciers and rather large alpine valleys with currents with high water-carriage during the spring and early summer melting period.

In total c. 15.000 ha spread over 103 reference plots with a mean area of c. 150 ha were covered by territory mapping following BIBBY et al. (1995) and SÜDBECK et al. (2005) with three visits per season. About 60 of these plots were situated around or above treeline and therefore with basically suitable habitat for Water Pipit and Wheatear. Location of the reference areas was originally selected by habitat modeling for two main-target species of the study (FRÜHAUF et al. 2013), namely Rock Ptarmigan (*Lagopus muta*) and Rock Partridge (*Alectoris graeca*).

Simultaneous registrations were marked separately in order to determine maximum territory numbers following TOMIALOJC (1980). Mapping was done by 5 different field workers, territory analysis was made by only one experienced ornithologist.

Two widespread songbird species (Water Pipit, Wheatear) of the alpine zone were chosen for this presentation. Both species are characteristic for alpine meadows at and above treeline and are limited by bare rock faces and scree fields without vegetation formerly covered by glaciers. Both species are migrants that arrive rather late in the season on their high breeding grounds in central Europe. The Water Pipit with its wintering areas around the Mediterranean Sea arrives first, but is often forced to repeated altitudinal migrations by late snowfalls in April, so the main breeding season for both species reaches from May to mid July.

Results

Both species show similar maximum abundances of 0,37 and 0,43 territories/10 ha for Water Pipit and Wheatear, respectively. Though, using the same habitat and occurring regularly in the same reference plots, the two species show some differences in habitat preference. The Wheatear tolerates higher coverage of scree and rock boulders and avoids rather uniform alpine meadows dominated by a few grass species. The Water Pipit prefers weakly structured alpine meadows, often interspersed with scree; the species is often found near tiny streams or moist ground conditions. Both species tolerate a quite low coverage of dwarf bushes (*Rhododendron ferrugineum*, *Juniperus communis*).

Discussion

Variations of species' abundance and habitat preferences are discussed in the presentation.

Conclusion

The presentation gives to our knowledge the first large-scale breeding census of the Water Pipit and the Wheatear in the National Park Hohe Tauern, some older census works were done on comparatively small plots that were furthermore geographically concentrated. The results should serve as a baseline (I) for future common breeding bird monitoring in the National Park and (II) and for climate change research in an alpine area, where global warming is known to go forward in an outstanding intensity (CAMENZIND 2012).

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Modelling of Habitat Preferences of water pipits (*Anthus spinoletta spinoletta*) in "Nationalpark Gesäuse" using Remote Sensing and GIS

Nationalparks Austria Science Award 2013

Jakob Pöhacker, Christian H. Schulze, Lisbeth Zechner, Franz Suppan, Helmut Fuchs

Keywords

Modelling of Habitats, Water Pipit (Anthus spinoletta spinoletta), Remote Sensing, GIS, Logistic Regression, Landsat 5, NDVI, Nationalpark Gesäuse

Abstract

In spring 2009 a survey was done on a grid patterned cell basis (100x100m), and data on absence and presence of water pipits (*Anthus spinoletta spinoletta*) in "Nationalpark Gesäuse" were collected.

From this data we performed a habitat preference model, using logistic regression in a stepwise forward procedure. 64 habitat variables were calculated mainly using biotop data from Nationalpark Gesäuse, a digital elevetion model (resolution 25X25m), Landsat 5 TM satellite data and data from our bird-survey. We used the satellite data to calculate an index for biomass, the NDVI (Normaliced Differential Vegetation Index).

The Nationalpark Gesäuse was choosen as investigation area because of the presence of very good digital data sources that make it ideal to do such surveys, furthermore the scientific team from Nationalpark Gesäuse provided great help during preparation and performing the studies as well as organising facilities and contacts.

We started the modellbuilding process by calculating univariat models using Nagelkerke R^2 and choosing the most powerful variables to reduce the number of variables. To avoid multicolliniarity, bivariat spearman rang correllations (Rs) were calculated and if Rs was >0,5 only the variable with the more powerful Nagelkerke R^2 was chosen for further calculations.

To avoid spatial autocorrelation, absence-gridcells were only taken for further calculations if they showed a minimum distance of 500 meters to the next precence dataset.

Principal component analysis showed the necessity to calculate two separated models for alpine pasture and alpine meadow, because there are differences in habitat preferences of water pipits breeding in primary habitats to those breeding in secondary, manmade habitats.

A total of 235 out of 804 examined grids showed presence of water pipits. The level of occupancy on the alpine pasture areas reached 16% compared to alpine meadows, where about half of the grids were populated.

In both habitats, snowfields proved to be very important prerequisites of a potential habitat. While on alpine pastures great distances to the next snowfield had a negative effect, on alpine meadows the length of the boundaries of snowfieds where most important and showed a positiv effect. Snowfields and their boundaries showed to be the most importand foraging grounds for water pipits during the time of reproduction.

Different structures of wood and high average levels of the normalized differential vegetation index (average biomass) showed positive influence on habitat suitability, while large rocky areas of the alpine meadows were avoided.

Alpine pastures are more attractive if they show characters of open land with great distance to the next forested habitats.

Furthermore influence of minimal biomass was proven and we could conclude that the water pipit needs areas with sparse vegetation.

LANDSAT 5 TM satellite data was very helpful to characterise the habitat preferences of water pipits by calculating the NDVI, one of the variables that came out very powerfull during the modelling prozess. Those data are easy to get, they are cheap and available all over the world, for different timepoints over several years. There are great options for ecological surveys using GIS and Remote Sensing Data, since there are sensors existing with better resolution than the Landsat 5 TM.

The water pipit can be seen as an umbrella species for alpine open, but vegetated land. There are several species that benefit from habitat management done for waterpipits. Those management tasks could be taking care of alpine pastures, to keep them open and prevent them from growing with woods. Intensive agriculture or grazing should be avoided and some structures like rock or small shrubs should be left or planted. The water pipit is also

an interesting indicator species for climate change effects. It is one of the species that will loose potential habitat if the woods will grow up in higher altitudes. It is therefore easy to measure those effects by monitoring water pipits.

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Impact of dams, dam removal and dam-related river engineering structures on sediment connectivity and channel morphology of the Fugnitz and the Kaja Rivers

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Abstract

In terms of changing flow and sediment regimes of rivers, dams are often regarded as the most dominant form of human impact on fluvial systems. Dams can decrease the flux of water and sediments leading to channel changes such as upstream aggradation and downstream degradation. The opposite effects occur when dams are removed. Channel degradation often requires further intervention in terms of river bed and bank protection works. The situation evolves more complex in river systems that are impacted by a series of dams due to feedback processes between the different system compartments.A number of studies have recently investigated geomorphic systems using connectivity approaches to improve the understanding of geomorphic system response to change. This paper presents a case study investigating the impact of dam construction, dam removal and dam-related river bed and bank protection measures on the sediment connectivity and channel morphology of the Fugnitz and the Kaja Rivers using a combination of DEM analyses, field surveys and landscape evolution modelling. For both river systems the results revealed low sediment connectivity accompanied by a fine river bed sediment facies in river sections upstream of active dams and of removed dams with protection measures. Contrarily, high sediment connectivity which was accompanied by a coarse river bed sediment facies was observed in river sections either located downstream of active dams or of removed dams with upstream protection. In terms of channel changes, significant channel degradation was examined at locations downstream of active dams and of removed dams. Channel bed and bank protection measures prevent erosion and channel slope recovery after dam removal. Landscape evolution modeling revealed a complex geomorphic response to dam construction and dam removal as sediment output rates and therefore geomorphic processes have been shown to act in a non-linear manner. These insights are deemed to have major implications for river management and conservation, as quality and state of riverine habitats are determined by channel morphology and river bed sediment composition.

Keywords

Dams, sediment connectivity, river engineering, channel morphology, river recovery

Introduction

The construction of dams has a major influence on the flow and sediment regimes of rivers as they significantly reduce the downstream flux of water and sediments (i.e. sediment connectivity) which further involves geomorphic channel changes (e.g. upstream aggradation and downstream degradation). In contrast, dam removals generally show the opposite effects. Channel degradation often requires further intervention in terms of river bed and bank protection works. This potentially induces further (unintended) geomorphic channel changes and/or may prevent from river recovery. However, the situation gets more complex in river systems that are impacted by a series of dams due to emerging feedback processes. A number of studies have recently investigated how connectivity approaches can be used to understand complex environmental systems in order to provide a better understanding of geomorphic system response to changes (e.g. Brierley et al. 2006; Poeppl et al. 2012).Furthermore, connectivity assessments are of major importance for river management and conservation, especially in protected areas, since sediment connectivity further determines the downstream transfer and residence times of nutrients and pollutants as well as the geomorphic channel conditions and therefore the state and quality of riverine habitats. In this paper, we present a case study in which we investigated the impact of dam construction, dam removal and dam-related river bed and bank protection measures on sediment connectivity and channel morphology of two rivers impacted by multiple dams.

Study area

The rivers Fugnitz and Kaja are located in the Northeast of Austria (Fig. 1a). Both rivers are mixed-load single-thread perennial streams that enter the Thaya River within the boundaries of the Thayatal National Park (Fig. 1b).

The region of the Fugnitz River (29.7 km; 138.4 km² catchment area) and the Kaja River (10.7 km; 21.3 km² catchment area) is characterized by a humid temperate climate (POEPPL et al. 2012).

Both rivers have been impacted by multiple dams which were built as overflow dams between 1425 AD and 1782 AD (KNITTLER 2005). They range from three to six meters in height with a rather small storage capacity and are or were mainly used for fish farming purposes (POEPPL 2010). In 2013, three dams are still active along the Kaja River, while all others had been removed (Fig. 1b). Five weir dams are currently present along the Fugnitz River. These were built as mill dams or for water diversion and extraction for the water supply of fish ponds. Some sections of the upper and middle reaches have been engineered by installing river bed and bank protection measures which are still present in the systems. In the middle reaches of the Kaja River a river section has been impacted by three active dams which were built before 1782 AD (Fig. 1c). Two of them had been removed between 1823 AD and 1966 AD.

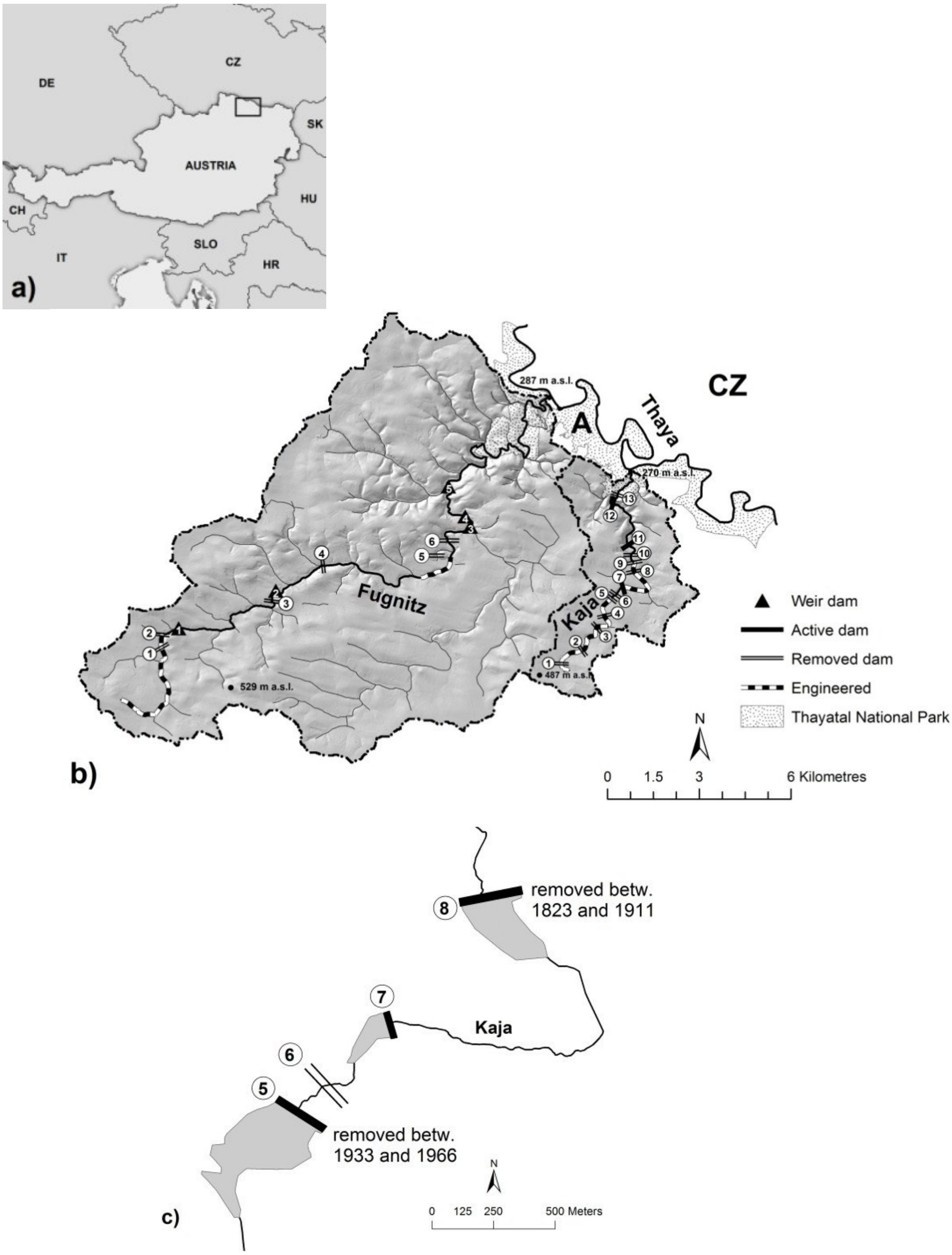


Figure 1; Study area; a) Location of the study area. b) Fugnitz and Kaja River with type and location of dams and river engineering structures. Data source: Provincial Government of Lower Austria, 2010. c) Study area for the modelling approach:situation in 1823 (derived from historical cadastral maps of the "Land register of Francis I" 1823)

Methods

Sediment connectivity is defined as the "potential for a specific particle to move through the system" (HOOKE 2003) which is mainly determined by local stream power. As for a given amount of sediment and discharge the most dominant factor in determining stream power is channel slope. Changes of channel slope are therefore seen as changes of sediment connectivity. In order to assess (changes of) channel slope, longitudinal river profiles were compiled for both rivers based on elevation information derived from a DEM in ArcGIS 10.0 (ESRI 2010).

Sedimentary river bed deposits distinct in grain size and/or sedimentary structure were mapped (= facies mapping) and information on the sediment facies was used as a proxy for stream power and hence sediment connectivity. The grain size categories were determined visually referring to WENTWORTH (1922): 0) no sediment (bedrock or engineered), 1) boulders (> 256 mm), 2) cobbles (64 - 256 mm), 3) gravels (2 - 64mm), 4) sands (0.63 - 2 mm), and 5) fines (< 0.63 mm). Furthermore, backwater area outreaches upstream of active dams were surveyed in order to delineate their influence on sediment connectivity. A fine sediment facies is interpreted to reflect low stream power and hence low sediment connectivity, while the opposite accounts for a coarse sediment facies. Changes of channel slope and sediment facies were then related to the presence of (removed) dams and dam-related river bed and bank protection measures.

In order to delineate geomorphic channel responses to dams, dam removal and dam-related river bed and bank protection measures, we compared channel cross-sections up- and downstream of the dams. The channel cross sections were digitally compiled 20 m up- and downstream of the dam toes based on a the DEM using the Path Profile/LOS Tool in Global Mapper 10 (Blue Marble Geographics 2009). The channel cross-sections were morphometrically analyzed according to their maximal channel widths, depths and cross-sectional areas assuming a bankfull discharge. Differences between up- and downstream reaches were calculated and interpreted according to the presence of dams and river bed and bank protection measures.

The CAESAR-Lisflood 1.2 landscape evolution model was used to simulate the effects of dam construction and dam removal on channel morphology (incl. sediment budgeting) and sediment input/output rates (sediment connectivity) for a specific reach of the Kaja River (see study area, Fig. 1c). CAESAR-Lisflood 1.2 (freely available via *http://www.coulthard.org.uk/CAESAR.html*) is a new hydrodynamic version of the CAESAR model developed by COULTHARD (1999) and COULTHARD et al. (2007). CAESAR is a cellular model that allows the simulation of geomorphic processes (erosion and deposition) as well as the calculation of sediment input/output rates for different grain sizes at fine-resolution temporal and spatial scales. Two scenarios, each over an experimental time period of 1000 years were modelled: 1) presence of 3 active dams (see also Fig. 1c), 2) removal of all dams after scenario 1. For this, the DEM was adapted to the physiographic settings of 1823. Water and sediment input arriving from the catchment area upstream the studied river reach were simulated using hourly rainfall data over a period of 10 years (data source: Hydrographischer Dienst Niederösterreich 2001-2010). Sediment particle size data were obtained from river bed sediment samples and soil samples in spring 2010 (POEPPL 2010).

Results and discussion

Impact of dams, dam removal and dam-related river engineering structures

The Fugnitz River has an overall channel slope of 0.068 ‰ and generally shows a nearly straight longitudinal profile in the upper and middle reaches and slight convexity in the lower reaches before entering the deeply-incised Thaya River (Fig. 2a; see also Fig. 1b). However, a multiplicity of knickpoints is present, mainly related to the presence of weir dams (e.g. weir dams 1 and 3) as well as to the presence of removed dams in river sections exhibiting upstream engineering (e.g. dams 2 and 5). The Kaja River has an overall channel slope of 0.172 ‰ and shows a very diverse longitudinal profile with alternating concave and convex sections in the upper reaches and convex steeply sloping lower reaches before entering the deeply incised Thaya River (Fig. 2b; see also Fig. 1b).

Sediment facies mapping resulted in the delineation of 50 river sections along the Fugnitz River showing all types of grain size categories except category 0 (Fig. 2a). The channel slope of the different river sections varies between 0.009 ‰ (section 5) and 0.264 ‰ (section 4). All river sections with low channel slope values showed a sediment facies of either category 5 or 4 which indicates low sediment connectivity (see Fig. 2a). Contrarily, all river sections with high channel slope values exhibited a sediment facies of category 1 indicating high sediment connectivity. All river sections within the coarsest sediment facies class 1 and high channel slope values are located downstream of either active dams or removed dams with upstream engineering. Whereas all sections exhibiting a fine sediment facies (i.e. grain size category 5 or 4) and low channel slope values are located upstream of active dams, within their backwater reaches, removed dams with upstream bed and bank protection measures, or at the river mouth.

Following the results of sediment facies mapping, 24 river sections were delineated along the Kaja River showing all types of grain size categories (Fig. 2b). The channel slope of the different river sections varies between 0.007 ‰ (section 16) and 1.118 ‰ (section 21,). Three river sections with the highest channel slope values exhibited a sediment facies of either category 0 or 1 which indicates high sediment connectivity. However, one river section within the range of the highest channel slope values (i.e. section 7) showed a sediment facies of 4 indicating low sediment connectivity which might be caused by the backwater effect of dam 7. All river sections within the range of low channel slope values exhibited a sediment facies of category 5 or 4 which indicates low sediment connectivity. All river sections within the coarsest sediment facies class 1 and high channel slope values are located downstream of either active dams or removed dams with upstream engineering. Whereas all sections exhibiting a fine sediment facies and low channel slope values are located upstream of active dams, within their backwater reaches, removed dams with upstream bed and bank protection, or at the river mouth.

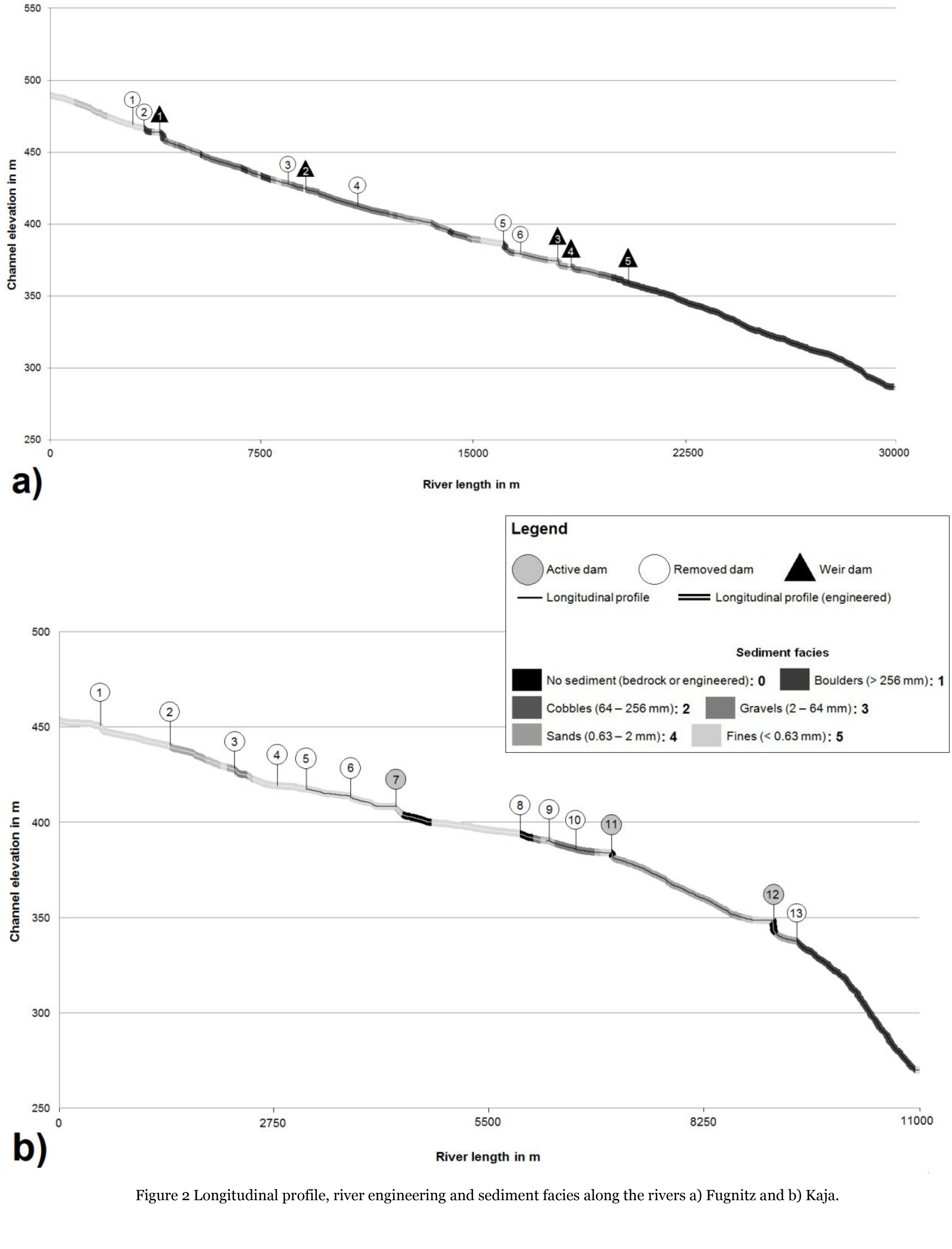
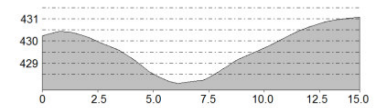
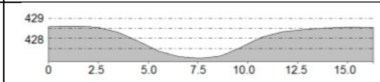
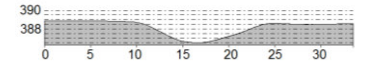
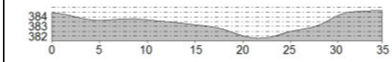
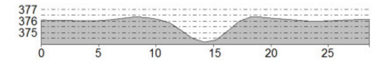
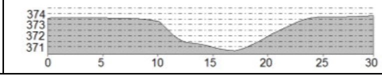


Figure 2 Longitudinal profile, river engineering and sediment facies along the rivers a) Fugnitz and b) Kaja.

Along the Fugnitz River, significant increases in cross-sectional channel areas, in channel depth and/or channel width between sections up- and downstream of dams were observed at locations of weir dams (e.g. W3; see Fig. 3a) as well as removed dams where the upstream sections have been engineered (e.g. D5; see Fig. 3a). These results indicate lateral and vertical channel erosion in non-engineered reaches downstream of active dams. Significant decreases in cross-sectional channel areas and in channel depth between sections up- and downstream of dams were examined at locations of removed dams without upstream engineering(e.g. D3; see Fig. 3a). Like in the Fugnitz case, significant increases in channel depth, channel width and cross-sectional channel areas between sections up- and downstream of dams were examined at locations of removed dams where the upstream sections exhibited engineering (e.g. D9; see Fig. 3b). Furthermore, significant increases in channel depth and cross-sectional channel area were detected at the location of an active dam without channel engineering (e.g. D12; see Fig. 3b).

a) Fugnitz River

Dam no.	Upstream cross-section	Engineering	Downstream cross-section	Engineering
D3rem		no		no
D5rem		yes		no
W3act		no		no

b) Kaja River

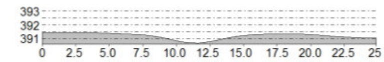
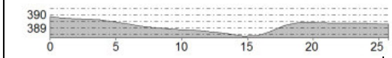
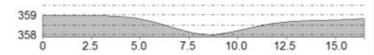
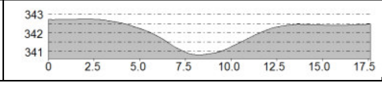
Dam no.	Upstream cross-section	Engineering	Downstream cross-section	Engineering
D9rem		yes		no
D12act		no		no

Figure 3 Selected channel cross-sections and the presence of river engineering structures ("Engineering") up- and downstream of dams along a) the Fugnitz River and b) the Kaja River. Dams are numbered from source to mouth ("Dam no.") referring to Fig. 1b. Active dams are referenced with "act", removed dams with "rem". Profile labeling is in meters.

Reach-scale modellingon the effects of dam construction and dam removal

1) Dam construction scenario

After dam construction, modelled sediment output rates (= sediment connectivity) declined for all grain size classes, but then increased with time due to an infilling of the reservoirs (Fig. 4a, 4b, 4c) indicating a recovery of sediment connectivity due to aggradation processes. The suspended sediment output rates showed a continuous increase with time (Fig. 4b), while a stepwise increase after infilling of all reservoirs was observed for bedload sediments (Fig. 4c). Simulation of channel changes due to dam construction exhibited aggradation in the reservoirs as well as in the upstream reaches affected by backwater, while channel degradation was observed in the downstream reaches. Sediment budgeting showed a net balance of plus 542,200 m³ indicating high sediment deposition rates due to dam construction. Nevertheless, after infilling of all reservoirs, sediment output outweighs sediment input which suggests increased channel erosion rates downstream of the dams (Fig. 4d).

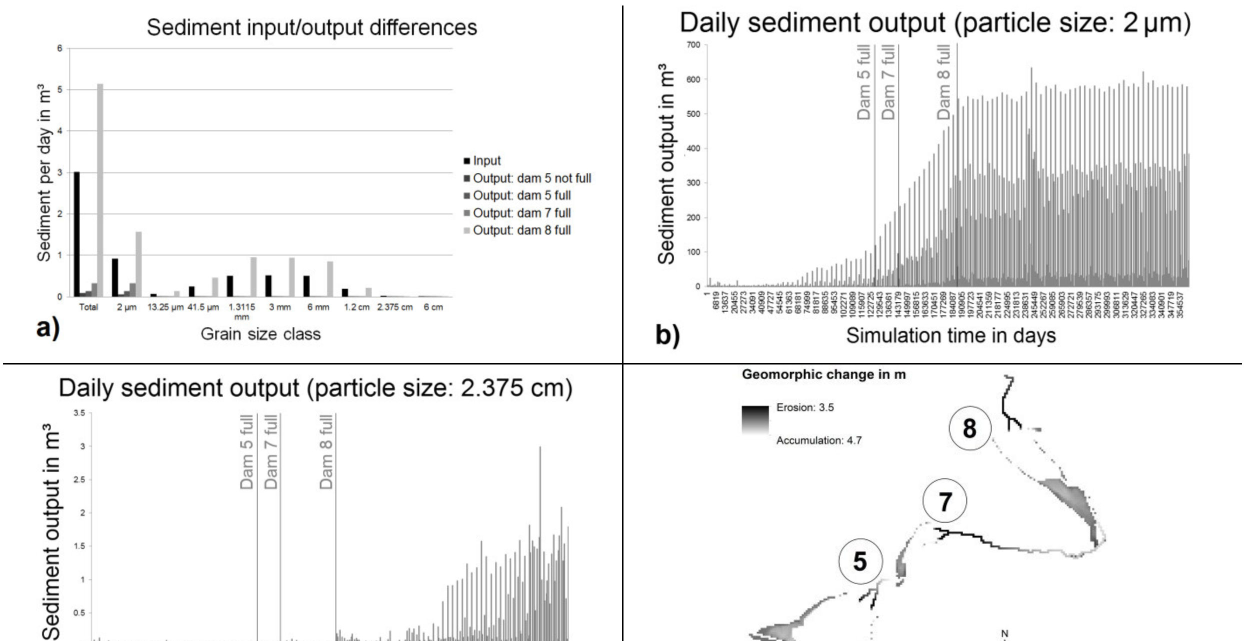


Figure 4: Modelling results for the dam construction scenario (examples): sediment outputs for a) all grain size classes, b) suspended sediments, c) bedload sediments; d) geomorphic channel changes

2) Dam removal scenario
After the removal of all dams, modelled sediment output rates outweighed sediment input rates (Fig. 5a, 5b, 5c) indicating a phase of high erosion rates removing most of the sediment volume which was accumulated during the dam construction scenario. This is also reflected by the results of the simulated channel changes after dam removal (Fig. 5d) exhibiting high erosion rates especially in the former reservoir areas as well as by the sediment budget calculations which resulted in a net balance of minus 529,700 m³ of sediment. However, 12,500 m³ of sediment are still stored in the system which shows that not all deposited sediment has been eroded after dam removal. It is interpreted that after a phase of high erosion rates the establishment of bed armoring prevented from further bed erosion processes. This assumption is also strengthened by sediment output rates that equal sediment input rates after the phase of erosion which indicates a system in equilibrium (see Fig. 5b, 5c).

Conclusions

Dams and dam removal significantly alter the sediment connectivity and sediment dynamics of river systems which results in geomorphic channel changes (e.g. channel degradation downstream of dams). Channel degradation calls for further intervention in terms of river bed and bank protection measures. However, the installation of such mitigation measures has been shown to prevent from channel slope recovery and therefore from recovery of sediment connectivity along the river channels. Based on our modelling results, we further conclude that geomorphic response to dam construction and dam removal can be complex in space and timeas sediment output rates and therefore geomorphic processes have been shown to act in a non-linear manner. These insights have also major implications for river management and conservation, as quality and state of riverine habitats are determined by channel morphology and river bed sediment composition (e.g. spawning grounds for fish, macrozoobenthos community structure).

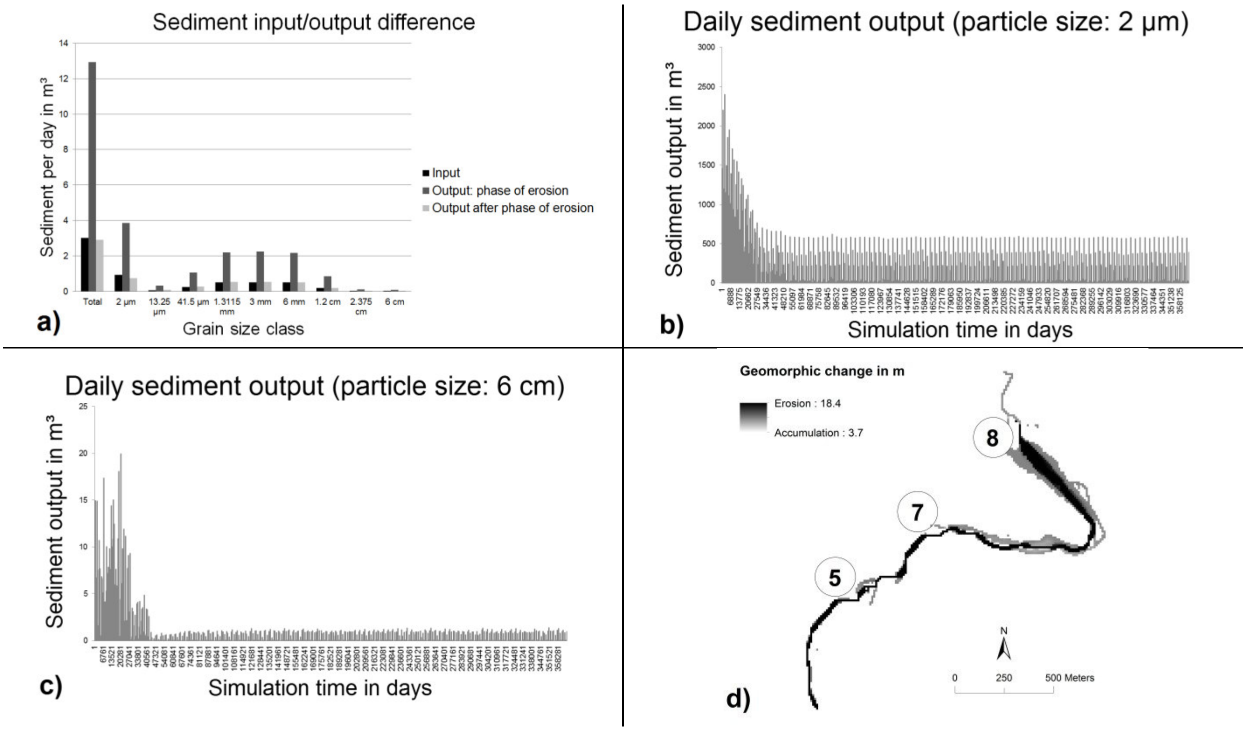


Figure 5: Modelling results for the dam removal scenario: sediment outputs for a) all grain size classes, b) suspended sediments (example), c) bedload sediments (example); d) geomorphic channel changes

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Development of an integrated modeling tool to assess the nutrient dynamics and trophic status of a decoupled floodplain along the Danube River in Austria

S. Preiner & T. Hein

Abstract

The Lower Lobau, a floodplain of the River Danube southeast of Vienna, today represents a back-flooded groundwater-fed lake system, mainly decoupled from the main stem of the river.Ongoing terrestrialisation processes have led to a reflection on restoration measures aiming at the improvement of thelateral connectivity of the Lower Lobau. Potential measures plan to increase the hydrological dynamics and are expected to have far-reaching consequences on ecosystem processes and properties. In line with these expectations, the measures are supposed to have a major impact on the cycling of matter and the sediment balance.Therefore, a dynamic water quality model is adapted to cover the trophic development of surface water quality for different management options. WASP 7 (Water Quality Analysis Program, DiToro et al. 1983, Ambrose et al. 1988) is a 2- dimensional compartment-modeling program including water column and the uppersediment layer.Based on hydrological data the model computes the limnochemical conditions, nutrients and algaeunder varying hydrological and seasonal conditions in hourly time steps.Based on this coupled model approach we expect a high potential to predict the effects of the planned measures on the trophic development in different habitats andto locate hotspots of ecosystemmetabolism.

Keywords

primary production, nutrient cycling, modeling, floodplain restoration

Introduction

In functionally intact river-floodplain systems lateral exchange processes are essential for the biogeochemical cycling (Thorp et al. 2006), which is the basis for primary production and other fundamental ecosystem properties (Junk & Wantzen 2004). Regulation and damming have led to fragmentation and disrupted structure and function of most European rivers (Ward 1998, Friedl & Wuest 2002).These human alterations have led to reduced hydrological connectivity and in consequence to changes in biogeochemical cycling and productivity patterns (Hein et al. 2004), which has also been observed in floodplains of the Danube (Welti et al. 2012, Preiner et al. 2008). One of the floodplains in this region, the Lower Lobauis characterized by the continuing loss of aquatic and semi-aquatic habitats during the last decades (Hein et al. 2006, Reckendorfer et al. 2005, Schiemer 1999). Despite degradation, the areas ecological value is still high (Alluvial Zone National Park, Natura 2000, NP, RamsarConvention area).

Table 1.Areas with different hydrological connectivity with the main channel of the River Danube and their percentage on total surface-water areas.

Connectivity	Area (m²)	% of total area
> 100 d a^{-1}	719480	43,8
< 100 d a^{-1}	602764	36,7
floods	321193	19,5

Considering the trend in the hydromorphological development since the major river regulation in the 19th century, restoration efforts in the Lower Lobauare essentialto improve the ecological conditions (Sanon et al. 2012). Though, the realization is difficult because of multiple different partly conflicting use forms, like drinking water supply for the city of Vienna, recreation and ecologyof the area.

Addressing major aspects of expected changes, a comprehensive modeling framework is developed to generate reliable prediction of the effects of potential restoration measures on the surface- and groundwater hydrology, water quality and ecological parameters.

Main objective of the presented studyisthe application of a generally accepted and for this case study adapted water quality model (WASP 7.5) to accessthe spatial development of the phytoplankton biomass and main nutrients for different potential restoration measures and varyinghydrological situations. Aim is to detect, whether internal nutrient sources or external sources from the Danube River are mainly controlling the nutrient dynamics and the trophic development in different floodplain sections and how this is changed by different restoration measures.

In this paper the general problem, the restoration setting and the modeling approach are presented.

Study site

The Lower Lobau is a large floodplain area (1,040 ha) at the eastern border of Vienna, where the Danube is a 9th order river and drains a 104,000 km^2. The annual flow is characterized by an alpine regime with highly variable and stochastic patterns and a mean discharge of 1,950 $m^3 s^{-1}$.
The historically braided river section has been strongly altered by regulation schemes conducted in the late 19th century, cutting of the side-arm systems from the main channel. The Lower Lobau is part of the semi-natural reach of the River Danube between Vienna and Bratislava which represents one of the last remnants of river-floodplain systems (SCHIEMER 1999) in Europe and has been designated as a National Park ("Alluvial Zone National Park") in 1996.

Hydrological conditions

The water body of the Lower Lobau is devided into distinct basins (Figure 1), connected only at its downstream endto the main channel and thus is characterized by a backflooded flooding pattern. The hydrological conditions in the basins are determined by the water level of the river. Surface water connection in the downstream parts of the Lobau is established at a point of 0.5 m above mean water level, which happens on about 137 days per year. The higher the water level, the more basins are connected. Some basins are only connected during floods.Potential restoration measures are aimed to establish an upstream surface-water connection between main channel and side-arm for more than 300 days per year.

Restoration measures

Two different restoration measuresto increase the upstream connectivity are considered. First, a controlled reconnection with low discharge (4.5 m^3s^{-1}) will be constructed(2012 – 2013) to decrease the hydrological retention time and establish transport phases in large sections of the Lower Lobau. Second,a reconnection with discharges up to 80 m^3s^{-1}, depending on the water level of the Danube, is discussed.

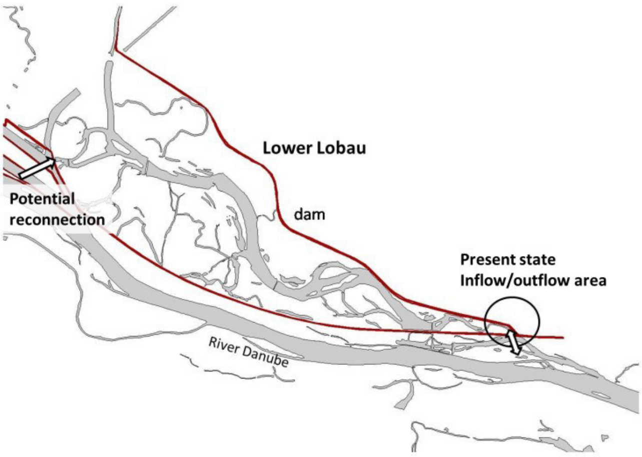

Figure 1: Map of the study area Lower Lobau.

Methods

Model description

The Water Quality Analysis Simulation Programm (WASP 7.5, 2011) is an enhancement of the original WASP (DITORO et al. 1983, AMBROSE et al. 1988). WASP is a dynamic compartment-modeling program for aquatic systems, where the time varying processes of primary production, nutrient cycling and the degradation of organic matter are represented. WASP will be linked with a hydrodynamic model developed for the Lobau area and is based onsmall compartments of the basins, so called segments, which are differentiated by their hydromorphology and their macrophyte coverage. Empirical data out of a frequent monitoring program (ZORNIG et al. 2010, ZORNIG et al. 2012) and two flood events are used to define boundary conditions (Danube limnochemical conditions) and initial conditions of the segments. Of high importance for the water quality modeling is the inclusion of the underlying sediment layer and the major processes on the water/sediment-boundary layer like degradation of organic material and phosphorus release (oxic and anoxic).

Table 2: Macrophyte coverage (reed, floating leaf plants) depending on water depth.

Depth (m)	Makrophytes	Mean makrophyte coverage (%)	Max. makrophyte coverage (%)
< 0.5	reed	37	98
	floating leaf plants	24	88
0.5 - 2	reed	9	94
	floating leaf plants	35	93
> 2	reed	3	16
	floating leaf plants	7	21

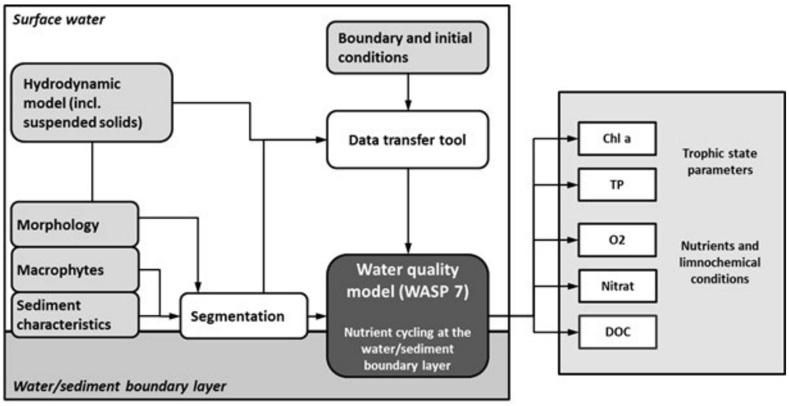

Figure 2: Model framework for water-quality modeling in the Lower Lobau.

Segment characterisation

The project area was differentiated in 400 surface water segments, 310 primary flooding zones, usually dry areas rewetted during floods and 76 bottom sediment segments. The mean area of the surface-water segments is 4,100 m², where the smallest are about 100 m² and the largest are about 37,000 m².In 62 % of the aquatic area the depth is less than 0.5 meters at mean water level, only 13 % are deeper than 2 meters. At the present state, approximately 45 % of the surface-water area is frequently connected to the main channel of the river (> 100 days per year), 20 % are connected at most during floods. Macrophytesare frequent in the whole project area. The lower the connectivity, the higher is the share of floating-leaf plants. In segments with a depth up to 2 m, ratios of floating-leaf plant cover up to 93 % was calculated. Segments deeper than 2 m are showing significantly lower macrophyte coverage. Reeds are frequent in segments up to 0.5 m depth showing maximum coverage ratios (98 %) in isolated water bodies.

Modeling approach

Alterations of limnochemical parameters (Figure 2) are calculated by the model in time-steps of 1 h for each segment.Based on the hydrological exchange, computed by the linked hydrodynamic model and the actual loads of matter (nutrients, phytoplankton biomass, dissolved organic matter, etc.), the exchange with adjoining segments is, calculated(Figure 3). Furthermore segment-internal processes calculated by state-of-the-art algorithms, foraquatic primary production, respiration, phosphorus and nitrogen cycling and the degradation of organic mattermodify the concentrations of the modeled parameters.

Different hydrological conditions like flood events and periods of mean or low water level for the present state of the Lower Lobau and the potential reconnection measures, will be modeled.

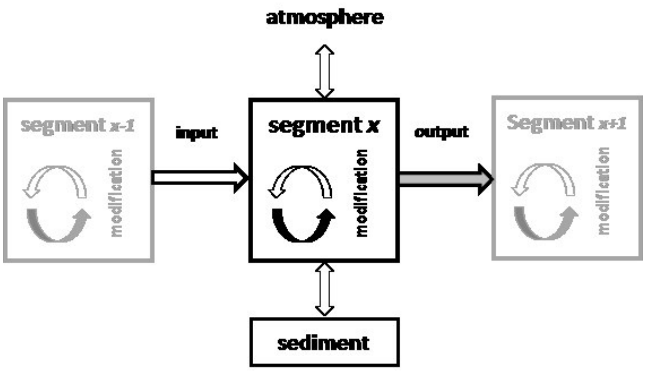

Figure 3: Schematic presentation of the calculationcontextwithin and between modelsegments.

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Innovative Actions Against Illegal Poisoning in Protected Areas of Crete

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Abstract

In the framework of LIFE+ Biodiversity project on “Innovative actions against illegal poisoning in EU Mediterranean pilot areas” [LIFE09 NAT/ES/000533], the Spanish organization “Fundación Gypaetus”, acting as coordinating beneficiary, along with the Portuguese partners “Quercus” and “Centro de Estudos da Avifauna Ibérica” (CEAI) and the Greek partners “Arcturos” and “University of Crete – Natural History Museum of Crete” (NHMC), are implementing specific actions on this issue since October 2010 for a 5-years’ project. The main goal of the project is to evaluate and spread the effectiveness of several innovative actions based on voluntary agreements with the main rural groups related with the fight against the illegal use of poisoned baits (municipalities, hunters, stockbreeders, etc.). Thanks to the demonstrative character of the foreseen actions, it is expected to relevantly improve the current anti-illegal poisoning strategies and so diminish the biodiversity loss related with this malpractice at EU level. In Crete, Greece, the project is being implemented in Eastern Mountains of Crete (pilot area GR-2), more specifically the following NATURA 2000 protected areas: Idi Oros (GR4330005), Asterousia (GR4310005) and Dikti (GR4320002). Among other innovative actions, the establishment of three (3) European networks against illegal use of poisoned baits, i.e. stockbreeders (ENSPAIP), municipalities (ENMAIP) and hunters / hunting associations (ENHAIP), will be under short presentation, as far as their design and operation is of concern. Results and constrains of the operation of these networks will be also under consideration. Finally, a brief description of other innovative actions and actions of public awareness will be briefly presented.

Keywords

Crete, poisoned baits, biodiversity, innovative actions, European networks against illegal poisoning, LIFE+ Biodiversity project.

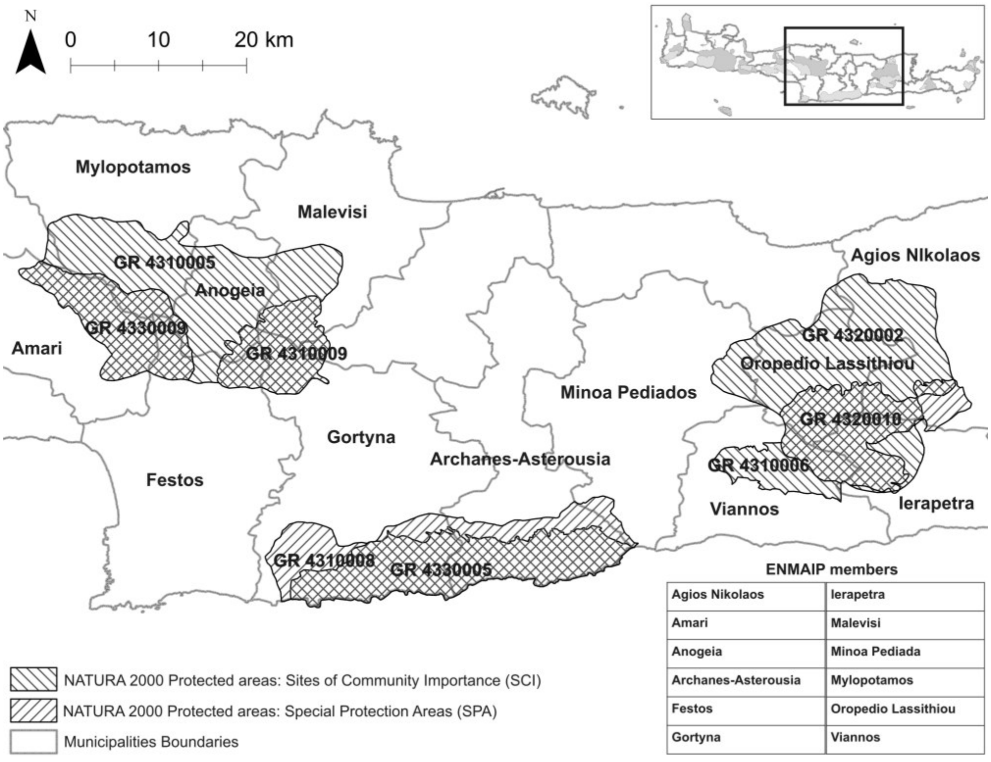

Figure 1: Map of the pilot area GR-2 and list of Municipalities involved in the LIFE+ Biodiversity project on “Innovative actions against illegal poisoning in EU Mediterranean pilot areas”. © NHMC

Introduction

The illegal use of poisoned baits is a harmful practice for the environment and for the preservation of biodiversity. In addition, it can be a potential source of negative effects for public health. The main purpose of LIFE+ Biodiversity project on "Innovative actions against illegal poisoning in EU Mediterranean pilot areas" [LIFE09 NAT/ES/000533] is to contribute to the minimization and/or eradication of illegal use of poisoned baits with the implementation of a series of innovative actions. In total, the program evolves 8 pilot areas in Spain, Portugal and Greece. Specifically in Crete, Greece, the project is being implemented in Eastern Mountains of Crete (pilot area GR-2: see relevant map, Figure 1). Main actions of the program include the following: a) establishment of three (3) European Networks against illegal poisoning, b) formation and function of a European Canine Team, c) monitoring and evaluating the use of illegal poisoned baits with bioindicator species, d) communication –public awareness actions, and e) promotion of the participation of social stakeholders.

Photo 1: Stockbreeder – member of the "European Network of Stockbreeders Against Illegal Poisoning" (ENSAIP) with the identification plaque placed in his establishment. © NHMC

Methods and Results

European Networks Against Illegal Poisoning

A contract with the "Group of Producers Stockbreeders of Crete – KRITIKA MITATA" was signed on October 2011, for assisting in the establishment and function of the "European Network of Stockbreeders Against Illegal Poisoning" (ENSAIP) in Crete. The duration of the contract is 2 years (ending on July 2013). During November 2011, an official meeting was organized with the "Association of Professional Stockbreeders of the Prefecture of Heraklion" (SEKNH) and "KRITIKA MITATA", for coordination of their activities. Both organizations signed the relevant contract for their support in ENSAIP and the project. So far, 34 stockbreeders in the pilot area GR-2 have become members of the ENSAIP, while more than 100 questionnaires have been distributed in the whole area for expressing interest of joining the network. The network is operative since May 2012. All stockbreeders participating in the ENSAIP have been provided with relevant signs for their establishments (see Photo 1).

Photo 2: Representative of the "European Network of Municipalities Against Illegal Poisoning" (ENMAIP) during the collection of the identification plaque. © NHMC

Moreover, contracts of commitment have been signed between the University of Crete – NHMC and all the 12 municipalities in the pilot area (pilot area GR-2: see relevant map, Figure 1), thus creating the "European Network of Municipalities Against Illegal Poisoning" (ENMAIP) in Crete. The network ENMAIP is operative since March 2012. All members of ENMAIP have been provided with relevant signs to be hanged in visible places of municipal offices (see Photo 2).

Photo 3: Meeting with members of the "European Network of Hunting Areas, Hunting Associations and Hunters Against Illegal Poisoning" (ENHAIP). © NHMC

Also, the University of Crete – NHMC has already made discussions with the 1st Hunting Confederation of Crete and Dodecanese (AKOKD). Contacts have been already made with individual hunters and most of the Hunting Associations of Crete (total number: 17) for informing them about the project and the "European Network of Hunting Areas, Hunting Associations and Hunters Against Illegal Poisoning" (ENHAIP) in Crete. Except AKOKD, members of ENHAIP are already 7 Hunting Associations of Crete, and the network is operative since March 2012 (see Photo 3).

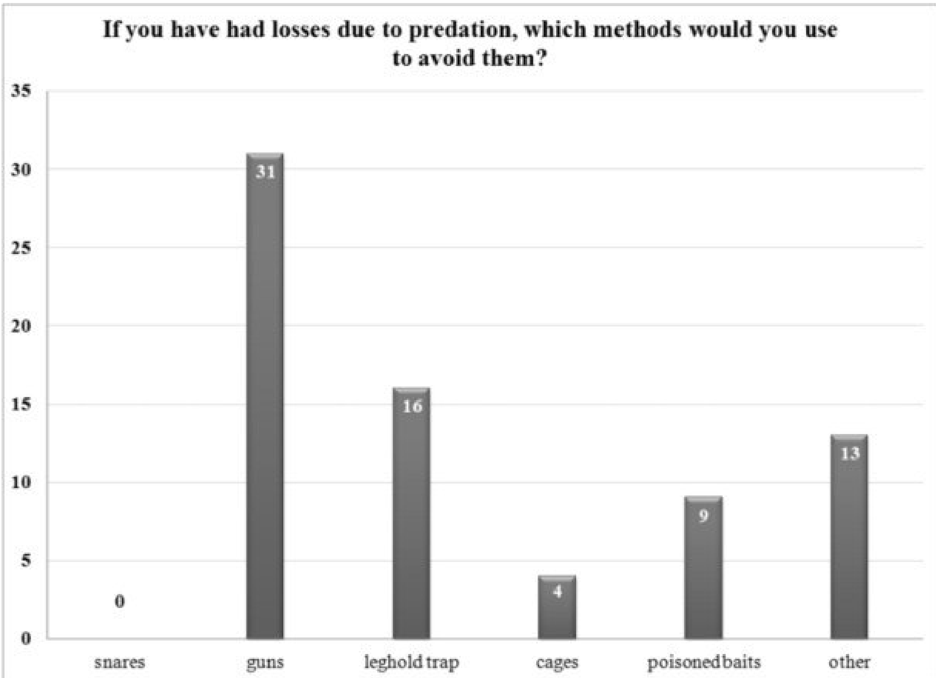

Figure 2: Answers provided by stockbreeders of Crete to the question: "Which method would you implement for controlling predation of stock from wild animals?" © NHMC

In order to acquire an overall idea of the difficulties and problems that stockbreeders and hunters of the pilot areas may face, questionnaires were handed out to them. In total, 95 stockbreeders and 45 hunters answered the questionnaires. For stockbreeders, results show that the most popular method implemented for controlling predation of their stock from wild animals is the use of firearms, while a lower percentage would use poisoned baits (Figure 2). Moreover, when hunters were questioned which method is the most effective for controlling the predators the majority answered use of guns, poisoning and traps (Figure 3).

Also, within the framework of the LIFE+ Biodiversity project, University of Crete – NHMC in collaboration with members of the three networks, namely ENSAIP, ENMAIP and ENHAIP, has scheduled to make workshops in the pilot area. In addition, public events are held in order to raise awareness among local communities on the consequences of illegal use of poisoned baits in biodiversity and its importance on the sustainable development of the island.

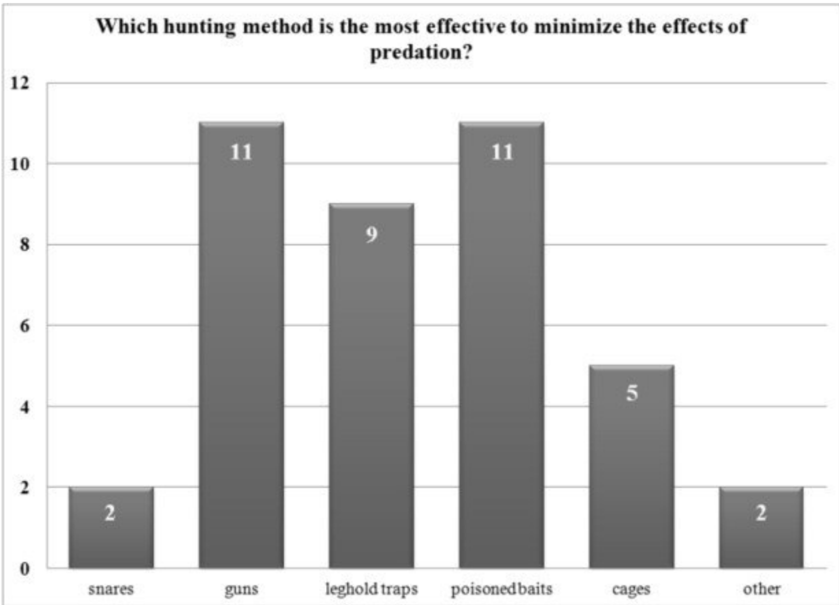

Figure 3: Answers provided by hunters of Crete to the question: "Which method is more effective for controlling predators?" © NHMC

In this direction, several conferences have already been organized in the framework of the LIFE+ Biodiversity project in the pilot areas of Crete (Eastern Crete Mountains: Idi, Asterousia, Dikti). For example, the Meeting entitled «Stockbreeding and Biodiversity» was recently conducted (13th of February 2013). "SEKNH" and "KRITIKA MITATA" were the two main participants as members of the ENSAIP. The objective of this pilot action was to highlight the problem of illegal use of poisoned baits, their impact on biodiversity and its connection to the conservation and development of primary sector of Crete and especially to livestock breeding. Moreover, the major problems concerning the stockbreeders were discussed. The crucial role of a healthy environment in the sustainability of stockbreeding was analyzed. Finally, the importance of biodiversity in agricultural food chain, on economic development (e.g. tourism) and on social cohesion (e.g. by strengthening the image of stockbreeders in local communities) was pointed out (see Photo 4).

Photo 4: Meeting on «Stockbreeding and Biodiversity» with stockbreeders (members of the ENSAIP), within the framework of LIFE+ Biodiversity project. © NHMC

Another action to raise public awareness in the framework of the LIFE+ Biodiversity project was the 2-days' festival themed "Environment-Crisis-Development" (23-24 February 2013). The University of Crete – NHMC in cooperation with the Municipality of Agios Nikolaos participated in this event with an information kiosk. The main goal of the information kiosk was to inform the citizens and visitors of the Municipality of Agios Nikolaos on the impacts of illegal use of poisoned baits on biodiversity and public health. In addition, they were acquainted with the environmental activities of the Municipality of Agios Nikolaos as a member of the ENMAIP. Visitors had the chance to learn about the problems of illegal poisoning use by representatives of the ENMAIP and the University of Crete – NHMC. Moreover, they were supplied with information material and were given the opportunity to exchange ideas and thoughts on the reduction and/or elimination of the illegal use of poisoned baits in their area (see Photo 5).

European Canine Team (ECT)

One of the most important aspects of the LIFE+ Biodiversity project is the inspection of the pilot areas from trained dogs specialized in identifying poisoned baits. During the periods 18-30 October 2011 and 20-31 October 2012, the University of Crete –NHMC coordinated two official inspections of the European Canine Team (ECT) from Spain, Andalusia. The European Canine Team was consisted by 1-2 dog trainers and 3-4 dogs (Labrador and Belgian Malinois pedigrees). They visited areas with intense hunting activity and tried to detect dead animals and baits. The whole operation was monitored and supported by the local Forestry Departments and Hunting Associations. During the first visit in 2011, the inspections took place in the Prefectural Units of Heraklion and Lasithi. During the second visit in 2012 the Prefectural Unit of Rethymno was searched as well. These areas were selected according to the instructions of the Hunting Associations reliant on the losses of hunting dogs and on the use of poisoned baits during the last 2 years and also with the assistance and guidance of local Forestry Departments. The relevant routes followed and areas visited by the ECT and colleagues from NHMC are shown in Figures 4a & 4b (routes for October 2011 and October 2012, respectively).

Photo 5: Participation in the Festival "Environment-Crisis-Development", in cooperation with the Municipality of Agios Nikolaos (member of the ENMAIP), within the framework of LIFE+ Biodiversity project. © NHMC

In 2011, the European Canine Team detected 11 dead animals: 1 marten (*Martes foina*), 2 domestic cats (*Felis catus*), 6 hunting dogs (*Canis familiaris*) and 2 hedgehogs (*Erinceus concolor*), and moreover identified 6 poisoned baits and one loop (snare). The following year, the trained dogs found 32 dead animals: 1 vulture (*Gyps fulvus*), 8 martens (*Martes foina*), 8 domestic cats (*Felis catus*), 12 hunting dogs (*Canis familiaris*), 2 hedgehogs (*Erinceus concolor*) and 1 snake (*Telescopus falax*), while they identified 45 poisoned baits (see Photos 6a-d).

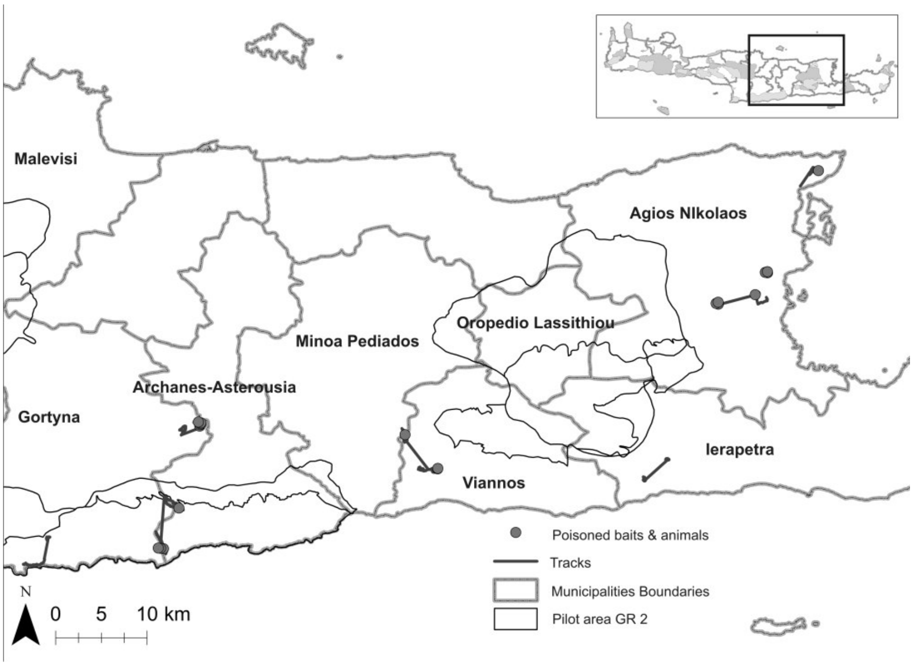

Figure 4a: Routes of the European Canine Team (ECT), poisoned baits and poisoned animals found during the inspection of October 2011 in Crete. © NHMC

The conclusions of these inspections and the on-the-spot fieldworks indicated that the use of poisoned baits is mainly used by: a) stockbreeders to control small mammals and hunting dogs (feral or not) that they prey or scatter the flocks, b) hunters at the hunting areas in order to discourage the hunting activity, due to competitive or dispute reasons, and c) beekeepers against bee predators (e.g. wasps). In addition, the number of poisoned raptors brought forward to the NHMC and the Wildlife Rehabilitation Centres due to secondary poisoning, in combination with the increase of poisoning incidences, coincides with the training period of hunting dogs, few weeks before the beginning of hunting season (August-September), and the period of birth of sheep (October-December) when poisons are used against predators, mainly ravens (*Corvus corax*).

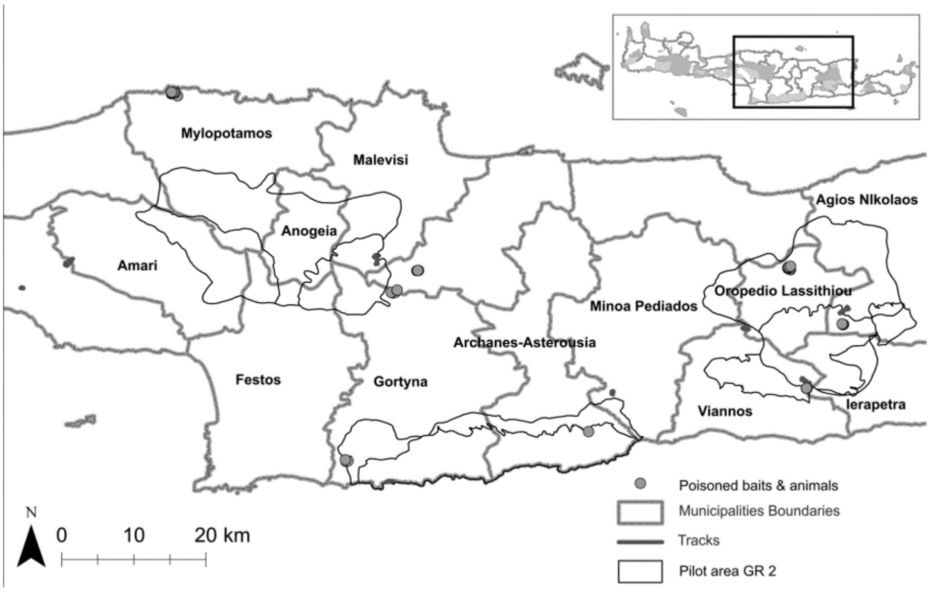

Figure 4b: Routes of the European Canine Team (ECT), poisoned baits and poisoned animals found during the inspection of October 2012 in Crete. © NHMC

<u>Other innovative actions against illegal poisoning</u>

Another action in the framework of the LIFE project is the creation of a special telephone line where citizens of Crete can call without charge for complaints, information and advices for all cases of illegal poisoning of wild animals. The objective of the operation of this telephone line is the provision of direct assistance to poisoned animals, as well as the encouragement of local community to participate in the project, for becoming more efficient the establishment and operation of the foreseen networks against illegal poisoning (municipalities, stockbreeders and hunters). The line is operational since August 2012.

Photo 6a: Visit of the European Canine Team in Crete, October 2011. © Jesus Lopez / NHMC

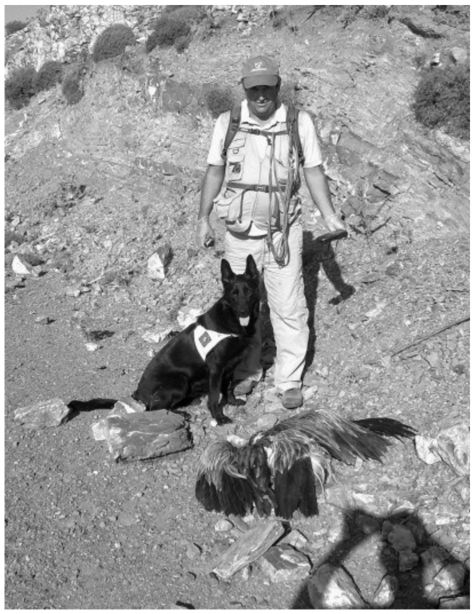

Photo 6b: Visit of the European Canine Team in Crete, October 2012. © M. Filippakis / NHMC

Photo 6c: Visit of the European Canine Team in Crete, October 2012. © Jesus Lopez / NHMC

Photo 6d: Visit of the European Canine Team in Crete, October 2012. © Jesus Lopez / NHMC

Moreover, important part of the project is to raise awareness of the illegal poisoning issue to school children. Thus, on a yearly basis, 15 visits to schools of the pilot areas are implemented (see Photo 7). A brief presentation of the project is presented and the effects of the illegal use of poisoned baits on wildlife, biodiversity and public health are discussed. In addition, the children have the opportunity to share their own experiences on the illegal use of poisoned baits and solve any queries they may have. So far, the visits of the years 2011 and 2012 are complete, while for 2013 the demand for presentations has exceeded the project's expectations.

Photo 7: Presentation of LIFE+ Biodiversity project to schools in Crete. © NHMC

In addition, a Quarterly Electronic Newsletter is uploaded in the official site of NHMC (http://www.nhmc.uoc.gr/el/programs/life-poisons) and also distributed to more than 300 electronic addresses all over Greece. The first issue was published in the first quarter of 2012. The aim of this online edition is to inform the public about the activities such as workshops, festivals and conferences of the LIFE project, as well as results of all actions that are being implemented in Crete, on a quarterly basis.

Finally, the release of technical guidelines for the: a) Control of Predation in Hunting Areas / Improvement of the Hunting Management in the ENHAIP, b) Control and Management of Feral Dogs and Cats, and c) Predation Minimization in Livestock Farms are under preparation.

Discussion & Conclusion

Regarding the ENSAIP and ENHAIP networks, the University of Crete – NHMC continues the efforts to expand them, with a larger number of participants to both direct (personal contact) and indirect contacts (disclosure, information material, telephone, etc.). The ENHAIP network has not been yet fully structured and operated, due to the fact that Hunting Associations and hunters have not been persuaded for the necessity of this network, while some hunters are not fully convinced for the problem of illegal poisoning or they are not fully aware on environmental issues. In the following months we will intense our efforts for having more members participating in the ENHAIP network, with emphasis given to the remaining 10 Hunting Associations of Crete.

Moreover, we are planning to provide anti-illegal poisoning tools to livestock owners of the ENSAIP network. Such tools include the provision of shepherd dogs, stray animal control management and free legal consulting on poisoning related issues. Also, we will provide an evaluation of illegal poisoning activity in the pilot areas by means of monitored bioindicator species. For completing the monitoring of bioindicators, we have already requested a trapping and tagging permission from the Greek Ministry of Environment, Energy & Climate Change. The selected target species are: the Bearded Vulture (*Gypaetus barbatus*), the Griffon Vulture (*Gyps fulvus*), the Common Buzzard (*Buteo buteo*), the Beech Marten (*Martens foina*), the Long-eared Owl (*Asio otus*), the Common Raven (*Corvus corax*) and the Golden Eagle (*Aquila chrysaetos*). So far, one individual of *Gypaetus barbatus*, seven individuals of *Asio otus*, five individuals of *Gyps fulvus* and ten individuals of *Corvus corax* have been tagged.

Up until now, we have extracted results from the questionnaires distributed to stockbreeders and hunters of the pilot area. This has provided us with a general idea on what problems they encounter and how they address such difficulties. A following step is to gather and analyze the questionnaires which have been distributed to the personnel of municipalities and public services that have experience in environmental issues. This will grant us with another perspective concerning the problem of illegal use of poisoned baits.

To sum up, stockbreeding and good hunting practices are fully compatible with biodiversity and the conservation of natural protected areas, while they can strengthen local economy. Nevertheless, bad practices may lead into a threat for biodiversity and farming activity, while a negative contribution to game management can also be established. In order to avoid these complications, several actions have been created by the LIFE+ Biodiversity project. The University of Crete – Natural History Museum of Crete (NHMC) continues its activities in the pilot area of Eastern Crete Mountains (Idi, Asterousia and Dikti), in the framework of the LIFE+ Biodiversity project on "Innovative Actions Against Illegal Poisoning in EU Mediterranean Pilot Areas" [LIFE09 NAT/ES/000533]. As pointed out before, among the innovative actions are communication with media in local and national level and divulgation activities for local stakeholders and the general public. Future perspectives include the production and distribution of more information material for the general public, stakeholders and the three networks, the organization of several different demonstration activities addressed to specific target groups, the implementation of a series of technical and scientific workshops on issues related to poisoning and effects on biodiversity, as well as the evaluation of illegal poisoning activity in the pilot area in Crete.

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Adapting conservation management to climate change – Challenges and solutions from protected areas in Central Europe

Sven Rannow & Christian Wilke

Abstract

The EU-funded project HABIT-CHANGE studied opportunities to adapt conservation management to climate change. HABIT-CHANGE brought together conservation managers from Central European National Parks, Biosphere Reserves and Nature Parks with conservation agencies and research institutions. This unique science-practice partnership jointly analysed existing management approaches, and the potential impacts of climate change and adaptation options for management. A main result of the project is a tested framework for the development Climate Change Adapted Management Plans. The framework provides support for identifying adaptation strategies and measures at site level. Important results are practice oriented guidelines to support effective awareness raising and stakeholder involvement and guidelines for the development of Climate Change Adapted Management Plans.

In this paper we present major outcomes of the project and discuss existing obstacles that constrain climate adaptation of the management in protected areas.

Keywords

Climate adaptation, conservation management, adaptation process, protected areas, habitat conservation, stakeholder involvement

Introduction

The current discussion about climate change is often focused on reducing or capturing greenhouse gas emissions. Mitigation is of utmost significance; however, the management of Europe's natural capital and heritage needs also to be adapted to the effects of climate change. Climate change has already noticeable impacts on biodiversity (Parmesan et al. 1999; Root et al. 2003). The timing of seasonal events like first flowering date of plants and breeding dates of birds have advanced as spring is taking place earlier in the year (Crick et al. 1997). Species are changing their geographic distribution northwards or to higher altitudes. In consequence, established ecological interactions like hatching of offspring and availability of food sources are disrupted in time or in space. Altered water regimes are likely to change character of habitats and ecosystems. Projected climate trends are expected to intensify overall biodiversity loss (Carvalho et al. 2010, Chen et al. 2011; McLaughlin et al. 2002). Handling these changes by adapting to them is a challenge for conservation management, from international to local level.

The EU-funded project HABIT-CHANGE developed and tested an adaptation approach for protected areas that allows effective, adaptive management in times of climate change. The acronym HABIT-CHANGE not only stands for the expected habitat changes caused by climate change and land use but also for the necessary adaptation of our own habits in close connection to this. HABIT-CHANGE is a unique science-practice partnership that brought together conservation managers from Central European National Parks, Biosphere Reserves and Nature Parks with conservation agencies and research institutions. Existing management strategies, trends in climate change and potential impacts on protected habitats and protected areas were analysed in 14 investigation areas in Central Europe. Six investigation areas developed a Climate Change Adapted Management Plan (CAMP).

This short paper outlines the procedure to adapt protected area management and develop a Climate Change Adapted Management Plan.

Framework for the adaptation of protected area management

In HABIT-CHANGE, a framework for Climate Change Adapted Management Plans (CAMPs) was drafted (Wilke and Rannow, in prep.). The concept is based on an evaluation of existing management plans and practices as well as the assessment of current land use conflicts. A step by step guideline for the implementation of CAMPs was developed in close cooperation with local conservation management. A CAMP aims at the climate adaptation of all management activities in a protected area. The framework incorporates the concept of adaptive management and allows for evaluation of management effectiveness.

The framework builds on seven steps (Wilke & Rannow, in prep.):

- Definition of objectives and scope of the adaptation process
- Revision of existing management and management plan
- Data collection and inventory of available data

- Assessment of climate change and its impacts on biodiversity
- Stakeholder involvement, communication and participation
- Development of monitoring concept
- Definition of adapted management strategies and measures

The procedure was tested in six investigation areas and experiences have been used to improve the framework in an iterative process.

Challenges and obstacles of the adaptation process

Adaptation to climate change is a complex task and considerable challenge for conservation areas. So far, little experience is available. During the project several major obstacles for implementation of climate change adapted management were identified, which included:

- Missing monitoring or outdated baseline data;
- Lack of awareness and support for climate adaptation (even within the administration of the protected area);
- Uncertainties related to modelling results for climate trends and impacts on biodiversity;
- Missing resources, manpower or expertise in protected area administrations;
- Missing approaches to incorporate modelling output, scenarios and assessment results into decision making and management plans;
- Established management "habits" that are in conflict with the systematic learning process required by Adaptive Management.

Climate change is interacting with non-climatic pressures. This makes it difficult to identify individual drivers and provide clear concepts of causes and impacts. Even if the knowledge about effects of climate change in protected areas is available at local level, it is limited to few specialists, rarely documented and not often exchanged with other protected areas and scientists. HABIT-CHANGE tried to activate this knowledge. It utilized expert knowledge and management experience for impact assessments and the development of adaptation strategies that suit the tasks and competences of protected area management.

Discussion and conclusion

The process of adaptation must be site-specific to meet the needs of individual protected area. A generic framework structured in clearly defined working steps is suited best to fulfil the conditions for an individual adaptation process (RANNOW 2011). It provides guidance without prescribing analytical steps or mandatory obligations (e.g. like modelling efforts). The process builds on existing management strategies and incorporates local knowledge. In addition, effective awareness raising and stakeholder involvement are primary concerns within the CAMP process. It guarantees the reflection of the results from climate impact assessments in future management decisions beyond conservation management (e.g. in agriculture or forest management).

To overcome the identified obstacles in adaptation to climate change at site level the HABIT-CHANGE project developed two practice oriented guidelines for protected area managers that support necessary working steps of the adaptation process. The step by step guideline for stakeholder involvement defines essential working steps and aspects for the communication with stakeholders and provides support with checklists and short background information. The management handbook describes necessary working steps of the adaptation process and allows site managers to "qualify" their management plan into a CAMP. Both guidelines will help to make the first and most important step in the adaptation process: raise awareness for climate change and adaptation needs among local stakeholders and initiate cooperation between conservation management and land users.

CAMP implement the concept of adaptive management in protected area management by institutionalising stakeholder involvement and the development of a monitoring concept that enables area managers to evaluate effectiveness of measures as well as changes in the status of natural resources. The introduction of an active adaptive management (WILLIAMS et al. 2009) allows coping with uncertainties and knowledge gaps in conservation management. Adaptive management includes the definition of measurable and time-bound conservation objectives, an intensive stakeholder involvement throughout the entire management process, modelling of expected impacts of management activities and a structured monitoring of management effectiveness. The intention of adaptive management is to organise the management of natural resources as a learning process, understood as learning by doing. In times of climate change, adaptive management allows to develop adaptation strategies and adapted management measures together with relevant stakeholders and to monitor effectiveness of management under changing climatic conditions. This structured learning process enables conservation managers to gain new knowledge about the impacts of climate change on biodiversity and to evaluate the effectiveness of alternative activities.

Conservation management on site level is in need for methods to address climate change issues (e.g. DAWSON et al. 2011; HOBBS et al. 2010; JULIUS & WEST 2008; STOLTON & DUDLEY 2010). Without active management impacts of climate change will lead to the degradation of habitats, the extinction of species and the loss of ecosystem services that are essential for human well-being. However, adaptation to climate change is not only a challenge; it offers a chance to reshape the future of land use and conservation strategies in individual sites. Most protected species and habitats can only be maintained cooperatively by protected area management and land users. An adaptation process with a wide stakeholder involvement allows the identification of win-win-solutions that conservation management and stakeholders may benefit from and enhances awareness for climate induced changes. Climate change adaptation for protected areas requires an integrated approach that balances conservation goals, economic growth, and social stability. Strong cooperation and effective coordination will increase the overall resilience of protected areas also in regard to functional and spatial aspects. It provides the opportunity to identify and exploit economic and social chances of adaptation, and thus raise the acceptance for nature protection.

Sufficient funding and staffing as well as capacity building at site level are a prerequisite for effective adaptation. Furthermore, the adaptation process needs backup and support from research, conservation agencies and the policy level. They should help to build capacity, make necessary data and modelling results available and provide the appropriate legal framework for the implementation.

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Biomass-mapping of alpine grassland with APEX imaging spectrometry data

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Abstract

Today remote sensing is a standard technique for mapping land cover in high spatial resolution over large areas. Not only land cover but also the quality and quantity of vegetation can be classified by the analysis of hyperspectral data. In the Swiss National Park (SNP) we use data from the Airborne Prism Experiment (APEX) imaging spectrometer to expand the possibilities of vegetation analysis in alpine territories. The high spectral and spatial resolution of APEX data allows the correlation of the measured reflection with ground truth data. We generated an optimized simple ratio index (SRI) with selected bands to model the biomass content of the alpine grassland of one particular valley in the SNP, the Val Trupchun. The correlation between biomass *insitu* measurements and SRIs was non-linear, most likely due to sensor saturation. The model underestimated high biomass values above 600 g/m². The accuracy of 57% was good considering the challenging terrain. The biomass prediction map showed plausible values for the grassland with high concentrations around former alps. High biomass sources were linked to former anthropogenic land use, dominant vegetation structure and to preferred ungulate habitat today. The high-resolution map is now a useful basis for future research in the SNP to investigate forage amount and analyse ungulate habitat pattern in Val Trupchun. This a welcoming issue for ungulate research, which is an important research area of the SNP.

Keywords

imaging spectrometry, hyperspectral data, biomass modeling, vegetation indices

Introduction

Imaging spectrometry or imaging spectroscopy is a remote sensing technique recording the earth's surface by a hyperspectral sensor. With increased number of spectral bands and increased spatial resolution the technique allows today not only the mapping of land cover types but also the mapping of vegetation quality and quantity.

An imaging spectroscometer samples contiguously in the optical part of the electromagnetic spectrum using dozens to hundreds of narrow spectral bands. For each image pixel, the sensor acquires the reflectance of the earth's surface from the ultraviolet through the visible to the near- and mid-infrared (i.e. 250 - 2500 nm) part of the electromagnetic spectrum at a high spatial resolution.

In Fig. 1 a schematic of the function of an imaging spectrometer is illustrated.

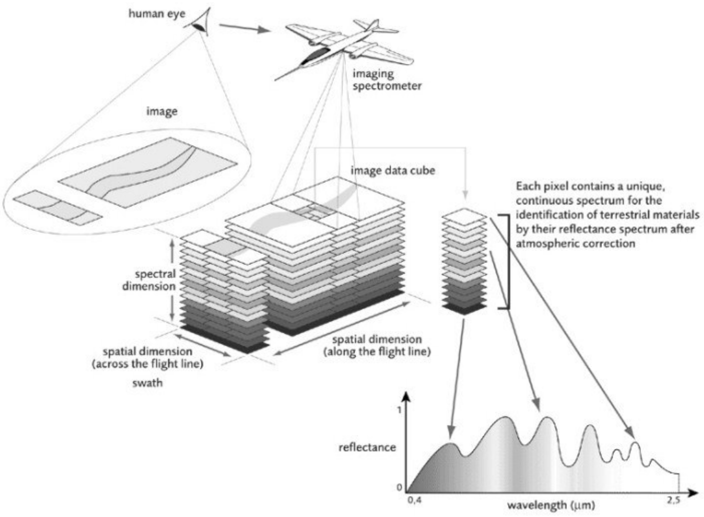

Figure 1: Working Schematic of a imaging spectrometer (Image: www.apex-esa.org, last accessed 20.03.2013)

Analysing the vegetation using remotely sensed data requires knowledge of the biochemical, structural and functional vegetation characteristics and its optical properties. Water, pigments, nutrients and carbon are each expressed in the reflected optical spectrum from 400 nm to 2500 nm, with often overlapping, but spectrally distinct, reflectance behaviours. The absorption characteristics of these compounds determine the optical properties, which as a result are then visible in e.g. the reflectance spectra. With these known signatures it is possible to combine reflectance measurements at different wavelengths to enhance specific vegetation characteristics. Vegetation indices (VIs) have been widely adopted for studying vegetation cover, chlorophyll content or quantifying other vegetation properties. As different materials have characteristic spectra with maxima or minima at particular wavelengths, there is often no need for complex physical models to determine key biophysical parameters. VIs based on empirical or semi-empirical models are new variables generated by mathematical combination of two or more of the original spectral bands chosen in such a way that the new indices are related to the biophysical parameters of interest. A variety of VIs have been published so far. A well-known and simply applicable VI is the Simple Ratio Index (SRI, BIRTH & MCVEY 1968; ROUSE et al. 1974; TUCKER 1979). This index is typically used for modelling the healthy green vegetation or quantifying the photosynthetic capacity of plant canopies. With the advent of imaging spectroscopy and the availability of the large amount of narrow spectral bands, VIs can be individually designed for a specific vegetation property and a specific territory. By correlating the results of the VIs with on site field data, the optimal VI is chosen to model the desired vegetation property. The advantage of the index implementing two to many bands is to minimize the sensitivity to irradiance, illumination and to other factors such as variation in atmospheric transmission. The disadvantage of empirical models and VIs is that the structural property of the vegetation can't be modelled. Especially for dense canopies (high biomass) the VI have its limitations due to saturation.

Studies using hyperspectral data to estimate biomass by relating field data to vegetation indices have been carried out in several studies. (MUTANGA & SKIDMORE 2004; RAHMAN & GAMON 2004; MIRIK et al. 2005; TARR et al. 2005; BEERI et al. 2007; CHO et al. 2007; PSOMAS 2009). These studies show the complexity of the spectral response of mixed grasslands, especially in the presence of a high fraction of non-photosynthetic active vegetation (NPV) and exposed soil (BEERI et al. 2007; HE et al. 2006; BOSCHETTI et al. 2007), grazing impact (NUMATA et al. 2007), canopy architecture complexity due to mixed species composition and phenology (CHO et al. 2007), and sensor saturation occurring at high biomass concentration (MUTANGA & SKIDOMRE 2004).

The Swiss National Park (SNP) was mapped by APEX (Airborne Prism Experiment) for the first time in June 2010. Land cover mapping and monitoring of landscape dynamics are essential for the management of protected areas. Since ungulate research plays an important role in the SNP, the application possibilities of the APEX data are of great interest. Until now, vegetation mapping has been based on the interpretation of single plots and visual observations, which enables only limited interpolations over large areas. Since 1917, the vegetation has been monitored on more than 150 permanent plots (BRAUN-BLANQUET et al. 1931). In 1968 an analogue vegetation map of part of the SNP was produced in cartography work by Trepp/Campell at a scale of 1:10'000 (TREPP & CAMPBELL 1968). In 1992, Zoller published a vegetation map of the entire SNP (ZOLLER 1992). It was based on observation plots and field trips, and mapped at a 1:50'000 scale. An interpretation of colour infra-red aerial images was conducted over the whole territory of the SNP as part of the project Alpine Habitat Diversity in 2006 (HABITALP 2006). The HABITALP project has been the first study with a standardized method to classify vegetation types area-wide from aerial images. With APEX not only a classification of habitat types is possible, but also pixel-based modelling of vegetation composition at a scale of 2 x 2 meters.

Despite the 100 years of protection, traces from the former land use can still be found on subalpine and alpine grassland. Cattle and sheep grazed the territory of the SNP for several centuries until 1914 (PAROLINI 1995). As a result, tall-herb communities dependent on nutrient enrichment from the excreta of cattle or sheep can still be found on several former pastures in the SNP (BRAUN-BLANQUET 1931; BRAUN-BLANQUET et al. 1954; ACHERMANN et al. 2000).

The aim of this MSc thesis is to generate a biomass map of the grassland of one particular valley of the SNP (Val Trupchun) with APEX imaging spectrometry data from June 2010. A semi-empirical method is implemented in the modelling process. The produced biomass map is analysed for accuracy and plausibility relating to the former land use of the Val Trupchun.

Methodology

Study site

The study site is located in the upper Engadin valley in south-eastern Switzerland (46°40'N, 10°15'E), within the territory of the Municipality of S-chanf. The Val Trupchun is dominated by grassland communities distributed over a large gradient of altitude and phenological stages (fig. 1). Large numbers of red deer (*Cervus elaphus, L.*), ibex (*Capra ibex, L.*) and chamois (*Rupicapra rupicapra, L.*) are inhabiting the valley which makes it an interesting area for ungulate research.

The APEX instrument

In June 2010 the SNP has been mapped by the APEX pushbroom imaging spectrometer for the first time. The Airborne Prism Experiment (APEX) is an airborne imaging spectrometer developed under the scientific lead of a Swiss-Belgian collaboration between the Remote Sensing Laboratories (RSL, University of Zurich (CH)) and the Flemish Institute for Technological Research VITO (B) on behalf of the European Space Agency (ESA) PRODEX programme. APEX is collecting 301 bands covering wavelengths from 380 - 2500 nm with a spatial resolution of 2x2 meters (fig. 2). The APEX data sets were geometrically and atmospherically corrected by the RSL using standard approaches (PARGE, Atcor4,) (Schläpfer & Richter 2002). The APEX flight was carried out on 24 of June under cloud free conditions. The specific study site Val Trupchun was covered by four image strips, each with an extend of about 2x6 km and a ground resolution of 2 m. The flight lines are SW to NE oriented, cross-wise to the valley and the mountain ridge (see Fig. 2).

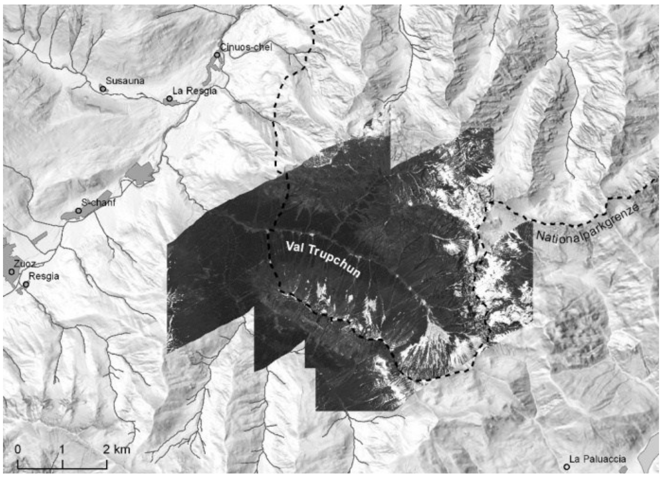

Figure 2: Overview of the research area Val Trupchun in the SNP which was mapped by 4 flight strips.

Field data collection

Fieldwork was carried out to collect ground-truth data of the grassland. Twenty-five plots had previously been defined, which were distributed over the valley and at various altitudinal gradients in order to account for differences in species composition, productivity, phenological stages and soil type. On the day of the flight we clipped 1m² of vegetation in 25 homogenous plots and measured the wet and the dry weight.

Data analysis

The collected biomass samples were randomly divided into two groups, one used for the calibration and one for the validation of the model. Simple ratio vegetation indices (SRI) are developed from the hyperspectral data with all possible combination of bands and regressed against the calibration data set. The result is illustrated in a 2D-correlation plot. For our biomass model we chose the best SRI within the range of visible (RED) and near-infrared (NIR) region (700 - 1300 nm). Within this range high reflection on healthy biomass occurs and no water absorption interferes the signal. We computed a regression model to predict and map the biomass content and used the validation data set to test the accuracy of the model.

Results

Simple ratio indices (SRI) were calculated with all possible combinations of bands and correlated against the calibration data set. Spearman's rank correlation coefficients (R) were plotted on a 2D-contour plot to identify the best wavelength combination, shown in Fig. 3.

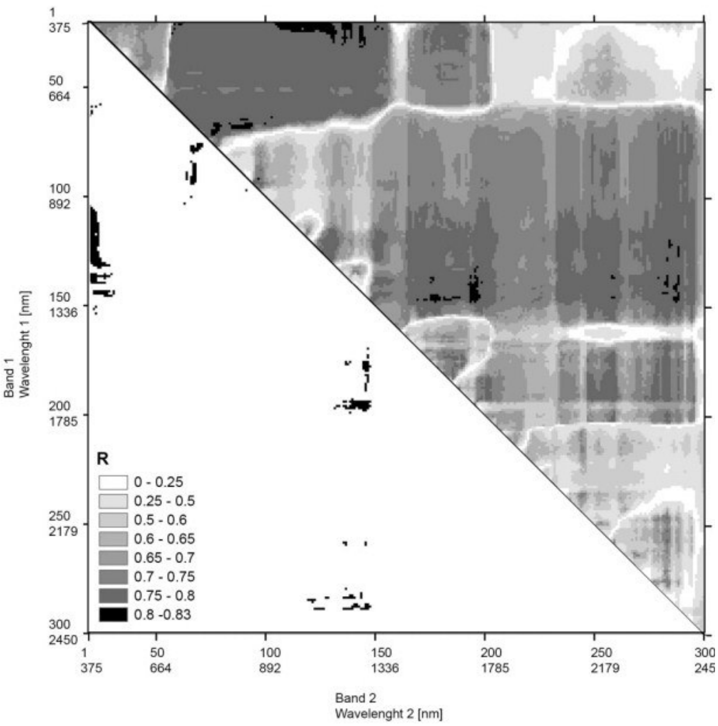

Figure 3: 2D-correlation plot showing the correlation between measured wet weight biomass and Simple Ratio Indices (SRI) from all combination of bands. The matrix is symmetrical. Below the diagonal, band combination are marked in red where R> 0.8.

For our final biomass model the best SRI within the range of visible (RED) and near-infrared (NIR) (700 - 1300 nm) region was chosen. Within this range high reflection on healthy biomass occurred and no water absorption interfered with the signal.

The SRI of band 92 (842 nm) and band 68 (727 nm) achieved the best R (0.823) overall. This combination was chosen for the final biomass model. An exponential regression model was computed again between SRI and wet weight biomass of the calibration data set resulting in an R^2 of 0.77 (see Fig. 4).

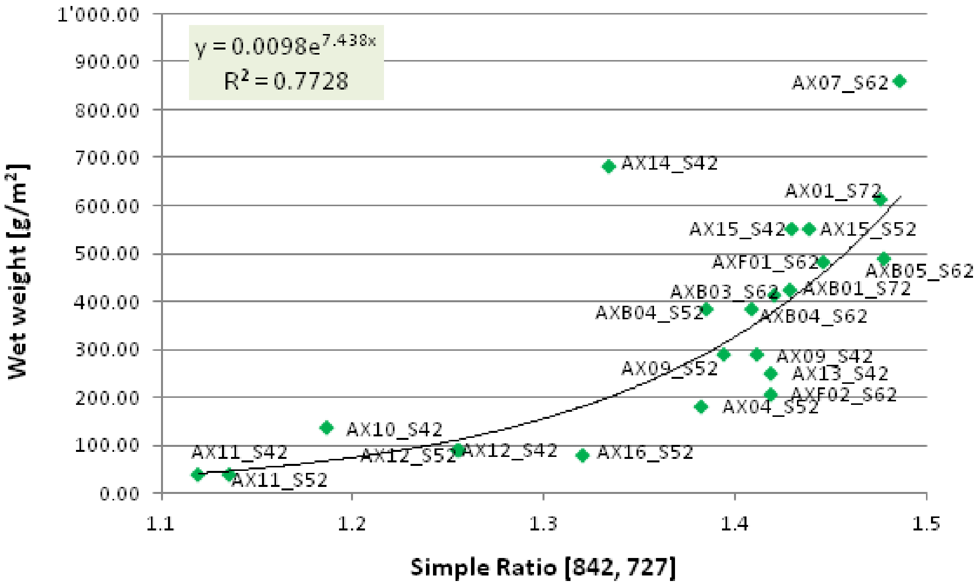

Figure 4: Regression between SRI derived from APEX reflectance spectra from band at 842 nm and 727 nm and the wet weight biomass calibration sample data.

The validation of the model was carried out by calculating the predicted biomass using the model equation for the validation sample plots and comparing them to the true wet weight values. The R^2 and RMSE were 0.57 and 238 g/m^2 respectively (see Fig. 5). The outliers were again AX14, AX06 and AX07. The calibration model underestimated biomass values above 600 g/m^2.

Fig. 6 shows the resulting biomass prediction map.

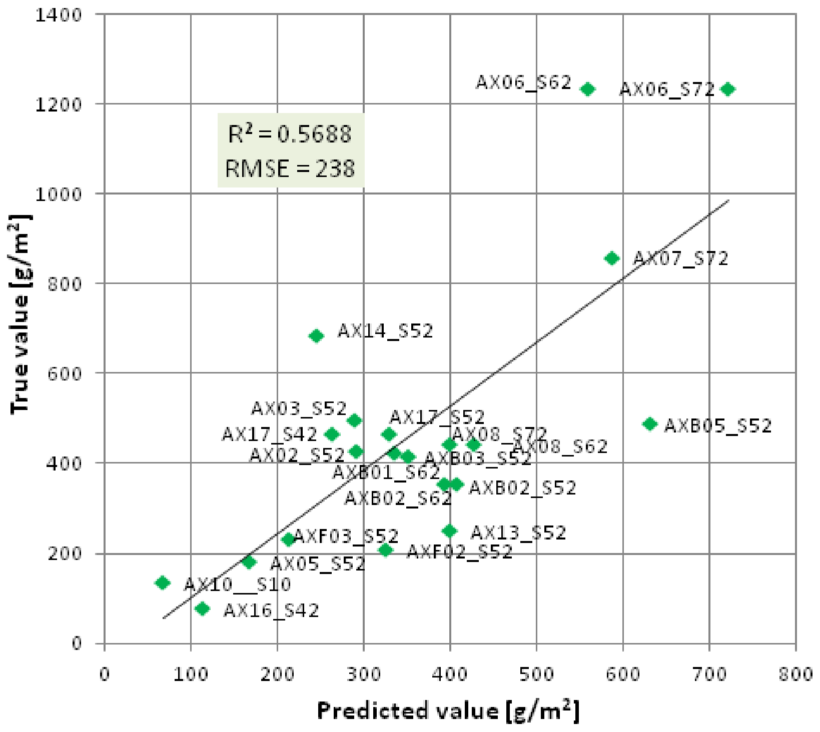

Figure 5: Regression between the predicted biomass value calculated from the SRI model calibration and the true biomass value of the validation sample plots

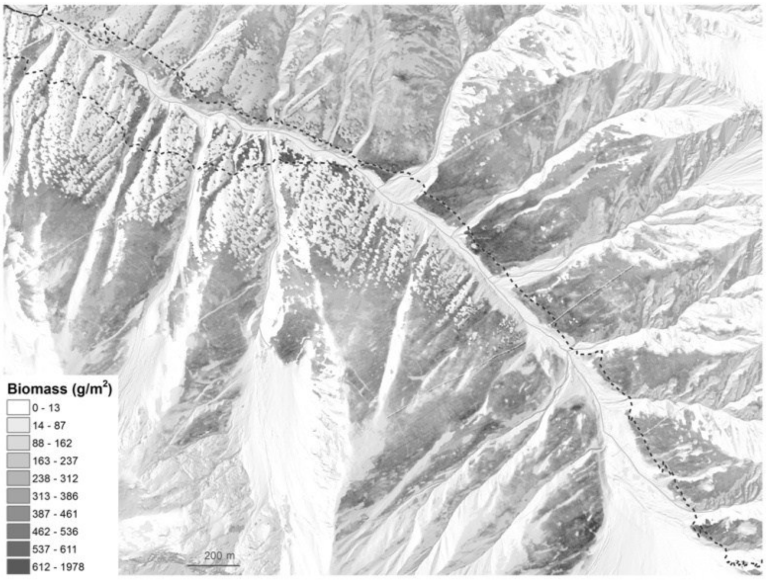

Figure 6: Biomass map of the grassland of Val Trupchun

Estimated biomass values were generally in a reasonable range. On the map, it can be seen that biomass decreases with increasing altitude at the slopes. Three locations with high biomass are noticeable. The highest biomass sources are located around the former Alp Trupchun, Alp Putcher and on the bottom south slope. Fig. 7 shows a close-up of the map around Alp Trupchun. To analyse the biomass source, the HABITALP dataset is overlaid. This map includes herb/grass functional types or dominant species if one vegetation unit stands out. It can be seen that high biomass correlates with the occurrence of monkshood. This means that excessive nutrients are available in this area which stem from former anthropogenic activities on the alp (cattle or sheep excreta). It can be concluded that high biomass concentration occurs where former anthropogenic activities took place (cattle or sheep excreta).

Figure 7: Close up of the area around former Alp Trupchun

Discussion

The model is non-linear and underestimates high biomass values (above 600 g/m²). Such bias can be caused by random noise or fundamentally non-linear relationship in the true physical relationship (GELADI et al. 1999). Another reason is saturation of NIR reflectance in dense vegetation, which can affects SR indices.

The 57% accuracy of the SRI model (842/747) validation means that 57% of the biomass variance can be explained. This is a comparatively good validation for such a complex terrain conducted with completely independent plots. The uncertainties are mainly due to sensitivity to external factors, which overlap the measured signal and influence the model, such as atmospheric effects (cloud, haze and other scatterers), topographic effects (shading), illumination effects (sun angle and viewing geometry), soil effects (soil fraction), structural effects (scattering due to objects/leaf architecture) or random noise.

The biomass prediction map showed plausible values for the grassland with high concentrations around the former Alp Trupchun, Alp Purcher and on the south slope at the end of the valley.

Conclusion

Imaging spectroscopy techniques permit not only the classification of vegetation, but also the quantitative mapping of different vegetation variables due to their high spectral and spatial resolution. This study demonstrates the utility of vegetation indices involving APEX bands for estimating biomass in alpine grasslands.

The SRI model was suitable for the generation of the biomass prediction maps implementing biophysical parameters. We found that the correlation between biomass *insitu* measurements and SRIs was non-linear, most likely due to sensor saturation. The model underestimated high biomass values above 600 g/m^2. The model accuracy of 57% was good considering the challenging terrain.

The biomass prediction map showed plausible values for the grassland with high concentrations around the former Alp Trupchun, Alp Purcher and on the south slope at the end of the valley. We found that high biomass sources were linked to former anthropogenic land use, dominant vegetation structure and to preferred ungulate habitat today.

The high-resolution map is now a useful basis for future research in the SNP to investigate forage amount and analyse ungulate habitat pattern in Val Trupchun.

Outlook

The generated biomass prediction map can be used for future research in Val Trupchun. This work was carried out within the scope of a PhD thesis at the Swiss National Park analysing ungulate habitat patterns relating to biophysical and biochemical parameters. The APEX campaigns have been continued during the years 2011 and 2012.

The produced model is applicable only for the study area, since semi-empirical. These predictive models are site- and sensor-specific and unsuitable for application to other areas or to different seasons. With this model we tried to predict another area of the SNP, the grassland of Il Fuorn, which is located ca. 15 km north-east, and didn't find suitable agreement with *insitu* measurements. This finding highlights the importance of local models, based on local measurements for small scales in complex terrain.

The main proposal for a model improvement based on this work is to increase the number of sample plots in the study area. With more samples covering the full range of biomass concentrations, we suppose that the model accuracy and stability will improve. However, the improvement proposal would require a lot more effort in the field which is a limiting factor.

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The development of abandoned side-channels: ecological implications and future perspectives

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Abstract

River–floodplain habitats have been strongly affected by damming and river regulation, which have initiated long-term trends towards terrestrialization and fragmentation. We studied the terrestrialization processes in the Donau-Auen National Park over the last 80 years by means of airborne images. The aggradation of side-arms is an ongoing process. The main parameters affecting the terrestrialization process are river bed degradation, the connectivity to the main river and the size and shape of the water bodies. As smaller water bodies silt up faster than larger ones, the process of terrestrialization speeds up. From a nature conservation point of view, inhabitants of small temporary water bodies such as amphibians and molluscs are particularly affected. First results of river engineering projects to re-connect abandoned side-channels show that the trend may be impeded. But for a sustainable solution of the problem the stop of river bed degradation is indispensable.

Keywords

Terrestrialization, river management, river engineering, isolated, connectivity, Lobau, wetland

Introduction

Land use changes in the catchment and water engineering measures such as channelization and impoundments have led to severe impairment of river-floodplain-systems (PETTS et al. 1989). The Donau-Auen in Vienna (Lobau) were not spared from these developments. Originally, this river landscape was in a dynamic equilibrium, i.e. a balance between erosion of existing and aggradations of new floodplain terrain existed (e.g. HOHENSINNER et al. 2008).

As a result of the Danube regulation in the late 19th century and a chain of imoundements upstream, the dynamic equilibrium now is disturbed, and aggradation of the floodplain and siltation of its water bodies prevail (HOHENSINNER et al. 2008, KLASZ et al. 2013).

About 10 years ago first restoration measures with the aim to reduce the sediment load in the Lobau (controllable weir, HEIN et al. 2006) have been implemented and it's a key question to predict effects of restoration measures on hydromorphological processes. Of great importance in this context is which factors affect the siltation rates in the various water bodies. Certainly the sedimentation during floods (RECKENDORFER & HEIN 2006) plays a significant role. Other potential factors are the conditions in the river itself (degradation of the river bed, RECKENDORFER et al 2005), as well as changes in the groundwater table in the "Marchfeld", where it came to significant reductions in the water table in the 1970s.

Within the project "Gewässervernetzung (Neue) Donau - Lobau (Nationalpark Donau-Auen)" these issues have been analysed in detail to answer open questions related to the silting of the Lobau. We used a multi temporal landscape analysis with high temporal resolution based on visual interpretation of aerial photographs from 1938 to 2005 to visualize and quantify the large-scale changes in the landscape. These changes reflect the processes which are acting now within the area and allow assessing their impact on the landscape and on threatened species and habitats. The morphological changes in the river-floodplain system were analysed with respect to the above mentioned controlling factors (sediment, bed degradation, groundwater levels, ...). The geostatistical analysis of the data led to a prediction model for the further development of the Lobau and its habitats for threatened species (FFH).

Methods

The study area is located below Vienna on the left bank or the Danube (river km 1918-1908). The region, with a size of about 30 km², is bordered by the "Marchfeldschutzdamm" in the south and the Schönauer Rückstaudamm in the north. Fifty-two water bodies (sections) were delineated based on transverse check dams, points of intersection, fjords (natural high points) and changes in morphology. Aerial photographs and digital orthophotos from 1938 to 2005 were analysed. The aerial photographs from 1938, 1960, 1968, 1973, 1973, 1980 and 1986 were rectified and georeferenced. From the years 1992, 1996, 1997, 1999, 2000, 2004 and 2005 orthophotos were available. Aquatic and semi aquatic areas were delineated. Areas were classified as aquatic or semi-aquatic when they were either free of vegetation, or had typical riparian vegetation (sedges, reeds, cattails). This procedure ensured that the analysis was independent of the actual water level at the time of recording. Between two consecutive time-periods the rate of sedimentation was calculated as:

$S = [-1 + ((F2/F1) (1 / J))] * 100$
F1: aquatic and semi-aquatic area at time 1 (= starting time of the observation period)
F2: aquatic and semi-aquatic area at time 2 (= end point of the observation period)
J: difference in years between the starting and ending time

Positive sedimentation rates occur when there are gains in water areas, and negative numbers when water areas disappear.

The relationship between the rate of sedimentation and the hydrological and morphological parameters was analyzed using a linear model (forward selection of variables).

The following predictor variables were used:

- Water levels of the Danube
- Water levels in the Lobau area
- Ground water levels in the Marchfeld area

Based on these hydrological data and a digital elevation model of the Lobau the following hydromorphological parameters were estimated or calculated for each homogeneous section using a geographic information system (ArcGIS, ESRI):

- Surrogate parameters for connectivity:
    - Distance to the Schönauer Schlitz (m) - the distance a body of water inflow to the Schönauer Schlitz in meters;
    - Connection (m) - height at which a water body is connected to the Danube;
    - Connection rate (%) - relative frequency of access to the Danube
    - Water level (m) - Water level at the gauge Fischamend (km 1908);
- Surrogate parameters for the impact of dam seepage:
    - Distance from the Danube (m) - the distance a body of water to the Danube and New Danube in meters;
    - Distance to flood control dam (m) - the distance a body of water to the flood control dam in meters;
- Surrogate parameter for energy input and autumnal leavefall: Direct sunlight (hours per day);
- Surrogate parameter for the permanence of a body of water: Frequency of water coverage (%);
- Surrogate parameter for the shape of a body of water:
    - Mean Shape Index; higher values indicate a more complex form;
    - Fractal dimension; the fractal dimension varies between 1 for compact, simple shapes and 2 for complex shapes (McGarigal & Marks 1994);

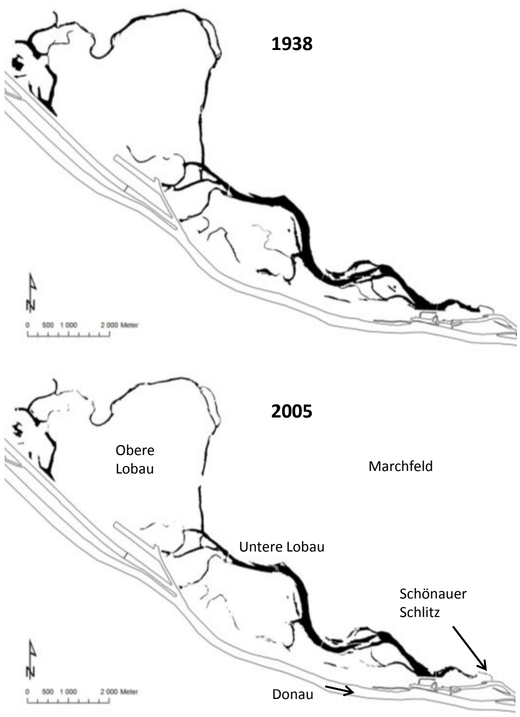

Figure 1: Development of aquatic and semiaquatic areas in the Lobau Floodplain between 1938 and 2005.

Results

Over the period of 66 years, a significant reduction of the aquatic and semi-aquatic areas by 30 % is evident (P <0.05, Figure 1).

If the Obere and Untere Lobau are considered separately, a higher sedimentation in the Obere Lobau is apparent. This is due to the fact that the siltation of small water is much faster than that of larger ones (Figure 2) and the waters bodies in the Obere Lobau are significantly smaller. Another factor affecting the siltation is the shape of a water body: Complex, narrow waters dry up faster than wide or compact ones.

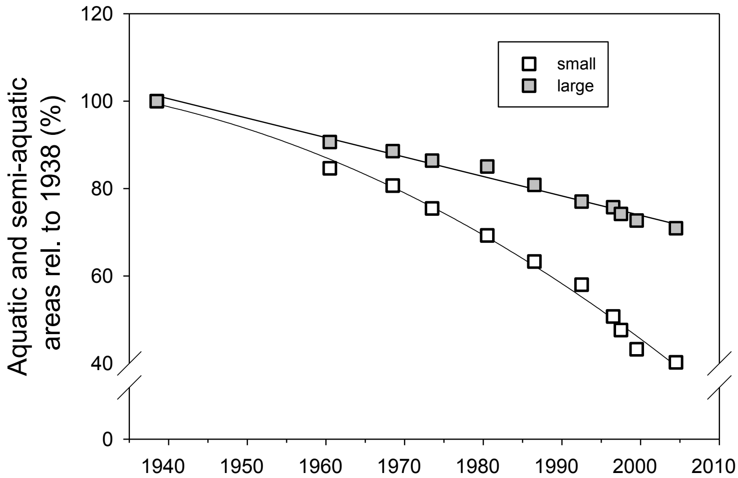

Figure 2 Development of the aquatic and semi-aquatic areas during the study period (1938 - 2005) separately for small and large water bodies

The average sedimentation rates ranged from 0.2 to 3.5% per year. Between 1996 and 1997 the sedimentation rate was particularly high (Figure 3). There was a significant trend with an acceleration of the sedimentation rates in the last decades (r = 0.66, p = 0.038).

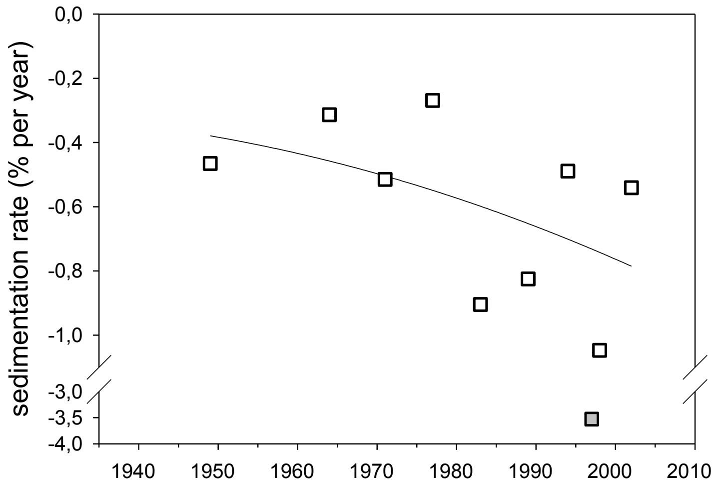

Figure 3 Development of sedimentation rates; the sedimentation rate between 1997 and 1998 (marked in gray) was not considered for the regression shown.

A general linear model explained 29 % of the variability in the sedimentation rates. The siltation of water bodies is promoted by a small size, an elongated or complex shape, the river bed degradation in the Danube, and a frequent downstream connection.

Discussion

The present study demonstrates a strong sedimentation of backwaters in the study area and underlines previous findings of SCHRATT-EHRENDORFER & ROTTER (1999), DISTER (1994) and AMOROS (1991) who also described significant terrestrialisation in isolated floodplains. SCHRATT-EHRENDORFER & ROTTER (1999) calculated a loss of more than 40 hectares of water bodies and wetlands in 50 years for the total Lobau area. Our data showed a loss of 93 ha in 56 years, including 66 ha in the Untere Lobau and 27 acres in the Obere Lobau. All authors refer to a close correlation between the extent of siltation and the connection to the main stem of the parent river. In waters with decreased hydrological dynamics, fine sediment accumulation is favoured, a frequent upstream connection leads to reduced sedimentation (RECKENDORFER & STEEL 2004). A downstream connection, however, has the opposite effect: Frequently connected waters often receive a high input of suspended solids from the river. In contrast, isolated waters, without connection to the main stem or in large distance to the river receive less suspended solids since the sediment load decreases with increasing distance to the river (RECKENDORFER et al. 2013).

Small oxbow show particularly high sedimentation rates. This can be explained by a relatively higher allochthonous nutrient and sediment input associated with a small size and shallow depth. The river bed degradation in the Danube of about 2-3 cm / year (since 1938 about 1-1.5 meters; RECKENDORFER et al. 2005, KLASZ et al. 2009) also had negative impacts in the studied floodplain. Due to artificial bed load addition by the "Verbund Hydro Power AG" this trend is now stopped and no longer relevant for the future development.

As smaller water bodies silt up faster than larger ones, the process of terrestrialization speeds up. From a nature conservation point of view, inhabitants of small temporary water bodies such as amphibians and molluscs are particularly affected (FUNK et al. 2012). First results of river engineering projects to re-connect abandoned side-channels show that the trend may be impeded. But for a sustainable solution of the problem the stop of river bed degradation is indispensable.

Acknowledgements

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Metacommunity structure in a floodplain system: implications for conservation and restoration

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Abstract

We investigated the importance of local and regional processes in structuring aquatic communities in a river-floodplain-system. Both, environmental and spatial factors had a significant impact on the structure of the different communities. Metacommunity processes are thus of importance in river floodplain systems and must not be ignored in management. Our findings are of particular importance for the enhancement of the lateral integration between the river and its floodplain. The structure of the network is thereby significantly altered, with subsequent effects on the relative importance of spatial and local processes in structuring metacommunities.

Keywords

specialist, generalist, colonization, variance partitioning, neutral model, species sorting

Introduction

Traditionally community ecology has emphasized the discrete nature of ecological communities and dealt with the biotic interactions and environmental characteristics that permit coexistence at the local level. Biotic processes acting at the local scale include competition and predation; what also is emphasized is the importance of the abiotic environment. In freshwater ecology, current velocity, depth, and substratum have often been put forward in explaining the distribution of different species. These variables are also frequently used in species distribution models such as phabsim (physical habitat simulation models).

Over the past decades it has increasingly been recognised that local communities are products of both local (niche-assemly) and regional scale (dispersal assembly) processes (Ricklefs 1987). The relative importance and interactions of these processes in structuring species assemblages is addressed by metacommunity ecology (Leibold et al. 2004, Leibold & Miller 2004; Cottenie 2005; Driscol, 2008).

Only few studies have analyzed metacommunities in river-floodplain systems. Most of these studies emphasize the significance of environmental heterogeneity in generating and maintaining biodiversity, only few studies stress the significance of dispersal (see Winemiller et al. 2010).

We used a river-floodplain system (RFS) as a model environment to analyse the significance of niche-assembly and dispersal assembly processes in structuring aquatic communities. Due to their spatial heterogeneity, their temporal stochasticity, and the network configuration of water bodies RFS's are especially challenging from a metacommunity point of view.

Methods

The structural connectivity of the aquatic network was assessed using a network centrality measure. Environmental variables included “hydrological connectivity”, “depth”, “solar radiation”, “sinuosity” and “distance to the Danube”.

To assess the relative importance of local (e.g. competition, predation) and regional (i.e. dispersal) processes in the structuring of the different communities we conducted a partial canonical correspondence analysis with forward selection (Borcard et al. 1992). We used Canoco for Windows 4.5 to partition the variance between spatial and environmental variables.

Results & Discussion

Both, environmental and spatial factors had a significant impact on the structure of the different communities. The spatial configuration explained between 5 and 10 % of the differences between the local communities. Seven to 20 %were explained by environmental factors (Figure 1). Metacommunity processes are thus of importance in river floodplain systems and must not be ignored in management.

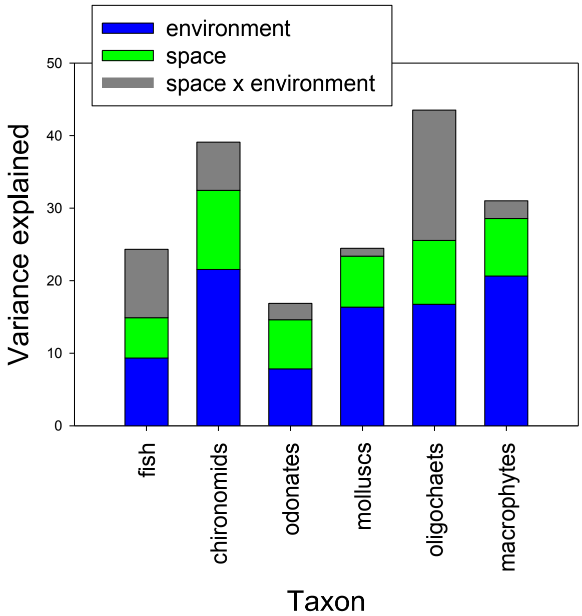

Figure 1: Results of multivariate variance partitioning (Borcard et al. 1992) for different aquatic communities using a CCA model: discriminating between the environmental factors (blue), the spatial configuration (green) and their intersection.

Our findings are of particular importance for the schemes to restore large rivers where the main emphasis is the enhancement of the lateral integration between the river and its floodplain (RECKENDORFER et al. 2006, SCHIEMER 1999, SCHIEMER et al. 1999, BUIJSE et al. 2005). The structure of the network and the habitat connectivity of the river-floodplain system are thereby significantly altered, with subsequent effects on the relative importance of spatial and local processes in structuring metacommunities. An understanding of the spatial context of river-floodplain networks is thus of central interest for planning measures for the restoration of rivers.

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Conference Volume | 5th Symposium for Research in Protected Areas 10 to 12 June 2013, Mittersill | pages 645 - 646

Influence of tourism activities on mountain hares (*Lepus timidus*) and their consequences

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Abstract

Winter human outdoor recreational activities are increasing in the European Alps and have a significant impact on wildlife. Wildlife is often disturbed by these activities as they mostly occur in an unpredictable manner, and animals may only have limited possibilities for adaptation. However, the physiological and behavioural reaction to tourism activities in Mountain hares (Lepus timidus) is still unknown. In this study, we measured levels of faecal glucocorticoid metabolites (GCM) in Mountain hares in areas that had either no, low, or high tourism activities during winter 2011. Also we compared changes in food intake and behaviour in six captive Mountain hares between experimental stress and non-stress periods. Our results showed that GCM secretion was positively correlated with increased touristic. In order to protect Mountain hares populations, we recommend that managers keep forests inhabited by Mountain hares free from tourism infrastructure and retain undisturbed forest patches within skiing areas.

Keywords

Faeces, cortisol, non-invasive, stress, touristic

References to the guiding theme and to protected areas

Wildlife management, Swiss National Parc

Introduction

In this study, we measured levels of faecal glucocorticoid metabolites (GCM) in free-ranging Mountain hares (*Lepus timidus*) in areas that had either no, low, or high tourism activities during winter 2011 in order to evaluate potential responses to such activities.

Methods

A non-invasive method was utilized, which enabled an easy sampling in the field (Rehnus et al. 2009). Faecal samples were collected on transects with a total length of 42.9 km along ways of tourist activities (if available) in areas with no, low and high tourist activities. After field collection, all samples were frozen immediately at -22°C until further analysis with an 11-oxoaetiocholanolone enzyme immunoassay.

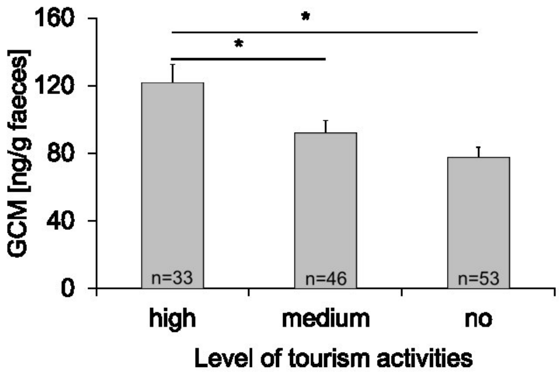

Figure 1: GCM concentration (mean ± SE; n=132) in areas with different level of tourism activities. The Tukey test showed significantly differences between the area with highest activities to the areas with low (t= 2.2364, P<0.05) and no tourist activity (t= 2.6901, P<0.05 on GCM-concentration.

Results

GCM secretion was positively correlated with increased touristic activities. Highest concentrations of GCM were found in areas with highest tourist activities, followed by those with low and no activities (Fig. 1).

Conclusion

In our study we investigated the physiological stress reaction of Mountain hares in the Alps on tourist activities for the first time. Therefore, a non-invasive method was applied which delivered reliable information in free-ranging Mountain hares in the wild by measuring GCM. The results indicate that Mountain hares are influenced by such activities. To protect their populations, we recommend that managers keep forests inhabited by Mountain hares free from tourism infrastructure and retain undisturbed forest patches within skiing areas.

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Soil inventory in forests of the Biosphere Reserve Wienerwald
Water shortage due to climate change? A simple application of the data

Rainer Reiter & Karl Gartner

Abstract

The Biosphere Reserve Wienerwald is one of the biggest continuous areas of deciduous forest in Central Europe. During the years 2009 through 2012 a soil survey was performed on 488 plots mainly focusing on the core zones. It consisted of a simplified profile description, photographic documentation and sampling of genetic mineral soil horizons.

As one example for the broad applicability of the obtained data, two plots were selected and used to generate a simple water balance for 3 different temperature scenarios. The available water storage capacity of the soil was estimated using density of dry fine soil, texture class, content of organic carbon and coarse material content. The potential evapotranspiration was calculated with the help of temperature and location. Furthermore it was assumed that there will be no change of the precipitation regime in the future.

It became apparent that an increase of already +3°C compared with present climate conditions partly results in a complete depletion of the plant available water reservoir during the summer and autumn months. If additionally the annual distribution of precipitation will shift towards the winter half-year, as expected in literature, the possible impact may be even worse.

Keywords

soil survey, monitoring, Biosphärenpark Wienerwald, available water storage capacity, potential evapotranspiration, water balance

Introduction

The Biosphere Reserve Wienerwald

The Wienerwald is one of the biggest continuous areas of deciduous forest in Central Europe extending across the two federal states of Vienna and Lower Austria covering an area of approximately 1000 km². It was admitted as a biosphere reserve in 2005 by UNESCO, dividing it into a mosaic of core-, buffer-, and transition zones.

The whole area can be roughly assigned to two main geological zones which is reflected in different land forms. The northern area is part of the Flysch zone showing mainly smooth hillsides whereas the southern part belongs to the Northern Limestone Alps with in general more steep rugged terrain. (See figure 1)

The soil inventory project

The diversity of soil types in the forests of the Biosphere Reserve Wienerwald was surveyed during the years 2009 through 2012 on behalf of the following partners: Biosphärenpark Wienerwald Management GmbH, Österreichische Bundesforste AG, Forstamt und Landwirtschaftsbetrieb der Stadt Wien (Ma 49) und RU5- Land NÖ.

This survey was based on a grid of roughly 1600 monitoring plots existing in the core zones where a conventional forest inventory expanded by samples of vegetation and coarse woody debris is performed every 10 years.

In a first stage, every fourth plot of this monitoring grid was selected, resulting in 423 soil sampling plots, where general site characteristics were assessed and a description of the soil profile was performed. A simplified protocol was applied, which comprised assessing the sequence and thickness of horizons in humus and mineral soil, as well as soil texture, coarse material content, and presence/absence of mottling, concretions, and carbonate only in mineral soil horizons. Every soil profile was documented photographically including a close-up of the humus layer and the upper mineral soil as well as several photos of the general situation on the site.

In a second stage, 65 sampling plots were selected from managed forests in the development zones of the reserve. These were assessed according to the same field methods.

Samples were taken for chemical analysis from every genetic soil horizon in all 488 profiles. However, in order to reduce costs, only samples from two horizons of about 10 % of the plots actually have been analysed. All samples including the rest are stored in a soil bank and are available for analysis on demand. This approach is cost efficient and allows additional chemical analyses when required later.

The data have a wide field of application. Re-sampling the same plots allows monitoring of changes in the soil carbon pools after abandonment of forest management. A comparison with carbon pools in managed forests seems to be possible, when site characteristics are considered. Furthermore the data may serve as a base for a modelling of vegetation changes caused by a change of climate or nutrient status. As an example for the wide applicability we did an exercise with the *available water storage capacity* (AWSC) as the set of assessed parameters is sufficient for a rough estimate of the AWSC.

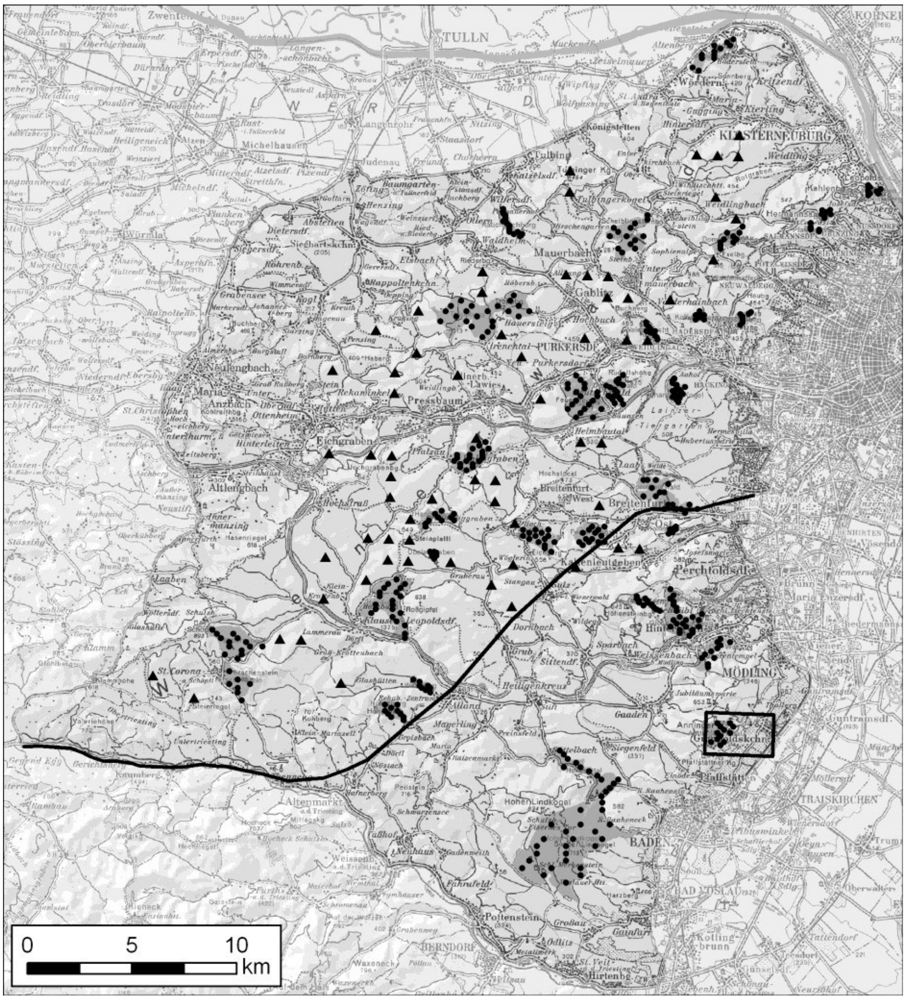

Figure 1: The Biosphere Reserve Wienerwald with the core zones and the border delineating Flysch- and Limestone areas. Soil inventory plots in the core zones are marked by dots. Soil inventory plots in the managed forests are marked by triangles. Core zone Anninger Tieftal is indicated by rectangle (see also figure 2). (Base map: Biosphärenpark Wienerwald Management GmbH)

<u>Objectives of the study</u>

As an example for the possible further utilisation of the soil inventory's data, two plots from one of the core zones were picked out exemplarily to demonstrate the effect of possible climate scenarios on the water balance of soils with different available water storage capacity.

We applied a simplified version of the water balance only using the following input variables:

- Potential evapotranspiration (PET)
- Precipitation
- Changes in soil water storage

This simple approach ignores other factors of the water balance like interception, lateral fluxes in the soil, actual transpiration of the tree stands for reasons of unavailability of data.

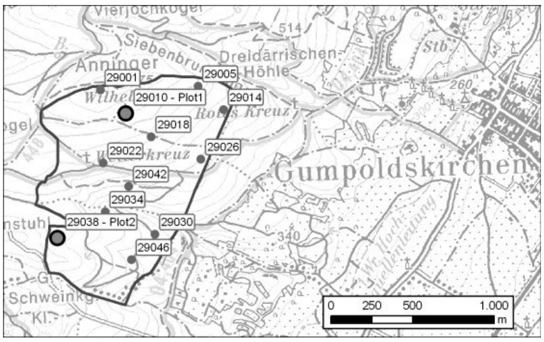

Figure 2: Situation of the core zone Anninger-Tieftal and plots 1 and 2 (Base map: ÖK50)

Methods

The study area – core zone Anninger

The core zone "Anninger-Tieftal" (see figure 2) at the western border of the Vienna basin was chosen for this specific study. The 675 m high Anninger is situated in the southern part of the reserve representing the offset of the northern Limestone Alps. It can be geologically divided into two main categories and only features two different classes of soils according to the Austrian Soil Systematics (*Österreichische Bodensystematik* - ÖBS) (NESTROY et al. 2011)

The northern part of the core zone consists of dolomites and hard limestones. In this area only Rendzic leptosols (*Rendzina)* with A-horizons showing a widely varying range in depth as well as coarse material content were found.

The southern part is built up from breccia and series of marl and limestones resulting in Calcaric Clayic Cambisols (*Kalkbraumlehm*) with more or less deep B-horizons.

At all investigated plots the humus forms uniformly were classified as Mull according to the Austrian Soil Systematics (NESTROY et al. 2011) thus the organic surface layers not being relevant for the water storage capacity.

- Plot 1 (Plot 29010)
  is situated at an altitude of 637 m a.s.l. on an undulating middle slope facing south at an inclination of 28 %. The bedrock is hard limestone (*Plattenkalk*). The current tree canopy solely consists of European beech (*Fagus sylvatica*). Table 1 shows the soil profile discription by genetic horizons.
  Humus form: Mull
  Soil Type: Rendzina

Table 1: Humus- and soil description of plot 1 by horizons according to Englisch & Kilian (1999) and Nestroy et al. (2011)

	Horizon [ÖBS]	Depth [cm]	Texture	Coarse material [%]	Mottles present	Nodules present	Carbonate in fine soil
Humus	L	2,5 – 2	-	-	-	-	-
	Fzo	2 – 0	-	-	-	-	-
Mineral Soil	Ahb	0 – 10	silt	40	n	n	n
	AC	10 – 30	silt	75	n	n	n
	CA1	30 – 45	silt	80	n	n	y
	CA2	45 – 60+	silt	90	n	n	y

- Plot 2 (Plot 29038)
  is situated at an altitude of 566 m a.s.l. on an even, flattened portion of a slope facing southeast at an inclination of 15 %. The base material for the pedogenesis is a colluvium of limestone debris and marl. The soil profile is influenced by stagnant water. The current tree canopy mainly consists of European beech (*Fagus sylvatica*) with intermixed single checker trees (*Sorbus torminalis*) and Scots pines (*Pinus sylvestris*). Table 2 shows the soil profile discription by genetic horizons.
  Humus form: Mull
  Soil Type: pseudovergleyter Kalkbraunlehm

Table 2: Humus- and soil description of plot 2 by horizons according to Englisch & Kilian (1999) and Nestroy et al. (2011)

	Horizon [ÖBS]	Depth [cm]	Texture	Coarse material [%]	Mottles present	Nodules present	Carbonate in fine soil
Humus	L	1– 0	-	-	-	-	-
	F	sparsely	-	-	-	-	-
Mineral Soil	Ahb	0 – 5/10	loam	40	n	n	y
	AB1,gd	5/10 – 30	loamy clay	75	n	y	y
	AB2,gd	30 – 45	loamy clay	80	n	y	y
	BCv,gd	45 – 60+	loamy clay	90	n	y	y

Available Water Storage Capacity

Estimation of the AWSC was done according to AK Standortskartierung (2003) using the following input parameters:

- Density of dry fine soil [g.cm^{-3}]
- Texture class
- Content of organic carbon [%]
- Coarse material content [%]

For the actual calculation, the fine soil density classes were estimated based on expert knowledge, using comparable soil profiles from other projects. Taking density samples using core cutters could raise the accuracy.

The AWSC values were calculated for a depth of 1 m for reasons of comparability by extrapolating the values of the lowest horizon to a depth of 1 m where necessary.

As a result of this procedure we estimated a total AWSC of 61,2 mm m^{-2} for plot 1, and a corresponding value of 126,5 mm m^{-2} for plot 2.

Temperature

The calculation of the mean monthly temperatures for a specific location is based on a spatial interpolation between several neighbouring climate stations using the method of KINDERMANN (2010).

Two climate scenarios assuming an increase in temperature of +3°C and +5°C until 2100 were used encircling the increase of +4°C expected by NIEDERMAIR et al. (2007) in comparison to the last 30 year period, i.e.:

- The period 1981-2010 based on measured values
- The period 2071-2100 with an assumed linear increase in temperature by +3°C between 2000 and 2100
- The period 2071-2100 with an assumed linear increase in temperature by +5°C between 2000 and 2100

From the year 1981 to the year 2012 calculations are based on measured values. From 2013 until 2100 base values are randomly taken from past measurements and a temperature trend is added mathematically to these base values.

Precipitation

Mean monthly precipitation values for the specific locations were derived in an analogous manner according to the interpolation method of KINDERMANN (2010). However, we used the simplifying assumption that the amount of monthly precipitation as well as its annual distribution remain constant in comparison to the last observation period.

Potential Evapotranspiration (PET)

For reasons of the availability of data modelled for a specific position, the Thornthwaite formula (SIEGERT & SCHRÖDTER 1975 after THORNTHWAITE & MATHER 1955 in SCHRÖDTER 1985) was used to calculate the PET using the following input parameters:

- Geographic position
- Monthly mean temperature [°C]

The algorithm implicates that for months with a mean temperature below 0°C the temperature has to be set to 0 as well as the value of PET. This means that in these months no PET is taken into account for the water balance.

Water balance

As starting month for our calculation, March was chosen for the fact that normally full saturation is given at that time and the vegetation period is at its beginning.

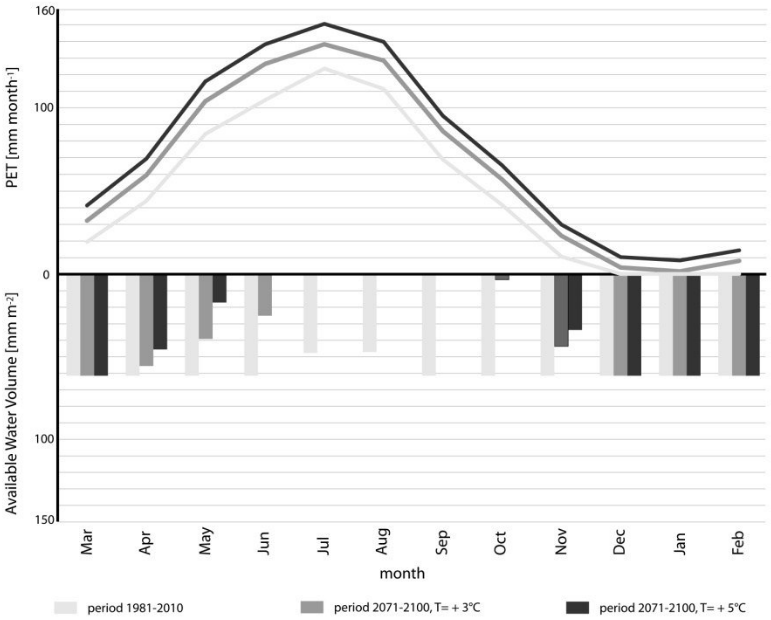

Figure 3: Water balance diagram of plot 1 (Rendzina) for the different scenarios.

Results

The following figures 3 and 4 show the water balance diagrams for the two selected investigation plots 1 and 2.

The upper part of the diagram shows the long term course of the PET in mm per month. The lower part of the diagram shows the corresponding values for plant available water in the soil in mm.m^{-2} for a depth of up to 1m for the 3 given scenarios.

- the period 1981-2010 based on measured values (light grey)
- the scenario 2071-2100 with an assumed increase in temperature by +3°C (dark grey)
- the scenario 2071-2100 with an assumed increase in temperature by +5°C (black)

Conclusions

At both plots - considering all assumptions necessary for the model - it becomes apparent that an increase of already +3°C compared with present climate conditions partly results in a complete depletion of the plant available water reservoir during the summer and autumn months.

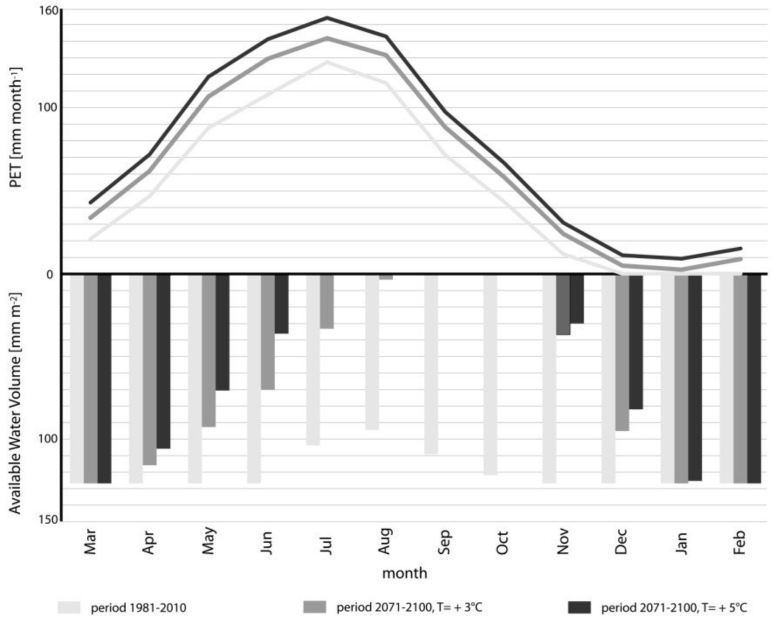

Figure 4: Water balance diagram of plot 2 (Kalkbraunlehm) for the different scenarios.

It becomes clearly visible that - under equal climatic conditions – plot 2 with its higher water storage capacity is able to ensure the water supply for plants at all scenarios for approximately one month more than plot 1.

Comparing the values of AWSC of the two plots with the results found in the German Soil Condition Survey 2006-2009 of Bavaria (KÖLLING & FALK 2010) it has to be stated, that both plots are located in the lowest third of the distribution.

Besides a few, certainly simplified, assumptions for the model it has to be considered that there are factors both enhancing as well as reducing the shown impacts.

Reducing factors

- In fact the absolute plant available water volume per month can be higher than the calculated monthly AWSC values as the precipitation usually is distributed to several separate events repeatedly refilling the storage of plant available water, which in the meantime has been constantly reduced by actual evapotranspiration. Our procedure of balancing based on monthly values treats any amount of precipitation that causes an exceedance of AWSC as to get lost from the system, e.g. by run-off.
- Using the potential instead of actual evapotranspiration displays the effects more drastically than they really are, as plants can individually reduce transpiration to a variable extent. However, this may imply a future shift in vegetation composition towards plants using the available water resources more economically than the present stands.

Enhancing factors

- Even with increasing amounts of precipitation the temperature-induced increasing evapotranspiration remains a problem.
- SCHÖNER et al. (2010) expect an increase of winter precipitation simultaneously coupled with declining summer rainfall already for the period 2012-2050 but especially after the year 2050. Assuming that the annual distribution of precipitation will shift towards the winter half-year the expected impact will be even more drastic than under the present presumptions. So periods showing the highest PET-rates probably will no longer coincide with the precipitation maximum.

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The effect of Climate Change during the Lateglacial in the Hohen Tauern

Jürgen M. Reitner

Abstract

Climate change and its impact on the Alpine landscape during the Lateglacial (~20.000-11.700 years) are reviewed with special focus on current research in the Hohen Tauern mountain chain (Eastern Alps) and surroundings. Based on three time slices (20-19 ka, 17-15 ka & 12 ka) the chronology of glacial, gravitational and periglacial processes with respect to climatic forcing is highlighted.

Keywords

Lateglacial, landscape, glacier, mass movement, rock glacier

Introduction

High mountain areas such as the Alps are one of the most climatically sensitive regions of the Earth. This is true not only with respect to modern climate change but also to paleoclimate change.

High resolution reconstructions of climate change at the global scale during the Lateglacial (~20 - 11.7 ka BP) are available from Greenland ice cores. In the case of the Eastern Alps data from e.g. peat bogs and lacustrine sediments provide useful proxies of temperature and precipitation changes during this time. However, major environmental changes in high mountain areas like glacier advances, alluvial aggradation, permafrost activity and mass movements (landslides, rock avalanches) are recorded - if at all - only indirectly.

Detailed geological mapping of sediments and morphological features in combination with various modern dating approaches (luminescence, surface exposure age and U/Th dating) leads to a chronology of landscape evolution during the Lateglacial in the Alps. Based on three time slices - 20,000-19,000, 17,000 -15,000 and ~ 12,000 years before present (BP) - the interaction of glacial, periglacial and gravitational processes in relation to changing climatic conditions is highlighted. Such geological findings promote our understanding of possible climate impact in an alpine environment.

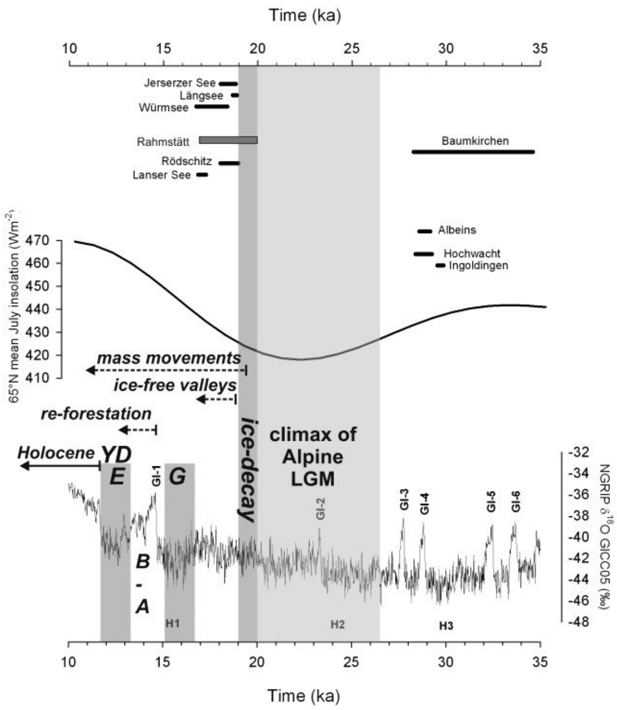

Figure 1: Diagram showing timing of climatic phases and processes (modified after STARNBERGER et al. 2011.) (A) Sites constraining the onset and termination of the LGM ice advance in the Eastern Alps and their foreland (for details see STARNBERGER et al. 2011). (B) 65°N mean July insolation (BERGER & LOUTRE, 1991). (C) NGRIP isotope record with numbered Greenland Interstadials (GI) and Heinrich (H) events (ANDERSEN et al., 2006). Important sites showing ice-free conditions in Alpine valleys are indicated. The climax phase of Alpine LGM is based on constraining data from the Tagliamento glacier area (MONEGATO et al. 2007). Abbreviations: E - Egesen, G - Gschnitz, B-A - Bølling - Allerød Interstadial, YD - Younger Dryas

The aim of this paper is to give a short overview of recent research in the Hohen Tauern mountain chain and its surrounding, with a special focus on the upper Salzach valley (Salzburg), Eastern Tyrol and Upper Carinthia.

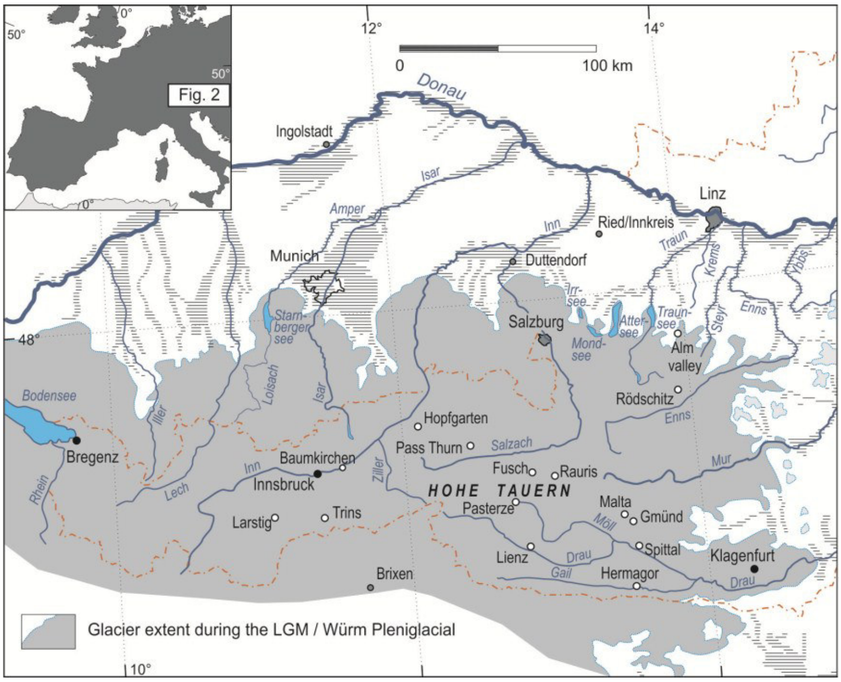

Figure 2: Map of the Quaternary landscape of Austria with the limit of the Last Glacial Maximum (LGM / Würm Pleniglacial)and key locations mentioned in the text.

The Termination of the Last Glacial Maximum - phase of ice-decay 20,000-19,000 years

Today, ice-decay at Austria's biggest glacier, the Pasterze, appears to be gigantic compared to the loss of volume of 50 percent and more since the last glacier highstand around the year 1850 (LIEB & SLUPETZKY 2011). The picture of a stagnant glacier tongue and isolated buried ice serves as a modern analogue of the situation after the Last Glacial Maximum (LGM) when the big network of valley glaciers spanning most parts of the Alps decayed and eventually vanished.

At the climax of the Würm Pleniglacial (the regional expression of the LGM) valleys of the Hohen Tauern and adjecent regions where filled with up to 2500 m thick glaciers and annual temperatures in the Northern foreland where lowered by 10-12°C (FRENZEL et al. 1992) compared to modern conditions. Ice flow occurred across todays' watersheds (transfluence passes) like the Pass Thurn (Salzburg) independent of the current drainage system. The global maximum ice extension was due to a decrease of summer insolation (Fig. 1) linked to variations in the Earth's orbit (HAYS et al. 1976) generally referred to as the "Milankovic Theory". On the other hand a slight increase in summer insolation caused the beginning of the Last Termination (Termination I) of the LGM.

Due to the geometry of the LGM valley glacier network in the Alps with a gentle slope from the centers of the glaciation to the Alpine foreland, a slight rise of the equilibrium line caused by orbital changes led to a sudden increase of the glacier's ablation area at the expense of its accumulation area. In addition the shift in mass balance of the glaciers initiated a positive feedback. The sudden appearance of huge quantities of melt water along the margin and on the surface, partly transferred via moulins (sink holes) to the glacier bed, accelerated ice-decay. Short-lived ice-dammed lakes were formed where calving ice fronts collapsed and produced icebergs. Finally, the ongoing reduction of ice thickness in relation to the water depth of lakes in the glacial environment led to the floating of ice and thus to the rapid collapse of glaciers. Today, up to 100 m thick ice-marginal terraces (kame terraces; Fig. 3) located hundreds of meters above the modern valley floors document the downwasting of the glacier network. Hollows, so called kettle-holes, within relatively even terrace slopes were formed by the melting of a mass of buried ice (Fig. 3). The most impressive examples of such features are found in the area of Spittal (Drau vally) and Gmünd (Carinthia; REITNER 2005, PESTAL et al. 2006, SCHUSTER et al. 2006) and in Hopfgarten (Northern Tyrol, REITNER 2007a).

The warming and ice-decay was interrupted by at least one cold spell as indicated by advances of small glaciers which reacted to short climatic deteriorations (REITNER 2007a). Most glaciers did not reach a balance with climate, as terminal moraines are missing. Till deposited by tributary glaciers on top of Kame terrace sediments are a wide spread phenomenon in the Alps like e.g. at Lienz (Eastern Tyrol; REITNER 2003a & 2003b).

The only direct dating, in this case by luminescence dating of ice-marginal deposits from Rahmstätt / Hopfgarten in Northern Tyrol (KLASEN et al. 2007) gives an age of 19 ± 2 ka. ^{14}C - datings of organic material from peat base layers (see compilation in VAN HUSEN 2000 & REITNER 2007a) show already ice-free conditions in the major valleys around 19 - 18.5 ka thus providing further age controls for this phase of ice decay (Fig.1).

With the beginning of ice-decay gravitational processes on different scales were initiated due to the failure of slopes which were oversteepened by glacial erosion during the LGM (REITNER et. al. 1993). The ^{36}Cl exposure dating of a rock avalanche deposit in the Alm valley (VAN HUSEN et al. 2007) provides an age of around 19,000 years showing that slope instabilities started together with the downwasting of glaciers when no vegetation was able to stabilise slopes.

A modern re-investigation of a bog located in a tension gap near Hermagor (REITNER et. al. 1993) provides a calibrated ^{14}C date of around 17.000 as the minimum age for the onset of early mass movements (REITNER & DRESCHER-SCHNEIDER, in prep.) at this location.

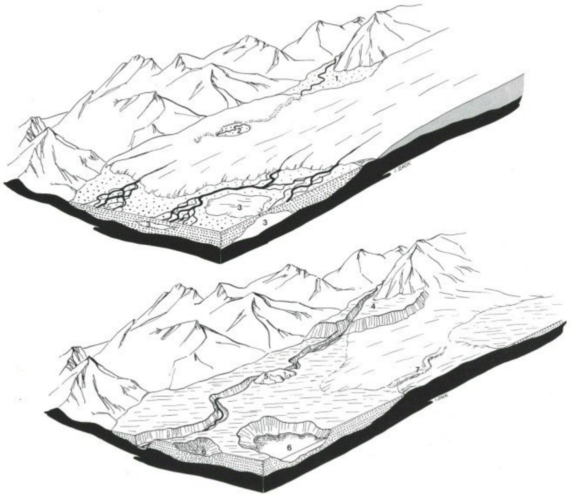

Figure 3 Schematic sketch of a decaying glacier and its deposits (VAN HUSEN 1987). The condition for the formation of a kame terrace (1 & 4) and kettle-holes (3 & 6) are indicated.

The Gschnitz glacier advance and accompanied processes - 17.000-15.000 years

Beside the onset of sparse vegetation (see ^{14}C data above) and the start of mass movements our knowledge about processes just after the phase of ice-decay is quite limited.

As a result of severe changes in the North Atlantic circulation during the so called Heinrich event 1 (H1 in Fig. 1) a major glacier advance occurred in the Alps lasting several centuries. At the type locality of the Gschnitz stadial at Trins (Northern Tyrol) a prominent terminal moraine was formed at around 16,000 years (Ivy-Ochs et al. 2006) when summer temperatures were up to 10° C below modern level (KERSCHNER & IVY-OCHS 2007; KERSCHNER 2009). A similar situation is evident in the area of Malta near Gmünd where a fluvial terrace was formed in the forefield of the glacier terminus indicating strong aggradation under free drainage (ice-free) conditions. Preserved remains of stadial, mostly isolated lateral moraines can be found in most of the major valleys in the Hohe Tauern region. Mass movements overridden by the glacier e.g. near Fusch and in the Möll valley (REITNER, in prep.) as well as ice-marginal sediments deposited during the waxing of the glaciers, are useful indicators to constrain the starting position of this major glacial advance.

The Younger Dryas glacier advance - around 12.000 BP

Reforestation started with the onset of a prominent climatic amelioration around 14.7 ka BP linked to the Bølling - Allerød Interstadial (Fig. 1). With the stabilising effect of vegetation mass movements should have reduced. However, the biggest landslide of the province of Salzburg occurred in the Rauris valley at Kolm -Saigurn at this time (BICHLER et al. 2012). As the last glacial erosion at the toe of the slope happened most probably during the previous stadial, such an event may be regarded as an aftermath of the Gschnitz stadial. In addition, higher interstadial precipitation leading to e.g. higher hydraulic pressure in tension gaps may have accelerated the slope failure as well.

Again due to changes in the North Atlantic circulation, a severe climatic deterioration called Younger Dryas occurred and Alpine glaciers once again advanced from their cirques to lower valley floors during the Egesen stadial reaching their maximum extent at summer temperatures 3.5 ° C lower than today (KERSCHNER & IVY-OCHS 2007, KERSCHNER 2009). Multiple moraine ridges prove several phases of glacier tongue stabilisation. In the second half of the Younger Dryas cold and dry conditions promoted rock glacier formation.

This last cold phase of the Lateglacial ended around 11.7 ka BP with a tremendous warming at the onset of the Holocene.

Permafrost degradation in the Lateglacial

It is a well known fact that continuous permafrost existed during the major glaciations like the LGM in the non-glaciated areas of the Alps and at least in the Northern Alpine foreland as indicated by ice wedge features 25 to 40 m below the surface (VAN HUSEN 1997). Paleo-permafrost investigations and the re-construction of permafrost degradation in the Alps during the Lateglacial rely mostly on geomorphic-geological features as relict rock glaciers (= rock glacier deposits). In general the elevation of a rock glacier terminus is regarded to provide an indicator of the lower limit of discontinuous permafrost (e.g. LIEB 1996). This point of view has to be critically re-considered as HARRIS et al. (2009) showed that depending on the general conditions e.g. morphology of the slope, duration of the climatic phase the stabilisation position of rock glaciers may not represent a climatically steady-state situation.

However, based on the findings of very low reaching rock glacier deposits in Malta valley near Gmünd up to 1300 m below modern permafrost limits in these areas (REITNER 2007b) a formation of such features prior to the Younger Dryas seems to bee plausibel. Unfortunately, until now only one exposure dating age of rock glacier stabilisation, 300 m below permafrost limits of the 20th century, with an age of around 11 ka just is available (Larstig valley/ Tyrol; IVY-OCHS et al. 2009).

Conclusions and outlook

The Lateglacial record preserved especially in protected areas provides an excellent opportunity to study the climatically controlled transformation of landscapes and to increase our understanding of possible future climate impact scenarios. It recorded, direct or indirect reaction of the different landscape elements (glaciers, permafrost, slope) to changes of the climate signal are recorded.

The early phase of ice decay after the LGM provides a large scale example and worst case scenario of what is possible in an Alpine landscape regarding e.g. mass wasting and erosion.

Situations during Gschnitz and Egesen stadial are analogues for what is going on during glacier oscillation and for mutual interactions of glaciers and mass movements. Deciphering past permafrost degradation in order to understand the reaction time of the Alpine cryosphere on climate warming is still one of the greatest challenges in Lateglacial research.

However, resilient data on Lateglacial environmental change based on modern methodology are rare in the Alps. Further progress can be achieved only by combining geological-geomorphological surveying in order to establish a relative chronology of glacial, periglacial and gravitational processes with modern absolute dating methods i.e. exposure dating using cosmogenic nuclides (e.g. ^{10}Be, ^{14}C, ^{36}Cl), luminescence and radiocarbon dating. This forms the basis for robust correlations with regional and local high-resolution climate archives such as Greenland ice cores and Alpine speleothemes. Finally, a better understanding of past climatic changes in the Alps is a pre-requisite for assessing future climate impact.

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Reconstruction of a pre-historic past rock avalanche in the Hohen Tauern region: The Auernig sturzstrom

Jürgen M. Reitner & Ralf Schuster

Keywords

Mass movement, rock avalanche, dynamic fragmentation, sedimentology, Hohe Tauern

Introduction

Gravitational processes i.e. mass movements are constantly re-shaping mountain morphology and thus altering a landscape which was formed mainly by the interplay of tectonics and climatically-controlled processes (glacial and fluvial erosion and sedimentation).

Amongst the mass movements, a rock avalanche, also called sturzstrom (HEIM 1932; HSÜ 1975) is the most impressive phenomenon, not only because of its dimension (> 1 Mio m^3) and its high velocity (in the range of 100 m/s). In addition the onset of such a sudden events has been barely recognized in due time by human societies, thus leading to major catastrophies in historical time (e.g. Dobratsch rock avalanches near Villach in 1348 A.D.; EISBACHER & CLAGUE 1984) as well as to myths and sagas. In many cases the sheer size of such rock avalanches leads to a blocking of rivers and the rapid formation of lakes affecting villages as well.

The long run-out increasing with the size (volume) of the sturzstrom mass indicates a completly different dynamics than much smaller rock falls with quite short and rather predictable transport paths. The responsible mechanism leading to kilometer long transport paths accompanied by a strong rock fragmentation is in the focus of modern research. How is a previously intact wedge of rock transformed into a fast flowing mass acting like a fluid? In order to understand this process of “fluidization” studies of former rock avalanche events including geological condition, morphology, structures and sedimentology complement considerations based on rock mechanical tests and models.

Further emphasizes is put on principal reasons for such kind slope failure. Are the big but rare rock avalanches triggered by earthquakes shaking and weakening the rock or by a wetter climate with higher precipitation leading to increased hydraulic pressure in open joints promoting slope instability (PRAGER et al. 2008). As most of the rock avalanches occurred in pre-historic time any correlation with other e.g. climatic archives has to be based on reliable physical dating (exposure age, ^{14}C etc.)

The research project Auernig sturztrom is supported by the “Nationalpark Hohe Tauern” and has been carried out in the course of regular Austrian geological mapping program for map sheet UTM Obervellach. The final report including dating results from Susan Ivy-Ochs and Christian Wirsig (ETH Zürich) will be published soon.

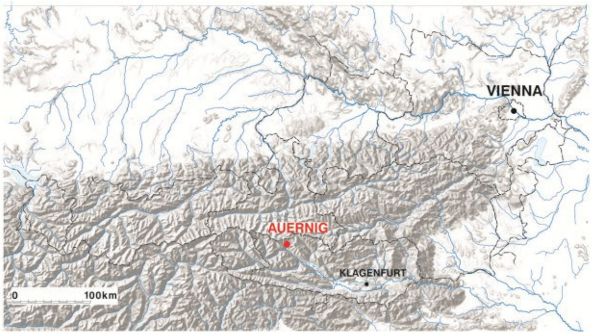

Figure 1: Location of the study area

Field evidence

The Auernig sturzstrom which was first described by HAMMER (1926) represents one of the rare pre-historic rock avalanches in the Eastern Alps which occurred in crystalline rocks, here in prasinite (amphibolite). A synform in the detachment zone with an axis in direction of the slope enabled most probably a first, short sliding phase. After around two kilometers of travel distance the rock mass shows already a strong disintegration due to dynamic fragmentation, as exhibited during excavations for a railway tunnel. The maximum thickness in the range of 100 m is found in the area where the sturzstrom was deflected by the opposing valley flank. From this location on, longitudinal ridges occur in marginal position partly high above the valley floor indicating a “swashing” flowpath. A 25 m high outcrop in around 5.5 km travel distance exhibits the internal structure of a ridge. The angularity of clasts increases towards the top from subangular to very angular. This is accompanied by a decrease in matrix content, which in lower part consists predominantly of silt and gets more sandy towards the upper part. Thus in the lower part, the appearance of the sturzstrom deposit, a massive matrix-supported diamicton, shows a striking similarity with basal traction till, especially in the lowest part, where "erratic" fluvial clasts got entrained. In contrast, the sediment in the upper part of the sequence, just beyond the huge angular boulders on top of the ridge, is clast-supported. Data on grain-size distribution and clast shape complete the picture of a "coarsening-upward" sequence indicating an increase in comminution towards the base. In total, the Auernig sturzstrom provides a nice example for studying dynamic fragmentation (McSaveney & Davies 2006) and the effect of fluidization.

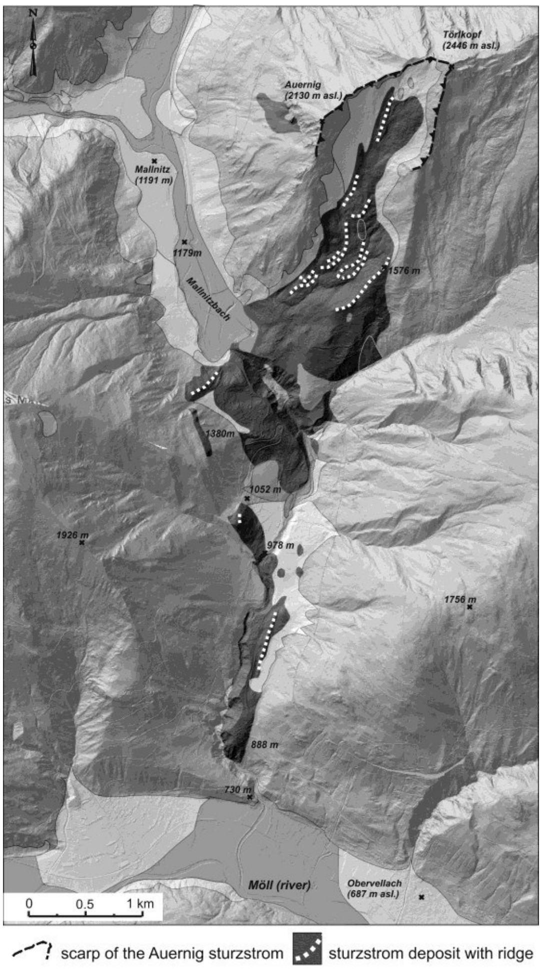

Figure 2: Simplified geological map of the Auernig sturzstrom scarp and deposits.

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EO-based habitat structure assessment in a trans-boundary Natura 2000 site

Barbara Riedler, Lena Pernkopf, Thomas Strasser, Stefan Lang

Abstract

Rivers often demarcate the border line between adjacent countries, which also affects protected sites (e.g. Natura 2000 sites) along rivers. As a consequence, the same habitat omplex may underlie different regulations and management strategies of neighbouring Member States. The historical development and recent conservation policy on Member State level may result in different patterns of usage. This special situation requires a monitoring of protected areas independent from national boundaries to evaluate the effect of conservation measures on the whole biotope complex. Earth observation (EO) methods, and in particular the use of satellite images, support such a monitoring beyond boundaries, leading to a more harmonized assessment of riparian habitats. Habitat structure analysed on the basis of EO data can be used to determine habitat quality in general and to reveal different structural patterns and compositions of habitats. Here, we present a case study in the Salzach river floodplain, a trans-boundary Natura 2000 site in Austria/Germany, which is part of the continental biogeographical region. Forest and woody vegetation patches with homogenous tree species composition were visually delineated on a very high resolution (VHR) satellite image. Two form parameters (shape index and fractal dimension)and patch size were calculated to describe the habitat structure. The results showed that the forest patches on the German side are on average smaller and more complex than on the Austrian side. This significant difference reflects different usage pattern, which can be explained by historic development.

Keywords

Riparian forest, habitat quality monitoring, landscape metrics, shape index, fractal dimension, patch size, Salzachauen

Introduction

Riparian forests are known for their high biodiversity and importance to provide ecological services (NAIMAN & DECAMPS 1997, WANTZEN et al. 2008). The monitoring of these ecosystems is essential to protect them and stipulated within the Natura 2000 network of protected sites. Information services for monitoring such habitats with the help of Earth observation (EO) are currently developed within the FP7-project MS.MONINA (www.ms-monina.eu). These services are offered in a multi-scale approach on local site level, as well as on Member State and European level (LANG et al. 2012).

Satellite imagery provides key assets for monitoring nature protected areas, where terrain conditions hinder accessibility or political borders limit a harmonized evaluation outcome. Added value information on habitat quality can be provided by landscape metrics that quantify structural heterogeneity, habitat form, diversity or fragmentation(LANG et al. 2008).

Here, we present an illustrative example of a trans-boundary Natura 2000 site with protected riparian forest habitats (alluvial forest: 91E0* and riparian mixed forest: 91F0),which occur on both sites of the border river Salzach in Austria and Germany. About200 years ago, both countries agreed to regulate the river to better demarcate the border between them (WEISS, 1981). This process was finished in the 1930s and since then different national management strategies have been implemented, influencing today´s habitat structure.

Methods

For habitat structure assessment, we compared mean values of shape index, fractal dimension and patch size between Austria and Germany. In a first step, patches were visually delineated on a multi-spectral, VHR satellite image of the WorldView-2 sensor, which was acquired in June 2012. These homogenous forest patches with a similar tree species composition (Fig. 1) were then used to calculate the landscape metrics. The shape index (FORMAN & GODRON 1986) relates the patch area to its perimeter and characterises the deviation of the patch form from an optimal circular shape. Fractal dimension (MANDELBROT 1983) describes the irregularity of an object. Both form metrics are standardised measures (LANG & BLASCHKE 2007), which can be used to determine the spatial configuration of riparian vegetation patches in terms of complexity (FERNANDES et al. 2011). Higher values of form parameters reflect more complex forms, and are often found along water bodies indicating natural conditions, whereas low values reflect compact forms, which are in many cases the result of anthropogenic management (e.g. STRASSER et al. 2012).Patch size is one indicator used to detect structural heterogeneity (AQUIAR et al. 2011). More and thus smaller patches are considered to increase heterogeneity, which generally leads to a positive assessment of habitat quality (LANG & BLASCHKE 2007). For the calculation of landscape metrics we used V-LATE, a vector-based analysis tools extension for ArcGIS (LANG & TIEDE 2003).Statistical analyses (Mann-Whitney U (MWU) as non-parametric test for two independent samples) were conducted using SPSS 21.0to validate the differences between the countries.

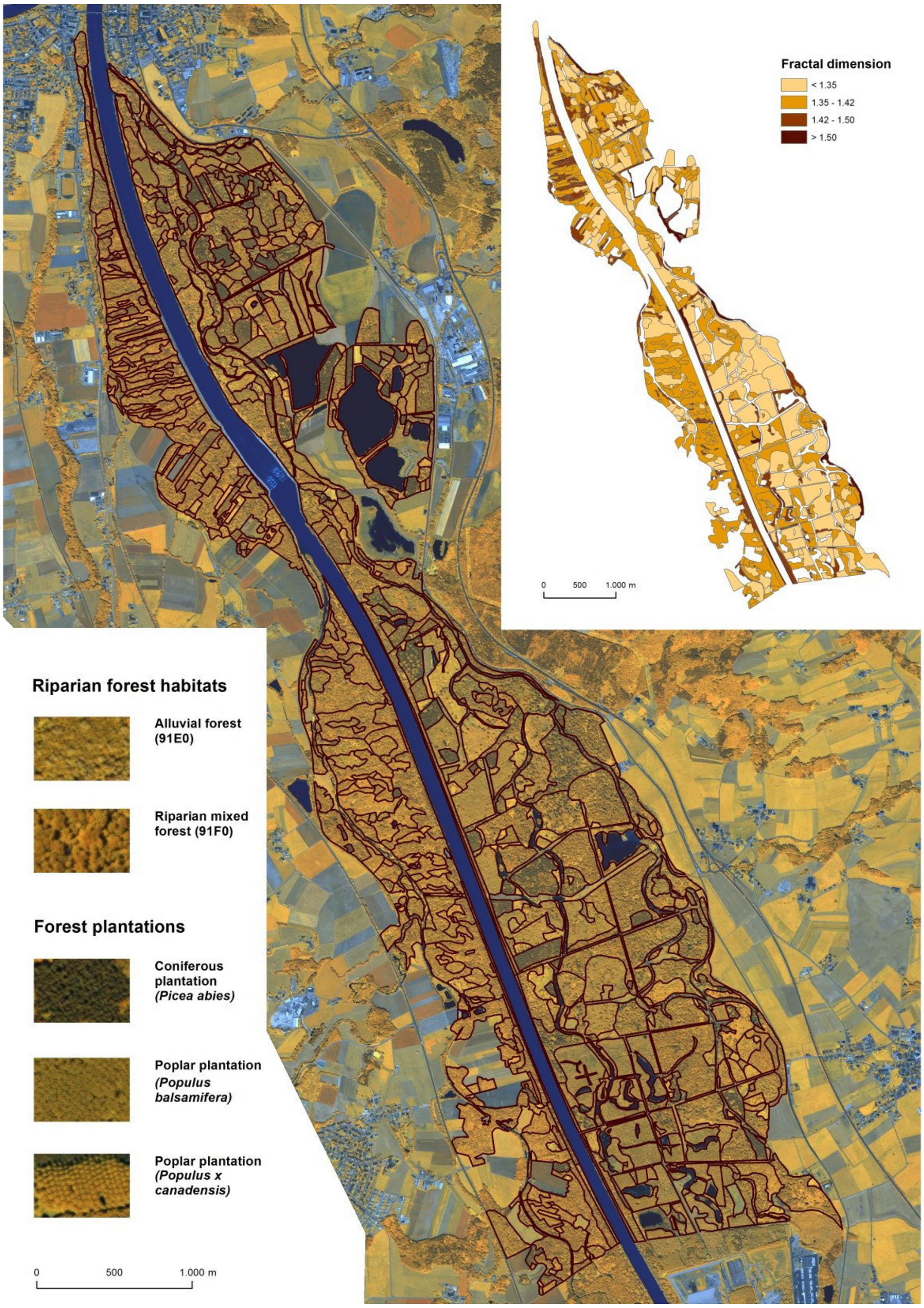

Figure 1: Forest patches and fractal dimension values describing patch form.

Results

The visual delineation of homogenous forest areas resulted in 770 patches in total. Different tree species were identified that can be assigned to different habitat types like alluvial forest (91E0), riparian mixed forest (91F0) or forest plantations (Fig. 1).

By comparing forest patches of the Austrian side to those of the German side, highly significant differences were found (mean patch size: MWU, $p<0.010$; shape index and fractal dimension: MWU, $p<0.000$).The mean patch size is significantly higher on the Austrian side, which indicates bigger, coherent forest areas. On contrary, the higher mean shape index and fractal dimension values on the German side reflect more complex forms of forest patches (Tab. 1; Fig.1).

Table 1: Landscape metrics calculated for riparian forest patches.

MEMBER STATE	Total number of patches	AREA		FORM			
		Patch size (m^2)		Shape index		Fractal dimension	
		Mean	STD	Mean	STD	Mean	STD
Austria	485	13 179	16 870	1.60	0.67	1.38	0.07
Germany	285	10 311	13 474	1.67	0.49	1.41	0.11

Discussion and Conclusion

Although the riparian forest of the Salzachauen can be considered as one biotope complex, the differences between the Austrian and German side are significant. While the German part, as a general trend, is characterised by smaller forest patches with more complex forms, the Austrian part has bigger patches with simpler forms. These differences reveal a difference in usage structure of the riparian forest in the two countries. For example the northern part within the German territory is divided into private parcels with individual silvicultural usage. The historical development of ownership has led to rather small, elongated parcels. The form of these parcels results in high form index values. Thus, the chosen indicators mainly reflect structural differences that are a result of historical development. More detailed inference on habitat quality can be obtained by also taking tree species distribution and additional landscape indicators into consideration.

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Summer mountain tourism in climate change: Scenarios and need for action using the example of the high Alpine trail network

Florian Ritter (formerly: Braun)

Abstract

This contribution summarizes the findings of a doctoral thesis that dealt with the need for action to adapt the high Alpine trail network to consequences of climate change. In three pilot studies different aspects of former and current changes of the trail network were analyzed. To investigate possible future effects of climate change on the high Alpine trail network, landscape and tourism scenarios were developed for three sections of the Austrian Alps (Glocknergruppe, Venedigergruppe, ÖtztalerAlpen). In five workshops these scenarios were discussed with regional stakeholders, who are concerned with summer mountain tourism in the study areas. The need for action differs a lot in the particular mountain ranges and main problems cannot be solved just by local measures. Facing the ongoing glacier retreat and permafrost degradation, a change of the trail concepts as a whole might be necessary in some high Alpine regions.

Keywords

mountain tourism, mountaineering, climate change, glacier retreat, mountain hazards, trail network

Figure 1: Examples of changes along trails in already ice free areas: Extreme runoff peak of a glacial stream flooding a bridge in ÖtztalerAlpen (left). Partial destruction of a trail along the ridge of the 1850-moraine along a glacier in Venedigergruppe (right). © Erich Heuke

Introduction

The Alpine trail network and the Alpine huts are the infrastructural basis for summer mountain tourism (hiking, mountaineering) in a mountainous country such as Austria. Due to landscape modifications resulting from climate change (e.g. glacier retreat, permafrost degradation and associated processes) risk potentials for mountaineers are changing in high mountain areas, as well as the accessibility of the terrain and the maintenance of the trails (for examples see Fig. 1, 2, 3).

Figure 2: Examples of changes due to terrain becoming ice free in glacier forefields: Unconsolidated debris slope along a route in a glacier forefield in Silvretta (left). Glacio-fluvial outwash fan developing in front of a glacier in ÖtztalerAlpen (middle).Melted hollow in an intensely debris-coverd dead-ice-body in ÖtztalerAlpen (right). © Florian Ritter

Figure 3: Examples of changes due to terrain becoming ice free in summit areas: A former easily accessible firn ridge in ÖtztalerAlpen has turned into an unstable, hazardous rock ridge as a consequence of becoming ice free (left). Old ascent to a mountain pass across a former firn couloir that has become ice free (orange), and new ascent equipped with fixed ropes leading across compact rock (red) in StubaierAlpen (right). © Florian Ritter

The first objective of the thesis was to identify the problems in the field summer mountain tourism and climate change. The second one was to develop ideas how to deal with these phenomena in future, i.e. how to adapt the high Alpine trail network or its organization. The practical implementation was conducted in three sections of the Austrian Alps: Glocknergruppe and Venedigergruppe in the National Park Hohe Tauern and a part of Ötztaler Alpen.

Methods

The project followed the principles of transdisciplinary research with the goal of integrating different scientific disciplines and the experiential knowledge of the case actors. Several groups of scientists and stakeholders could be integrated in different stages of the project (Fig. 4).

In three pilot studies different aspects of former and current changes of the trail network were analyzed: A collection of examples of current changes in the trail network related to climate change, an investigation of glacier changes at steep mountain passes using maps and measurements of the ice thickness and an analysis of the development of the high Alpine trail network in the study areas using historical maps.

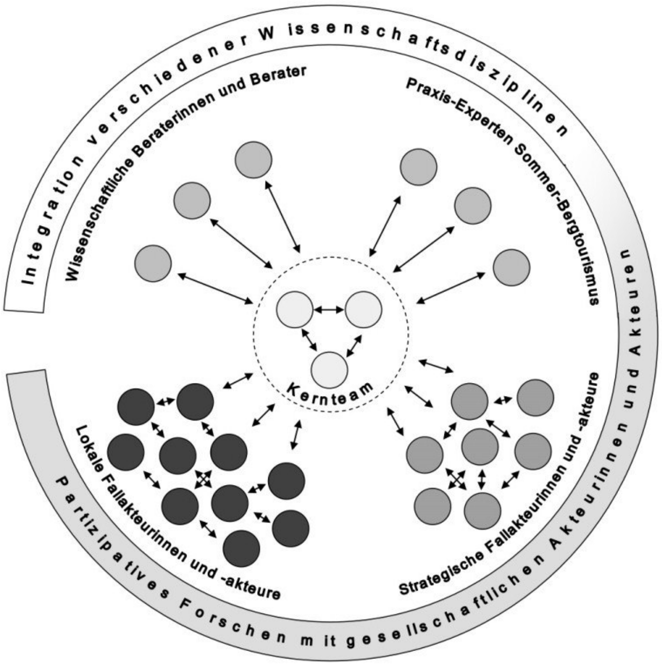

Figure 4: Integration of several groups of scientists and stakeholders in different stages of the project (in German). © Florian Ritter

To investigate possible future effects of climate change on the high Alpine trail network, two different kinds of scenarios were developed (landscape scenarios, tourism scenarios). The landscape scenarios show the dimension of possible impacts of climate change on the trail network in the study areas. Based on hiking maps (1 : 25 000) three scenario maps were developed for each study area, which described the state of the trail network in 2008, as well as a moderate and an extreme scenario for 2040 (Fig. 5). Complementary the tourism scenarios were three short narratives about the situation of summer mountain tourism in 2040: ‘Classical Mountaineering’, ‘Wellness-Hiking’ and ‘High Alpine Adventure’.

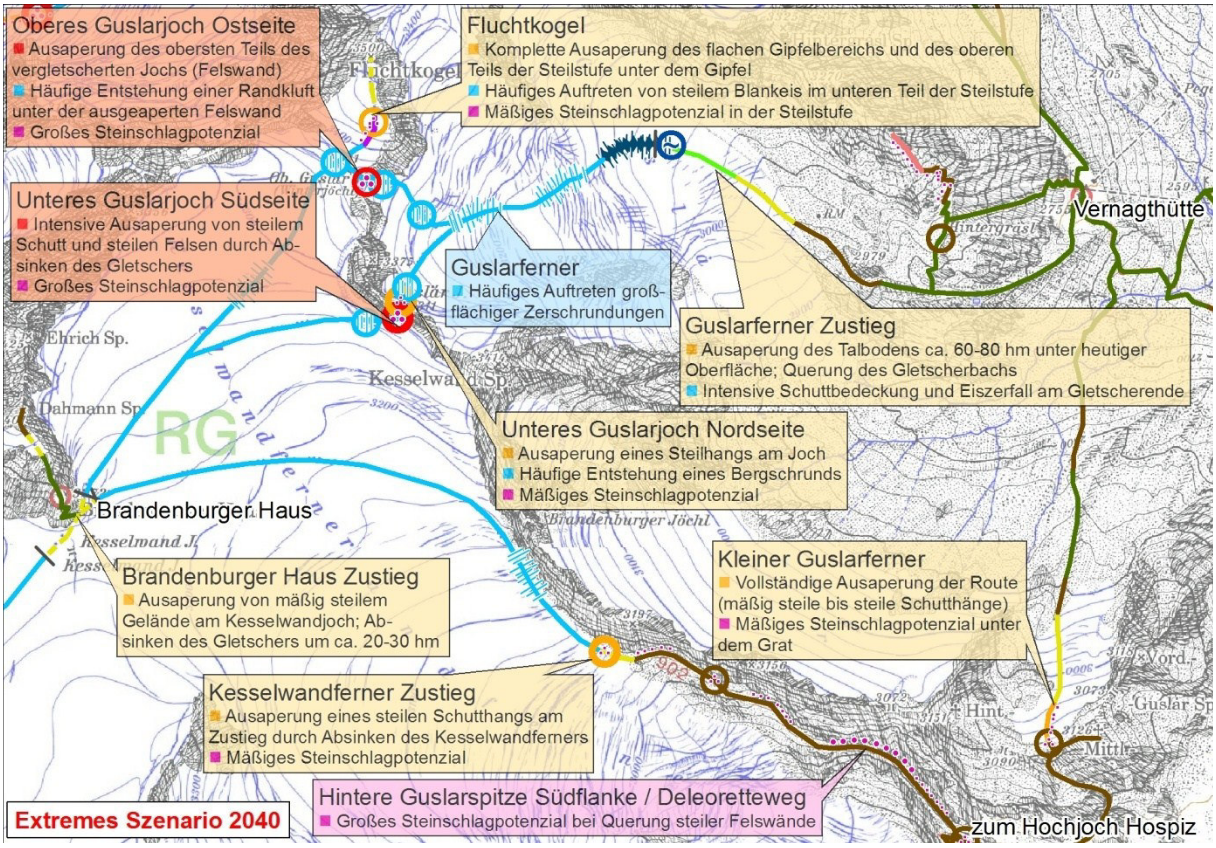

Figure 5: Detail of the scenario map in the surrounding of Brandenburger Haus (in German; Background: Alpine Club Hiking Map Ötztaler Alpen - Weißkugel) © Florian Ritter

In five workshops the scenarios were presented to regional stakeholders (e.g. Alpine Clubs, mountain guides, national park management, local tourist boards) and were further developed and evaluated. Afterwards the stakeholders discussed the need for action and their ideas to adapt the high Alpine trail network.

Results

The results of the scenario workshops show that the need for action is mainly related to organizational and tourism strategic questions. The suggestions of the participants were grouped as follows: The field 'Concentration and Reduction' describes ideas for prioritizations concerning the maintenance of trail infrastructure. 'Integration and Cooperation' deals with the involvement of all relevant stakeholders. 'Coordination and Professionalization' concerns the adaptation of maintenance activities and quality standards. The field 'Proactive behaviour and Positivity' includes suggestions regarding the motivation and the commitment of the stakeholders.

Furthermore two different operating scales could be identified: The regional scale, dealing with problems in a particular mountain range, and the scale of the total system, concerning the general surrounding conditions as well as the organization of the trail network maintenance in the national context. Both scales are important since the need for action differs a lot in the particular mountain ranges and main problems cannot be solved just by local measures. Main recommendations were the implementation of new organizational forms concerning the maintenance of the trail network and the installation of a computerized trail-information system.

Discussion

In Fig. 6 we present a possible framework for investigation of effects and development of management measures at local level. This can only successfully be implemented by integration of a wide variety of stakeholders. Cumulative effects of numerous individual critical developments at the local level can also induce a need for strategic decisions at a different scale level, such as a complete redesign of the trail network or even the abandonment of trail maintenance in critical sections of a mountain range.

Planning and management of the trail network has to be adaptive and future-oriented. Trail holders have to look for alternatives in time. Our findings show that many problems are foreseeable. Actions should be taken before severe accidents happen or trails become completely impassable.

Concerning transdisciplinarity our work showed that scientists and stakeholders can play different parts in specific stages of projects like our case study. Mostly they have different objectives and hopes concerning the cooperation. Therefore a key skill is to manage and overcome the boundaries between the groups so that different perspectives of the research problem can meet each other. As a consequence a more comprehensive perception and a more holistic handling of real-world problems can emerge from transdisciplinary processes.

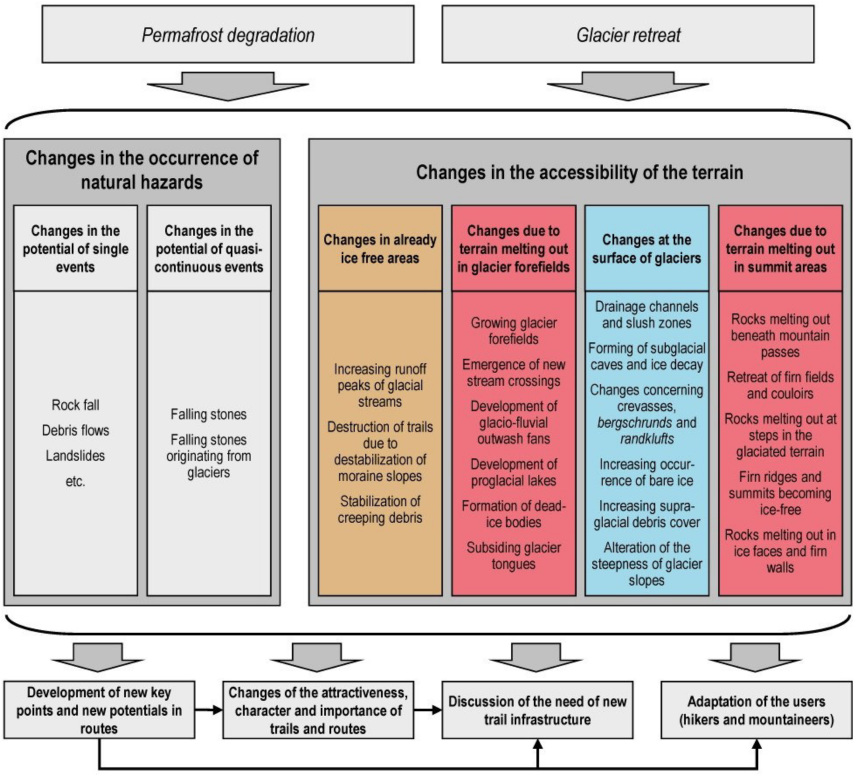

Figure 6: Overview of the phenomena and the resulting changes concerning the high Alpine route and trail network (brown = non-glaciated areas only; red = transition zone between rock and glacier and areas that are getting ice-free; blue = glaciated areas only; grey = all mentioned areas). © Florian Ritter

Conclusion

The high Alpine trail network is a dynamic system and has to be managed according to this. There is not only need for action to adapt the high Alpine trail network to certain changes. In fact the further development of the total system of summer mountain tourism is necessary against the background of a changing landscape as well as changing surrounding conditions in society.

Acknowledgments

This contribution is a summary of a doctoral thesis by Florian Braun, submitted at BOKU University of Natural Resources and Life Sciences, Vienna (in german, original title: Sommer-Bergtourismus im Klimawandel: Szenarien und Handlungsbedarf am Beispiel des hochalpinen Wegenetzes), supervised by Markus Fiebig (Institute of Applied Geology, BOKU) and Andreas Muhar (Institute of Landscape Development, Recreation and Conservation Planning, BOKU).

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A participatory method for agrobiodiversity conservation

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Abstract

Which sites would be best to revive cultivating crops and vegetables? In the Swiss mountains, the area used for arable farming decreased by over 50% from 1990 to 2010. Our research investigates methods that allow the integration of different knowledge forms and viewpoints with spatial reference. Arable farming contributes to culture, local knowledge, and landscape aesthetics. At the same time it is dependent on those elements. Therefore, biosphere reserves are candidates for reviving arable farming.

This paper presents an approach based on participatory mapping used for finding areas suitable for farming specific crops. Airborne photos serve as a basis with a direct reference to the physical world. Various stakeholders then create a thematic map by drawing suitable areas on top of the photos. While participatory mapping was applied on a broad range of topics, this method often lacks scientifically sound guidelines for best practice. Hence, we research required sample size and the influence of mapping scales and technologies. In addition, we examine precision, accuracy, and validity of the data gathered through participatory mapping. We further look into additional effects such as social learning or emerging conflicts as a consequence of the mapping process. In this project, arable farming in the protected areas serves as a case study. However, the method has much broader application possibilities.

Keywords

Participatory Mapping, PPGIS, Agrobiodiversity, Transdisciplinarity, Ecosystem Services

Project description

Introduction

In the Swiss mountains, the area used for cultivating crops and vegetables decreased by over 50% from 1990 to 2010 (Swiss Federal Statistical Office 2012). Biosphere reserves are especially suitable for conserving agricultural practices in marginal areas. A big portion of the worlds protected areas are in mountains (Rodríguez-Rodríguez & Bomhard 2011), which are a refugium for crop diversity (Bardsley & Thomas 2004). Arable farming in mountains contributes to biological diversity and the retention of tradition and culture (Bardsley & Thomas 2004; FAO 2010: 4). Conserving crop diversity, a natural resource, through use, fits perfectly to the aims of UNESCO biosphere reserves (Lange 2011). Recently, the new agrarian policy of Switzerland aims at securing and enhancing landscape qualities. Farmers can list arable farming as a landscape quality and thus apply for government subsidies. However, it is complicated to locate where policy measures would most likely take effect. We research methods to find the most promising areas for reviving arable farming in the mountains.

Bringing back arable farming depends on several factors and stakeholders. For example appropriate machines, suitable soils, and a good climate are required. At the same time, the individual motivation, experiences, and knowledge plays an important role (Bardsley & Thomas 2004; FAO 2010). Thus, there is a need for methods able to integrate different knowledge sources and types of knowledge.

Method

Participatory Mapping (PM) is a promising approach for integrating different knowledge. In our case, participants are asked to draw areas for possibly cultivating rare species on top of an airborne image. The maps then are digitised and merged, resulting in an aggregated map. Thus the setup and the result have a clear spatial reference. PM was already applied on similar issues. For example PM was applied on conservation management (Brown & Weber 2012), landscape values (Sherrouse et al. 2011) and ecosystem service assessment (Brown et al. 2012). Research has shown various influences on the results of the PM process, such as the familiarity of the participants with the area (Brown 2012; Brown et al. 2012), the use of points or polygons as input geometry (Brown & Pullar 2012), and effects of paper- vs. web-based solutions (Brown et al. 2012; Pocewicz et al. 2012). Despite the promising aptness of PM for complex socio-ecological tasks, we identified a lack of scientific sound guidelines for best practice.

Conclusion

Studying the case of arable farming in the Swiss mountains, we research PM. Hence; PM is compared to other approaches that identify the potential areas for identifying areas for arable farming. However, if the aim is a participatory process PM is a valuable tool for assessing complex socio-ecological phenomena. PM can be carried out without much computer technology, by using paper and pencil. On the other hand, bigger samples can be reached and processed if using web-based tools. For different aims different setups and scales yield best results. In any case, PM is able to show perceptions of the participants regarding a complex subject in a defined area.

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Long term monitoring of natural regeneration in natural forest reserves in Austria - results from the ELENA project

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Abstract

Research in natural forest reserves (NWR) provides insights into the dynamics of natural forests that can serve as a basis for a targeted oriented management of forests. In this context, the research project ELENA has studied the natural regeneration in unmanaged mountain forests in Austria. A comparative analysis of the natural regeneration was done in seven natural reserves (Goldeck, Laaser Berg, Schiffwald, Hutterwald I and II, Kronawettgrube, Krimpenbachkessel) by establishing 197 permanent sample plots for a long-term monitoring. The study focused on seven different forest associations, where as the main focus was put on the *Homogyno alpinae-Piceetum*, *Athyrio alpestris-Piceetum* and *Adenostylo glabrae-Piceetum*. This contribution presents the study design and the results of the first investigation of the natural regeneration in these natural forest reserves. The results allow an evaluation of the dynamics of the natural forest reserves and the establishment of natural regeneration in mountain forests. The numbers of individuals in the natural regeneration and their distribution among different categories vary greatly between the natural forest reserves (between 766 $n*ha^{-1}$ in the Hutterwald and 15869 $n*ha^{-1}$ in Krimpenbachkessel). The growing stock lies between 334 and 725 m^3*ha^{-1} and the coarse woody debris volume (lying and standing dead wood) summaries up to 44.2 and 73.2 m^3*ha^{-1} (10-20% of the growing stock). The analysis focuses on the relation between the occurrence of natural regeneration and the availability of coarse woody debris. It is shown that the number of seedlings established and saplings depend on the amount, type and distribution of coarse woody debris strongly.

Keywords

natural regeneration, natural forest reserves, Norway-spruce, long-term monitoring, coarse woody debris

Introduction

Undisturbed forests are valuable objects to study vegetation structure and dynamics (Mayer et al. 1987; Leibundgut 1982). The Austrian "Natural Forest Reserves Program" was launched in 1995 to support the in-situ conservation of rare and endangered forest types and the study of natural dynamic processes, including the effect of natural disturbances and catastrophes (Frank & Müller 2003). The natural forest reserves also serve as references for biodiversity assessments and ecological monitoring, as they are not subject to any human activities (Frank & Koch 1999; Frank & Müller 2003). Research in natural forest reserves aims at identifying the structure and dynamics of forest ecosystems. While the structure of a forest may be described rather easily at a certain moment, the dynamics results from a temporal development of the structure and can only be identified by repeated surveys on permanent sample plots. The initiative for the establishment of such a network has its origin in the signing of the Helsinki Resolutions (H2 - General Guidelines for the Conservation of the Biodiversity of European Forests; MCPFE 2000) and the COST-Action E4 Forest Reserves Research. Until 2012 a number of 200 natural forest reserves with a size of 8603 ha have been established (BMLFUW 2010). Due to its location at the interface of alpine, subcontinental and subatlantic climatic influences Austria comprises around 125 different forest communities. The aim of the network is to reach a representation by at least one reserve per eco-region and forest community of all typical forest communities occurring in those 22 eco-regions (Kilian et al. 1994). Currently 0.15 % of the total forested area in Austria is represented with natural reserves.

In this context, the research project ELENA has studied the natural regeneration in selected natural reserves of mountain forests in Austria (Ruprecht et al. 2012). The dependence of seedling recruitment on deadwood has been reported from various studies (Lonsdale et al. 2008; Zielonka 2006). It was also reported that decaying logs form a major seedbed for trees in European subalpine *Picea abies* forests (Bače et al. 2012). Therefore a comparative analysis of the stand and site characteristics as well as the natural regeneration dynamics was initiated to analyse the implications of site and stand characteristics on regeneration success. This contribution presents the study design of the long-term monitoring research and the results of the first investigation of the natural regeneration in the studied natural forest reserves. The results allow an evaluation of the dynamics of the natural forest reserves and the establishment of natural regeneration in mountain forests.

Study site and methods

The study sites of the spruce-dominated natural forest reserves (Goldeck, Hutterwald I, Hutterwald II, Krimpenbachkessel, Kronawettgrube, Laaser Berg, Schiffwald) are located in the eco region 1.3 „Interior Alps – eastern part“, 3.3 „Southern Intermediate“, 4.2 „Northern Rim Alps – eastern part“ and eco region 5.2 „Foothills“ (figure 1 and table 1). The study analysed different forest associations, where as the main focus was put on the *Homogyno alpinae-Piceetum, Athyrio alpestris-Piceetum* and *Adenostylo glabrae-Piceetum*. The classification follows the taxonomie of WILLNER & GRABHERR (2007).

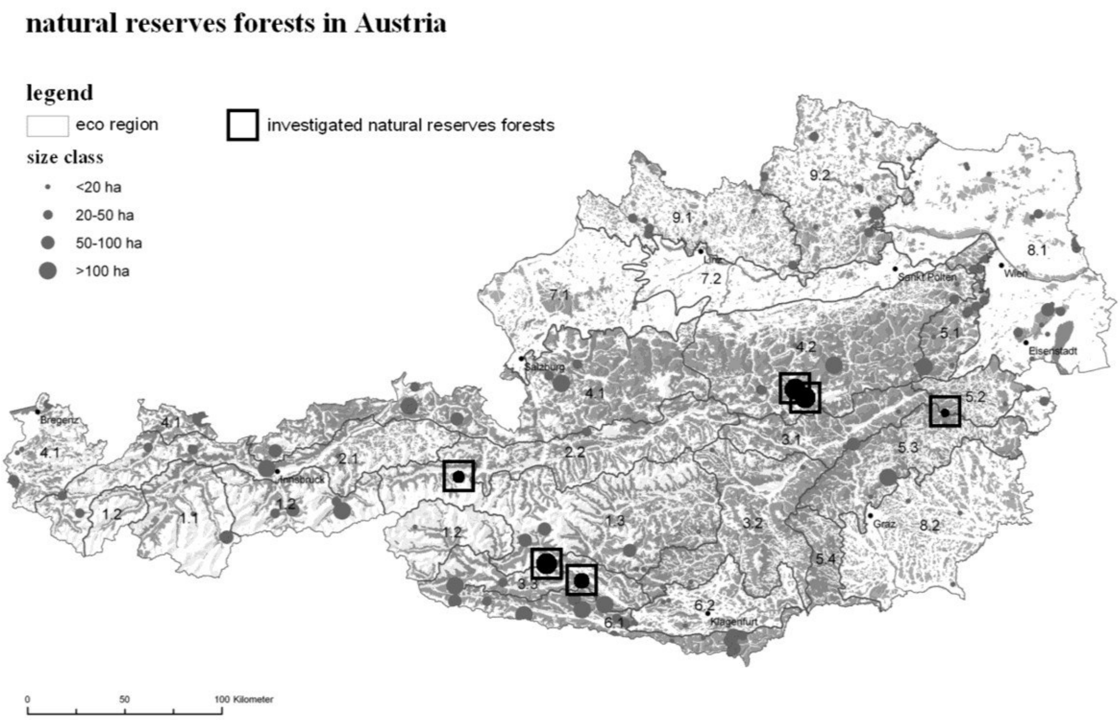

Figure 1: Location of Natural Forest Reserves in Austria and the observed study sites

The reserves at the study sites range from 840 to 2080 m above sea level, whereas the sample plots are mainly situated in the montan and subalpine altitudinal zone. The bedrock is mainly from silicate origin, whereas in the reserves Schiffwald and Krimpenbachkessel the bedrock is calceaus. The average daily mean temperature ranges between 3.6 and 5.9°C and the mean precipitation between 1054 and 1532 mm (period 1960-2009). A short characterisation of the natural reserves can been found in table 1. Detailed information on the study sites are published in RUPRECHT et al. (2012) as well.

Table 1: Characteristics of the observed natural forest reserves

reserve	eco region	forest association	sea level [m]	bedrock	slope [%]	aspect	temp. [°C]	precip. [mm]	area [ha]	established	points [n]
Goldeck	3.3	*Adenostylo alliariae-Piceetum* *Athyrio alpestris-Piceetum* *Calamagrostio villosae-Fagetum* *Homogyno alpinae-Piceetum* *Saxifrago rotundifolae-Fagetum*	1040-1620	silicate	40-**80**-110	W-**N**-E	4.7	1107	58.3	1997	30
Hutterwald I	1.3	*Calamagrostio villosae-Piceetum* *Homogyno alpinae-Piceetum* *Sphagno-Piceetum* *Vaccinio-Pinetum cembrae*	1500-1700	silicate	10-**50**-80	W-**N**-E	3.6	1354	18.3	1997	18
Hutterwald II	1.3	*Athyrio alpestris-Piceetum* *Homogyno alpinae-Piceetum*	1550-1700	silicate	10-**50**-80	W-**N**-E	3.6	1354	11.1	1999	11
Krimpen-bachkessel	4.2	*Adenostylo glabrae-Fagetum* *Adenostylo glabrae-Abietetum*	840-1330	carbonate	20-**50**-80	W-**N**-E	5.9	1332	151.2	1997	25
Kronawett-grube	5.2	*Athyrio alpestris-Piceetum*	1400-1540	silicate	10-**40**-80	N-**E**-S	4.2	1532	7.5	1997	20
Laaser Berg	1.3	*Homogyno alpinae-Piceetum* *Adenostylo alliariae-Piceetum* *Vaccinio-Pinetum cembrae*	1500-2080	silicate	20-**70**-90	**S**-W-N	4.9	1054	63.2	1998	26
Schiffwald	4.2	*Saxifrago rotundifolae-Fagetum* *Adenostylo glabrae-Piceetum* *Rhodothamno-Laricetum*	960-1500	carbonate	0-**20**-110	all	4.6	1477	692.5	1999	67

In the context of the given size of the studied reserves a regular grid of sampling plots with a distance between 75 to 200 m has been established. Each sample plot has a size of 300 m² (radius 9.77 m) and the measurements have been investigated according to six strata (natural regeneration, dead wood, site and stand attributes, hemispherical photographs and angel count (Bitterlich) sampling). Plots for sampling natural regeneration are located in each of the four main expositions (figure 2). Each regeneration plot was composed of 7 subplots whereas individuals up to a tree height of 1.30 m have been investigated. The seedlings have been sampled on 16 subplots with a size of 0.25 m² (figure 2: VI) and samplings older one year up to a tree height of <30 cm have been sampled on the 16 subplots with 0.25 m² and on the 12 subplots with a size of 1.0 m² (figure 2: VII). Larger individuals (tree height ≥30 cm) have been sampled on the whole sample plot. For all individual larger then ≥15 cm tree height a detailed investigation of tree characteristics and damages was done (compare figure 2). Additionally the regeneration on the lying deadwood (having a mean diameter ≥10 cm) was sampled.

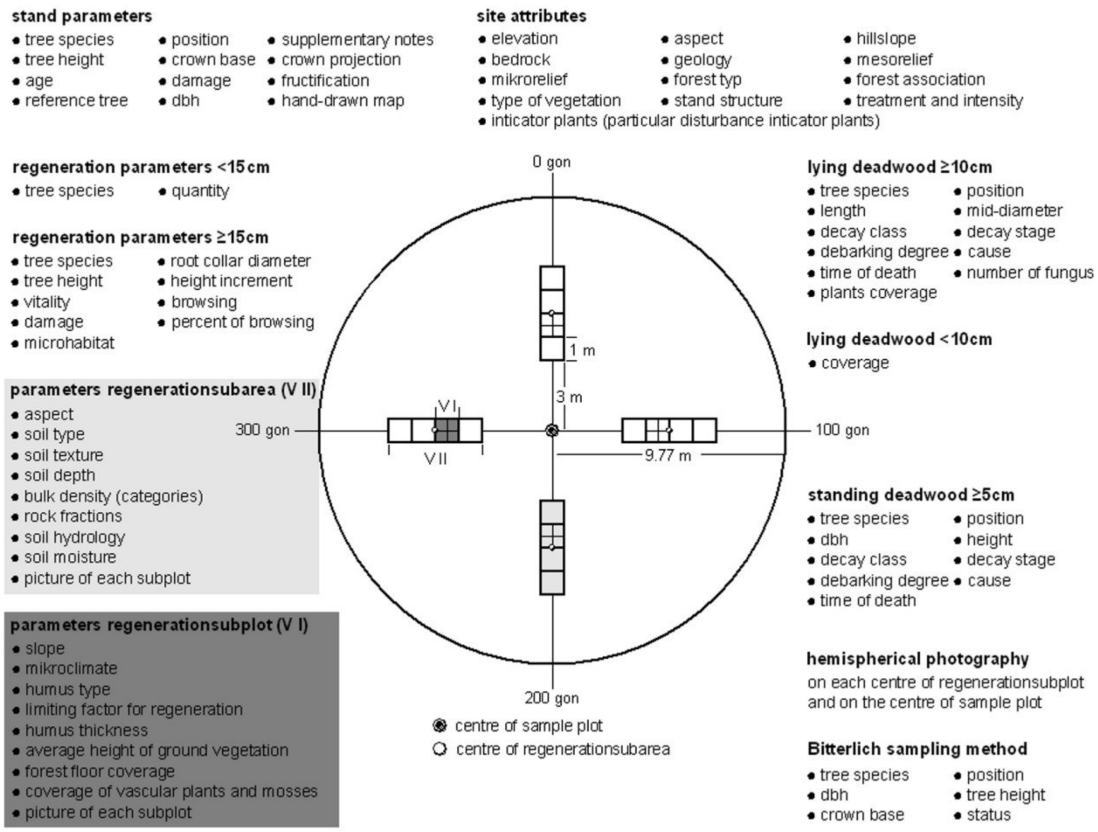

Figure 2: Sampling design and measurement parameter

Logistic regression has been used in this study to analyse the influence of lying deadwood on the occurrence of natural regeneration, since we found it to be a useful instrument to model several phenomena and to predict the presence or absence of a particular characteristic based on the values of a group of predictive variables. Model phenomena with binary or dichotomous variables – such as recruitment and natural regeneration - are described best by means of logistic regression. Moreover logistic regression proves to be relatively flexible, since it accepts a combination of continuous, categorical and non-normally distributed variables (BELLGARDT 1997).

Table 2: Mean values and standard error for the volume of deadwood classified by categories and its share of the growing stock of the living trees (≥1.30 m height)

reserve	standing dead wood [≥5 cm]		lying dead wood [≥10 cm]		stumps [≥5 cm]		∑ dead wood	living trees	ratio dead wood / living tree
	Vfm*ha-1	%	m³*ha-1	%	m³*ha-1	%	m³*ha-1	Vfm*ha-1	%
Goldeck	18.3 ±9.4	26	46.5 ±9.6	67	4.3 ±0.9	7	69.3 ±14.5	724.8 ±56.8	10
Hutterwald	23.1 ±5.5	32	45.6 ±18.2	61	5.6 ±1.1	7	73.2 ±19.4	361.7 ±40.3	20
Krimpen-bachkessel	13.7 ±4.0	21	48.4 ±14.4	72	4.9 ±1.0	7	67.0 ±15.8	334.4 ±32.4	20
Kronawett-grube	45.3 ±10.6	64	24.5 ±13.8	35	0.4 ±0.4	1	70.2 ±19.6	477.9 ±44.7	15
Laaser Berg	15.6 ±4.3	26	33.2 ±5.5	56	10.4 ±3.1	18	59.2 ±7.5	537.7 ±59.1	11
Schiffwald	36.3 ±7.8	82	7.1 ±1.6	16	0.8 ±0.7	2	44.2 ±8.1	345.2 ±20.8	13
all	27.0 ±3.4	45	29.2 ±4.1	49	3.8 ±0.6	6	60.0 ±5.4	443.0 ±18.7	14

Results

Characteristics of the natural reserves

The amount of the stand volume varies between 334 and 725 Vfm*ha^{-1} in the studied reserves (table 2). The coarse woody debris volume (lying and standing dead wood) summaries up to 44.2 and 73.2 m^3*ha^{-1} (10-20% of the stand volume). The reserve Goldeck has the highest total volume (724.8 Vfm*ha-1), whereas the reserves Hutterwald and Krimpenbachkessel have the highest share of deadwood (20%) in relation to the total volume (table 2). In total 1050 individual logs respectively stumps have been sampled. The size, decay stage and number of fungi varied strongly. The differences between the reserves are mainly based on the existence of different development stages within the forest communities and the time that has passed since the last human intervention (table 1).

Amount of Regeneration

The numbers of individuals in the natural regeneration and their distribution among different categories vary to a high degree between the natural forest reserves (table 3). The total number of seedlings found on the lying coarse woody debris is 5799. It was found that there is strong relationship between the amount of deadwood sampled on a plot and the regeneration found on the sample plots. Plots with no lying deadwood had a significant lower number of individuals in the regeneration than plots with lying deadwood (respectively logs and stumps). There were no significant differences found between the different classes of deadwood (1=to 50 m^2*ha^{-1}; 2=to 150 m^2*ha^{-1}; 3=to 250 m^2*ha^{-1}; 4=to 350 m^2*ha^{-1}, 5= >350 m^2*ha^{-1}).

Table 3: Mean number of individuals and standard error of the natural regeneration classified by regeneration type and natural forest reserve

reserve	category of regeneration			
	seedling	<15 cm height	15 to <30 cm	30 to <130 cm
	n*ha^{-1}	n*ha-1	n*ha-1	n*ha-1
Goldeck	16286 ±2970	12288 ±4237	303 ±157	394 ±142
Hutterwald	661531 ±162812	766 ±256	683 ±287	543 ±200
Krimpenbachkessel	19235 ±3785	15869 ±4018	2065 ±598	2222 ±579
Kronawettgrube	139565 ±21071	8123 ±2085	55 ±29	183 ±61
Laaser Berg	39221 ±5592	1242 ±332	238 ±136	413 ±85
Schiffwald	6574 ±1757	6911 ±1164	436 ±120	587 ±96
all	123888 ±28726	7337 ±990	581 ±106	696 ±98

Logistic regression model

A total of 907 logs were used to study the relationship between the occurrence of natural regeneration and coarse woody debris. 379 logs had no regeneration and 528 logs had natural regeneration. All parameters from lying deadwood and stumps that have been investigated in the field have been used for the model building process. In order to eliminate multicollinearity between the variables selected for this study, the Pearson correlation has been conducted for the whole datasets independently. All variables with a correlation higher than 0.7 were not further considered for the model building procedure.

Table 4: Significant variables of the logistic regression model and outcomes of the Wald-statistic

variable	estimate	std. error	z value	Pr(>|z|)	signif.
(intercept)	-2.0009E+00	3.34E-01	-5.990	<0.001	***
projected area	2.2366E-01	7.05E-02	3.172	1.51E-03	**
moss coverage	5.3565E-02	1.09E-02	4.933	<0.001	***
moss coverage ^2	-4.0930E-04	1.35E-04	-3.022	2.51E-03	**
spruce	9.4117E-01	2.30E-01	4.090	<0.001	***
non-determinable tree species	1.4505E+00	2.57E-01	5.638	<0.001	***
no exposition	9.0078E-01	2.17E-01	4.145	<0.001	***
decay class 8	1.5825E+00	8.04E-01	1.969	4.90E-02	*
decay stage 3	-4.6279E-01	1.66E-01	-2.783	5.38E-03	**
no fungus	6.6396E-01	2.24E-01	2.965	3.03E-03	**

signif. codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.', 0.1 ' '

Various methods were tested examining the level of significance through which the variables were introduced and removed from the equation. Variables were introduced into the model according to a significance of $p < 0.05$ (Wald significance) and removed from the model with a $p > 0.1$ (Wald significance). The variables “projected area of deadwood”, “moss coverage”, “non-determinable or spruce as tree species”, “deadwood with no orientation”, “deadwood with decay class 8 (root plate with trunk)” and “no fungus available” showed a positive significant effect for regeneration whereas the “decay stage 3 of the deadwood (advanced decomposition)” was found to have a negative significant effect on regeneration (table 4). The Nagelkerke´s R^2 test, ROC (receiver operating characteristic) value and the Hosmer & Lemeshow goodness-of-fit test was used to estimate goodness of fit. 2 x 2 classification tables of observed and predicted responses were calculated in order to test the predictive capability of the models. For that purpose the logs were categorised with a probability threshold of 0.5.

The selected model includes nine variables (table 4) predicting regeneration on deadwood correctly with a percentage of 73%. “No regeneration” is modelled with 66% and the total percentage of correctly predicted cases is 70%. The model has a quite acceptable goodness of fit with a Nagelkerke´s R^2 of 0.280, a ROC of 0.768 and a Hosmer & Lemeshow goodness-of-fit test with a significance level of 0.90. It was found, that an increasing coverage of moss on the lying trunk has a positive effect on the seeding establishment. When the coverage exceeds 65%, the probability for a successful regeneration decreases again. Figure 3 shows the probability for successful regeneration based on the logistic regression model for the parameters moss coverage and projected area of deadwood.

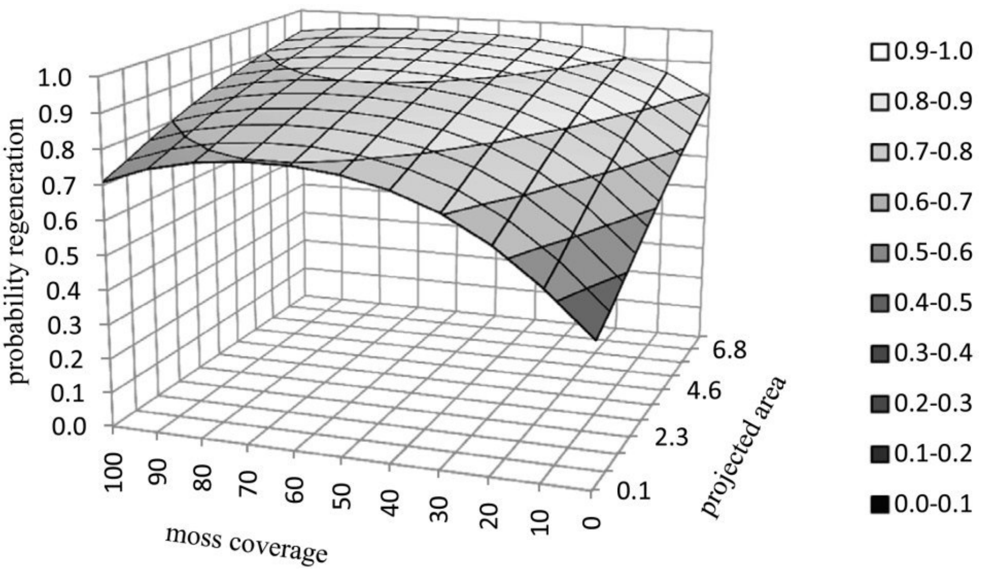

Figure 3: Probability for successful regeneration based on the logistic regression model for the parameters moss coverage and projected area of deadwood (for all other parameters median values are used)

Discussion and Conclusions

One of the main objectives of establishing natural forest reserves is to monitor natural vegetation processes, which will be used as a reference value in near-to-nature management of the same forest types.

The role of deadwood for a successful natural regeneration has been described by several authors (e.g. HUNZIKER & BRANG 2005; ZIELONKA 2006; LONSDALE et al. 2008; BAČE et al. 2012). In this context several parameters have been found to have a significant effect on the recruitment. BAČE et al. (2012) have shown, that similar to this study the diameter has a significant effect on a successful regeneration. The decay process seems to have mostly a variable effect (BAČE et al. 2012; ZIELONKA 2006), this could be confirmed in this study as well, as the decay stage 3 and other decay stages have a different effect. Surrounding vegetation was found by BAČE et al. (2012) has a positive effect on recruiment, but descreases with a high percentage again. This finding is in line with our results, as the moss coverage shows a similar trend and also IIJIMA et al. (2007) shows that moss have a positive effect for regeneration. Other authors have demonstrated the positive effect of special fungi species, this finding could not be confirmed with this study in each respect, as the availability of a fruiting body was found to have a negative effect.

Most of the studies have used different size classes for studying natural regeneration. In this study the whole population ranging from seedlings to individuals with a height less than 130cm have been used to model the effect of deadwood on regeneration success. Further analysis for different size classes of the natural regeneration could help to differentiate between the different parameters.

The long term monitoring network established in the context of this study has shown already some interesting insights in natural regeneration from its first sampling period. Further investigations will increase the importance of the sample plots for future studies (c.f. BUGMANN & BRANG 2009; BRANG et al. 2011). Although the sample plots are influenced by man to some extent, the study sites can serve as a good proxy to study natural dynamics. The set of parameters chosen for data investigation allows comparison with other national and international studies in protected natural reserves.

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The role of protected areas for rural tourism: a depiction of Swiss and Italian cases

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Abstract

This study aims to verify how and at what extent protected areas can contribute to protect and enhance the production of high quality regional products through the promotion of particular niche tourism. The reasoning is based on the assumption according to which the interaction between environmental policies, agriculture and destination promotion generates a situation that fosters quality in local development of mountainous regions of Italy and Switzerland and maintains agricultural biodiversity.

The research adopts a depictive comparative approach. Referring to the two different models of parks management in Switzerland and in Italy, the authors focus their attention on some destinations in the protected areas of Gran Sasso - Laga National Park and UNESCO Biosphäre Entlebuch. Thereby the enhancement of high quality productions in rural tourism is considered.

Keywords

agricultural biodiversity, niche tourism, protected area management

Introduction

Within the reflexive frame social sciences have been elaborating with special concern to the paradigm of socio-economic development and to the link between this frame and sustainable tourism (MARETTI & SALVATORE 2012), the study predicts on the analysis of the processes that local development in a protected area can trigger. The possibility to succeed in such a challenge seems to be particularly linked to the level of interrelation between natural environment and the different social and economic systems. This can be favoured by protected areas' policies and objectives, through the promotion of sustainable tourism. When adequately managed, this latter can represent useful mean able to activate virtuous dynamics at a local level, especially in the enhancement of high quality regional products, of micro-hospitality and in turn, in the safeguard of biodiversity richness.

Looking at the experience of Italian parks, this approach had already been highlighted on a national level by the first frame law about protected areas (L. 394/1991). In its article 1 (describing the main objective of a protected area) the law explains that the conservation goals must be reached through the application of management methods able to realize «an integration between man and natural environment which can ensure at the same time the safeguard of anthropological, historical, architectural, archaeological values and the agro-sylvo-pastoral activities». Thus, it has become more and more evident that natural parks will realize their conservation goal as far as the use of territory by human activities will happen according to a deeper synergy with an active maintenance of biodiversity. That is why some parks have started to promote specific projects aspiring to rediscover and enhance both biological and cultivated varieties at risk. This has represented a way to "give a new value" to ecosystems not only in preservation terms but also in economical ones. Thanks to virtuous examples of cooperation between parks and farmers, it has been possible to safeguard a natural resource without risking the scarcity of it and to ensure lively local communities.

Thanks to new policies in parks' management the synergy between the promotion of naturalistic values, landscape and rural activities in Switzerland has become even more meaningful. After the integration to federal law about the protection of nature and landscape entered into force in 2007, the will of safeguarding their territories expressed by local populations was recognised officially and a new model of protected land started to be realized. This new model, which was applied to three different kinds of parks of national importance (national parks, regional natural parks, and periurban natural parks) aims at preserving the peculiar naturalistic values of a region while enhancing biodiversity richness, landscape beauty, ecosystems functionality, cultural goods through the promotion of social local development (BAUMGARTNER 2011). In order to support such kind of approach, the park authority can grant individuals or organisations whose products and services are sustainably produced and provided within the grounds of the park with a special product label. By consuming labelled local goods and services, visitors contribute to preserve and improve the local biodiversity and countryside, to promote specific cultural values and to vitalise the regional economy.

Gran Sasso Laga National Park and UNESCO Biosphäre Entlebuch

The Gran Sasso Laga National Park (GSLNP) enlarges upon a surface of around 150,000 ha in the Apennines Mountains in Center Italy; the administrative boarders of the park involve three regions (Abruzzo, Lazio and

Marche) and 44 municipalities (40 in the Abruzzo region). In an orographic point of view, the park includes hill and mountainous areas from the minimum of 219 meters to the highest peak of the Apennines, Corno Grande (2,912 meters). The park was instituted by law in 1991, but the constitution of the administrative unit came four years later (see table 1).

Table 1: General information about the two Parks (Source: own elaboration on ISTAT (Italian Institute for Statistics) and LUSTAT Statistik Luzern)

General information	**GRAN SASSO LAGA**		**UNESCO BIOSPHÄRE ENTLEBUCH**	
Number of municipalities *	40		7	
Municipalities' surface (ha)	227,800		39,451	
Park Surface (ha)	125,284		39,451	
Altitude of municipalities *mslm* (min / max)	*263*	*1,420*	620	1,159
Population, year 2010**	62,615		16,638	
Var. % population 2010/2000		*-1.4*		*-1.2*
Average population for municipality		*1,606*		*2,377*

** Only Abruzzo Region (in total 44 Municipalities and 150,000 ha Park surface)*
** * excluded the city of L'Aquila, 72,696 inhabitants in 2010*

The territory is represented by deep naturalistic features, which have been modified during the centuries by the human action for a better organization of the territory in political, economical and social terms. The signs of agricultural and pastoral economies, as well as the network of historical villages (229 minor historical settlements have been counted in the park area), still represent the matrix in which the landscape is organized. Nevertheless, the economical changes occurred in the second half of the twentieth century modified the centuries-old rules of the socio-economical organization of this territory substantially. This transformation put at risk the conservation of that landscape matrix since it is no longer supported by its related traditional economies, which are slowly but progressively disappearing (CIALONE & CHIODO 2007).

The socio-economical characteristics are similar to those expressed by many mountainous areas in Europe: small villages with a high percentage of aged residents, daily or weekly commuting to the cities and valleys surrounding the Park and law entrepreneurial vivacity. The area represents an important pole for alpine tourism and eco-tourist activities such as climbing, hiking, horse riding. Some destinations provide winter tourism offers (e.g. alpine and cross-country skiing).

The UNESCO Biosphäre Entlebuch (UBE) instead is a major valley of the river Emme between the cities of Berne and Lucerne in Central Switzerland and it is home to some 17.000 inhabitants. The surface covers 39,451 ha, and made up of woods (43%), farmland (30%), mountain pastures (18%), human settlement (3%) and unproductive surface of moor and rocks (7%). More than 50% of the UBE surface is under special protection, mainly to preserve moors. The elevation ranges from 620 meters in the municipality of Doppelschwand to the peak of the Brienzer Rothorn in the very south, as a border to the canton of Berne.

In 2001 Entlebuch was registered as a biosphere reserve by the UNESCO. This label proofs that the man-made landscape with its precious value of nature is of international relevance. The UBE has received attention as a model region for responsible economic activity and sensible management. Even skis and electric power are produced by 'partners' of the UBE.

Looking at the agricultural sector, the Gran Sasso Laga National Park still presents diverse and important characteristics. A characteristic trait is the quantity of small and often nonprofessional farms intensively imbedded in the social context. These farms produce either for self-consumption or for the local market, a supplement for their income. Many farms practice direct selling (see table 2).

Table 2: Agricultural farms and surfaces (Source: own elaboration on ISTAT and LUSTAT Statistik Luzern, Herzog)

Agricultural farms and surfaces	**GRAN SASSO LAGA***	*Variation % 2010/2000*	**UNESCO BIOSPHÄRE ENTLEBUCH**
Number of farms	5,176	*-13.5*	974
Organic	*163*	n.s.	60
With direct selling	*1,730*	n.s.	25
UAA (Utilized Agricultural Area) (ha)	61,554	*+2.8*	18,568
UAA / Territorial surface (%)	*27.0*		*47.1*

** data referred to the municipalities*

During the last decade the reorganization of agricultural production affected the sector, with the consequence of a stronger professionalization. Mainly, an increase of the agricultural land is to notice that represents a turning point and a peculiar phenomenon of the Abruzzo mountainous areas compared to the tendencies in the last decades and to regional and national trends. This tendency, accompanied by the reduction of the number of farms, leads to a bigger average surface and to more professional farms. The process of reorganization was mainly of interest for cattle breeding (reduction of the number of enterprises, growth of the number of cattle and of the surface for pastures and grasslands) whereas sheep breeding, used to be the main economic activity of the area, still shows great difficulties. Also other productions gain importance such as legumes (especially autochthonous lentils) in the mountains and olive oil in the hills.

Farms in Entlebuch are considerably bigger compared to the farms in Gran Sasso. Mother cows and dairy farming are the main agricultural products. A big share of up to 40% derives from additional income, like agritourism and other multifunctional activities (HERZOG 2012).

With special concern to the tourist structure, Abruzzo showed a deep transformation in the last decade. Against a reduction of hotels both in the number of establishments and beds, we can notice a meaningful increase of B&B, agritourism offers and other types of accommodations (huts, camp sites, apartments, etc.). These are characterized by a smaller average dimension (twelve beds places for establishment) and often for the objective of income diversification. The total amount of beds increased strongly (+43%), which proofs the vivacity of the tourism sector and a strong entrepreneurial push (see tables 3 and 4).

Table 3 – Tourist establishments (Gran Sasso Laga National Park, 2000-2010) (Source: own elaboration on ISTAT)

Establishment typology	2000		2010		var. % 2000-2010	
	Number	Beds	Number	Beds	Number	Beds
Hotels	**45**	**1,605**	**43**	**1,557**	**-4.4**	**-3.0**
B&B	-	-	42	240	-	-
Agritourism	53	456	62	635	17.0	39.3
Other establishments	19	397	65	1,078	242.1	171.5
Total other establishments	**72**	**853**	**169**	**1,953**	**134.7**	**129.0**
Total	**117**	**2,458**	**212**	**3,510**	**81.2**	**42.8**

The weakness points of the system concern the lack of self-impulsion expressed by these small companies, the necessity of coordination in the promotion and in the destination management, the role of public communication and a lack of integrated tourist products such as itineraries and packages. A general reinforcement of the sector would be needed.

Table 4 – Tourists' demand (Gran Sasso Laga National Park, 2000-2010) (Source: own elaboration on ISTAT)

Establishment typology	2000		2010		var. % 2000-2010	
	Arrivals	Overnights	Arrivals	Overnights	*Arrivals*	*Overnights*
Hotels	18,192	76,599	23,881	97,231	*31*	*27*
Other establishments	2,991	12,239	8,004	25,068	*168*	*105*
Total	**21,183**	**88,838**	**31,885**	**122,299**	***51***	***38***

Beside agricultural and forest products also the UBE offers a wide variety of tourism attractions all linked to outdoor-experiences, sports in a hilly and alpine surrounding. It offers tourism attractions for day guests and overnight guests alike. Main attractions are outdoor experiences like hiking, skiing, biking and culinary experiences. The destination management adapted a structural change with a concentration of competencies at the head office in Schüpfheim and Sörenberg. Further tasks of national and international marketing are run by the Lucerne Tourism AG which operates worldwide. This kind of marketing and organization may explain in part a double value in the occupancy rate, and a higher level in the tourism intensity, compared to the Italian Park (see tables 5 and 6).

Table 5 – Tourist establishments and demand (UNESCO Biosphäre Entlebuch, 2010) (Source: own elaboration on LUSTAT Statistik Luzern)

Establishment typology	Number	Beds	Arrivals	Overnights
Hotels	23	664	21,716	51,065

Table 6 – Tourist indexes (Gran Sasso Laga National Park and UBE, 2010) (Source: own elaboration on ISTAT and LUSTAT Statistik Luzern)

Tourism indexes	GRAN SASSO LAGA*	UNESCO BIOSPHÄRE ENTLEBUCH
Average stay (days)	4.1	1.9
Occupancy rate (days)	62	77
Tourist function (%)	2.5	4.0
Tourist density	0.9	1.7
Tourism intensity	1.6	3.1

** Only hotels; excluded the city of L'Aquila*

The Slow Food presidia and the "network of custodian farmers": the Gran Sasso Laga National Parks' projects to enhance agro-biodiversity

Among Italian parks, the GSLNP is one of the fewest who has dedicated a specific department to the agro-sylvo-pastoral development aimed at giving technical support to agriculturists and farmers. Since 2000, within the publication of "Atlante dei prodotti tipici dei parchi italiani" (Slow Food 2002), they have successfully been cooperated with local farmers for the qualitative and quantitative enhancement of their work and on working on the mapping of regional productions

While working at the "Atlante", the park's agronomists discovered that many traditional products and cultivations were heavily jeopardised in their survival. In order to preserve this biodiversity, the park decided to join the new Slow Food's project by the identification and recognition of some *presidia*. A presidia is a network of willing agriculturists, retailers, cooks, scientific experts and deliberate consumers who advocate scarce breeds, organic food and cultural landscape (Slow Food 2013).

According to the park's experts, this venture could play a pivotal role towards a virtuous model of agriculture based on quality as far as it also implied the recovery of knowledge and traditional production techniques.

Since then, the park has promoted four "presidia": two pecorino (sheep milk) cheeses ("Pecorino di Farindola" and "Canestrato di Castel del Monte"), a special salami ("Mortadella di Campotosto") and some particular small lentils ("Lenticchie di Santo Stefano). The objectives linked to the enhancement of these certified selected products have also led to important improvements in terms of social and economical organization. Little by little, producers and farmers have learnt the significance of cooperation and networking opening up new opportunities for contemporary rural development (MURDOCH 2000). Through the constant park's support, they have clustered around the projects and given birth to associations and consortiums. Being part of such organizations has enabled re-thinking the way of farming radically. From a context in which the products were very limited and their selling was confined to the direct acquaintance of the buyers, the farmers unclosed more structured forms of safeguard and guarantee of the products. The certification through the medium of the presidia has enabled these productions to be showed within the most important fairs of the sector as well as to be clearly visible and recognisable to visitors, experts and enthusiasts. In other words, an informal and fragmented way of producing has been translated into a skill of being constantly on the market.

The success of the "presidia experience" has encouraged the park's experts in seeking further strategies to look for and to conserve other autochthonous products at risk. So in 2008 they started a new project, based on the network approach, in order to map - and eventually to preserve - also the cultivated biodiversity of the park. They called the project "the network of guardian agriculturists". The first phase was dedicated in particular to yearly herbaceous crops. After mapping the already existing cultivations, they started to organize a yearly event called "SeminLibertà" ("Seeds in Freedom") on St. Martin's day (11th November) during which farmers (both amateurs and professionals) can deposit some seeds of their cultivations at risk and exchange them with others. The park will keep some of the seeds in order to maintain its own "bank of autochthonous seeds". The event is an occasion also to share and rediscover knowledge, utilisation and local traditions related to these cultivations. At the moment the network is composed by almost 140 farmers, distributed in the four provinces of the park. They have contributed in safeguarding eleven varieties of cereals, fifteen varieties of beans, thirteen varieties of vegetables.

Once ensured the rescue of the species and the safeguard of agricultural landscapes as first goals to reach, a way of enhancing them needed to be found. The revenues coming from tourist movements usually represent a very efficient mean to obtain this. That is why the park has recently launched a new project and a new network called "Guardian Restaurants and Inns" which involve those restaurants and inns available to use the protected and autochthonous species in their recipes. The final consumption of these products from tourists, and eventually their visits at farms to buy them, close the circle of an "active" conservation.

Along this process, the Park has played the role of a «society in the middle» (BONOMI 2002). It has worked as an intermediate subject, which has had a linkage function between local societies (the farmers' ones) and national institutions (the Ministry of Agriculture and Slow Food), between living places and productions, producers and consumers. In other words, it has put itself in the middle between global economy of fluxes and the local lack of high competence in doing business. It has become interpreter of local cultural values whilst keeping on respecting the general objectives of conservation defined by the national environmental policies.

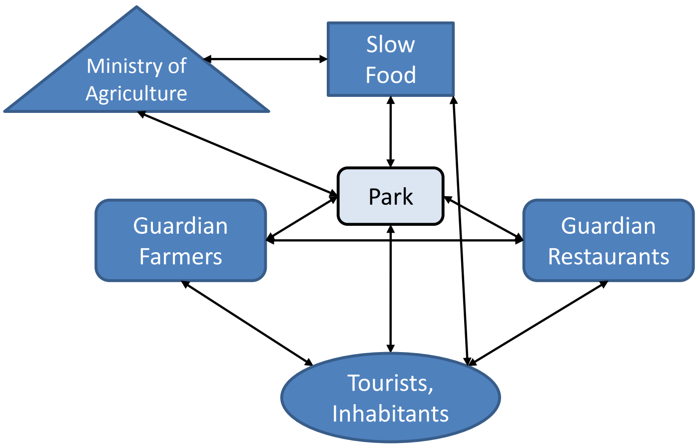

Figure 1: The park's role in enhancing local productions (compiled by the authors)

A similar process of enhancement happened also in the UBE, thanks to the establishment of a particular label, the ECHT ENTLEBUCH (real Entlebuch) which is now well known for its rural character and distinctive historical grown and well maintained sense of culture and origin. The people are proud of their over labeled 300 products of comestibles and natural products, generated by over 50 farms/enterprises with their outstanding quality. Typically labeled products are dairy, meat, herbs, tea, honey, jams, syrup, liquors and pastry. Besides comestibles, also handcrafts have been involved by the label, especially wooden and further art products. A part form ECHT ENTLEBUCH, this protected land can also refer to UNESCO labeled marketing pool and attracts by this other label a big share of its guests.

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Management and Research in Park Gantrisch of National Importance

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Abstract

The park of national importance Gantrisch has gained valuable experiences in knowledge transfer between theory and practice from his progressive cooperation with the research environment in Switzerland. The management converted its experiences in the context of studies work exemplarily. The results are summarized in form of a research strategy and in defined constituents for the coordination of scientific works. Both made a specific procedure possible. The partly considerable workload for many park employees was reduced distinctly and the research results reliably flow back to the park management.

Keywords

Switzerland, parks of national importance, protected areas, research, environmental education

Introduction

The park Gantrisch of national importance in Switzerland began the first 10-year business phase on 1-1-2012 and includes 26 park communities as bearer of the Fördervereins Region Gantrisch. The park area is about 400 km² with 43'500 inhabitants. Between the towns of Bern, Thun und Fribourg it reaches geographically into the midlands and into the alpine foothills.

The charter shows beside the management plan 25 projects, which support the three pillars of sustainability: ecology, society and economy. The executive institutions for the Gantrisch are besides the management committee five working teams with concentration on key areas: wood chamber, culture, tourism, landscape, regional products and quality.

Although by the legislator optional, research in park Gantrisch is firmly anchored in the management plan to the project "Park knowledge". From strategic partnerships with institutions from education and research on the one hand and the exchange with local experts on the other hand knowledge becomes generated. Special attention is devoted to knowledge transfer between theory and practice by the park management because the experiences have pointed that knowledge and behaviour are still two separate areas.

Bases for research

Research activities in parks of national importance are in the strategic aims of the federation associated. Because it is optional, the park Gantrisch is very progressive in comparison with other parks of national importance. The park management has realized early that research can contribute to reach the necessary aims of the park and in order to take adequate measures for valorisation and development.

After the first few years of experience with research activities within the confines of parks, three strategic requirements were defined to reduce the work load of the park personal by questions from the research areas and on the other hand to make sure, that in the park arisen dates flew back.

The three strategic areas for research activities in Gantrisch are as follows:

1. From park Gantrisch independent research, which is in any way, not accompanied by the park. These activities are, as far as known, listed in a database. As far as new projects in the park are finished, one can fall back to those dates and those relevant experts.
2. Research initiated by institutions, which are supported by dates of the park buissenes. With these research activities the experiences of the park practice flow back into research studies and it is secured, that those results are lead back to the park business.
3. Research initiated by the park and accompanied in cooperation with research institutions. Themes are generated by the projects from the management program. The results flow back instantly into the practice work of the park.

Own research of the park and on behalf contracted research are not part of the strategic areas. Neither the financial means are available none are personal capacities existing. On the other hand the areas 2. and 3. are executed by study works of students of different disciplines from research institution of the whole of Switzerland. The park aimed to accompany two to three studies by students. For these on one hand themes are formulated and written down by project leaders from the working groups, like tourism or wood. On the other hand requests of students are judged and dealt with in accordance to their relevance to the park.

Research commission on parks in Switzerland

Relevant to the park are of course also questions from other protected areas. For the coordination research on parks Switzerland has a project- and experts database (WALLNER). In Switzerland the foundation of a park law (Natur- und Heimatschutzgesetz) supports opportunities to study the development in comparative studies. The first step towards formulating a research strategy a thematic catalogue of research topics on Swiss parks was developed by a commission of experts (WALLNER & HUNZIKER 2013).

Knowledge transfer

The coordination between the management of protected areas and research experts by that way is consequently secured. But how can the results be converted reliably into the practice and how can knowledge transfer from theory to practice be organized in a protected area? This will be shown as an example of a bachelor thesis in the field of environmental education. It is known that newer discoveries in research about environmental education generally are considered too little in existing education concepts and courses. Parks of national importance offer themselves as an area of education about nature, environment and sustainability. With their offers they get in touch with large sections of the population and contribute an important part to the law (Natur- und Umweltschutzgesetz) (BAFU 2012). Exactly at this point the bachelor thesis "Education course for the promotion of the sheep's wool use in the park of national importance Gantrisch" (MÖSCH 2012) sets and offers a versatile example for the most important aspects of education on the environment (see the presented poster for the contents).

The coordination work of park management for knowledge transfer is going on parallel to the draft of scientific work (summarized in tabular form, table 1). Judging by experience the listed constituents have to be taken into account generally. As far as the content is concerned differences arise by the scientific topics. For example scientists and practitioners have mostly different ideas of a practical result. A written concept as a practical result often suffices the scientists. The park management however, demands something ready to hand. In the represented work about education these were:

1. very simple a complete list of contacts of experts around its primary topic "sheep" within and out of the region
2. a further training for park employees about "sheepwool"

Table 1: Most important constituents for the coordination between a scientific thesis and the park management in temporal sequence

	Scientific work	Coordination park
Temporal sequence	Written concept with contacts and time schedule	Information of involved park employees
		Discussion of the results to be achieved in terms of a practical aspect
		Contacting the scientific supervisor
		Data base entry of Swiss Research Commission on Parks
	Literature studies	Questions from the operating park
	Get in touch with experts	Prior information to selected known experts
		Documentation of contacts inside and outside the park area
		Exemplary participation in personal interviews with key persons
	Exemplary implementation for an evaluation	Further training for park employees
	Written report	Content study, correcting and supplementing in consultation with the lecturer
		Ensure practical results
	Presentation	Organizing an event with all parties and person of interest from research and practice
		Discussion about further research issues
	Completion and publication	Archive written work, photos and addresses
		Update the database of Swiss Research Commission on Parks
		Publish an article in a regional magazine or news paper
		Internal use of the results

In connection with the charter of the park, in the course of the study work it became obvious to the management that besides the education supply as such, the topic "sheep" until then had not been considered as an exclusive feature for the park Gantrisch. The variety of regional and supra regional experts and dedicated practitioners in the park area were the reason that further scientific work could be initiated to the topic "sustainable sheep farming on alp's in summer".

Research as a pillar for the park development

The graphic represents research functions as a pillar for the classic triangle of sustainability, which again are: ecology, economy and society (figure 1). The borders of research go beyond the practical knowledge. But also practical knowledge isn't investigated completely. Local experts make an astonishing contribution to the development of a park by dealing with experiences without scientific bases. By tourism and education the practical knowledge can get connected and carried further. In a developing region like a park of national importance, a complete picture for knowledge arises only by the exchange between practitioners and scientists.

Figure 1: From knowledge to behaviour represented by a course on the basis of the three pillars of a park according to research results

Conclusion

In company of a bachelor thesis in the park Gantrisch, an excellent example was worked out how the park management can organize knowledge transfer with scientific work. It was for the time being necessary to formulate a strategy for research activities and to become conscious which opportunities exist to establish research in the program of a park under a professional. Coordination of park research is time expensive and therefore studies must be restricted to a certain number. However, at the same time, the effort for other park employees goes down because you can assess whether an enquiry for an interview or a tour is regarding the aims of the park. Particularly the data flow and the transformation into the practice can be guaranteed by coordination and accomplish the park aims.

Knowledge transfer is said to create connections between research and practice in both directions by a constant flow of information and exchange. The explained example confines itself to the work with students and their attendants in scientific institutions. For the future it would be desirable if research institutions would get into contact with regional institutions like the park Gantrisch in general, in oder to strive for information and data exchange. So the first area of the research strategy, which was listed above, could fundamentally become more important and research would get a higher value in the park management for its development.

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Neophytes in the NP Thayatal - distribution mapping and evaluation of management

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Abstract

In the year 2000, the Nationalpark Thayatal-Podyji had comissioned a project to map the distribution of several invasive alien plant species, which also provided the background for subsequent management of these species. After a 10 years period, the distribution of the invasive alien species were re-mapped, the changes in distribution and the management efficiency were assessed. These results provide the basis for adjusting future alien species management.

The three neophytes of main concern were *Robinia pseudacacia, Impatiens glandulifera* and *Fallopia x bohemica*. Our survey showed that the management of *I. glandulifera* was successful, albeit the costs incured were substantial. As a result of substantial management efforts, population densities of *R. pseudacacia* have been strongly reduced, whereas its distribution has relatively little changed, mainly as a result of the formation of root-suckers. For this species, management efforts have to be continued. The third main target species*, F. x bohemica*, is rare in the Nationalpark Thayatal-Podyji, but notoriousely difficult to eradicate. The managed sites show lower densities than in 2001 but few new occurrences in near-natural habitats have been recorded.

For each occurrence a management goal has been proposed. The need for action was estimated and concrete suggestions for management measures were given where possible and most needed.

This study provides insights into adaptive management of invasive alien plants in national parks and thus is valuable for a wide range of protected areas, which have increasingly to cope with invasions.

Keywords

Fallopia x bohemica, *Impatiens glandulifera,* invasive species, management efficiency, neophytes *Robinia pseudacacia*

Introduction

The continuing progression of globalization increasingly affects the distribution of biota. Besides many benefits intentional and unintentional transfer of organisms among regions that were previously separated, increases. (PERRINGS et al. 2010, KELLER et al. 2011). Some of those introduced species actually become invasive and have negative impacts (KOLAR & LODGE 2001, ESSL & RABITSCH 2002). Because of frequent time lags between introduction and establishment of species the process of future invasions is likely to have been set in motion already (KOWARIK 1995, ESSL et al. 2011) and the magnitude of impacts of invasive species in Europe is expected to grow in the next future (PYŠEK et al. 2013). Therefore the need for action is high, especially in national parks which are bound in law to conserve the typical flora, fauna as well as habitats (PYŠEK et al. 2013).

In the year 2000 a first assessment of several invasive neophytes in the Nationalpark Thayatal was conducted, including species descriptions, dispersal and frequency, their habitat preferences, assessment of probable spread and issues for conservation (ESSL & HAUSER 2001). A first management plan and long term monitoring were developed. In 2010 a reassessment was conducted by the authors of this paper. The goal were i) to assess the current distribution of *Robinia pseudacacia*, *Fallopia x bohemica* and *Impatiens glandulifera*, ii) to aassess changes in distribution within the two mapping periods, iii) to record further potentially invasive neophytes, iv) to evaluate the efficiency of management measures undertaken since 2001 and v) to provide recommendation for adjusting management measures.

Study species

Fallopia x bohemica (Polygonaceae) is a hybrid of *F. sacchalinensis* and *F. japonica* (TIÉBRÉ et al. 2008), which are native to northeastern Asia (i.e. Sakhalin and northern Japan respectively Japan, China and Korea) (BMLFUW 2005). Both were introduced to Europe in the 19th century and in particularly *F. japonica* has become widespread in Austria. *F. x bohemica* is only documented more frequently since a few years, maybe due to earlier misrecognition of the species (WALTER et al. 2002, BMLFUW 2005). Considered aggressive invaders all three *Fallopia* species reproduce by clonal, rhizomatous growth and can quickly form monodominant stands (Aguilera et al. 2010). They preferably colonize shaded riparian habitats (BMLFUW 2005), disturbed sites demonstrate enhanced recruitment, colonization and spread of *Fallopia* species (TIÉBRÉ et al. 2008). *Fallopia* spp. can cause large changes to the communities and ecosystems they invade and reduce biodiversity (GERBER et al. 2008, AGUILERA et al. 2010).

Impatiens gandulifera (Balsaminaceae) is an annual forb originating from Himalaya, that favours wet and nutrient-rich riparian habitats (PYŠEK & PRACH 1995). Although in Austria the invasion history of *I. glandulifera* started as early as 1898 it has only in recent decades become one of the most widespread invasive species in Europe (BEERLING & PERRINS 1993, ESSL & RABITSCH 2006). Himalayan balsam is able to form monospecific stands, albeit the extant of negative impact on native flora and fauna is controversial (DRESCHER & PROTS 1996, TICKNER et al. 2001, HEJDA & PYŠEK 2006). HEJDA & PYŠEK (2006) implicate that control measures may even give way to invasions of other alien species.

Robinia pseudacacia (Fabaceae) is one of the most problematic alien plants in Europe (CHYTRY et al. 2005, HULME 2009,). It is native to southeastern North America and has been introduced to Europe during the 17th century (BMLFUW 2005). Black locust is a pioneer tree, able to colonize a wide array of different habitats in its secondary range (KLEINBAUER et al. 2009). However in Europe it particularly invades nutrient poor dry and semi-dry habitats, increases productivity due to nitrogen fixation and modifies nutrient cycles (KOWARIK 2003).

Methods

The field survey of the second distribution mapping period was conducted during the vegetation period 2010, mainly in July and August. All stands recorded in the first mapping period (2000) have been visitied, as well as all sites of the study species which have been found in the intermittent period. In addition, other potentially invasive neophytes were recorded and their population sizes and the invaded vegetation type were recorded.

The stands were mapped on aerial photographs in 1:10000 scale. To document the sites' size and density, all stands have been assigned to size classes (0-10m²; 10-100m²; 100-1000m²; 1000-10000m²; >10000m²), and the study species density measure was assessed based on BRAUN-BLANQUET (1964). Population trends between 2000 and 2010 were classified for each site (unknown, declining, spreading, stable).

The monitoring net installed in 2001 consists of 20 observation squares, measuring 3 x 3meters each. Eight lie within *R. pseudacacia* stands, eight within *I. glandulifera* stands and four within *F. x bohemica* stands. Within those continuous observation squares species cover of all vascular plants was estimated in percent and general data (date of assessment, verbal description of the site, localization via GPS, etc.) were surveyed.

The sites were digitalised, using ArcMap, an overview of the sites as well as 17 distribution maps were compiled. The non-graphic data were integrated into the existing ACCESS-data base from 2001.

The management evaluation is based on data from the years 2001, 2008, 2009 and 2010 provided from the national park management. Between 2002 and 2007, no data was available concerning duration and costs of management. Missing data was interpolated for this period by decreasing a steady percentage of 5,27% each year, based on data from 2001 for costs and calculating duration out of costs from 2001, thereof decreasing a steady percentage of 6,96% each year.

Results

In the year 2010, *Fallopia x bohemica* was present on 2699m² equalizing 2% of all neophyte stands (Table 1). Most stands in the national park are located in the proximity of anthropogenic settlements. Two sites were located in near-natural area of the stream Kaja. All stands are located in shadowed and wet habitats.

Management was implemented on six of the seven sites registered in 2001. Four sites were managed by mowing once a year, the date varied from May to September in the years 2008 to 2010. One site was eradicated manually by managers of the national park, two further sites were removed manually by the community. One site was not included into the management.

However, we found that *F. x bohemica* has been spreading in the National Park Thayatal since 2001. The number of polygones and sites increased from 8 polygones (7 sites) to 13 polygones (8 sites) in the year 2010, despite three sites registered in 2001 were eradicated completely. The total colonized area increased by 2028m². Regarding the four sites present in both survey periods we found an increase of the colonized area by 319m² (54%).

Average stand densities were very highy (>75%) in most sites existent in both survey periods. Only three of the four newly registered sites showed low densities (< 5%). The overall „area-density-index“, which is calculated by multiplying area (m²) by density categories (r=1, +=2, 1=3, 2=4, 3=5, 4=6, 5=7), increased by 658 points (+16%) between both survey periods. The average management effort (15 hours and 225 € per year) was rather low.

Impatiens glandulifera colonized 10.391m² (6%) in 2010 in the national park (Table 1). All 18 sites are located directly at the riverbank or within 25 meters to the Thaya river. *I. glandulifera* is found primarily in open and wet habitats (e.g. tall herb communities), the stands are small and densities are low.

The management of *I. glandulifera* included all sites registered in 2001. Large sites were mowed once a year in July (before seed set) smaller sites were removed manually. During August and September the sites were controlled and overlooked individuals were removed.

All *I. glandulifera* stands decreased in extent since 2001. The number of polygones and sites decreased from 45 (15 sites) in 2001 to 18 (11 sites) in 2010. Nine sites were eradicated completely, four sites were newly registered in 2010. The total area colonized decreased by 34,165m² (-77%), and sites which had been already colonized in 2001 and 2010 decreased even stronger (-84%, -31,159m²).

Interestingly, average population densities did only change little between 2001 and 2010. Most stands are sparse with average population densites <5%. The „area-density-index“ showed a substantial decline (-81,263 points, 85%) between 2001 and 2010. Management effort was high with average annual costs of 1600€ and 113 hours.

Robinia pseudacacia is present on 13,7 ha (137,358m²), thus contributing 85% to total stand sized of of the three study species combined (Table 1). The stands are mainly located ni forests and forest edges close to settlements.

Five of the 19 *R. pseudacacia* sites were subjected to management. They were girdled in 2001 leaving a small part of cambium to reduce resprouting. In subsequent years the root suckers were chopped and mowed several times during the vegetation period.

Overall, *R. pseudacacia* stands increased in area. The number of sites and polygones has increased from 28 (19 sites) in 2001 to 32 (26 sites) polygones in 2010. Two sites were eradicated since 2001, but six new sites were registered in 2010. Sites which were already existent in 2001 increased by 15,376m² (26%) until 2010.

Most stands with dense *R. pseudacacia* canopies (>50%) in 2001 decreased substantially. The newly registered sites show Black locust densities between 25% and 75% and are located mainly outside the borders of the national park. The „area density index“ increased by 12,302 points from 2001 to 2010. Management effort of *R. pseudacacia* was the most expensive (3800€ and 243 hours annually) of the study species.

Table 1: Change in number of polygones and sites and area invaded (m²) of studied neophytes in 2001 and 2010

	Fallopia x bohemica			***Impatiens glandulifera***			***Robinia pseudacacia***		
	polygones	sites	area m²	polygones	sites	area m²	polygones	sites	area m²
2001	8	7	671	45	15	44556	28	19	57541
2010	13	8	2699	18	11	10391	32	26	137358

Discussion

Although species composition changes fundamentally under dense *F. x bohemica* stands, the overall impacts in the National Park Thayatal are currently moderate due to the small extent of the infestations. However, the species is spreading since 2001 and it is expected to continue to spread and invade further near-natural habitats. In addition, *F. x bohemica* is difficult to manage, thus substantial negative effects are probable in the future. The management measures carried out since 2001 seem to have lowered the rate of spread, but even more dedicated management is needed. Especially sites close to along water courses should be eradicated to prevent further spread by rhizome fragments which are often transported by floods (Pyšek & Prach 1994, Hejda et al. 2009). Small stands should be managed manually by cutting and removing shoots and rhizomes. Large stands situated in less valuable habitats can be mowen once to twice a year to prevent further spread.

The invasion of *I. glandulifera* has been strongly reduced since 2001 due to dedicated mnagement efforts, and thus the negetaive impacts caused by this species are minor. To avoid re-invasion, management should continue. Remaining small stands should be eradicated manually, larger stands can be mowen annually just before seed set. Inspection of the sites in August is recommended to remove missed and later developed individuals. Management measures should be carried out until complete eradication of the species in the national park will be achieved.

R. pseudacacia ist the most wide-spread of the study species and it causes strong impacts on biodiversity in invaded habitats (Kleinbauer et al. 2009), .So far, management has been able to reduce stand densities, but further infestations have been recorded since 2010, and the overall extent of invaded sites has increased .

However, it has to be noted that improved quality of aerial photographs in 2010 facilitated exact mapping of the Black locust infestations. Thus, recording bias migth in part account for the increase in area invaded.

Within management sites older individuals should be girdled in early summer, in chest height leaving 1/10 of the bark to minimize the number of root suckers. To prevent resprouting from the stem the sapwood should not be harmed (SKEW 2006). Some of the ring barked individuals of 2001 still resprouted in 2010. In dry grassland root suckers should be removed once to twice a year, within other sites the upcoming individuals should also be removed manually. Consequent management is important until the stands are eradicated completely.

Conclusion

This study shows that management of neophytes in national parks is possible, but requires substantial and continuous ressources. The extent of the invasion and consequences for species composition and structure in the national park, the biology of the alien species, the complexity of control measures and their probable effect on the species, conservation value of habitats invaded and distribution of the study species outside the national park, which may function as source for (re-)establishment as well as the costs of management measures are some of the factors to be considered when undertaking neophyte management in national parks. Overall, the management measures taken until now show satisfying results also because of strong cooperation with the Czech Národní park Podyjí. However, invasive alien species are not perceived as a pressing problem by the public and there is a need for more education of visitors to protected areas. Education and public involvement are part of prevention which is the most effective and cheapest measure controlling IAS (Pyšek et al 2013).

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Conference Volume | **5th Symposium for Research in Protected Areas** 10 to 12 June 2013, Mittersill | pages 691 - 692

An assessment of population status and trends of the European Kingfisher in the Donau-Auen National Park and in eastern Austria

Matthias Schmidt

Keywords

European Kingfisher, population trends, habitat characters, lateral connectivity, breeding success, population index, winter mortality, Danube floodplain

Abstract

The European Kingfisher *Alcedo atthis* is a flagship species for natural dynamic riparian landscapes and floodplains. Fluctuations in population size, caused by strong winters, are typical for the European Kingfisher. During the breeding season of 2005 the European Kingfisher population in the Donau-AuenNational Park east of Vienna was studied. Population size, breeding success and characteristics of perches used by European Kingfisherswere evaluated.Morphological data and plant cover characteristics of the nest sites were collected and compared to other vertical banks without nest sites. The influence of degree of connectivity of different branches of the Danube on population distribution, breeding success and nest site characteristics were discussed.

In addition, an index for the European Kingfisher population in eastern Austria (Vienna, Lower-Austria and Burgenland) from 1988 to 2005 was calculated. The database for the index was provided by BirdLife Austria. Because winter mortality is a well known phenomenon in European Kingfishers, the index was tested by its correlation with winter intensity. For this purpose, an index for winter intensity was calculated using the total number of days and the duration of the longest period per winter with mean daily temperature below freezing point. Both indices were compared with the results from the annual European Kingfisher census of the Morava-Dyje floodplain (Verein Auring).

In comparison to a former study – 41 breeding pairs in 1989 (EICHELMANN 1990)– the results of this census (19 pairs) were relatively low. Breeding success was also very low with 34 %. In more than 75 %of cases flood waters were the reason for brood losses. Birds at breeding sites in branches of the Danube floodplain with lower connectivity to the main river had higher breeding success than those in more connected areas. Characteristics of the nest sites had no influence on breeding success.

The calculated index for the European Kingfisher population in eastern Austria correlates with the index for winter intensity. The index shows that 2005 was an average year for the European Kingfisher in eastern Austria. Both indices correlate with the results of the annual European Kingfisher census of the Morava-Dyje floodplains.

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Vegetation Monitoring of Open Habitats in the National Park Thayatal – Results of the First Period

Ingrid Schmitzberger & Barbara Thurner

Abstract

Open sites, such as meadows and dry grassland, account for a large portion of the plant biodiversity in NP Thayatal. A monitoring system consisting of 53 permanent plots distributed over the range of vegetation types and management issues was re-surveyed after 7 resp. 8 years in 2010 / 2012.

The vegetation monitoring system was capable of observing vegetation development and dynamics on a fine scale. Most sites showed considerable changes in vegetation composition and species abundance – more on managed sites. Wild boar disturbance showed no long-term effects. Management activities by the National Park, such as periodic mowing of semi-dry grasslands or holding back shrubs proved successful.

In some hay meadows insufficient mowing frequency led to fallow effects. Mowing was more efficient in reducing fallow indicators than grazing.

Some of the changes observed must be attributed to differences in weather conditions between the compared years. More frequent sampling of at least a part of the plots would be necessary to account for this effect.

Keywords

Vegetation monitoring, dry grasslands, meadows, National Park Thayatal, permanent plot, periodic mowing

Introduction

Although the National Park Thayatal is dominated by forest, a large portion of its biodiversity – especially plant diversity - is connected to its open habitats. Among those are meadows and fallow meadows on alluvial terraces in the valley bottom as well as dry grasslands on exposed and shallow sites higher up on the canyon slopes. Some are subject to management activities by the National Park authorities.

In 2003 a monitoring system was established for the vegetation of forest free sites (Schmitzberger & Wrbka 2005). It aims at observing vegetation development both induced by management activities as well as spontaneous processes. It includes 53 permanent plots to monitor vegetation changes on a very fine scale. From 2010 to 2012 they were re-sampled for the first time.

Methods

The core element of the monitoring system is a set of 53 permanent plots of 4 m², each subdivided into 4 subplots of 1m². In each subplot, all vascular plants are listed and their cover estimated each on a percentage scale. The monitoring system also includes a vegetation-complex monitoring to address the changes of vegetation types on the landscape level.

30 plots are on alluvial meadows, 23 on xeric grasslands. They are distriubuted over the whole range of site conditions and attempt to cover all major vegetation types. Some plots represent a management issue in additon, such as mowing vs. grazing, trampling, disturbance.

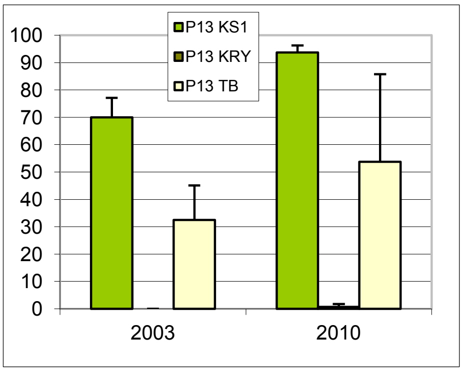

Figure 1: vegetation cover (%) in P13 in 2003 and 2010. KS1...herb layer, KRY...cryptogam layer, TB...old biomass

For analysis the species were attributed to ecological groups, such as the csr-strategy types after Grime (GRIME 1974, 1979) following the BIOLFLOR database (KLOTZ & KÜHN 2002, KLOTZ et al. 2002). Changes in the spectra of these ecological groups were analysed.

Results

Example 1 Disturbance in dry Bromus-meadow

The alluvial meadows are subject to episodic disturbance by wild boars that dig in the soil in search for worms and roots. Plot 13 at the site "Untere Bärenmühle" is an example of a species-rich dry Bromus meadow with moderate scuffing in 2003. In 2010 no signs of disturbance remain: herb cover changed from 70 percent to over 90% (Fig. 1), quite typical for meadow vegetation. Species number rose from 48 to 54. The strategy type spectrum reveals the main increase in stress-tolerant competitors (cs-type), represented by grass species typical for dry meadows, such as *Bromus erectus, Festuca rupicola* and *Elymus hispidus*. Ruderals (r) and stress-tolerant ruderals (sr) previously existing due to the disturbance vanished completely (Fig. 2).

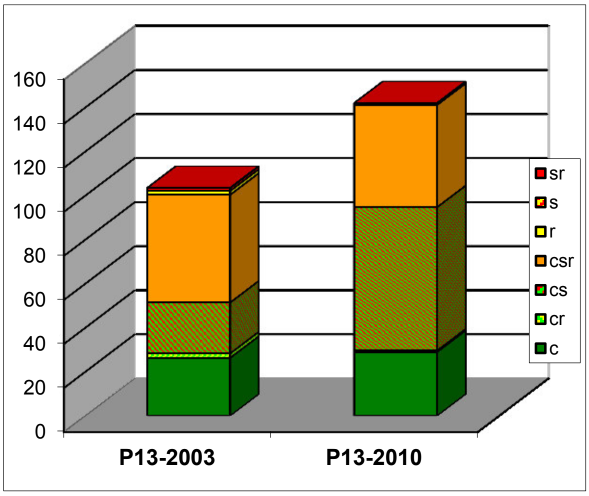

Fig. 2: percentage cover (cumulative) of Grime's strategy types in meadow-plot 13.
c… competitors, r… ruderals, s… stress-tolerants, and intermediate types.

Example 2 Periodic mowing management in semi-natural dry Bromus-grassland

Semi-natural Bromus grassland at the site "Hardl" in 2004 showed signs of fallow succession that may lead to a reduction in dry grassland species over the years. Periodic mowing management meanwhile took place two times: in 2008 and 2011.

The main fallow-indicator, *Brachypodium pinnatum*, was substantially reduced from about 25% cover to 1,4%. Winner was the sedge *Carex humilis* (5 to 16%), whereas *Bromus erectus* also showed a small reduction (from 19 to 16% cover). The strategy type spectrum moved from stress-tolerant competitors (cs) to intermediate csr-type (Fig. 3), mainly due to the changes between these grass species, as *Carex humilis* belongs to the csr-type.

The two occurring *Inula*-species - rather dynamic –switched in their significance for the vegetation stand: *Inula oculus-christi* largely increased (0,25 to 8,5%) while *Inula hirta* decreased from 10 to 1%.

Periodic mowing greatly changed this vegetation and can be attributed as successful.

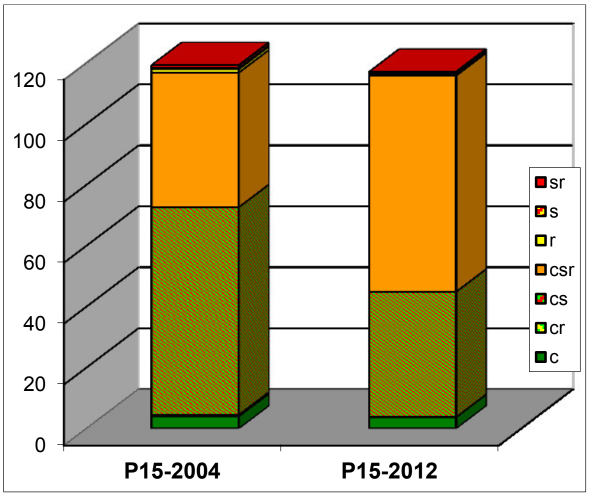

Fig. 3: percentage cover (cumulative) of Grime's strategy types in dry grassland-plot 15. c… competitors, r… ruderals, s… stress-tolerants, and intermediate types. Stress-tolerant competitors (cs) decreased while the intermediate csr-type increased.

Example 3 Blue grass steppe – Trampling

The blue grass steppe proved to be the most stable vegetation type of all. In this example we show a rather small spot above a rock face that attracts visitors by nice views although the path is closed. As can be seen in the foto-documentation the pattern of plant cover, especially that of the tufts of the blue grass *Sesleria varia*, remained quite constant. Much the same was the distribution of strategy types, and changes in single species remained marginal with the largest increase amounting to about 4% with *Potentilla pusilla*.

As in many other dry grassland plots, we lost some species between 2004 and 2012. Most of them were tiny representatives of (partly) ruderal strategy types (r, sr, cr). The extremely dry spring in 2012 prevented them from emerging. As we saw the reduction of therophytes in almost all 2012-plots, we attribute it to a weather effect rather than a sign of reduced disturbance.

The spatial stability of the plants suggests a constant or slightly reduced trampling impact - a positive report assuming increased visitor numbers along the paths in the National Park. This extraordinary constant vegetation type would be especially vulnerable to increased disturbance due to its low recovery rate

Discussion

The development in the 53 vegetation plots is quite different, much according to the different vegetation types and management issues. Most sites showed considerable changes in vegetation composition and species abundance. Only one vegetation type surprised by extraordinary stability up to the individual plant.

Altogether we saw large variations between the compared years presumably caused by disparate weather conditions: Meadows were sampled 2003 and 2010, 2003 being a slightly dry season whereas 2010 was the last of 7 rather wet years. Especially the winter was rich in long-lasting snow (ZAMG) which led to extraordinary good water supply in spring. Therefore the meadow vegetation was much lusher in 2010. Often we found increases in species richness. Many meadows showed significant turnovers in species abundance. Difficulties arise as to which degree the differences observed must be attributed to this weather effect.

For the dry sites-survey the effect is opposite, with a wet spring in 2004 that led to lush vegetation and the occurrence of many short-lived species that are missing in other years. In contrast, 2012 was the second extremely dry season in series. 90% of the plots on dry sites lost species, the vast majority of those being short-lived ruderals. We attribute this loss mainly to the weather effect.

The hay meadows are mown by local farmers according to management prescriptions. In some parts, problems with insufficient mowing frequency lead to fallow effects with increasing abundance of fallow indicating grasses, mostly *Brachypodium pinnatum* or *Calamagrostis epigeios*. Where such effects had already been evident before 2003, they were reduced, e.g. on the “Obere Bärenmühle”.

A special case is the “Große Umlaufwiese” that lay fallow for 10 years before the setup of the National Park. It was strongly overgrown mostly by *Calamagrostis epigeios*. In 2001 management was resumed partly by sheep-grazing, partly by mowing. Two plot-pairs compared these two treatments. Mowing proved to be more efficient in reducing *Calamagrostis epigeios* and restoring a species rich, nutrient poor meadow vegetation.

Wild boar scuffing is frequently observed both in meadows and on the dry sites. Short time effects are reduced vegetation cover and an increase in ruderal species. In meadows, its effect could no longer be detected seven years later. Only if the portion dug up every year exceeds a certain limit, wild boar scuffing becomes a management problem in meadows.

On the dry sites, the disturbed plots of 2004 were again disturbed in 2012, indicating a higher disturbance frequency there. In dry acid open grassland the effect was only slight, increasing openness and adding short-lived ruderals (that partly lacked in dry 2012).

Conclusion

Our vegetation monitoring system is capable of observing vegetation development and dynamics on a fine scale.

Management activities by the National Park, such as periodic mowing of semi-dry grasslands or holding back shrubs proved successful. Problems only arose in some parts where management actions have not (yet) been taken.

In hay meadows, management success differs very much between sites. Partly problems with insufficient mowing frequency and subsequent fallow effects persist. Mowing proved more efficient in reducing fallow indicator-grasses than grazing.

More frequent sampling of at least a part of the plots would be necessary to address the weather effect and better understand real trends in contrast to yearly oscillations.

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Modelling alpine permafrost distribution in the Hohe Tauern region, Austria

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Abstract

An assessment of natural hazards or the creation of risk maps in high alpine catchments very often requires the consideration of potential permafrost occurrence. The present study for the first time shows a high resolution and index based permafrost distribution for the region Hohe Tauern (approx. 4400 km²), which is based on the empirical model PERMAKART 3.0. The approach integrates three different relief classes (rock walls, steep slopes, foot slope position) in a topoclimatic key. The modelling results were validated with more than 600 BTS (bottom temperature of snow cover) measurements. At present an area of 550 km² is affected by permafrost to a lesser or greater extent. The occurrence of permafrost varies according to aspect and relief conditions in some locations more than 1000 m in altitude.In the national park "Hohe Tauern" (1856 km²) 25% of the area is underlain by permafrost. The produced permafrost map assists planers and decision-makers and contributes to better understanding of our mountain ecosystem.

Keywords

permafrost occurrence, PERMAKART 3.0, field geophysics, Bottom Temperature of Snow cover, GIS, Hohe Tauern

Introduction

Detailed knowledge about the current permafrost occurrence is of crucial importance with respect to climate change. In mountain areas, however, permafrost distribution is spatially very heterogeneous and available models have several limitations and uncertainties. Moreover, permafrost is a thermal phenomenon, defined by temperatures of lithosphere material at or below 0°C during two or more consecutive years, and sensitively reacts to increasing temperatures but is not easy to detect (Harris et al. 2003; Noetzli et al. 2007; Noetzl i& Gruber 2009; Haeberli et al. 2010). Thawing permafrost is one consequence of warming trends in the European Alps which causes a continuous change in permafrost distribution and influences a number of earth surface processes such as rock falls or debris flows (Krainer 2007; Sattler et al. 2011; Deline et al. 2012)(Fig. 1). New and accurate maps of permafrost for use by multiple audiences and outreach products regarding permafrost should be developed.

Early attempts regarding permafrost distribution in the Austrian Alps were based on an extensive rock glacier inventory of the Eastern Austrian Alps (Lieb 1996, 1998). For the entire Austrian Alps afirst digital permafrost distribution map with an adapted topoclimatickey was created by Ebohon & Schrott (2008). Austria has currently a surface area of approximately 1600 km² which is underlain by permafrost (Ebohon & Schrott 2008). Although this constitutes to only 2% of its entire territory, in its western part, like Tyrol, it can be as much as 10% and in the Hohe Tauern mountain region we expect extensive permafrost above 2500 m a.s.l. exceeding the surface area of present glaciers (see Tab.1)

The main objectives of this study are

(i) to develop a new index-based accurate permafrost distribution map for amountain area in the Austrian Alps (Hohe Tauern),
(ii) to calibrate and validate the empirical approach with numerous field evidences (bottom temperature of snow cover, field geophysics, geomorphological mapping), and
(iii) to assist the national park administration "Hohe Tauern" with a valuable outreach product for science and education purposes.

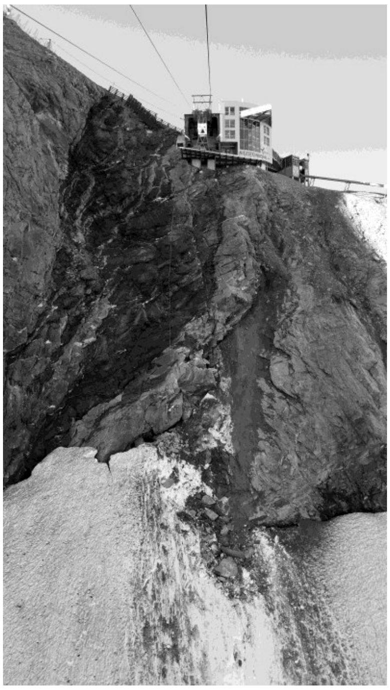

Figure 1: Permafrost related rock fall at the Kitzsteinhorn at approx. 2950 m (August 18, 2012 at 3pm). At the slip surface ice became visible after the failure. The Kitzsteinhorn region is one of our six test sites. Photo taken by M. Keuschnig.

Study area

The study area Hohe Tauern in Austria is situated in Salzburg, EasternTyrol and Carinthia, which counts to the eastern European Alps. The area under investigation comprises the “Hohe Tauern”national park (1856 km²) and its surroundings with a total surface area of approximately 4.400 km² (s. Tab. 1).The mountain ranges of Venedigergruppe, Granatspitzgruppe, Glocknergruppe, Schobergruppe, Goldberggruppe und Ankogelgruppeall belong to this area and comprise partly glacierized catchments.Numerous active rock glaciers in the Hohe Tauern region indicate the presence of discontinuous permafrost (BARSCH 1996; KRAINER & MOSTLER 2002).Within our study area we have selected six test sites for extensive local permafrost investigations, ground truth observations and validation purposes. Namely, from west to east: the Obersulzbachtal (glacierized), the Amertal, the Kitzsteinhorn (glacierized), the Glatzbach catchment (Glorer Huette), the Gradental, and the Kreuzkogel (see SCHROTT et al. 2012, OTTO et al. 2012).

Methods and data

In the field we applied measurements of the bottom temperature of snow cover (BTS), ground surface temperature recordings using UTL logger, and field geophysics (DC-resistivity, ground penetrating radar).This information was used to calibrate thetopoclimatic key and the lower limits of permafrost, respectively (see Fig.2).

<u>Bottom-temperature of snow cover (BTS) and ground surface temperature (GST)</u>

The bottom temperature of snow cover was introduced by HAEBERLI (1973) and is defined as the temperature measured at the snow/ground interface at the end of the winter (typicallybetweenFeb./Marchand April). In total we carried out 626 BTS measurements within our six test sites. In addition we installed at different locations 25 Universal temperature loggers (UTL) to record ground surface temperature (GST).

<u>Field geophysics</u>

Electrical resistivity (ERT) and ground penetrating radar (GPR) are meanwhile standard tools for permafrost detection (SCHROTT & SASS 2008).In this study we used our results of geophysics to calibrate the topoclimatic key and to cross check with BTS and modelling results (for details see OTTO et al. 2012).

<u>Empirical-statistical GIS modelling</u>

Permafrost occurrence is influenced by climatic (air temperature, solar radiation), topographic (aspect, slope), and site specific surface conditions (snow cover and duration, debris and boulder size). Air temperature and potential solar radiation can be considered indirectly by means of a topoclimatic key which distinguishes between slope and foot of slope locations (HAEBERLI 1975).The used topoclimatic key contains 24 different “relief classes” subdivided in eight different aspects each with three slope angles classified as rock slopes/walls, steep slopes (>11°) and slope foot-positions (Fig. 2). The altitudinal limits were adjusted to the Eastern Austrian Alps and differ from the original topoclimatic key which was developed for Switzerland in the model PERMAKART1.0 (KELLER 1992; KELLER et al. 1998). PERMAKART uses the statistical relationship between topographic parameters and empirically identified permafrost occurrences. For the model validation we used our BTS and GST measurements. Model calibration was realised in an iterative process using field data from geophysics which indicate permafrost absence or presence. These data were subsequently used for a further adjustment of the altitudinal limits with a general upwards shift of 50 m compared to the previous topoclimatic key applied by

EBOHON & SCHROTT (2008). An innovative amelioration of PERMAKART 3.0 is the index-based classification of permafrost probability from 1 to 100. A further important improvement of PERMAKART 3.0 is based on the new findings regarding rock permafrost temperatures (GRUBER et al. 2004). Therefore we added in the new model rock slopes as a separate unit which considers somewhat higher altitudinal limits compared to steep slopes(for modelling details see SCHROTT et al. 2012).To improve spatial accuracy we used a DEM with a grid resolution of 10 m.

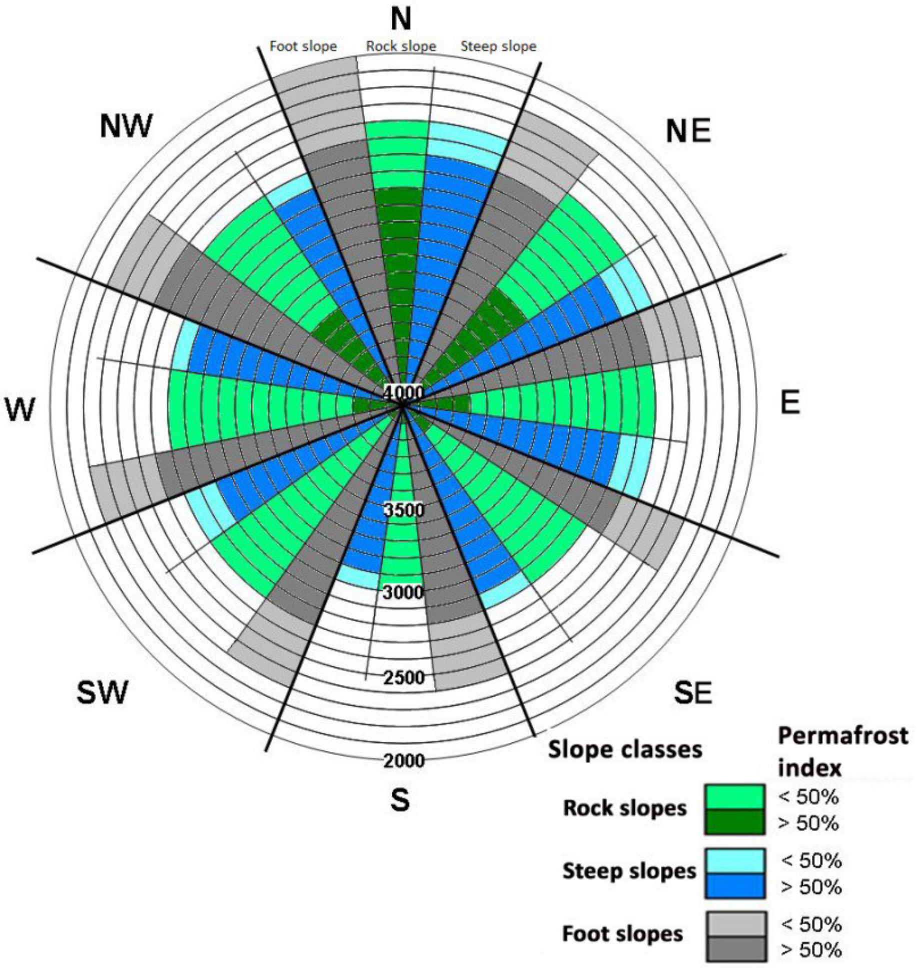

Figure 2: The adapted and modified topoclimatic key for the Hohe Tauern region used in the model PERMAKART 3.0. Three different classes of slopes (rock slopes, steep slopes, slope-foot position; read from left to right in each class) in eight aspects were analysed using a 10 m DEM.

Results

For the entire study area of the Hohe Tauern region (4378 km²) we estimatedan area of 550 km² which is currently underlain by permafrost to a lesser or greater extent. This corresponds to approximately 13% of the total area. For the national park "Hohe Tauern" with a surface area of 1856 km² the permafrost area becomes even more predominant with almost 25% (Tab. 1). In comparison to permafrost, glaciers cover only 160 km² showing currently a strong retreat which leads to a decrease in both surface area and ice volume. At present we observe especially between 3000 and 3500 m a.s.l. the most extensive glaciation (see Fig. 3).

Table 1: Surface areas underlain by permafrost and glaciers for the national Park "Hohe Tauern" and the states of Salzburg, East Tyrol and Carinthia.

Total area (4379 km²)	Permafrost distribution (km²)	Portion of surface area underlain by permafrost (%)	Glacier surface area (km²)(2003)
Study area	553,2	12.6	163.2
State Salzburg	182,8	2.6	60.8
State Tyrol[1]	218,4	10.8	66.2
State Carinthia	152	1.6	36.2
National park[2] "Hohe Tauern" (1856 km²)	455,4	24.8	159.8

[1]only East Tyrol; [2]includes states of Salzburg, East Tyrol and Carinthia

According to this approach permafrost can occur on north facing steep slopes (between 11 and 45 degrees) above an altitude of 2400 m, whereas onsouth facing slopes higher permafrost indices can be only expected above 3000 m. In slope foot-positions permafrost probability is modelled down to 2000 m on north facing slopes compared to 2400 m at south facing slopes.

Field geophysics

For details regarding local permafrost detection using geophysics we refer to OTTO et al. (2012) and KEUSCHNIG et al. (2011).

Validation of modelling results

BTS values provide the most comprehensive data set with a total of 626 measurements and allow a sophisticated validation in all six test sites. Permafrost occurrence is matched by overall 69%, classified into 46% in category (a) and 23% in (b), respectively. Very good matching is achieved in southeast, south and southwest-facing slopes (for details see SCHROTT et al. 2012).

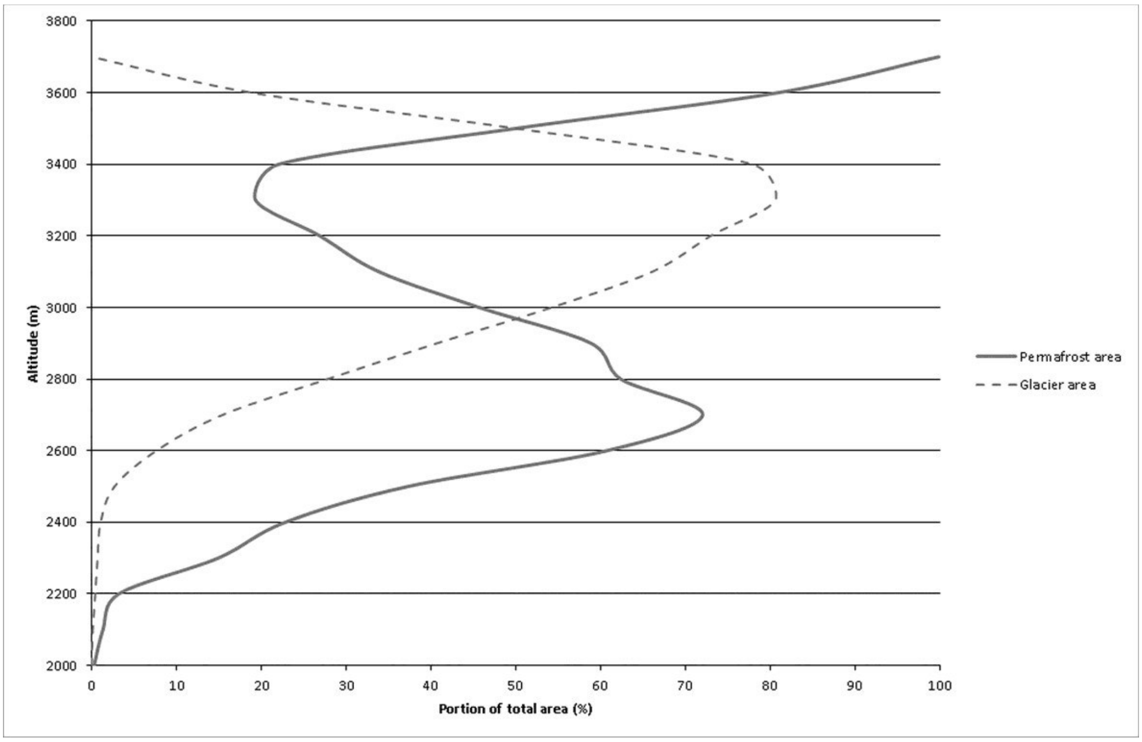

Figure3: Hypsometrical curves of glacier and permafrost extension derived from our data set used in the PERMAKART 3.0 model.

Discussion

Potential scenarios

In the European Alps climate change with warming trends can be observed since the second half of the 19th century and the mean annual air temperature increased in Austria since 1850 about 2°C (Böhm 2009). Mountain permafrost reacts sensitively to warming but somewhat delayed and almost invisible. Borehole temperature measurements in mountain permafrost in the Alps controlled by the Swiss Permafrost Monitoring Network (PERMOS) and more recently by the MOREXPERT project provide valuable information about permafrost evolution (NÖTZLI & VON DER MÜHLL 2010; KEUSCHNIG et al. 2011).In a first attempt we calculated potential altitudinal shifts of lower limits of permafrost assuming rising mean annual temperatures of 1 and 2K, respectively. Based on the average lapse rate of -0.51°K/100m we estimate theoretical shifts of lower limits of permafrost of 195 and 390m, respectively. This hypothetical assumption is, however, a strong simplification due to non-existing linear relationships between air and ground temperature. Nevertheless the proposed simple scenario can be considered as a raw indicator how permafrost distribution may change if degradation will occur extensively.

Thawing and degradation of mountain permafrost within rock walls is considered to be an important process influencing the slope stability of steep slopes and rock faces in alpine mountain ranges (KRAUTBLATTER & FUNK 2010).The interpretation of differing observations concerning permafrost thawing and degradation and potential natural hazards (e.g. rock falls, debris flows) remains a major challenge (SATTLER et al. 2011; HAEBERLI et al. 2010).

Conclusion and perspectives

For the first time a detailed permafrost distribution map is available for the region of the Hohe Tauern including the entire national park. Present permafrost occurrence is still a widespread phenomenon comprising 550 km² or approximately 13 % of the entire area. The visualized permafrost distribution primarily serves as an indication map at a regional scaleand provides the basis for a deeper understanding of permafrost related hazards. The map assists planers in permafrost related constructions, but does not substitute local investigations if detailed knowledge concerning permafrost occurrence is required.Effective adaptation measures of engineering structures in mountain permafrost terrain and estimates about permafrost evolution depend on detailed knowledge concerning permafrost distribution.

As a rule of thumb, permafrost can be expected above 2500 m a.s.l. in northerly exposed slopes and above 3000 ma.s.l. in southerly exposed slopes. A major challenge remains the estimation of the future development of permafrost in the Alps. Strong topographic variations (e.g. snow cover and duration, subsurface structure, rock vs. debris area) and different permafrost temperatures cause a different sensitivity to climate change even at a local scale (GRUBER & HAEBERLI 2007). Extensive borehole measurements in the Alps indicate the strong influence of snow cover on subsurface temperatures which enhance the heterogeneous pattern of permafrost in mountain areas (NOETZLI & VON DER MÜHLL 2010). A potential future application of the new PERMAKART 3.0 model is the integration of the cooling influence of a relatively thin (max. 40 cm) snow cover in early winter.

Acknowledgements

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Note: This paper is a short and slightly modified version of a recently published paper by SCHROTT, L., OTTO, J.-C. & KELLER, F. 2012.Modelling alpine permafrost distribution in the Hohe Tauern region, Austria. Austrian Journal of Earth Science, Vol 105/2, 169-183.

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Feeding behaviour of Ruffs during spring migration at a stopover site of international importance in Eastern Austria

Claudia Schütz & Christian H. Schulze

Nationalparks Austria Science Award 2013

Abstract

This study tested for effects of potentially important variables (location, vegetation cover, feeding habitat, wind force, date, time of day, flock size, scan rate, stepping rate) on the peck rate of foraging Ruffs *Philomachus pugnax* during spring migration at Seewinkel, an important stopover site for waders in Eastern Austria. Therefore foraging Ruffs were filmed at four salt ponds with 681 film sequences being available for analyses. Peck rate (number of pecks per 30 sec) of Ruffs proved to be mainly affected by wind force (positive effect) and feeding location. Our study emphasized the importance of maintaining a network of different salt pans, complementing each other most likely due to spatio-temporal dynamics in food availability and therefore enabling Ruffs to optimize food intake during their limited stopover time during spring migration.

Keywords

Seewinkel, *Philomachus pugnax*, food intake rate, foraging behaviour, flocking, number of steps, soda ponds

Introduction

Like many other shorebirds Ruffs *Philomachus pugnax* are long-distance migrants (van Gils & Wiersma 1996). They cover up to 11,000 km on migration routes between their wintering areas in Southern Africa and their breeding grounds in Northern Europe and Siberia (Scheufler & Stiefel 1985). In the course of migration long-distance flights are interrupted by filling up fat reserves at suitable stopover sites before continuing migration (Weber et al. 1998). At stopover sites migrants have to cope with varying prey availability, inter- and intraspecific competition for limited resources and predation pressure (Lyons & Haig 1995). Furthermore, their time schedule for spring migration is strongly constrained by selective pressures related to the approaching reproductive period (Lyons & Haig 1995; Muraoka et al. 2009).

How effectively waders adapt their foraging behaviour to the complex interactions of biotic and abiotic factors characteristic for individual stopover sites, determines the success of migration, which is ultimately measured in units of time and condition during passage and upon arrival at the destination (Smith & Moore 2003). This study aimed to analyse if, how and to which extent the variables scan rate, flock size, feeding location, weather conditions, vegetation cover, date, time and habitat patch selection affect food intake behaviour of Ruffs *Philomachus pugnax* during spring migration at Seewinkel, an important stopover site for waders in Eastern Austria (Laber 2003). In contradiction to other studies, which focused mainly on effects of single or a small number of biotic and/or abiotic variables on the foraging behaviour of birds (Beauchamp 1998; Evans 1976; but: Ward & Low 1997), we evaluated effects of a large set of different factors potentially influencing food intake of foraging Ruffs.

Food intake as quantified by birds´ peck rates can be affected by intraspecific competition. In foraging Redshanks *Tringa totanus* an increase of flock size can cause a decline of prey accessibility. Birds compensate for this by a higher mobility, measured as stepping rate, to reach habitat patches with better access to prey (Minderman et al. 2006). Therefore, stepping rate was suggested to be a good indicator of competition in foraging Redshanks. In this study we tested if stepping rate is increasing with flock size, which could indicate a potential decrease of food availability when a habitat patch is (over-)exploited by a larger flock. Then stepping rate might be also negatively related to food intake quantified as peck rate.

Methods

Study area

The Seewinkel (47°82' N, 16°77' E, alt. 115m asl) located east of Lake Neusiedl at Burgenland, Eastern Austria is a stopover site of international importance for waders, particularly for Ruffs (Laber 2003). During spring migration Ruffs represent the most abundant wader species in the area with maximum numbers of more than 10,000 birds per day (Kohler & Rauer 2009; Laber 2003).

The study area is characterised by shallow soda ponds. These pools are shallow basins with a depth of about 30-50 cm having extremely high pH values (Wielander 2005) and some of them dry up nearly every year (Wolfram et al. 1999). Among these salt pans four have been chosen for this study: Darscho (D), Illmitzer Zicklacke (IZ), Neubruchlacke (N) and Oberer Stinkersee (OS) (Fig. 1).

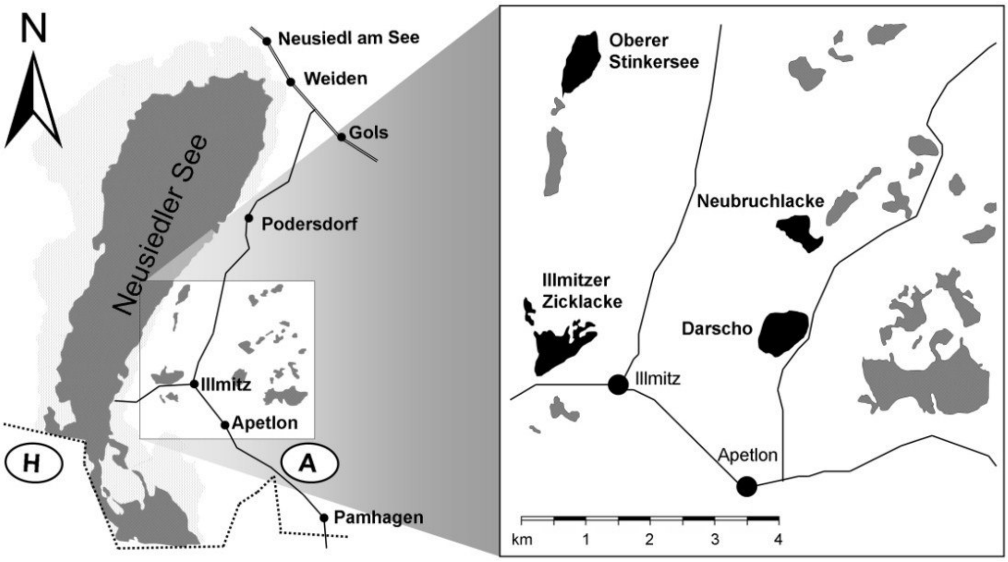

Figure 1: Maps indicating location of study area (left figure) and study sites (right figure). The four study sites, where foraging Ruff were observed (Oberer Stinkersee, Illmitzer Zicklacke, Darscho and Neubruchlacke), are marked by black fillings, other salt pan-areas are grey.

Recording bird behaviour

Foraging behaviour of Ruffs was recorded with a digital hand cam (Panasonic HDC-SX5) from an observation hut or a car to get as close as possible to the birds without affecting their behaviour by the presence of the observer. Filming of individual birds, small flocks or parts of larger flocks lasted for at least one minute. Date and time were recorded automatically during filming by the digital hand cam. Additionally, observation site and wind force (1: windless; 2: weak wind; 3: moderate wind; 4: strong wind) were noted. For bird flocks, additionally total flock size and – for mixed species flocks – the number of individuals per species were recorded. A bird flock was defined as a con- or heterospecific group of waders all within a distance of approximately 20 body lengths to the nearest neighbour.

Due to the large number of present Ruffs an individual was most likely not recorded more than once on consecutive days. In several instances information on foraging behaviour of Ruffs in larger flocks was recorded on more than one focal bird. However, the same individual was never recorded twice during the same session.

Field work was conducted from 1 April until 30 May 2008 (max. 5 days a week; total of 40 observation days). There was no field work on weekends and holidays due to the risk of higher anthropogenic disturbance potentially affecting foraging behaviour and feeding site selection of Ruffs. Furthermore, no field work was done during extremely bad weather conditions (e.g. heavy rain). Each salt pan was visited twice a day at an interval of three to four hours.

Analysis of film sequences

To quantify the frequency of scan and peck rate of foraging Ruffs, one 30 sec film sequence of every film was selected during which the focal bird was not hidden by vegetation structures or other birds. Peck rates (quantified as number of pecks per 30 sec) were used as measurement of food intake. Pecking was defined as touching or investigating the surface of water, soil or vegetation with the tip of the bill. Scan rates (quantified as number of scans per 30 sec) were used as measurement of vigilance. Scanning behaviour was defined as rising of the head from the head-down foraging position (0°) to a bill position of at least 80°.

Two types of feeding habitats were defined: semi-aquatic (foraging in water) and terrestrial (foraging on land). Additionally, vegetation cover of foraging habitats was categorized as no or sparse, low vegetation (A) or dense, high vegetation reaching at least the bird's intertarsal articulation in height (B).

Data analysis

Effects of abiotic and biotic variables on peck rate (as surrogate for food intake) of Ruffs were assessed by a Generalized Linear Model (GLM) using a log-link function. Wald statistics for the GLM were used to detect univariate effects of variables on peck rates of Ruffs. All analyses were carried out in Statistica version 7.1 (Statsoft Inc. 2005).

Results

A total of 681 film sequences of foraging Ruffs were analyzed. The two main components of foraging behaviour, scan rate and peck rate, were not correlated (r = -0.05, N = 681, p = 0.205). Stepping rate did decrease with increasing flock size (r_s = -0.32, N = 681, p < 0.001). Furthermore, peck rate decreased with increasing stepping rate (r = -0.12, N = 681, p = 0.001). However, a GLM testing for effects of biotic and abiotic variables (location, vegetation cover, wind force, date, time, feeding habitat, flock size, stepping rate and scan rate) did neither indicate an important contribution of stepping rate nor flock size in explaining variance of peck rate (multiple R^2 = 0.25, $F_{13,667}$ = 16.74, p < 0.001), whereas wind force (F = 5.13, p < 0.001; Fig. 2) and location (F = 41.56, p < 0.001; Fig. 2) showed a strong effect on the food intake rate. These two variables also proved to strongly affect Ruffs´ pecking rates according to Wald statistics (Table 1).

Table 1: Results of Wald statistics testing for effects of nine predictor variables (included in the GLM) on peck rate of foraging Ruffs (variables with a $P < 0.01$ are printed in bold).

Variable	Df	Wald statistic	*P*
Constant	**1**	**319.83**	**<0.001**
Location	**3**	**41.56**	**<0.001**
Vegetation cover	1	0.48	0.489
Feeding habitat	1	0.37	0.541
Wind force	**3**	**5.13**	**<0.001**
Date	1	0.36	0.551
Time	1	1.91	0.417
Flock size	1	0.00	0.972
Scan rate	1	2.82	0.094
Stepping rate	1	1.65	0.199

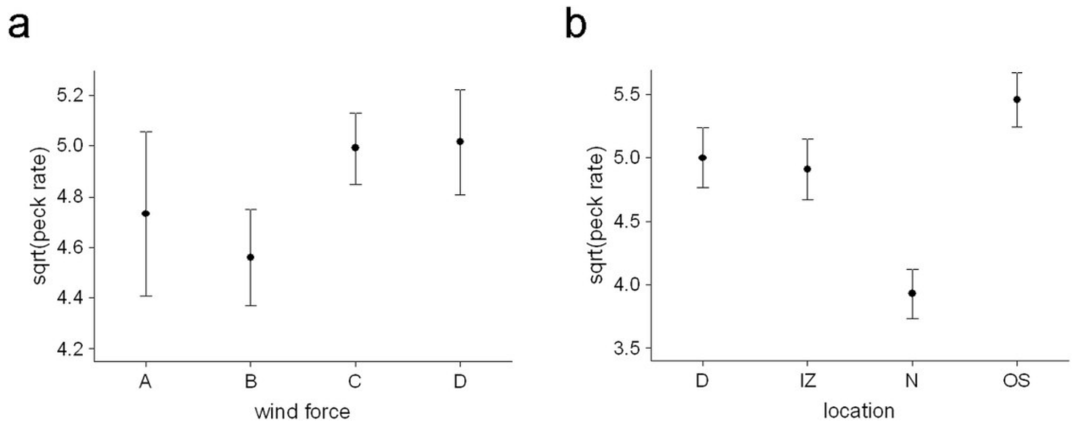

Figure 2: Least square means of peck rate (square root transformed) ± 95% confidence interval for Ruffs exposed to different wind forces (a) and foraging at four different salt pans (D ☐ Darscho, IZ ☐ Illmitzer Zicklacke, N ☐ Neubruchlacke, OS ☐ Oberer Stinkersee) (b).

Discussion

It is often assumed that an increase in vigilance, e.g. in response to increased predation risk, translates into a decrease in food intake (PULLIAM 1973; FRITZ et al. 2002) because a bird cannot peck for food and raises its head to scan for predators at the same time (SLOTOW & ROTHSTEIN 1995). An increase in vigilance can have a direct negative effect on the food intake rate through a reduction in the time available for feeding or through a decrease in foraging efficiency (LIMA & DILL 1990). However, our study demonstrated that pecking and vigilance do not always have to be mutually exclusive. Also others studies showed little evidence supporting a trade-off of peck rate against scan rate (CRESSWELL et al. 2003; SIROT et al. 2012).

In peck rate an influence of flock size is often assumed as birds in larger flocks can spend more time foraging (SANSOM et al. 2008; VAN DIJK et al. 2012). However, this does not appear to translate necessarily into a foraging benefit. For example, in foraging Redshanks food intake was not related to flock size (SANSOM et al. 2008). In general the relationship between mean food intake rate and group size can take on different shapes (BEAUCHAMP 1998). Most commonly mean food intake rate increases with group size (BEAUCHAMP 1998; CEZILLY & KEDDAR 2012; MORAND-FERRON & QUINN 2011). For example, peck rate can increase with group size because time needed to locate food patches can be reduced (BEAUCHAMP et al. 1997) and as a consequence more time can be allocated to foraging. Conversely, mean food intake rate can decrease with group size because of increasing aggressive interactions, which can decrease individuals´ foraging time and lower food intake in larger groups (STILLMAN et al. 1997). Or the relationship can be a combination of the two relationships mentioned before. Then mean food intake first increases to a maximum and then decreases with group size, a relationship that could be found in captive Skylarks *Alauda arvensis* (POWOLNY et al. 2012).

Studies have shown that flock size is an important variable in explaining variance in scan rate of foraging Ruffs (SCHÜTZ & SCHULZE 2011). However, peck rate was not directly related to group size, which was also reported by other studies (VAN DIJK et al. 2012). But our data also show that stepping rate decreased with increasing flock size, which is contrary to the expectation that flock size increases competition and, therefore, increases stepping rate because birds have to search more intensively for food. The decreased stepping rate of Ruffs in larger flocks, as found in our study, indicates better food availability at sites with larger aggregations of feeding birds. This is underlined by the observation that food intake increased with decreasing stepping rate.

Food intake rates recorded in our study differed significantly between salt pans. Peck rate was highest at Oberer Stinkersee, intermediate at Darscho and Illmitzer Zicklacke and lowest at Neubruchlacke. This may reflect different prey availability levels at our four study sites.

As Ruffs are mainly visual foragers (GLUTZ VON BLOTZHEIM et al. 1975) it did not come as a surprise that wind force had an influence on peck rate. Wind can produce strong wave action, especially at the shallow salt pans. This in turn stirs up sediments and clouds the sight for prey (EVANS 1976). Furthermore birds which feed with their heads above the water surface have to overcome the problem of the change in refractive index between air and water, which leads to distortion of the location of potential prey (EVANS 1976). This problem is augmented by wind action, which makes the water surface more turbulent (EVANS 1976). Perhaps, Ruffs foraging in salt lakes at Seewinkel showed higher peck rates during periods of stronger wind because they had to compensate for a smaller proportion of successful feeding attempts.

Conclusions

Our results clearly showed that feeding locations and weather conditions strongly affected food intake behaviour of Ruffs foraging at salt pans at Seewinkel. Differences of peck rates between feeding locations may have been the result of salt lake specific differences in food supply. Substrate characteristics and the abundance of macrophytes seem to determine seasonal and spatial differences in abundance of benthic invertebrates in the salt pans at Seewinkel (WOLFRAM et al. 1999). Due to the spatio-temporal dynamic of food availability different salt pans at Seewinkel are not redundant as stopover sites for migrating waders, but may complement each other. Therefore, the protection of the existing salt pans may be an important precondition for maintaining the high conservation status of the Seewinkel as important stopover site for Ruffs and other waders. While in the year 1850 still around 139 salt pans (3,615 ha) existed, in 1957 only 79 salt pans (1,360 ha) remained with an ongoing decrease leading to a total of only 40 salt pans in the 1990s (KOHLER et al. 1994). If the number of salt pans further decreases, the conservation value of Seewinkel as important staging site for migrating waders will most certainly decline.

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Adequate indicators for environmental change in alpine river systems (Hohe Tauern NP, Austria)
Preliminary results

Stefan Schütz & Leopold Füreder

Abstract

Alpine rivers are among the most threatened ecosystems due to increasing human pressures and environmental/climate change. As a consequence, various effects on their function and structure have been suggested, cause-effect relationships have hardly been studied. Within the research project PROSECCO.ALPS we recorded abiotic parameters and collected water chemistry and macrozoobenthos samples at 18 sites in two high alpine catchments (Großglockner and Sonnblick region) three times in 2011. After sample analyses we tested more than 30 biological indicators on their applicability to assess ecological conditions in high alpine streams. Preliminary results showed distinct differences in the species communities, individual densities and diversity with decreasing environmental harshness. Although most tested indices were developed for lower altitudes, they have the potential to provide a comprehensive set on ecological information important for indicating environmental/climate change effects.

Keywords

biological assessment, Chironomidae, macrozoobenthos, monitoring

Introduction

Alpine rivers are among the most threatened ecosystems due to increasing human pressures and effects from climate/environmental change (HANNAH et al. 2007). These impacts strongly alter ecosystem structure and function (BROWN et al. 2009),nevertheless, cause-effect relationships have hardly been demonstrated in high alpine catchments (BROWN et al. 2006; FÜREDER 2007). Within the framework of the project *PROSECCO.ALPS* (*PRO*glacial*S*tream *E*cology and *C*limate *C*hange over the *ALPS*), this study wants to i) assess faunal patterns along a gradient of environmental conditions, and ii) apply a comprehensive set of biological indices, in order to iii) find the most adequate ones for alpine lotic ecosystem condition and change.

Study sites and methods

We selected 18 study sites along a gradient of environmental harshness, 14 with (GAG1-4, KRP1, PAZ1-3, GBK1-2, GBK5-6, GBK9-10; Figure 1 & 2) and four without glacial influence (GAG5, GBK3, GBK4 and GBK8; Figure 1 & 2), in two alpine catchments (Sonnblick and Großglockner Group, Table 1).

Table 1: General information about the two investigated areas in the Hohe Tauern National Park, Austria within the framework of PROSECCO.ALPS

Facts about	Großglockner Group	Sonnblick Group
Coordinates	47°04`49''N	47°02`52''N
	12°44`49''E	12°59`06''E
Area [km²]	484.5	18.6
Altitude range [m a.s.l.]	2074-2627	2186-2359
Exposition	East & North	South & West
Sampling sites	1 without &	3 without &
	8 with glacial influence	6 with glacial influence

Semi-quantitative macrozoobenthos samples were collected in three replicates at each sampling site, using a Euro-kick-net (100µm mesh size). Simultaneously water chemistry was measured with a multi-parameter probe and water was filtered for gaining the organic and inorganic content. In the laboratory all captured invertebrate larvaeand pupae were sorted and, where possible, identified to the lowest taxonomic (species) level, using suitable identification keys: Chironomids (JANECEK 1998), Ephemeroptera (BAUERNFEIND & HUMPESCH 2001), Plecoptera (LUBINI et al. 2000) and Trichoptera (WARINGER & GRAF 1997). With these datamorethan 35indicators were tested (Table 2) in order to find the most adequate for environmental change in alpine rivers.

In our presentation we present the results of one sampling occasion in July 2011.

Table 2: Tested indicators

Indicator Type	Index
Abiotic Index	Chemical Index to Bach
Biotic Index	Extended Trend Biotic Index
	Longitudinal Zonation Index
	Trent Biotic Index
	Saprobic Index
Diversity Index	Brillouin Diversity
	Fisher`s Alpha
	Margalef Diversity
	McIntiosh Diversity
	Menhinick Diversity
	Shannon Wiener
	Simpson Diversity
	Strong`s Diversity
	Whittaker Bw
	Cody Bc
	Harrison 1
	Harrison 2
	Routledge Be
	Routledge Bi
	Routledge Br
	Wilson & Shmida Bt
	Brillouin Evenness
	Camargo
	McIntosh Evenness
	NHC
	Pielou J
	Shannon Maximum/Minimum
	Simpson Evenness
	Gini
Functional Approach	Functional Feeding Groups
	RETI
Multimetric Approach	Index of Biotic Integrity
	"Standorttypieindex"
Multivariate Approach	RIVPACS
	SERCON

Results

Preliminary results showed that besides KRP1, the Großglockner Group (Figure 1) was characterized by a quite uniform benthic community which was dominated by Diamesinae and other Chironomids.

The nine sampling sites of the Sonnblick Group (Figure 2) offer a more diverse species community. Both investigation areas show a similar trend. With decreasing environmental harshness (GAG1 to GAG4 and PAZ1 to PAZ3; GBK10 to GBK1), the benthic invertebrate abundance and Simpson diversity (SD) are increasing. Sampling sites without glacial influence (GAG5; GBK8, GBK4, GBK3) follow this trend but are characterized by comparatively higher individual density and diversity. Overall we evaluated 35 relevant indices of six indicator types (single parameter – multivariate/multimetric; Table 2) and grouped them according to their suitability and sensitivity. The most adequate indicators were applicable for: assessment of the overall situation (SERCON), assemblage changes along a stream (LZI), biodiversity (S&W, S, M), ecosystem health (SI, IBI, EBI, BMWP) and environmental harshness (Bach's CI).

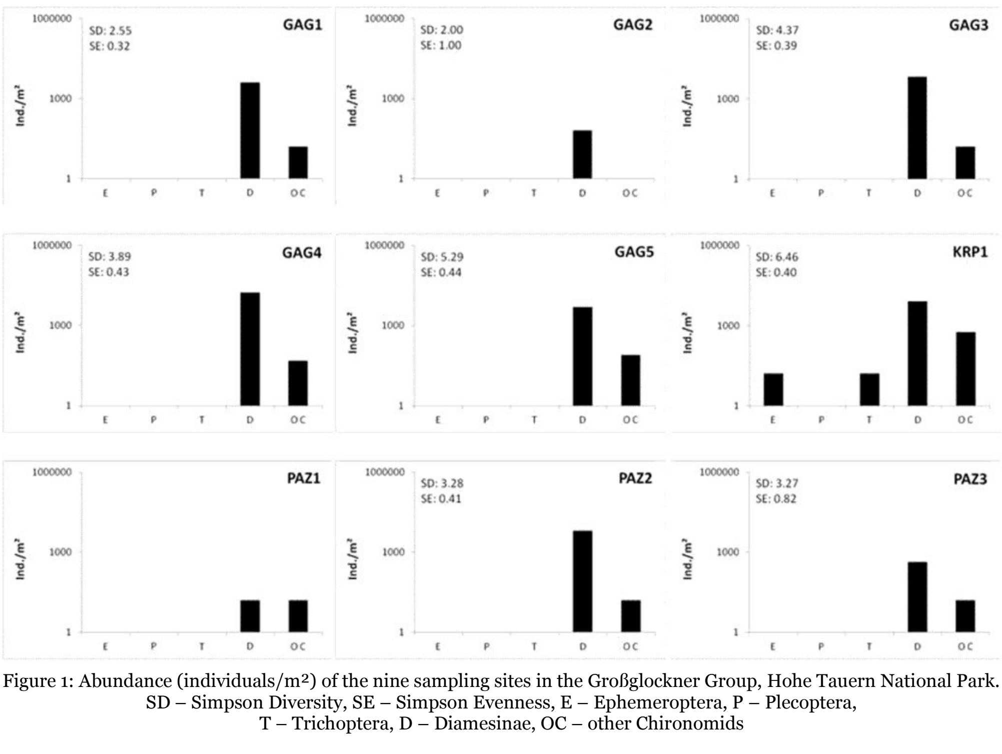

Figure 1: Abundance (individuals/m²) of the nine sampling sites in the Großglockner Group, Hohe Tauern National Park.
SD – Simpson Diversity, SE – Simpson Evenness, E – Ephemeroptera, P – Plecoptera,
T – Trichoptera, D – Diamesinae, OC – other Chironomids

Discussion

Our study showed that the paucity of information on the conditions and functions of alpine ecosystems can be compensated by applying sophisticated methodologies. Although most indices were developed for the implementation in river systems at lower altitudes, they still have the potential to provide a comprehensive set on ecological information. With the inclusion of recently elaborated knowledge (e.g. adaptations of biota, tolerances to harshness), we currently work on models for indicator modification and fine-tuning to unerringly evaluate and predict effects from environmental/climate change.

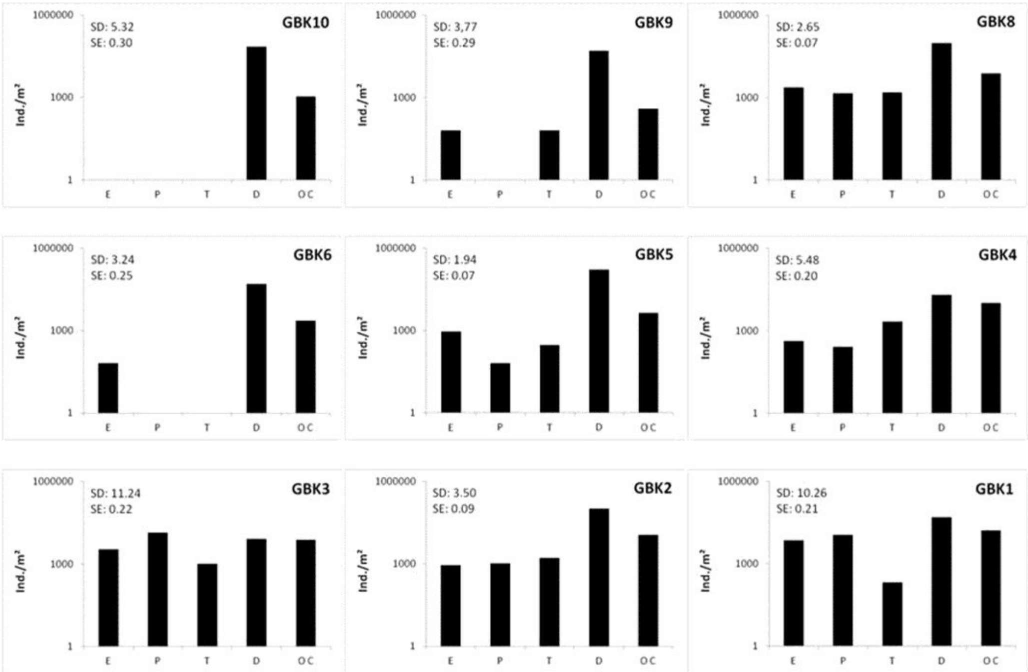

Figure 2: Abundance (individuals/m²) of the nine sampling sites in the Goldberg Group, Hohe Tauern National Park. SD – Simpson Diversity, SE – Simpson Evenness, E – Ephemeroptera, P – Plecoptera, T – Trichoptera, D – Diamesinae, OC – other Chironomids

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The Bearded Vulture in the Alps – importance of protected areas and long term monitoring

Andreas Schwarzenberger, Jens Laass, Richard Zink

Abstract

Following the extinction of the bearded vulture (*Gypaetus barbatus* L.) in the Alps, a reintroduction program was started in the National Park Hohe Tauern, Austria in 1986. Currently the program is carried by 14 partners from the whole Alpine range many of them represent protected areas. Since the first breeding attempt in 1996, 92 wild born birds have fledged in the Alps. The most important tool for the evaluation of the program´s success is the collection of observations and reproduction events. These records are the basis for analysis of the distribution of observations and breeding pairs throughout the Alps in regards to protected areas. More than half of all reported observations (61%) and 65% of all reproduction events occurred in protected areas. Major differences could be detected between countries. In Austria and France considerably more observations have been reported from inside protected areas than outside, whereas for Switzerland and Italy the opposite was found. Considering reproduction, in Italy and Austria a vast majority of reproduction events occurred inside protected areas. In France the events are more or less equally distributed between protected and non-protected areas, whereas in Switzerland, with the least amount of protected areas of all countries in the Alps, most reproduction events (61%) have been detected in areas without a special protection status. Beside specific behavioural characteristics (e.g. natal philopatry), a series of different reasons can be identified for the uneven distribution of bearded vulture observations and reproduction events, like focus of public awareness following the releases and consequently higher observation activities in the release area. But for the monitoring and the management of a reintroduced species like the bearded vulture protected areas have proven to be essential, as they have provided long-term support and participation in the creation and maintenance of this multinational monitoring system.

Keywords

Bearded vulture, reintroduction project, Alps, protected areas, long term monitoring

Introduction

The bearded vulture (*Gypaetus barbatus*, L.) is one of Europe´s largest scavenging raptors living in mountain areas of Europe, Africa and Asia. Due to food shortage and human persecution it went extinct in the Alps between the late 19th and early 20th century (MINGOZZI & ESTÈVE 1997). An international reintroduction program was started in 1986, based on the release of young bearded vultures born and reared in captivity (FREY 1992). Up to 2012 in total 184 birds have been released in the Austrian, French, Italian and Swiss Alps, the vast majority within protected areas. In 1997, the first successful breeding in the Alps after the extinction took place in Haute Savoie, France. Since then 92 bearded vultures have fledged in the wild. By now some of them are already part of successful breeding pairs. In 2006 the average number of wild born birds has exceeded the average number of released birds per year (ZINK 2010).

Methods

From the beginning of the project observation data have been collected by local and national responsible specialists. In 2000 the International Bearded Vulture Monitoring (IBM), featuring a central storage and management of all available monitoring data, was installed (ZINK & FREY 2005). In the first years most of the observations were located near the release sites. With a rising number of released birds and an increasing popularity of the re-introduction project, observations are now covering large areas of the Alpine Arc. Currently almost 55.000 observations are documented in the central online data base.

Most observations are reported by professional ornithologists and hundreds of voluntary birdwatchers, but also especially employees of protected areas. Systematic observations regularly done at the release sites have not been entered into the database to avoid additional biasing since the establishment of the IBM. For this study observation data of the last 10 years (01.01.2003 and 31.12.2012) have been used, based on the International Bearded Vulture Monitoring.

Reproduction data are collected based on an active monitoring of breeding birds conducted by dedicated monitoring specialists, park wardens and other persons in charge. The first breeding attempt was documented in 1996. For the analysis reproduction data we defined reproduction events as events where at least the production of a clutch has been documented. All collected reproduction events from 1996 to 2012 were used. Frame of reference is the Alpine Convention (1991).

All observation and reproduction data have been kindly provided by the partners of the IBM (Nationalpark Hohe Tauern, Stiftung Pro Bartgeier, Parco Nazionale dello Stelvio/Nationalpark Stilfserjoch, Provincia di Sondrio, Ufficio Faunistico, Regione Autonoma Valle d'Aosta & Parco Nazionale Gran Paradiso, Parco Naturale Alpi Marittime, A.S.T.E.R.S., Parc National de la Vanoise, Parc National les Ecrins, Parc National du Mercantour, Parc Naturel Régionale du Vercors, LPO Grands Causses, Vulture Conservation Foundation, AlpArc, see also www.gyp-monitoring.com). Data of boundaries of the protected areas (as of 2004) have been provided by AlpArc http://www.alparc.org/.

Results

Distribution of observations

In the years 2003 to 2012 a total of 22.165 observations from the Alpine region have been documented in the IBM database. The highest number of observations has been reported from France (6574), followed by Austria (6517), Italy (5803) and Switzerland (3241) (tab.1). Considering the area covered by the Alps in each country, the observations of bearded vultures are quite evenly distributed. 61% of the reported observations have been located in protected areas in the Alps. Austria is the country with the highest percentage (88%) of bearded vulture sightings within protected areas, for Switzerland (18.5% of the Swiss Alps are designated as protected area) only 15% of all observations have been located within protected areas. This suggests an even distribution of observations within and outside of protected areas. A similar situation was found for Italy where 42% of all observations have been located in protected areas which comprise 45% of Italy´s Alps. For Austria and France the bearded vulture observations are clearly concentrated in the protected areas. For Italy and Switzerland the ratio of observations within protected area is very similar to the proportion of protected areas in each country´s Alpine region.

No difference in the distribution has been found for the different age classes of bearded vultures on an Alpine scale.

Table 1: Distribution of bearded vulture observations (2003-2012) within and outside protected area (as of 2004) per country.

Country	Protected area				Sum	
	N outside	% outside	N inside	% inside	N	%
Austria	790	12,1%	5727	87,9%	6517	29,4%
France	1833	27,9%	4741	72,1%	6574	29,7%
Germany	12	44,4%	15	55,6%	27	0,1%
Italy	3354	57,8%	2449	42,2%	5803	26,2%
Liechtenstein	1	100,0%		0,0%	1	0,0%
Slovenia	1	50,0%	1	50,0%	2	0,0%
Switzerland	2746	84,7%	495	15,3%	3241	14,6%
Sum	**8737**	**39,4%**	**13428**	**60,6%**	**22165**	**100,0%**

Reproduction

Since 1996 151 breeding events have been recorded in the Alps. Out of these, 92 young bearded vultures have fledged in the wild. The first wild born bird fledged in Haute Savoie (France) in 1997, until 2012 a total of 70 reproduction events have been documented in France, 46% of all events recorded, followed by 45 events in the Italian Alps, 23 in Switzerland and 13 in Austria (tab. 2).

Of 151 breeding events 98 (65%) have been located within protected areas, but relevant differences have been noted among the countries (tab. 2). Based on the proportion of protected areas in each country, reproduction events are more often located in protected areas in all four countries then expected from an even distribution.

Of 151 documented reproduction events 92 (61%) have been successful. On an Alpine scale bearded vultures have been equally successful breeding within (60%) and outside (62%) protected areas. On a country scale breeding has been more often successful inside protected areas in Italy (74% inside vs. 33% outside). Whereas the opposite was documented for Switzerland, where 71% of reproduction events outside a protected area have resulted in fledged birds, but only 56% of events inside protected areas were successful. In the French Alps breeding success was more or less equal inside and outside of protected areas. For Austria only three successful breeding events have been documented, two of which within Nationalpark Hohe Tauern.

Table 2: Distribution of bearded vulture breeding events (1996-2012) within and outside protected area (as of 2004) per country. Breeding events are defined by a documented clutch at least.

Country	Protected area				Sum	
	N outside	% outside	N inside	% inside	N	%
Austria	3	23,1%	10	76,9%	13	8,6%
France	33	47,1%	37	52,9%	70	46,4%
Italy	3	6,7%	42	93,3%	45	29,8%
Switzerland	14	60,9%	9	39,1%	23	15,2%
Sum	**53**	**35,1%**	**98**	**64,9%**	**151**	**100,0%**

Discussion & Conclusion

Based on the population modelling by Schaub et al. (2009), the Alpine bearded vulture population in 2012 was estimated at 181 individuals. During the 7th International Bearded Vulture Observation Days (5th - 14th October 2012) at least 127 different individuals were identified through an organised effort of 720 observers at 446 sites all over the Alpine arc (Schwarzenberger & Zink 2013). Though this yearly event has mostly been organized by national parks and other protected areas which are partners of the International Bearded Vulture Monitoring, the resulting observations have been distributed over wide areas of the Alpine arc and show a similar distribution pattern as the complete dataset of observations (2003-2012) available in the international monitoring database, though these records mainly depend on chance observations.

Overall, 61% of all reported observations of bearded vultures and 65% of all reproduction events of the species have been located in protected areas in the Alps, which in 2004 comprised 31% of the area covered by the Alpine arc. Thus protected areas definitely are centres of the known bearded vulture distribution in the Alps. But as considerable differences among the four Alpine countries have been detected, the main reason(s) for this still remain unclear. One of the potential reasons is that - with the exception of two - all release sites of the reintroduction program are located within protected areas. Bearded vultures (as shown also for other large raptor species, e.g. Hiraldo et al. 1979; Milburn 1979; Newton 1979; Steenhof et al. 1984; Grubac 1987; Rymon 1989; González et al. 1992; Rudnick et al. 2008) show strong philopatric behaviour. But this behaviour explains the current distribution of documented bearded vulture pairs only to some extent (Zink 2010). Another reason for the importance of protected areas for the bearded vulture can be found in the support of protected areas to the monitoring program. With the participation in the reintroduction program, many large protected areas have also become partners of the international bearded vulture monitoring, responsible for the collection of monitoring data in their region. Unfortunately this can also lead to potential bias in the distribution of data, if a whole national monitoring program (e.g. Austria) is managed by a protected area and a clear focus of the monitoring efforts is understandably within the respective park.

Additionally many of the regional partners have established information centres focusing on the biology and behaviour of the bearded vultures and related species which often act as contact point for interested persons, which in turn results in additional chance observations being reported. Finally protected areas attract a lot of people especially interested in nature and wild animals. This often leads to increased (touristic) attendance compared with similar regions outside of protected areas, and in turn to higher numbers of reported observations, as bearded vultures are usually not negatively influenced by the high numbers of people attracted to protected areas.

Finally the habitat suitability as well as the availability of suitable nest sites have been cited as the major factors in the distribution of bearded vulture observations and their reproduction units (Zink 2005). For example a crucially low availability of suitable food sources inside and outside of protected areas, could be a reason for the low number of reproduction events in the Austrian Alps. In comparison Italian protected areas are famous for their abundance of wild ungulates and featured 28% of all recorded reproduction events. The French Alps are known for their very high numbers of livestock. Protected areas definitely can have some influence on the abundance of wild ungulates and livestock.

But regardless of the main reason for the selection of protected areas by bearded vultures, these protected areas and their organisation have proven to be essential for the monitoring and the management of a reintroduced species like the bearded vulture. They have been able to provide long-term support and participation in the creation and maintenance of this multinational monitoring system.

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Effect of active conservation management on biodiversity: Multi-taxa survey in oak woodlands of Podyji National Park, Czech Republic

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Abstract

European woodland used to be managed by livestock grazing, coppicing and fire that kept the forests open and favourable for fauna associated with open woodland habitats. However, these practices have been discontinued during the last two centuries in most of Europe. It has lead to increased canopy closure, loss of precious habitats and subsequent decrease in biodiversity. This is also the case of oak woodlands that cover most of Podyji (Thayatal) National Park, Czech Republic. Numerous endangered open woodland specialists, including such emblematic species as the aesculapian snake (*Zamenis longissimus*), the clouded apollo (*Parnassius mnemosyne*), *Purpuricenus kaehleri* longhorn beetle or the great capricorn beetle (*Cerambyx cerdo*) are restricted to forest edges or to remnants of the former forest steppes. As a part of a restoration management, small clearings with retention trees (each 40x40 m) were created. Using multi-taxa survey approach, we observe the recolonisation dynamics. We search for origin of species associated with clearings in matrix of other, locally available habitats. Preliminary results show that creating gaps in forest canopy is favourable for forest biodiversity. In comparison to closed canopy forest, the treatment plots generally harbour richer assemblages of most taxa investigated (e.g. plants, butterflies, saproxylic beetles and reptiles). However, hands off approach prevails in management of protected oak woodlands putting emphasis on maintaining natural processes rather than conservation of biodiversity. Our results based on response of the numerous taxa demonstrate that it is crucial to adopt active approaches in conservation management of protected forests in order to avoid further loss of biodiversity.

Keywords

endangered species, active conservation, open forest, forest steppe, traditional silviculture

Introduction

Open forests are biodiversity hotspots (Hunter et al. 2001; Peterken 2001; Sutherland 2002; Nilsson et al. 2005; Konvička et al. 2006; Spitzer et al. 2008). In ancient European landscape, forests were used for e.g. livestock grazing (as pasture forests) and as a source of firewood (as coppices) (Warren & Key 1991; Rackham 2003; Thomas & Packham 2007). These traditional silvicultural practices kept the forest structure open by mimicking historical natural disturbances (e.g forest fires and grazing by large herbivores) (Vera 2000; Bakker et al. 2004; Lindbladh et al. 2003). They have thus helped to maintain the forest biodiversity that has been accumulating since the end of the last ice age (Harding & Rose 1986; Brown & Boutin 2009). However, during last two centuries the traditional practices have largely been abandoned. Open forest habitats, former pasture forests and coppices have been afforested or gradually become overgrown by secondary succession and transformed into shady, closed-canopy forests. Reduced disturbance (both natural and human-induced) (Bouget 2005; Eriksson et al. 2006) has lead to lack of early-successional habitats and to subsequent decrease in biodiversity (Litvaitis 1993; Hunter et al. 2001; Nilsson et al. 2005). Active disturbance is therefore required to preserve the species associated with these successional habitats.

Disturbed forest habitats often harbour specific plant and animal species that are rare or absent in closed canopy forests because these species require sunny habitats or tend to be less competitive (Bouget 2005). Species associated with early successional stages and disturbances tended to be considered generalists associated with forest edges that do not need any kind of specific management. Many species exploiting disturbed areas are, however, specialists associated with specific site conditions (DeGraaf & Yamasaki 2003).

For effective management planning in protected areas, it is important to have knowledge about the principles of biodiversity dynamics of disturbed habitats. In 2011 and 2012, we investigated the effect of small scale disturbances on biodiversity of forest habitats in Podyji National Park. Also, we wanted to know what is the difference between gaps isolated in the forest and disturbed plots connected to open habitat (meadow or forest edge). To answer this question we performed a multi-taxa survey based on different groups of organisms, including butterflies, moths, epigeic beetles, saproxylic beetles, reptiles, birds, and plants. Here, we present the preliminary results of the study.

Methods

Study area

Podyji National Park (South Moravia, Czech Republic) protects an area of 63 km^2 covering the deep Dyje (Thaya) River canyon, mostly covered by oak dominated forests. Large part of the area used to be managed by livestock grazing and coppicing until the Second World War. The traditional management has been abandoned afterwards, and secondary succession has lead to increase in the canopy closure. Numerous endangered open woodland specialists still can be found here, including such emblematic species as the aesculapian snake (*Zamenis longissimus*), the clouded apollo (*Parnassius mnemosyne*), *Purpuricenus kaehleri* longhorn beetle or the great capricorn beetle (*Cerambyx cerdo*), are now restricted to forest edges or remnants of the open forests or forest-steppes on shallow soils of steep, rocky parts of the canyon (Picture 1).

Picture 1: An open forest stand in Podyji National Park. © P. Sebek

Study design

At six sites within the national park, pairs of experimental clearings (40x40 m) with retention trees have been created in dense forests near the bottom of the river canyon close to the alluvial meadow (Picture 2). One clearing always adjoined the meadow, while the other clearing has been isolated from the meadow by at least 20 m wide forest belt. Further, four control study plots of 40x40 m representing four types of habitats were established at each of the six sites. The habitat types sampled include closed-canopy forest, forest edge, open forest (i.e. forest steppe), and alluvial meadow. Hence, the sampling was carried out on six localities with 12 experimental clearings and 24 control plots.

Model taxa observed include: butterflies (studied by walking transects carried out four times during the season - May, June, July, August), moths (captured by ultra-violet light traps; one trap per plot, four times throughout the season), epigeic beetles (captured using pitfall traps; five traps per plot was installed from end of April to end of July), saproxylic beetles (sampled using two flight interception traps installed at 1.5m height on each study plot from end of April to end of July), reptiles (sampled using artificial shelters of 1x1m size; four shelters were placed at each plot), and birds (sampled by direct observation). Finally, census of flowering plants has been carried out at each of the plots.

Picture 2: An experimental clearing with retention trees near Hardegg. © P. Sebek

Results and Conclusions

Preliminary results of the study indicate that creating experimental clearings had a positive effect on diversity and abundance of most model taxa. Different groups, however, responded to the management in different ways. The clearings were species rich for plants, saproxylic beetles, reptiles and butterflies (among them the critically endangered clouded apollo). For moths and epigeic beetles, the clearings were less species rich than the control habitats, however, the species composition was different, with no or few species of conservation interest found in closed-canopy forest. The clearings were an important habitat for many endangered species, and might thus play an important role in streghtening their populations.

The results also show the differences between the two types of clearings. Diversity and abundance of most model taxa was higher in the clearings connected to the meadow than in the isolated clearings. Connection between the clearing and the meadow or connection to a flight corridor (forest edge) was also found to have an important effect on the species composition, the composition of the clearings connected to the meadow being more close to the composition of the open habitats or the forest edges. For future conservation planning, it is thus important to ensure the connection between clearings and other open habitats, such as open forest, meadows or forest edges.

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Glaciological Monitoring, Venedigerkees, Hohe Tauern, Austria

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Abstract

Glacier mass balance is a sensitive indicator of climate change. Changes in glacier mass result from ablation and accumulation and are directly related to prevailing atmospheric conditions. Since glacier mass balance also governs glacier runoff, it is a valuable parameter for glaciological modelling and has various climatological and hydrological applications.

The spatial and temporal storage of water as snow and ice has a significant impact on stream flow of Alpine head waters. Glacier mass balances are vital for gauging the extent of changes in ice firn and snow in different areas for different glaciers. In our case study we will carry out a direct mass balance, particularly a winter and a summer balance.Direct glacier mass balance monitoring is an opportunity to see and measure changes directly on the object of interest in a cautious manner in protected areas.

Keywords

Mass balance, glacier, monitoring, runoff, Venedigerkees

Introduction

Temporal glacier variations are among the clearest natural indicators of ongoing climate change (IPCC 2007).

A sound knowledge of the response of glaciers to climate change is of crucial importance for the assessment of water resources, sea level rise and natural hazards (Haeberli & Hoelzle 1995)

Climate change causes variations in temperature and snowfall, changing mass balance. Changes in mass balance control a glacier's long term behaviour.Since glacier mass balance also governs glacier runoff, it is a valuable parameter for glaciological modelling with various climatological and hydrological applications.

The mass balance could be determined by applying the direct glaciological or the geodetic method (Hoinkes 1970). To reach a general estimate of the past and current reactions of the cryosphere to climate change, both methods are necessary, but the direct method can lead to better understanding of glacier melt (Fischer 2011).
The purpose of this study, commissioned by the Hydrological Service Salzburg is to investigate how the Venedigerkeeswill react to climate change in future years.

Methods

We applied direct mass balance measurements to Venedigerkees. The direct mass balance is based on direct measurements in different areas on the glacier. The time frame for the measurements is the hydrological year, which runs from 1 October to 30September. In this time period ablation and accumulation were measured and will be continued annually.

Mass balance is measured by determining the amount of snow accumulated, and later measuring the amount of snow and ice removed by melting and sublimation. Mass balance is reported in water equivalent (SWE). This represents the average thickness gained (positive balance) or lost (negative balance) from the glacier during that particular year.

The mass change of the whole glacier area within a hydrological year is calculated by integrating point measurements. Ablation stakes are used to measure mass loss directly. We currently use 16 ablationstakes, which are drilled between 8 m and 10 m into the ice.

For mass gain several snow pits are used. These snow pits have to be in the same place every year and have to be characteristical for particular surroundings. The snow pits have to be as deep as last year's glacier surface was. The density of the measured snow weight lets us know the snow water equivalent (SWE) for each snowpit.

The results from these two kinds of measurements, plus additional probings, will be drawn as SWE value isolines in maps. Mass balance values derived from these maps are displayed in tables. The calculated difference of annual mass balance and winter mass balance is the summer balance.

$S = Sc + Sa$ $B = Bc + Ba$

S= whole glacier area
Sc= accumulation area
Sa= ablation area

B= entire mass balance
Bc= entire mass balance in the accumulation area
Ba= entire mass balance in the ablation area

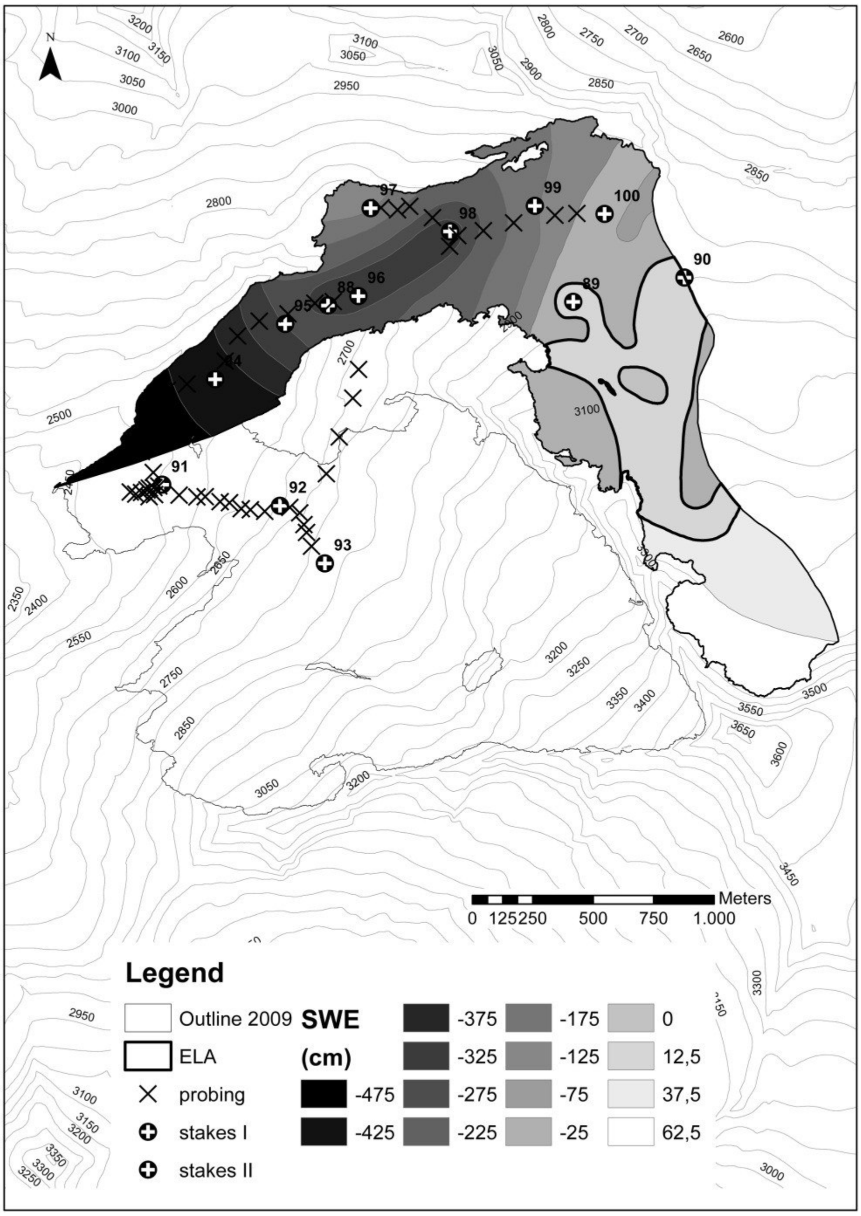

Figure 1: Mass balance Venedigerkees for the hydrological year 2011/12.

Study site

The Venedigerkees is located in the Venediger range in the core zone of Hohe Tauern National Park, Austria. The upper part of Venedigerkees is north-exposed while the lower part, and especially the tongue, is exposed to the south-west.

The area of Venedigerkees in 2009 was 2.17 km².

The elevation range of this typical valley glacier is from about 2480 m up to 3400 m, with Großvenediger the highest summit in the area at 3662 m.

Results

<u>Winter mass balance</u>

To arrive at the winter mass balance, the SWE is calculated from the depth and density of the snowpits. Snow heights from probing with mean density from all snow pits are also included.

$Bwi = 2861.9 \cdot 10^3 \text{ m}^3$
$bwi = 1323 \text{ mm}$

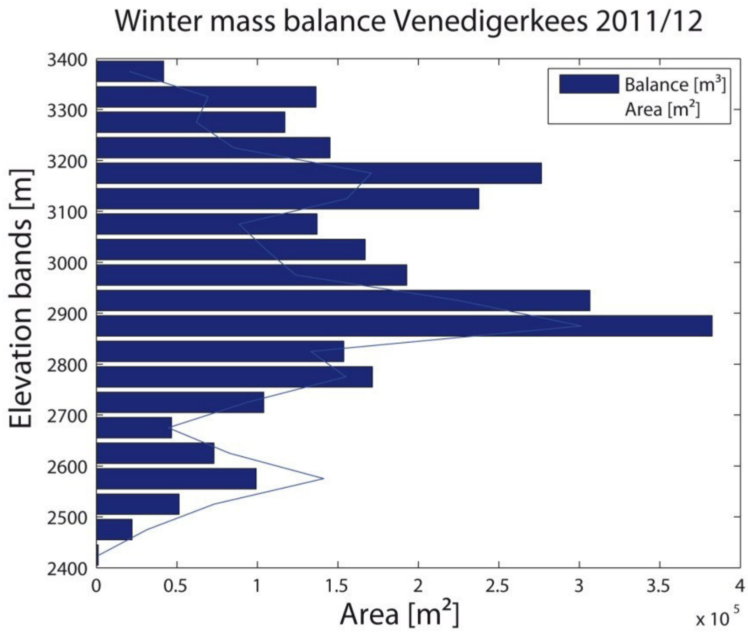

Figure 2: Netto mass balance [10^5 m3] and Area [10^5 m2] per altitutinal belt [mm ww] for winter 2011/12 on Venedigerkees.

<u>Annual mass balance</u>

The annual mass balance includes all mass loss and mass gain within one hydrological year. To calculate the SWE of the measured ablation, we assume a density of 900 kg/m³. Also mass gain is converted into SWE with the measured density from snow pits. The additional snow heights from probing are also included as SWE value with an average density of the snow pits.

B=-2847.7*10³
b=-1229 mm

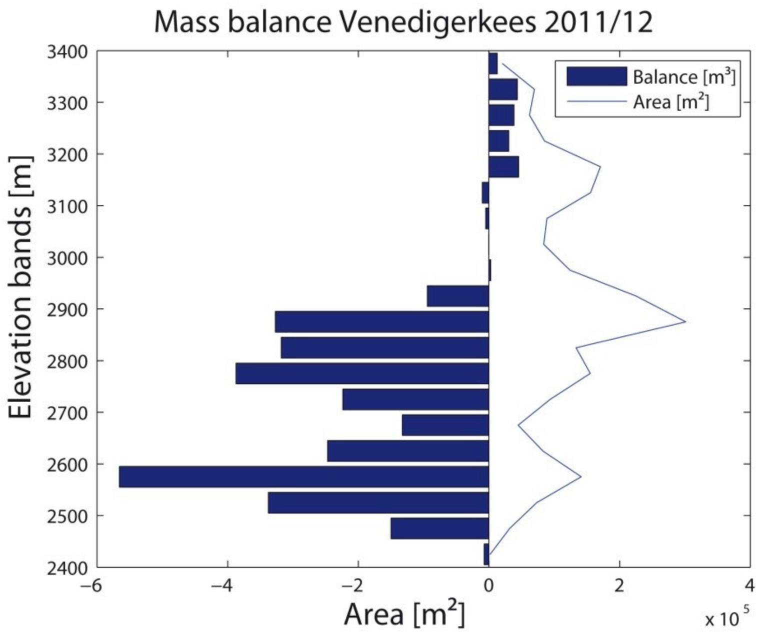

Figure 3: Netto mass balance [10^5 m³] and area [10^5 m²] per altitudinal belt [mm ww] for the hydrologic year 2011/12 on Venedigerkees.

Conclusion

The year 2011/12 was the first monitoring year for Venedigerkees, this year the mass balance was negative with a value of -1229 mm SWE. It is important to get long data series to learn how this glacier reactsto meteorological changes and to get an idea of the trend for the mass balances.

For many hydrological departments, sound knowledge about stored water in the catchment and changesin this storage are necessary for planning current and future water supply.

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Conference Volume	5th Symposium **for Research in Protected Areas** 10 to 12 June 2013, Mittersill	pages 725 - 730

Quality Standards for nature-based tourism in Protected Areas in the Alps

Dominik Siegrist & Susanne Gessner

Abstract

Nature-based tourism can be regarded as a form of sustainable tourism referring particularly to nature and protected areas. Its basic condition in terms of a strong sustainability is to make a relevant contribution to a sustainable protected area management while preserving the natural resources. The configuration of nature-based tourism in protected areas can be supported by quality standards. Therefore by means of expert interviews ten action fields of nature-based tourism are defined. Based on this and an alpine-wide written survey of actors around nature-based tourism a set of quality standards of nature-based tourism is developed. A high quality nature-based tourism in protected areas has to be deve-loped, configurated and implemented in the framework of the destination management. It has to be integrated in the underlying strategy as well as in the concrete scopes of duties of the destination. Thereby the protected area managers, the single service providers and further actors have to be included, and the quality standards have to be considered in all phases of the management cycle.

Keywords

alpine tourism, nature-based tourism, protected area, sustainability, destination, Alpine Convention

Introduction

The alpine-wide dimension of the touristic collaboration with protected areas has a long tradition, be it on destination level, in politics or in research. Since 1991 the alpine convention serves as a productive basis for the promotion of sustainable development in the alpine regions. With this an overall perspective of sustainability and cooperation is opposed to the partially hard competition between the alpine destinations. This contribution on hand for an alpine wide, nature-based tourism is to be seen within this tradition (see CIPRA 1985; CIPRA 2001; HASSLACHER 2000; HAMMER & SIEGRIST 2008).

Nature-based tourism can be regarded as a form of sustainable tourism referring particularly to nature and protected areas. Its definition comprises a responsible stay in natural areas and cultural landscapes which are close to nature. Nature-based tourism develops out of regional requirements and the participation of the involved actors. The environment as well as the social, cultural and economic circumstances shall be respected and protected, promoted and financed in a sustainable way. The visitor is enabled to experience nature and culture with all his senses. The active sensitization for the needs of nature, environment, protected areas and the region is an important component of nature-based tourism (SECO 2002; BAUMGARTNER 2003; SIEGRIST 2006; SIEGRIST et al. 2007; NEWSOME et al. 2009; FREDMAN &TYRVÄINEN 2010; RÜTTER-FISCHBACHER et al. 2011).

Nature-based tourism possesses a spatial dimension (orientation on nature and landscape) and a normative dimension (reference to sustainability). It is not only about a sole section of tourism in the sense of a specific touristic product. In fact nature-based tourism comprises the whole spectrum of the touristic service chain, from the ecological high quality accommodation and provisions, the environmentally friendly touristic offer and the sustainable mobility to the professional information and marketing (SIEGRIST & STREMLOW 2009; FREDMAN & TYRVÄINEN 2010).

Fundamental precondition for nature-based tourism is the existence of nature and landscape as a protected area (first nature) in a fair amount and high quality as well as the availability of touristic structures and infrastructures (second nature). Of central importance is also the participation of the locals, the protected area managers, the touristic service providers and further relevant actors. The demand for nature-based tourism in the alpine countries is considerable and growing by trend. Yet it cannot be allocated to a single guest segment. A "nature-based guest" in the narrow sense cannot be identified (SCHNIDER 2009; FRIEDL et al. 2005; FORSTER & SIEGRIST 2009).

Though in the single alpine countries accordant initiatives have been taken, to date there exist no alpine wide quality standards for nature-based tourism. Yet for the alpine destinations with its manifold forms and specifications, for its touristic service providers and for the protected areas managers such standards would bring an additional use. The paper on hand concentrates on the following research questions:

- Which are adequate action fields and which quality standards apply for the nature-based tourism?
- And based upon this: How can the nature-based tourism be integrated ideally in the management of alpine destinations and protected areas?

Methods

For the examination of the research questions a mix of qualitative and quantitative methods was chosen: literature- and document analysis, qualitative expert interviews and a representative quantitative survey.

The first task was the clarification of the definition, the delimitation and the characteristics of nature-based tourism in the alpine space as well as a first draft of alpine wide quality standards. To structure the action fields ten guideline-based expert interviews with actors of nature-based tourism (touristic stakeholders, researchers, protected area managers, NGOs, public and private departments) in the alpine countries Germany, France, Italy, Austria, Switzerland and Slovenia were taken. The interviews took place between September 2011 and January 2012, the content and results of the interviews are recorded in interview-notes.

Based on the results of the basic research and the expert interviews currently a representative written survey concerning nature-based tourism is carried out with touristic actors and further relevant stakeholders in the whole alpine space. Therewith the quality standards of nature-based tourism in the protected areas can be further specified. In the advanced course of the project they are going to be validated by stakeholder involvement with actors out of the practice and with pilot destinations.

Results

Nature-based tourism and touristic destinations in the alps

In the alpine protected area destinations the nature-based tourism has a great significance. Destinations are spatial entities that are clearly delimited outwards and consist of different touristic service providers and other actors (like protected area managers) that are linked with each other and outwards by complex relations and networks. Destinations focus on a certain touristic demand and are in relationship to the different environmental spheres (economic, physical, political and social). For this reason they agitate within the limits of sustainable and non-sustainable action. The higher the share of the existing natural basic factors, the higher the possible share of nature-based tourism offers. The smaller the share of natural basic factors (e.g. in cities), the smaller is the potential of nature-based tourism (cp. BIEGER 2004; LUNDBERG & FREDMAN 2011).

The destination management organization (DMO) as the main agency responsible for the comprehensive and cooperative functions in tourism possesses a scope to design its action fields more or less nature-based. A framework for that is the character of the relevant key markets and their affinity for nature-based tourism. The DMO is responsible for planning, creation of touristic offers and marketing. It faces the challenge to create a comprehensive nature-based touristic offer within the framework of the (sustainable) overall touristic product together with the service providers.

However the nature-based tourism until now is in many cases only beared by single service providers within the destination or even outside the destination (e.g. single tour operators), but not by the destination itself. Yet a high quality nature-based tourism in protected areas can only prevail if it gets its adequate significance within the destination management. The nature-based tourism is to be included in the underlying strategy as well as in the concrete scopes of the destination, but also of the protected area. Thereby the single service providers and further actors have to be included and to be sensitized for the nature-based tourism (cp. BIEGER 2004; LUNDBERG & FREDMAN 2011; WILLIAMS & PONSFORD 2009).

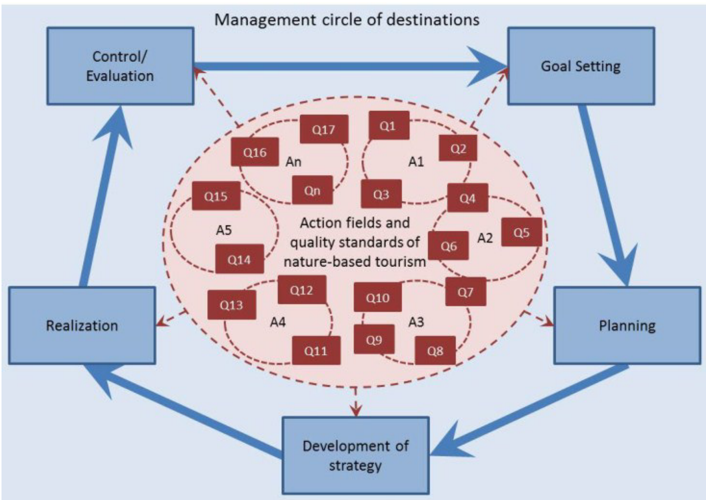

Figure 1: Quality standards (Q) of nature-based tourism and its action fields (A) in the management circle of the destination. (Source: own design).

Alpine wide quality standards for nature-based tourism

Normative standards are common in the quality management of the service economy and nature management. Standards are meant to be consistent and generally acknowledged directives for the organization and execution of a service or a protected area. Quality refers to a state of systems, in this case the subsystem nature-based tourism in the framework of the overall system tourism (ULRICH & WAXENBERGER 2002).

Quality standards of nature-based tourism constitute a normative basis for the management of destinations and protected areas. They illustrate to the management how the nature-based tourism in destinations and protected areas can be designed and further developed and which requirements should be fulfilled. Figure 1 shows how the quality standards should be considered in all phases of the management circle of the destination. The quality standards (Q) are allocated to one of multiple action fields (A).

Which are from the requested experts points of view the most important quality features for a nature-based tourism in the alps? For an interim answer of this question ten action fields can be differentiated:

- *Action field „activities"*: The nature-based design and practice of activities in nature-based tourism depends on the intensity of utilization, the adequate carrying capacity of the recreational space, the kind of activity and the individual behavior of the people searching for recreation. Examples for standards are the balanced allocation of different nature sport activities in an area or the interdiction of motor sports in natural areas.
- *Action field "development of touristic offers and infrastructure"*: The quality in the development of offers in nature-based tourism depends on the environmental sustainability of the offers respectively infrastructures. Further important are the authenticity and the originality, the nature experience quality and the orientation on target groups. Quality standards are e.g. the authentic geographical reference or the special features of the touristic offer.
- *Action field "information, environmental education, sensitization"*: Component of a nature-based tourism are professional information and educational offers regarding nature, culture and ecology. Thereby guests are sensitized for nature and enabled to independent nature experience. Examples for quality standards are the orientation on target groups of the information offers or the considering of contemporary requirements on offers of environmental education.
- *Action field "Protection and maintenance of sensible areas"*: The existence of an attractive natural and cultural landscape and a special flora and fauna is the major basis of nature-based tourism. At the same time nature-based tourism has to consider protected areas and to contribute to the protection and maintenance of nature and landscape. Quality standards are e.g. the professional integration of destination management and management of protected areas, or the financing of protected areas through the tourism.
- *Action field "accommodation and provisions":* A high environmental quality of accommodation and provisions and their promotion by the destination is of high importance for the quality of nature-based tourism. Original, authentic hotels and products typical for the region increase the holiday experience of the guests. Quality standards are related to the architectonical quality of guest houses or the high share of provisions typical for the region.
- *Action field "mobility":* Important for the nature-based tourism are the development and implementation of sustainable tourism traffic in the destination as well as options for the mobility of guests by human power. Quality standards comprise e.g. the arrival by public transport or the slow traffic within the destination.
- *Action field "regional added value":* The nature-based tourism promotes the regional economic cycles and contributes to the added value in the destination. Quality standards apply e.g. to the number of full-time or part-time positions generated by the nature-based tourism.
- *Action field "Support within the destination":* The support by the stakeholders in the destination, the cooperation of various partners and the broad participation of the locals are an important success factor of nature-based tourism. Quality standards are e.g. the acceptance of the population to nature-based offers and nature protection or the number of successful cooperation.
- *Action field "positioning and marketing":* Based on the touristic overall concept the profile, the positioning and the communication of nature-based tourism have a fundamental importance. The professional and long-term marketing is indispensable. Quality standards refer e.g. to the significance of nature-based tourism in the destination strategy or to the financial means which are used for the communication of nature-based offers.
- *Action field "further education":* A good and well-addressed further education of the service providers and other actors of nature-based tourism pose a great challenge. This applies touristic aspects as well as nature and environmental protection. Quality standards concern e.g. the number of further educational offers respectively its participants.

Discussion and Conclusion

By reason of the findings of the expert interviews we have defined ten action fields of nature-based tourism in protected areas. Based on this and with help of an alpine wide written survey of actors of nature-based tourism currently a set of quality standards is elaborated.

Convertible quality standards need a definition of nature-based tourism as precise as possible. A central challenge thereby is the selective delimitation of nature-based and not nature-based forms of tourism. But just this task for the following reasons builds some difficulties:

- Not all nature-related touristic activities, e.g. in the field of outdoor recreation, are environmentally sustainable.
- Whole destinations in most cases cannot be called "nature-based", as they also include service providers and offers that pursue other goals.

- The success of nature-based tourism depends on the partly contradictory guests' preferences – the "typical" nature-based guest does not exist.
- A part of nature-based tourism includes several other touristic fields like mobility and accommodation that makes the delimitation still more difficult.
- Nature-based tourism cannot always be delimited spatially, because it does not concentrate only on protected areas and can also take place e.g. in the catchment area of touristic centers.
- In the different alpine countries partly diverse conceptions of nature-based tourism, protected areas and its significance exist.

Against this background it is necessary to define certain elements of the definition of nature-based tourism at first from a normative point of view. Furthermore it is important to adjust the therefrom deduced quality standards with participatory methods with the relevant actors. Likewise it is reasonable to test the effectiveness of the quality standards by means of pilot regions. Thereby the question has to be responded which actor groups have a special importance in this process and how the quality standards can explicitly be integrated in the quality management systems of the destination and the protected area.

The future of nature-based tourism in the alps depends not only on its professional and consequent implementation within the destination. At least as important for a nature-based tourism perspective is the further development of the general social framework conditions. Basically two dimensions seem to be significant: first of all the future social demand for "nature" and therewith for nature-oriented touristic offers. Second the general perspective of sustainability against the background of a further shortage of the worldwide resources. It will be crucial for the future of a nature-based and sustainable tourism if it succeeds to move to – however natured - scenarios of sustainability in a socio-political and economical way in sufficient time.

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Human Impact on Hydrographic Processes in Aquatic Complex of Nature Park Hutovo Blato

Muriz Spahić, Emir Temimović, Haris Jahić

Abstract

Aquatic complex of Nature Park Hutovo blato has suffered several anthropogenic changes due to construction of hydroelectric power plant HE "Čapljina". These processes are significant especially in Donje (Lower) or Svitava blato. Donje blato has been transformed, through anthropogenic actions, into Svitava lake. This lake has been artificially separated from hydrographical complex and also a system of Hutovo blato. Since then this aquatic complex has a processes which are different related to time before construction of accumulation.

Anthropogenic changes disturb the natural balance of hydrographical systems in aquatic complex in Hutovo blato. These processes has been accelerated a change of a natural systems, especially in a potamological processes on river Krupa and limnological processes in Gornje (Upper) blato, also known as a Deransko lake. River Krupa, as well as Gornje blato, were out of range of direct anthropogenic engagements.

This paper includes several comparative analysis of previous natural state of the Hutovo blato and its recent status.

Keywords

aquatic complex, ornithological park, nature park, crypto-depression, ecological balance, hydrogeographic analysis, ecological problems, hydro technical action

Introduction

Complex analysis regarding recent changes of living habitats in aquatic complex Hutovo Blato, are looking for new methods and new specific approaches to restore earlier natural conditions. By doing so, this formerly famous ornithological part of unspoiled nature would be given its primary role. The complexity of such research and the introduction of new methodologies in the assessment of the existing situation involve a program of research, which includes a qualitative assessment of the functioning of the earlier natural hydrographic conditions in aquatic complex Hutovo Blato.

Qualitative assessment of hydrographic conditions, prior to anthropogenic interventions in this aquatic complex provides sufficient information on the identification of stability and balance factors, involved in the creation of the natural conditions in aquatic complex that support natural habitat for waterfowl (swamp birds). These studies are comparing emerging anthropogenic conditions that clearly differ from the original, nature ones. Confirmation to this clam is the disappearance of aquatic habitat for aquatic fauna and waterfowl.

Monitoring results of hydro geographic studies allow comparison with the current situation in the changed aquatic complex Hutovo Blato. In addition, monitoring results provide the basis for newly anthropogenic systems to by measured and adapted, in order to, at least partially, return complex's natural role. This could only refer to the Gornje Blato or Deransko Lake because the Donje Blato is permanently lost due to adaptation of reversible basin of Power Plant "Čapljina." In elaboration of this problem comparative analysis was used of water levels before and after anthropogenication of aquatic complex, with the overall objective of introducing anthropogenic into natural aquatic system. (Fig. 1.)

Figure 1: Gornje Blato (left) and Svitava Lake (right)

Materials and Methods

First hydrographic studies of Hutovo Blato and its water resources was carried out in the context of complex diagnostic studies in 1983, ten years after the construction of the new complex of anthropogenic Power Plant "Čapljina" in 1972. Studies were comprehensive and lasted until 1985. New recognition observations and monitoring of development aquatic complex were performed in a informative manner (by the authors of the study), during the regular course of performing field teaching for students of geography (University of Sarajevo), followed by numerous scientific conferences and workshops, as well as media coverage of the events addressing this extremely important aquatic complex. National Park Hutovo Blato, was first proclaimed, a state protected "Ornithological Park Hutovo Blato" in 1954. Its name was changed in 1995 to "Nature Park - Hutovo Blato". This valuable natural monument is in the early stages of their natural existence was enlisted in the "Registry of Wetlands of International Importance" in 1971. After one year, park's natural component was changed to anthropogenic one. Nevertheless, during 1980, Hutovo Blato was included in the "International Project for the Protection of Mediterranean wetlands." These change, from natural to modified anthropogenic aquatic complex, demanded additional research, scientific observation, analysis of existing and previous conditions, etc. It was important to monitor these changes so that the new methodology to preserve and improve the functioning of its natural elements could be introduced.

Studies are based on the monitoring of seasonal, annual and statistical hydrological indicators in long term. Statistical data from the hydrological functioning pre-anthropogenic phase aquatic complex Hutovo Blato were compared with those after its anthropogenic changes. In addition to the analysis lacustrine-talmatologic (lake-wetland) monitoring, a detail fluvial (river) limnographic monitoring was considered, also including water levels on the river Krupa, which drainage Hutovo Blato into the lower course of the river Neretva.

Beside these statistical indicators, other scientific research methods were used: methods of field observation, morphometric methods, morphogenetic, geological, mineralogical and petrography and other contemporary geographical research methods. Monitoring methods in field research helped in determining the amount of water accumulation of Hutovo Blato in certain seasons.

In order to recognize current hydro-geographic state in aquatic complex Hutovo Blato, a periodical survey and measurements (of the quantity of the water) were conducted, including natural and other springs in the lower part of Gornje Blato, precisely Deransko Lake. On the bases of field observations, decade of data gathering, as well as diagnostically assessment in Hutovo Blato, a new cartographic map was introduced (Fig. 2.)

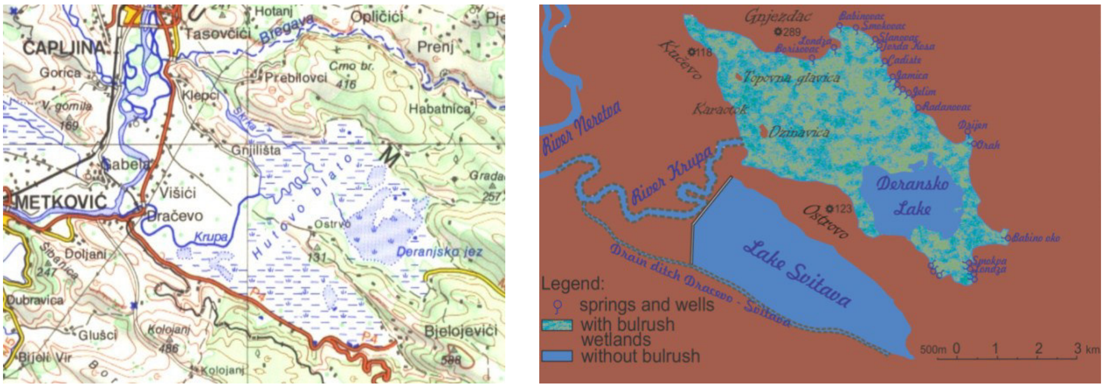

Figure 2: Topographic situation of Hutovo Blato before and after antropogenic actions

Survay Results

Hydrographic features Hutovo Blato - importance to define solutions to problem

Natural-aquatic complex Hutovo Blato, in modern age very anthropogenicly altered hydrographic system of the lower basin of river Neretva. Hutovo Blato is partially crypto-depressing, topographically situated on the left bank of the river Neretva, about 5 km southeast of the town of Čapljina. With a limestone ridge called Ostrovo, Hutovo Blato is divided into two morphological units, which in recent times (due to manmade dam on the Donje Blato) do not have a hydrographic functional connection. Gornje Hutovo or Deransko Lake is still a natural morphological unit, but since 1973 due to anthropogenic activities in aquatic geotechnical system, Donje or Svitavsko Blato has been turned into Svitavsko Lake. It was converted to compensation basin for Power Plant "Čapljina."

Its geographic location and great openness toward Neretva valley and the sea, aquatic complex and its surroundings have very prominent Mediterranean influences. The main characteristic of the climate in the area Hutovo Blato are mild winters with abundant rainfall and long bright summers. The hottest month is July (24.7 ° C), and it is most cold one is January (5.9 ° C). Cold period lasts 3 to 4 months, with average temperatures slightly lower than 10 ° C, and the warmer period regularly lasts 8 months. Annual rainfall is relatively high (1156 mm), but is unevenly distributed. In the colder part of the year is there is more than 60% of the total annual rainfall. According to pluviometric regime, wider basin of Hutovo Blato has two seasons: rainy (winter) and dry (summer). Maximum rainfall is usually during the December and minimum of rainfall is situated in July.

A wider basin of Hutovo Blato is made mostly out of Cretaceous limestone. These Limestones caused disorganization of the surface water to underground river networks. The Eocene flysh in the wider area of Hutovo Blato represents a partial remnant of a once much more spacious flysh zone. This zone is posteocenic orogenic movements, especially erosion during the Late Quaternary and Tertiary, went through considerable changes. Therefore Eocene flysh occurs only in a narrow zone between Cretaceous limestones, particularly in the area of Svitavsko accumulation (SLISKOVIC et al. 1962).

Recent relief of the environment and the bottom of Hutovo Blato was created by tectonic lowering of the river Neretva terraces in a single plane. There are exceptions: Island Karaotok, Island Džinavica and Island Topova Glavica. Bottom of Hutovo accumulation has micro morphological features noticeable in hypsometrical shift of wetland-marsh vegetation (SPAHIĆ 1986).

General hydrographic conditions of Hutovo Blato are related to hydrographic system of the lower Neretva, geologic characteristics of wider basin, geomorphologic evolution of the area and in particular climatic features of Hutovo Blato basin. Mentioned hydrographic natural conditions have been significantly impacted with recent anthropogenic doings conducted in the 1970's, with construction of Power Plant "Čapljina."

Water levels of Hutovo Blato, before anthropogenic intervention, directly depended on the water level of the river Neretva. Anthropogenic activities have disturbed the hydro geological state of inflow of water from detritus springs and wells, since most of them lost the hydrological function. In the Upper Blato, springs occur in the southern edge of Deransko Lake. Major springs are Babino Oko and Londža.

Hutovo Blato, especially Deransko Lake is crypto-depression because its bottom is lower than the level of the Adriatic Sea. The lake's surface elevation varies from 1 meter to 3 meters, depending on the level of lake water. Gornje Blato has retained its natural features and it consists out of five separate lakes, namely: Deransko, Škrka, Jelim, Drijen and Orah. They are connected by canals and river Krupa. River Krupa also drains hydrological system of Hutovo Blato to the river Neretva Today, Lower or Svitavsko Lake represents compensation basin for Power Plant "Čapljina" and represents completely separate unit from the Gornje Blato. Today's interest is in the preservation of the natural habitat of the Gornje Blato that has following morphometric parameters:

Lake surface	3,7 km^2
Lake length	3,3 km
Lake maximal width	2,4 km
The average width of the lake	1,1 km
Length of the coastline	13,0 km
Lake maximal depth	11,0 m
The average depth of the lake	2,0 m

Water regime in Hutovo Blato

Water regime in Hutovo Blato can be tracked on the basis of the regime and water balance of the river Krupa. It makes the river that drainage water of Hutovo accumulation. That is the last confluent on Neretva before its arrival in the Adriatic Sea. The total length of its course is 9 km with an average width of about 15 meters. Designations gradients in the longitudinal profile are insignificant and they are about 2 ‰.

For complete investigation of the water regime of Krupa, data from limnigraph of the Mala Svitava were used. This water level marker is based for the control of water levels in Bajovci, on the coast of Svitavsko artificial lake, and water meters on the banks of the Gornje Blato. How Svitavsko accumulation has direct impacts on water levels of Krupa, it was necessary to process and Svitavsko lake water levels. Frequent fluctuations of water in Krupa occur as a consequence of discharge water from the reservoir Svitavsko Lake.

The discharged water from the Svitavsko Lake creates a slowdown of water on the river Krupa all the way through Deransko Lake as a result of small designations gradients in the longitudinal profile of Krupa. High water levels on the river Neretva can cause natural slowdown of water on the river Krupa. They are seasonal, while the frequent and unnatural oscillation is caused by the release of water from Svitavsko Lake.

Based on the data from limnigraph, annual level of the water level does not depend directly on the amount of rainfall. This is a consequence of the Svitavsko artificial lake regime which directly depends on the work of power plant "Čapljina". Some of the water that is released from the reservoir Svitava, disturb the natural regime of the river Krupa. Because of small designation gradients on Krupas profile, discharged water from the reservoir partially drains downstream and partially goes upstream by river Krupa to Gornje Blato. Water slowdown on Krupa or its retrograde flow, affects the artificial water oscillations in the Gornje Blato.

To point out the artificial water level fluctuations, limnigraph data were analyzed and the results can be generalized in following facts: discharged of water from artificial reservoirs Svitava causes an increase in the average water level of 108 cm in the first 6 hours of an average day. Next 6 hours, the water level drops by 90 cm, and then for the next 6 hours increases up to 265 cm. Water level stagnation of 230 cm is maintained for the next 10 hours.

Artificial oscillations disturb the hydro- ecological system in aquatic complex Hutovo Blato. Early prognostic and technology solutions consider that this phenomenon will be avoided. Previous research programs, envisaged project "Hutovo Blato", by which the Donje or Svitavsko Blato should be transformed from swampland in to a lacustrine aquatic complex. Gornje Blato is supposed to preserve its natural environmental values of ornithological importance as it previously had.

Discussion

Assessment of the current situation

Study noted that the boundaries of the Gornje lake were far higher than today. Hydrological situation has significantly changed after power plant "Čapljina" construction. By field observations, initially in the first decade of the diagnostic and then in each repeated diagnostic, prognostic assessment were made for this once important ornithological station of migratory and resident birds that were settling in this nature park. Hydro-ecological studies have defined the current situation, particularly in the Gornje Blato, which according to all estimates in the research program, should remain entirely natural without artificial influence factors.

Prognostic studies have shown significant discrepancies from previous natural condition caused by indirect effects of anthropogenic intervention. In the Gornje Blato water meters and coastal swamp contours show the artificial fluctuations in water level. Undoubtedly these effects are greatly influenced by water slowdown, generated by frequent discharge of water from reservoirs artificial Svitavsko Lake. In addition, hydro reclamation operations in Popovo Polje disturbed karsts hydrological system, which reduced the flow of underground water from wells and springs. All of this has an impact on Gornje Blato aquatic complex functioning.

The most significant effects of artificial intervention in the Hutovo Blato are:

- Disappearance of the very high flood water levels, which lasted an average of 70 days, for a period of elevated water levels, which rarely, in spring time, lasted no longer than one month;
- Discharges of excess water from the artificial lake in the basin Svitavsko lake to river Krupa creates a water slowdown and return of the water to the Gornje Blato, causing frequent artificial fluctuations of water, which affect the aquatic organisms, and reproduction of nektonic plankton and aquatic species;
- during the warmer periods within the year, due to reduced underground water, larger part of the aquatic complex remains without hydrologic function, which reduces the optimal habitat of aquatic organisms;

All things mentioned resulted in the disappearance of the former functions of aquatic complex, as is evident from the decrease in the domestic and migratory bird populations. Their reduction is the result of changes in conditions that reduce hydro ecological resources, reducing benthic and aquatic organisms as a food for the bird population. Moreover, devastating consequences for the development of fish populations, especially eels, by whom this national park was famous of.

Improvement of hydro-ecological conditions

By balancing water levels on this aquatic complex Hutovo Blato, it would be a possible to obtain protection from artificial oscillations that arise from inflowing water from compensation lake basin Svitavsko. In order to achieve this requirement, it would be necessary to build an artificial dam on the river Krupa. Dams function should to be to eliminate any artificial fluctuations in water levels of the Gornje Blato, and to provide such a water level and restoring it to the period of pre-anthropogenic doings. In this way, once again natural environmental conditions would return and that would revive talmatologic-lacustrine conditions for the development of former aquatic organisms.

Instead of Conclusion

Suggested measures are intended to restore original, natural framework of environment in aquatic complex Hutovo Blato, as the only solution for its rescue and as well the only possible one. These measures would be brought to the attention to the public, influencing it to take more active approach in protection of Hutovo Blato, as well as to avoid unforeseen accidents (like two recent bush and forest fires). In addition, Hutovo Blato would be allowed its natural function.

The reversibility of the primal, natural conditions is generally very difficult and problematic, due to re-introduce of anthropogenic factor which still has its flaws. Natural frames and natural systems, as much as we try, cannot be realized by anthropogenic activities.

Summary

The natural-aquatic complex Hutovo blato belongs in the hydrographic sense to the Donja Neretva river basin and system. Through anthropogenic actions of 1973 this complex was transformed into an aquatic geotechnical system, especially the Lower (Donje) or Svitavsko Lake that represents today the compensation basin HE »Čapljina«. Today the compensation basin disturbs the natural balance in Gornje Blato.

Through hydrographic and other modern physical-geographic methods and research it was established that it is possible to preserve and bring back the Gornje jezero (lake) into its original natural limits.

Analyzing the water-meter statistical data that refer to Deransko jezero (lake) and river Krupa from the period before to the anthropogenic undertakings and the periods afterwards, as well as analyzing the water impressions on the shorelines and the way of sedimentation, it is possible to equalize the water-levels in Gornje jezero (lake) and bring them closer to the original hydrographic levels. The water-level equalization in Gornje jezero is possible by means of constructing an artificial dam on the Krupa river. Through the dam, the water-level regime in Gornje Blato would be regulated according to the seasons by approximately same periods of the previous original conditions. In addition, the dam would stop production of artificial oscillations in Gornje jezero (lake) that were the result of releasing the excess water out of the Svitava compensation basin. In this way, the natural-aquatic complex Gornje Blato would be preserved and brought into its natural limits, which would in turn produce a positive effect on the lives of aquatic and other organisms living in this accumulation.

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Monitoring of biodiversity in the core zones of Biosphere Reserve Wienerwald

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Keywords

Biosphere Reserve Wienerwald, monitoring biodiversity, core zone, forest

Abstract

The Wienerwald is situated in eastern Austria, in the federal states of Lower Austria and Vienna and is recognised by the UNESCO as a Biosphere Reserve since 2005. The Reserve covers an area of 1.050 km² and 51 communities in Lower Austria as well as 7 districts in Vienna. Goals of Biosphere Reserves are to sustainably establish protection of biodiversity, to persuit economic and social development and to preserve cultural values.

The Wienerwald is the largest contiguous broad leaved forest in Central Europe. It is dominated by vast beech forests of different types, from thermo- and calciphilous *Cyclamini-Fagetum* to mesophilous *Mercuriali-Fagetum* and *Galio odorati-Fagetum* to acidophilous *Melampyro-Fagetum*. The second most frequent forest type is oak-hornbeam forest of *Galio sylvatici-Carpinetum*. Furthermore, the largest downy oak forest in Austria and sub-mediterranean pine forests with endemic Austrian Pine (*Pinus nigra ssp. nigra*) are found in the Biosphere Reserve. The altitudinal range of the "Wienerwald" extends from 160m at the edge of the Pannonic Basin up to 893m in the western part of the Sandstone-Wienerwald.

The Biosphere Reserve „Wienerwald" has 37 core zones with a total area of about 5.500 ha guaranteeing long-term protection and natural succession of the different forest types of the Wienerwald. The core zones are established as nature reserves in Lower Austria and as landscape preservation areas in Vienna. Moreover large areas are identified as European Reserve Area (Natura 2000).

The monitoring program in the core zones started in April 2012 and continues in its primary phase of data collection until end of 2013. The monitoring program comprises the following organismic groups: lichens (80 plots), fungi (120 plots), mosses (60 plots), vascular plants (500 plots), terrestric snails (42 plots), pseudoscorpions (45 plots), spiders (45 plots), harvestmen (*Opiliones* – 45 plots), ground beetle (*Carabidae* – 45 plots), saproxylic beetles (45 plots), amphibians (78 plots), birds (400 plots) and bats (168 plots). In 28 monitoring plots in the core zone and in 14 monitoring plots in the commercial forests all 13 organismic groups are covered.

The establishment and organismic inventory of monitoring plots is a neccesary basis for collection of evidence-based data in nature protection. To validate the biodiversity- data of the core zones it is useful to establish monitoring plots also in the adjacent commercial forests of the Biosphere Reserve. In total there are 335 monitoring plots in the core zones and 168 outside the core zones in commercial forests, but inside the borders of the Biosphere Reserve. The standard size of monitoring plots is set as 400m² with adaptations for fungi, mosses and lichens, where sampling is extended to a 100m radius from the center of the monitoring plot if there are ecologically important special structures like outcrops or scree. Bird data is partially collected in transects between monitoring plots, due to the highly vagile character of this group.

Out of approx.1700 sample points of the forestry stand inventory inside the core zones 20% have been chosen by stratified sampling as organismic monitoring plots. Parameters for stratification contained plant community, exposition, lying deadwood >50 cm, geological microstructures, stand age, tree-species diversity, standing deadwood, density of the stand, and maximum diameter of trees. Different sets of parameters for stratification were chosen according to different organismic groups. So each point of the forestry stand inventory was ranked for each organismic group. The points with the highest total ranking over all organismic groups for each core zone have been chosen as monitoring plots. Minor corrections have been made in a subsequent step regarding the representation of vegetation units, so all forest types of the Wienerwald are represented with at least one monitoring plot.

The monitoring plots outside the core zones have been chosen by generating a point raster shape in GIS with a grid width of 100 x 100m, including information about the geological unit, exposition, inclination and elevation. For 50% of the monitoring plots inside the core zone (i.e. forestry stand inventory points with the highest ranking), the respectively nearest point from the point raster ouside the core zone with matching abiotic parameters has been chosen as monitoring plot.

After finishing the basic inventory in 2015, further monitoring should be carried out in 2023.

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Stand Dynamics in the Virgin Forest "Neuwald"

Herfried Steiner & Georg Frank

Abstract

The virgin forest "Neuwald", 20 ha in size, is one of the last remnants of virgin forest left in Austria. Based on an initiative of the owner in 1830, the stock has remained untouched without any further silvicultural interventions. Since 100 years, however, high deer densities have led to disturbed population dynamics. In 1986, a systematic grid of sample plots was established to study the stand structure of the dominant spruce-fir-beech-forest. On 34 permanent sample plots, each 1000 m² in size, data on stand structure were collected. Since then, surveys were made at an interval of 10 years. Tree mortality was recorded every 5 years. Although the virgin character of the forest is being gradually lost, the value of this stand is still high, particularly from a scientific point of view. Concerning the resilience of the overstorey, the lack of ingrowth has led to an inadvertent experiment.

The dominant tree species Norway spruce, silver fir and European beech show significant differences in the frequency distribution with respect to their dbh (diameter at breast height). Thus, beech is the most frequent tree species below 50 cm dbh, while silver fir is the most frequent tree species over 70 cm dbh. As to dbh- distribution, shifts in the composition of the tree species are expected. When comparing the observation years of 1986 and 2006, it became obvious that many trees died due to windthrow but also due to other diseases. On the other hand no considerable tree ingrowth into the sample plots could be identified. The number of trees has decreased significantly. Contrary to expectations, the stock volume in the same period remained at the same level. The virgin forest ecosystem is thus resilient enough to buffer the chronic lack of ingrowth by expansion of overstorey.

Keywords

Resilience, stand dynamics, mortality, deadwood, carbon sink, forest reserves

Introduction

The virgin forest "Neuwald" with a size of 20 hectares is one of the last remnants of virgin forests left in the Eastern Alps (ZUKRIGL et al. 1963; KRAL & MAYER 1968), (Fig. 1). On the personal initiative of the owner Count Hoyos a harvesting ban was imposed during the exploitation of the region in the early 19th century which has been observed until today (MAYER et al. 1972). However, with the establishment of wildlife feeding at the end of the 19th century followed a continued period of sustained high deer density (ZUKRIGL et al. 1963; FRANK & MAYER 1988). Until today, more than 100 years later, browsing has led to a permanent reduction of regeneration. Despite the sometimes very thin canopy neither regeneration nor ingrowth into the overstorey has taken place. The virtually complete absence of regeneration for over 100 years thus leads to an unintended experiment, an experiment with reluctance.

The main questions of this study are: (1) How does the lack of natural regeneration and ingrowth, at simultaneous tree mortality, affect the inventory parameters: stem number, basal area, volume, tree species composition and diameter distribution? (2) Is the ecosystem sufficiently resilient and able to compensate the long-lasting lack of ingrowth and dying trees with an increase of increment of the remaining stand?

Figure 1: The virgin forest "Urwald Neuwald". © Steiner

Methodology

The forest "Neuwald" is composed of a spruce-fir-beech forest, and, in small areas, also of spruce and spruce-fir forest (ZUKRIGL et al. 1963; MAYER et al. 1972). The present study is limited to a dominant spruce-fir-beech forest which can be assigned in equal parts to the Adenostylo glabrae-Fagetum Moor 1970 and the Cardamino trifoliae-Fagetum Oberdorfer 1987 (WILLNER & GRABHERR 2007).

A sampling grid was used which was originally established for the purpose of the recording and documentation of damaged trees ("forest dieback") (FRANK & MAYER 1988). The sampling grid established in 1986 consists of 34 sample plots à 1000 m², arranged in a 60 x 60 m grid. By limiting this study to spruce-fir-beech forest communities, 26 sample plots remained for analysis where - using a minimum dbh of 10 cm - all trees were recorded, coordinated, measured and assessed according to different criteria. The first survey in 1986 was followed by a study carried out at a five year interval on the survival of individual trees to capture the mortality rates. In 1986, 1996 and 2006 the dbh of all individual trees was measured. For the present study, the re-inventory of 2006 was compared to the results of the first inventory in 1986.

A methodological weakness of the survey design is the lack of identification of standing and lying deadwood in the first inventory in 1986 because other issues ("forest dieback") were more important at this time. While the absolute deadwood can be specified only vaguely, we can identify exactly the dieback rates at five 5-year periods since 1986.

As since 1986 a number of height measurements have been made, height functions (height model) could be adjusted for the dominant tree species, spruce, fir and beech. The volumes were then calculated for all tree species using form number functions (POLLANSCHÜTZ 1974) for all individual trees. By means of periodic repeat inventories both the dieback of trees (mortality) and the increment in merchantable timber volume of the remaining standing trees could be accurately determined, and conclusions drawn on the development and resilience of the stock.

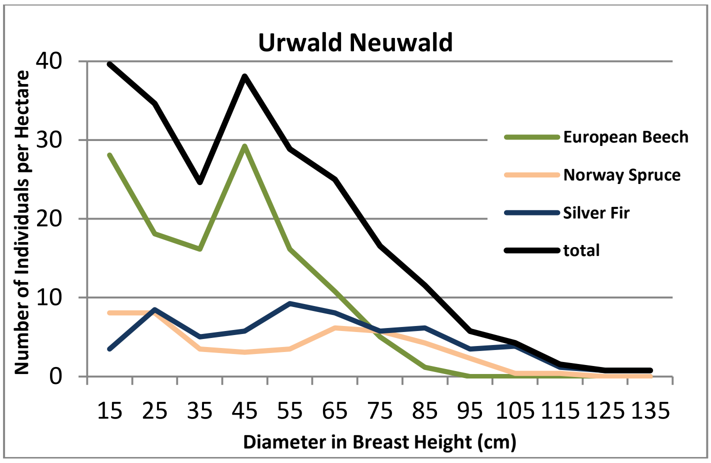

Figure 2: Diameter distribution of main tree species in the virgin forest "Urwald Neuwald".

Results

In the spruce-fir-beech forest area the overstorey of the forest "Neuwald" is composed almost exclusively of the three main tree species´. The dbh-distribution shows large differences (Fig. 2). Fir and spruce between 20 and 90 cm dbh have relatively constant stem numbers. In the diameter classes above this size spruce decreases rapidly. Fir, however, is found regularly in higher diameter classes reaching a dbh of up to 138 cm. Totally different is the dbh range of beech; in the range up to 60 cm dbh stem numbers twice to 3 times as high as conifer species were found. Above this size, it decreases rapidly reaching comparatively modest maxima of just over 80 cm. In the range below 50 cm dbh an unbalanced individuals density becomes evident.

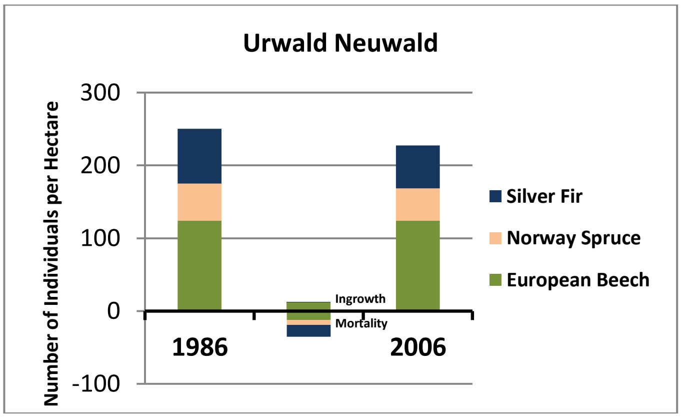

Figure 3: Comparison of 1986 survey with 2006; number of stems of main tree species per ha, ingrowth and mortality.

When comparing the 1986 survey with 2006, in the individuals over 10 cm dbh, a decrease of 250 n / ha to 227 n / ha can be noticed for a period of 20 years (Fig. 3). While in beech mortality and ingrowth were balanced at 12 n / ha, there is no ingrowth for 7 dead spruce trees / ha and 1 ingrowth for 17 fir / ha. Regarding the merchantable timber volume, there was a slight increase in volume over the course of 20 years of 715 m³ / ha to 741 m³ / ha (Fig. 4). Beech and fir show the best growth performance. The excellent growth performance observed especially in older fir trees results in considerable increment of the whole stand – despite the lack of ingrowth.

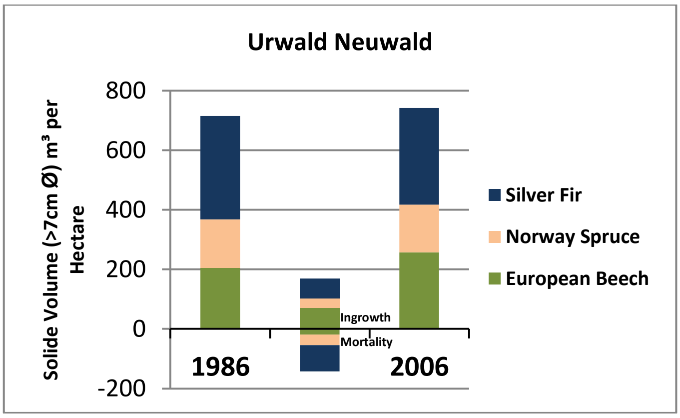

Figure 4: Comparison of solid volume of 1986 survey with 2006; total solid volume (>7cm Ø) m³ per ha, growth and mortality.

Discussion

Massive browsing on regeneration by red deer for decades has led to a permanent disturbance of the natural stand development in the virgin forest „Neuwald". Studies in spruce-fir-beech forests in south-eastern Europe suggest a similar trend to increasing beech dominance at the expense of fir in comparable forest types (VRŠKA et al. 2009; DIACI et al. 2011). However, in the virgin forest „Neuwald" not only a change of tree species can be observed, but a decrease of all three main tree species spruce, fir and beech. A total dieback of fir projected in 1988 (FRANK & MAYER 1988) from the perspective of air pollution induced „Waldsterben" (forest dieback) cannot be confirmed from today's point of view. All the more surprising is the long lasting capacity of the forest ecosystem to compensate the age-related mortality and the complete lack of regeneration by overstorey growth. Under the current view of climate change and the discussion concerning the status of unmanaged forests as carbon sinks these findings could be important because they demonstrate the ability of these forests for carbon storage over many decades.

Conclusions

Although for more than 100 years virtually no considerable ingrowth has occurred from regeneration, the merchantable timber volume has not decreased in the investigation period 1986 - 2006. To the contrary, the case of the forest "Neuwald" shows that such forest ecosystems are able to compensate age-related mortality over decades through increased increment of the remaining stand. In the study period of 1986-2006 increment and mortality are balanced despite the lack of ingrowth from regeneration, there is even a small stock accumulation.

Future

In the time scale, the present comparison of two observations is not more than a flash in the evolution of this „virgin forest". Nevertheless, first conclusions on the stand dynamics can be drawn from repeated surveys of stand structure. With each periodic survey of both the standing and the dead wood stocks, the value of the virgin forest remnant will increase as the reference stock of the development of a forest without direct human influence.

To get a better insight into the stock dynamics in terms of organic and necromass, but also of carbon storage, the differentiated identification of dead wood, regeneration and humus status in future studies will be sought.

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Trade-offs of ecosystem services provided by mountain hay meadows under land use change scenarios

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Abstract

Land use change has had a strong impact on Alpine land cover and might alter the ability of ecosystems to provide ecosystem services. Particularly affected have been high mountain hay meadows, which have often been subject to abandonment and consequently have become overgrown by dwarf-shrubs and young trees. This trend will have long lasting effects on the provision of ecosystem services. Analysis of possible trade-offs of ecosystem services may enable the development of best possible management strategies.

As study sites we chose a set of former mountain hay meadows representing various stages of succession, depending on the last time they were mowed. These sites are situated in the subalpine zone in the municipality of Brandberg adjacent to the nature park Zillertal.

Multi-criteria decision analysis (MCDA) is an important tool for environmental planning and decision making and is widely acknowledged to quantify possible trade-offs of ecosystem services. In order to carry out a MCDA we organised a workshop with local experts.

Preliminary results show that the six most important ecosystem services according to the ranking order were: biodiversity, aesthetic value/recreation, cultural heritage, fresh water, agricultural products, and protection from natural hazards.

Keywords

Trade-offs, MCDA, Land use change

Introduction

Human societies depend on goods and services they obtain from natural or semi-natural ecosystems. Fresh water, fertile soils, natural hazard regulation or recreation are just a few of these many services (MEA 2005). Over time, ecosystems and landscapes have been modified by man effecting the provision of multiple services. One characteristic feature of this modification in the Alps are mountain hay meadows. This labour intensive land use shapes the traditional cultural landscape of the Alps. In the past 50 years however, land use has changed; favourable agricultural sights have been intensified while, less favourable areas were subjected to abandonment (Tappeiner et al. 2006). In the case of mountain hay meadows this has a significant impact on the vegetation cover, gradually becoming over grown by dwarf-shrubs, bushes and trees. This change might alter the capacity to provide ecosystem services. Yet which services might increase or decrease, in other words, which trade-offs might occur is not certain (Rodriguez et al. 2006). On the one hand these open hay meadows, popular with walkers, might lose attractiveness and therefore get less frequented as a recreational sight. On the other hand natural hazard regulation might increase, as a dense tree cover provides higher protective functions. In order to facilitate best possible management strategies it is important to assess and value the provision of ecosystem services and weight possible trade-offs. Here multi-criteria decision analyses (MCDA) are useful, providing a tool to assist decision makers in finding an answer to which alternative is the best. For this study we used multiple ecosystem services as criteria to weigh which management alternative – labour intensive mowing or abandonment – is more suitable for mountain hay meadows.

In this context we aim at answering the following question:

1. Which are the most important ecosystem services provided by mountain hay meadows?
2. Are some of these ecosystem services considered more important than others?
3. To which extent are these ecosystem services provided under certain land use change scenarios and do trade-offs occur?

Study site

The study areas, situated around the Kolmhaus (1845m), are part of the municipality Brandberg and adjacent to the nature park Zillertaler Alps. The sites are located on a south facing slope of the Zillergrund, which is a tributary valley of the Zillertal. The annual precipitation of the municipality Brandberg amounts up to 1.365mm with an average annual temperature of 3,7°C.

Already in the 12th century extensive areas of the Brandberger forests were cut cleare in order to provide meadows and pastures. Because of the steepness, the secluded locations and lack of workers various mountain slopes were abandoned in the past century. However, until today mountain hay meadows represent a cultural heritage of traditional land use in the Zillertaler Alps (SCHACHNER 2005).

Images: Picture one shows a view of the hay meadows of Brandberg, which are still mowed. Picture two illustrates peasants at work and picture three shows an installation for hay transportation.

Method

General approach

Multi-criteria decision analysis (MCDA) is an important tool for environmental planning and decision making and is widely acknowledged to quantify possible trade-offs of ecosystem services. Generally the principle of this method is to arrange a preference ordering to a number of other options (STEELE et al. 2009). So a multi-criteria decision analysis helps to structure a problem and to investigate the decision-making process using multiple criteria. A clear definition of the alternatives as well as of the criteria is the framework of the decision-making process. Using multi-criteria decision analysis in ecosystem services research has the advantage (STEELE et al. 2009) that both quantitative and qualitative criteria are comparable, monetary and non-monetary attributes alike can be used and separate units can be obtained. The common process of the MCDA follows a set of successive steps (HOWARD 1991, KEENEY 1992 in SANON et al. 2012):

- Defining objectives
- Selecting set of criteria to measure the objectives
- Specifying the alternatives
- Transforming the criterion scales into commensurable units
- Pre-evaluating of the evaluation matrix
- Assigning weights to the criteria that reflect decision maker's preferences
- Selecting and applying mathematical algorithms for ranking alternatives
- Performing sensitivity analysis
- Choosing or recommending alternatives

Ranking of services (previous procedure)

We organized a workshop with local experts in order to:

i) determine the most relevant six ecosystem services provided by the study area in an open discussion,
ii) agree upon their relative ranking and
iii) identify suitable indicators to quantify these ecosystem services.

An extensive literature review helped to assign quantitative or qualitative values for the selected indicators. Only few references dealt with the valuation of the indicator group aesthetic value/recreation. Therefore an additional questionnaire was required. This questionnaire was set up in two parts: the first part consisted of manipulated landscape photos showing separate development scenarios to assess the aesthetic value. The aim of the second part was to investigate recreational values using a set of questions.

Preliminary results

Preliminary results show that for these mountain hay meadows of Brandberg the six most important ecosystem services according to the ranking order were: biodiversity, aesthetic value/recreation, cultural heritage, fresh water, agricultural products, and protection from natural hazards. According to these services (criterias) the following indicators were selected (see the table below):

CRITERIA	INDICATORS	REFERNCES
Biodiversity	Biodiversity	Botanical classification of plants
	Habitat diversity	Recording of habitats
Aesthetic value/Recreation	Perception	Questionnaire
	Structural diversity	Questionnaire with manipulated photos
Cultural heritage	Traditional land use	Land use register
	Identity	Data of the demographic structure
Fresh water	Runoff	Hydrological data
Agricultural products	Quality	Mountain hay certification
Protection from natural hazards	Erosion	Geomorphological mapping

Future steps

Further steps are 1) to analyse the questionnaire and to define values for the service group aesthetic value/recreation, 2) to quantify the selected six ecosystem services according to two management scenarios, 3) to evaluate benefits and disadvantages of these two management scenarios within the ecosystem services framework, and 4) to identify trade-off trends and to assess ecosystem services which directly compete.

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Six years of glacier mass balance on Mullwitzkees (Hohe Tauern) and Hallstätter Gletscher (Dachstein)

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Abstract

Since 2006 the Mullwitzkees, situated within the core zone of the Hohe Tauern National Park and the Hallstätter Gletscher, situated in the Dachstein region within the northern limestone alps, are subject to mass balance monitoring programs. The mass balance of these glaciers is measured using the direct glaciological method with fixed dates by ascertaining the ice ablation at stakes and the accumulation at snow pits. The Mullwitzkees is located south of the main Alpine crest and is exposed to the south. The highest point of the glacier is the Hoher Zaun (3450 m a.s.l.) and the lowest part of the snout called Zettalunitzkees reaches down to an elevation of 2690 m. In comparison the Hallstätter Gletscher is the northernmost glacier of the Austrian Alps and is exposed to the north within an elevation range between 2150 m a.s.l. and 2900 m a.s.l., but both of the glaciers cover an area of about 3 km².

During the past six years both of the glaciers have experienced negative mass balances but at different magnitudes. Within the hydrological year 2006/2007 the specific mass balance of the Hallstätter Gletscher was about -0.3 m w.e. (water equivalent) whereas the specific balance of the Mullwitzkees was approximately five times larger (-1.4 m w.e.). Despite of this huge difference the mean specific mass balance (2006/2007 – 2011/2012) is nearly the same for both glaciers.The ELA (equilibrium line altitude) on the Mullwitzkees is about 500 m higher as it is on the Hallstätter Gletscher. These differences are mainly caused by topographic effects and different climate conditions.

Keywords

glacier, massbalance, Mullwitzkees, Venediger, Hallstätter Gletscher, Dachstein

Aims and funding of the project

The projects on Mullwitzkees and Hallstätter Gletscher aim at the measurement and interpretation of mass balance and climate data and the interpretation of the relationship of these measured parameters with respect to the current glacial recession and hydrology as well as for the development of future glacier scenarios for the both. The project on Mullwitzkeesis funded by the Hohe Tauern National Park and the Hydrological Service at the Government of Tyrol. The project on Hallstätter Gletscher is funded by the Government of Upper Austria and the Energie AG. Both projects were started in 2006.

Area of study

The Mullwitzkees is situated in the Venediger Massive within the core zone of the Hohe Tauern National Park and is divided into the “innere” and “äußere” Mullwitzkees. Glacier fluctuations since the end of the LIA (Little Ice Age) are summarised by Patzelt 1973. This study focuses on the “äußere” Mullwitzkees which is therefore regarded as Mullwitzkees. The upper part of the glacier is exposed to the south and is confined by a ridge with the highest point Hoher Zaun at an elevation of 3450 m a.s.l.. The snout called Zettalunitzkees is exposed to the south-west and reaches down to an elevation of 2690 m a.s.l.. In 1998, Mullwitzkees (and Zettalunitzkees) covered an area of 3.24 km². The glacier area diminished to 3.08 km² in 2007 (Stocker-Waldhuber 2010).

The Hallstätter Gletscher covers an area of 3 km² and is the biggest glacier in the northern limestone Alps (Lambrecht & Kuhn 2007). The glacier is exposed to the north and surrounded by a mountain ridge with the highest point Hoher Dachstein. From a great plateau above 2550 m a.s.l., arise three short glacier tongues.The highest point of the glacier is located at the north face of the Hoher Dachstein at an elevation of 2900 m a.s.l.. The middle tongue of the glacier reaches down to an altitude of 2150 m a.s.l.. Since the LIA maximum in 1856 the glacier area diminished by 43% (Helfricht 2009).

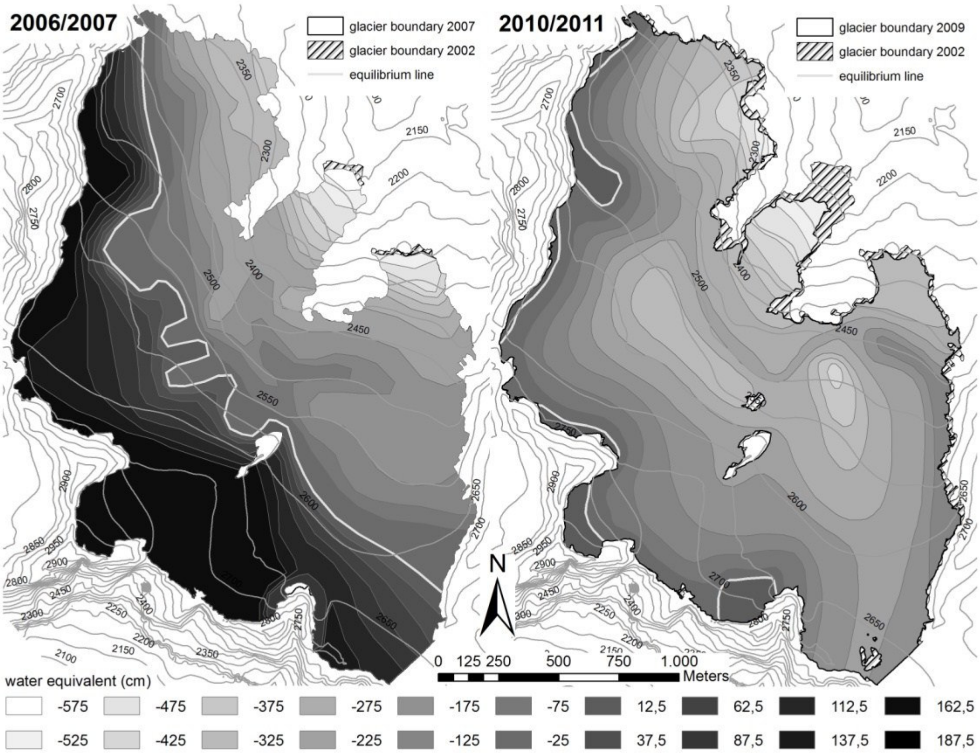

Figure 1: Distribution of the most positive (left fig.) and the most negative (right fig.) mean specific mass balance on Hallstätter Gletscher since the beginning of the measurements in 2006. The mass balance is colored gradually into 50 cm intervals within the ablation area and into 25 cm intervals within the accumulation area; the equilibrium line is plotted as a thick grey line.

The glacier boundaries in Figure 1 and Figure 2 originate from the second Austrian glacier inventory of 1998 (Lambrecht & Kuhn 2007, Kuhn et. al. 2008). For the years2007 and 2009 the glacier´s boundaries were reduced on the basis of Orthophotos and digital elevation models according to the third Austrian glacier inventory (Abermann et. al. 2010, Stocker-Waldhuber et. al. 2010). Zettalunitzkee sand Hallstätter Gletscher are also subject to measurements of glacier length by the glacier survey of the Austrian Alpine Club (e.g. Patzelt 2005, Patzelt 2006).

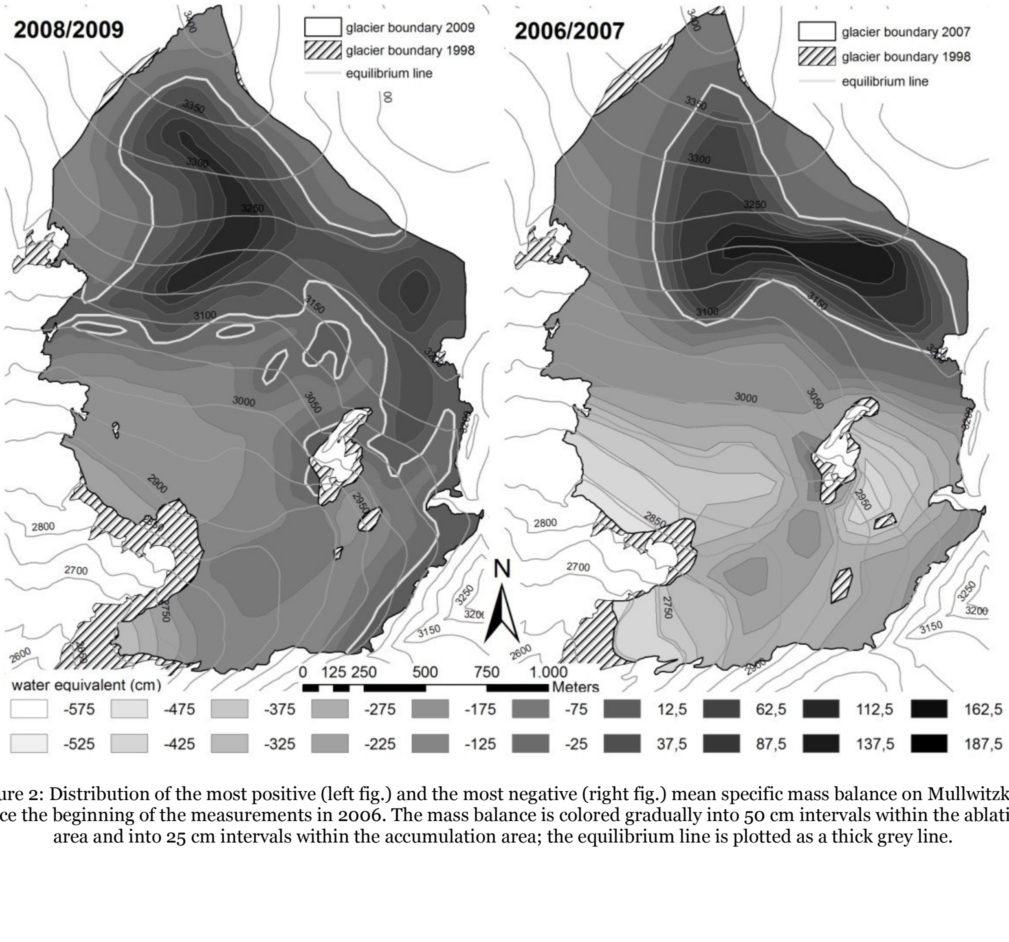

Figure 2: Distribution of the most positive (left fig.) and the most negative (right fig.) mean specific mass balance on Mullwitzkees since the beginning of the measurements in 2006. The mass balance is colored gradually into 50 cm intervals within the ablation area and into 25 cm intervals within the accumulation area; the equilibrium line is plotted as a thick grey line.

Method

To determine the mass balance of this glacier the direct glaciological method with fixed dates is used (HOINKES 1970). The method detects the mass gain and loss of the glacier within one year. The year is divided into the accumulation period from the 1st of October to 30th of April when a mass gain of the glacier is expected and the ablation period from the 1st of May to 30th of September when the glacier experiences a mass loss.

Ablation is measured with ablation stakes in the ablation area. During summer the free ends of the stakes are measured several times. At the 30th of April multiple snow pits are dug to measure the height and density of the accumulated snow cover and on the 30th of September this work is repeated to determine the mass gain of the glacier within the hydrological year. The direct glaciological method is described in PATERSON 1994.

Results

The Mullwitzkees (MWK) has experienced a mass loss of 4.46*10^6 m^3 w.e. (water equivalent) and a specific mass balance of -1447 mm during the first year 2006/07 which is the most negative balance whereas on Hallstätter Gletscher (HSG) the mass loss devoted 0.88*10^6 m^3 w.e. and a specific balance of -289 mm which was the minimum annual mass lossduring the six years between 2006 and 2012. During the second year 2007/08 both glaciers got about the same negative specific balance with -642 mm (MWK) and -700 mm (HSG). In 2008/09 Hallstätter Gletscher lost nearly twice as much of its mass (-924 mm) as Mullwitzkees (-487 mm) and in 2009/10 the specific balance of Hallstätter Gletscher was -700 mm and -490 mm on Mullwitzkees. The most negative mass balance of Hallstätter Gletscher with a specific balance of -2011 mm was measured in 2010/11 which corresponds to a mass loss of about -6*10^6 m^3 w.e., whereas on Mullwitzkees the specific balance with -1303 mm was nearly the same as is it was in 2006/07. In 2011/12 the specific mass balance of both of the glaciers were nearly the same with -1228 mm on Hallstätter glacier and -1276 mm on Mullwitzkees but there where huge differences between both glaciers with regard to the winter and summer balance. The specific summer mass balance of Hallstätter Gletscher in 2012 was the most negative one since the beginning of the measurements but was balanced in a large part by the most positive specific winter mass balance since 2006.

The ELA (equilibrium line altitude) was located at a mean elevation of about 2590 m a.s.l. on Hallstätter Gletscher and at 3140 m a.s.l. on Mulwitzkees during the first four years. In 2010/11 the ELA shifted up to 2822 m a.s.l.on Hallstätter Gletscher and on Mullwitzkees even above the summits and likewise during the summer 2012. Accordingly the AAR (accumulation area ratio) was very low during the year 2011/12 with 0.11 on Mullwitzkees. Due to the great amounts of winter and summer balances on Hallstätter Gletscher in 2011/12 the AAR was higher than on Mullwitzkees with 0.32.Table 1 gives an overview of the mass balance parameters of both glaciers of the yearsfrom 2006/07 to 2011/12 (FISCHER et al. 2013, STOCKER-WALDHUBER et al. 2013). Figure 1 and Figure 2 show the distribution of the most positive and most negative mean specific mass balances.

Table 1: Characteristic numbers of the mass balance onHallstätter Gletscher and Mullwitzkees for the hydrological years from 2006/07 to 2011/12. (S: glacier area, B: total mass balance, b: mean specific mass balance, bs: mean specific summer mass balance, bw: mean specific winter mass balance, ELA: equilibrium line altitude, AAR: accumulation area ratio, w.e.: water equivalent)

Hallstätter Gletscher

	mass balance						ratio
	S	B	b	b_s	b_w	ELA	AAR
	km^2	10^{6}m^3	mm w.e.	mm w.e.	mm w.e.	m	
2006/2007	3,04	-0,88	-289	-2222	1933	2581	0,490
2007/2008	3,04	-2,13	-700	-3270	2570	2592	0,490
2008/2009	3,01	-2,79	-924	-3069	2145	2616	0,341
2009/2010	3,016	-2,11	-700	-2334	1634	2588	0,483
2010/2011	3,016	-6,07	-2011	-3497	1486	2822	0,046
2011/2012	3,016	-3,70	-1228	-3953	2725	2664	0,318

Mullwitzkees

	mass balance						ratio
	S	B	b	b_s	b_w	ELA	AAR
	km^2	10^{6}m^3	mm w.e.	mm w.e.	mm w.e.	m	
2006/2007	3,08	-4,46	-1447	-2121	674	3163	0,207
2007/2008	3,08	-1,98	-642	-2052	1410	3115	0,396
2008/2009	3,03	-1,47	-487	-2006	1519	3116	0,367
2009/2010	3,03	-1,48	-490	-1797	1307	3150	0,332
2010/2011	2,93	-3,82	-1303	-2127	824	****	0,147
2011/2012	2,93	-3,74	-1276	-2772	1496	****	0,111

Discussion

Comparing the first six years of mass balance measurements on Mullwitzkees one of the most noticeable results is the position of the accumulation area, which is displaced from the ridge to lower elevations due to wind drift during winter. The ice thickness is decreasing at the highest elevations of this glacier (Span et. al. 2005, Fischer et. al. 2007). In contrast to the Mullwitzkees the mass balance of the Hallstätter Gletscher mainly depend on the snowfall amounts during winter which can be increased by orographic lifting of the Dachstein massive. Both glaciers react in a different way on the weather conditions during a specific year and benefit alternately depending on a northwesterly or southwesterly incoming flow direction.

These investigations do not relate to the status of protection, but both glaciers are located within protected areas. Nevertheless mass balance measurements are the coherency between glacier and climate and therefore it is of great importance to observe the actual conditions.These measurements help to answer questionssuch as how long the glaciers of the Hohe Tauern Nationalpark or within the areas of Natura 2000 tend to exist.

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Assessment of environmental education indicators in Triglav National Park, Slovenia

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Abstract

We present the analysis of a list of 89 environmental education indicators gruped in 14 dimensions for the assessment of the priorities in implementing environmental education in protected areas, Triglav National Park (TNP), Slovenia, in particular. The list of environmental education indicators is based on a thorough review of the TNP publication (Triglav National Park annual report 2008-2009) and TNP web page. The indicators have been evaluated in terms of their importance and measurability by eight TNP managers, directly and indirectly involved in the implementation of environmental education in the park. The importance of the indicators has been measured on a three-folded scale as: *essential* (3), *desirable* (2), *not significant* (1). Managers used measurability parameter to indicate for which indicators data are being collected in TNP and which indicators are already being in use in TNP, according to their experience. The results indicate that all 89 suggested indicators are at least desirable. Out of 89 environmental education indicators the analysis revealed 7 essential environmental education indicators, 5 evaluating direct environmental education in the park and 2 evaluating European funding sources. A comparison of the 4 essential indicators according to data from the years 2000 and 2009 has been performed showing a significant increase in environmental education activities in TNP over the years, i.e. increase in number of a) primary schools collaborating with TNP, b) environmental workshops for children, c) youth involvement in Junior Rangers program, d) thematic days in the park. Our results point out that some environmental education indicators strongly focusing on environmental education for children and youth have already been in use in TNP. However, this study provides a complete workable compilation of indicators for further assessment of environmental education implementation in TNP, with a possibility to be applied to other protected Alpine areas as well.

Keywords

environmental education, indicators, national park.

Introduction

Environmental education unites formal and informal education on ecological systems and their dynamics, environmental problems, interrelations of humans-environment interactions and their effects on social cultural and economic development. The aim of environmental education is to educate people about environmental topics and issues, in order to raise their awareness, so that they adopt more responsible attitudes and behaviour towards the environment by making informed choices. According to ALPARC (2013), "environmental education and awareness-raising targeting the general public (visitors, local residents, schoolchildren, etc.) are two key components in the Alpine protected areas' role". In the past a series of workshops on mountain environmental education have been organized by ALPARC and "Mountain Environmental Education" Working Group is operating under ALPARC organization. As of the high importance of environmental education in the Alps we developed and assessed environmental education indicators in Triglav National Park, the only national park in Slovenia. Indicators are tools that meet the criteria of policy relevance, analytical soundness and measurability (BRIASSOULIS 2001) and can quantify changes, monitor performance and provide framework for setting targets (HUNTER & GREEN 1995; CRABTREE & BAYFIELD 1998).

We focused on answering following research questions. Which are the most important environmental education indicators from the Triglav National Park managers' perspective? Are environmental education indicators already being in use in TNP? What is the trend for the indicators that are identified as essential? The indicators derived in this study aim to evaluate environmental education impact and performance in view of their implementation in TNP.

The study on hikers' pro-environmental behaviour in TNP revealed that previous enrollment in environmental education activities is strongly correlated to willingness to pay for environmentally friendly goods and services (STUBELJ ARS 2013). TSAUR et al. (2006) found that interpretative service based on environmental education could help tourists develop more awareness in conserving and protecting resources. Thus we argue that increase in environmental education activities in the park will consequently influence locals' and tourists' behaviour and contribute towards more environmentally friendly behaviour and nature conservation. Monitoring of environmental education in the park can be provided by the use of indicators. Indicators should be used to support the framework for setting development targets and investment decision making regarding environmental education.

Methods

Based on the official TNP annual report 2008-2009 (2010) and park's web site (2010) we identified all environmental education related activities in TNP and proposed environmental education indicators list. Within the workshop held in May 2010 in the headquarters of TNP, eight protected area managers evaluated indicators importance and measurability in TNP based on their first-hand experience in implementing environmental education in the park. Out of eight TNP managers three were from professional services, two park rangers, one head of professional service, one working at Information Center Trenta Lodge and one working on a project. Five managers had more than 7 years of experience in working in TNP, two more than 3 years and one was recently employed on the project. The head of the professional service "Education and nature conservation education" has been working in the park for 24 years and contributed significantly to the workshop discussion. The managers took a survey on environmental education indicators in which they evaluated a list of 89 indicators according to their importance and measurability. The indicators importance was measured on a three-olded value scale as *essential, desirable* or *not significant*. The managers have been asked to make a mark after each indicator if in their opinion the data for this indicator are already being collected by TNP or if the indicator is already being used in TNP.

Results and discussion

Environmental education decision dilemmas

There is a need for a strategic plan for the implementation of environmental education on national level, in which the role and importance of environmental education would be determined. As the only national park in Slovenia, TNP managers feel they should present a model of good practice at the national level. The strategy is needed for the development of infrastructure for environmental education (educational information points and educational trails in the park) and development of strategy how to use this infrastructure in terms of working directly with people. This raises the question of financing the educational programs. Aside from national funding there is a need to join synergies of different stakeholders and services and focus all of them on strategic plan for the implementation of environmental education. In this process the organizations that directly work in nature should be involved (mountaineering, hunting, fishing organizations). Managers find important to balance the environmental education activities between visitors and inhabitants. Making decisions and shaping new educational programs is a challenge in itself.

Managers took a standpoint that environmental education should receive more attention and funding. They find a need for strategic decision towards attributing greater weight to environmental education in terms of orientation and material support. All managers emphasized that for environmental education direct connection with nature is essential, and education should take place in natural environment as much as possible.

The environmental education indicators assessment

The list of 89 indicators was made based on the official TNP annual report 2008-2009 (2010) and park's web site overview (Triglav National Park 2010). Adopting the terminology of the sustainability indicators study of Choi & Sirakaya (2006) we group the indicators in the following dimensions, based on the type of information they refer to: Direct environmental education (15 indicators), Events (3), Projects (3), Surveys (2), Guiding (3), Publications (12), Work (9), Professional events (6), Promotion (10), Collaboration in the Alps (5), Courses (2), Visitors (10), Funds (7) and Eco category (2).

We asked workshop participants to evaluate indicators importance on the value scale: *essential* (3), *desirable* (2), *not significant* (1). The managers also indicated which data are already collected or already being in use in TNP. The question on measurability of indicators in TNP was not answered by two managers.

In short survey conducted at the very beginning of the workshop only two out of eight TNP managers stated they are using indicators to measure the investment in environmental education activities. As for the indicators source of information they stated surveys conducted in TNP and data provided by the Alpine Association of Slovenia.

Environmental education indicators importance and measurability

We calculated the averages and standard deviations for indicators importance. The maximum average was 3 for seven indicators and the minimum 2.13 for one indicator. Due to the fact that all indicators have been evaluated between desirable (2) and essential (3), it is feasible to evaluate the use of all 89 suggested indicators in the future. We ranked the indicators according to their importance averages and clustered them in five groups (Table 1). In the following discussion we used the number of indicators in brackets to refer to the indicators being in a certain group or dimension.

Essential indicators

From the list of 89 environmental education indicators seven indicators were identified as essential by all workshop participants (average mark 3):

1. Number of environmental workshops for children,
2. Number of primary schools that collaborate with TNP,
3. Number of Junior Rangers in TNP,
4. Number of EU calls on which TNP applied,
5. Number of EU projects in implementation,
6. Number of environmental workshops for local inhabitants,
7. Number of thematic days (e.g. Wednesday's nights).

In the following we refer to those as *essential indicators*. By evaluating the list of *essential indicators* we draw a conclusion that: special attention is given to the education of children and youth (indicators 1., 2. and 3.), EU projects present an important funding source (4. and 5.), the educational workshops for local inhabitants are of most importance (6.), as well as thematic days (7.) which are open days for the public and combine various groups of visitors according to their interests, age and origin.

Table 1: Indicators grouped in four groups based on their importance averages.

Groups	Importance averages	Number of indicators
1	3	7
2	2.99 - 2.76	15
3	2.75 - 2.51	42
4	2.50 - 2.26	23
5	2.25 - 2.00	2

In this group five indicators are directly or indirectly linked to environmental education (1. 2. 3., 6. and 7.), all of them involving people in educational activities or events. These five indicators belong to dimension Direct environmental education. The two other indicators focus on EU projects from dimension Funds, thus we conclude that applying for EU funding calls and later implementation of EU projects in TNP are of high importance and bring a significant international recognition to TNP. In order to illustrate the *essential indicators* use in TNP, we present the example of four *essential indicators* data in years 2000 to 2009 in Table 2.

Table 2. Examples of essential indicators for years 2000 and 2009. In year 2000 data for environmental workshops for children have been collected under lectures on the field.

Essential indicators (number of essential indicator)	**2000**	**2009**
Number of primary schools that collaborate with TNP (2.)	14	16
Number of environmental workshops for children (1.)	*	67
Number of thematic days (e.g. Wednesday's nights) (7.)	13	74
Number of Junior Rangers in TNP (3.)	from 2002	every year + 10
Number of lectures on the field (indicator in use)	59	23

Number of primary schools that collaborate with TNP has risen from 14 in year 2000 to 16 in year 2009. In the park there are six municipalities, but only one primary school in Soča, which is a branch of Bovec primary school. This indicates that 13 schools outside TNP boarders collaborate with TNP. For the year 2000 data on *Number of environmental workshops for children* is within the *Number of lectures on the field* (indicator already being in use in TNP), thus we do not have exact data for year 2000. Still we can suggest that it would have been at least 36 or more, since in 2009 there were 23 lectures on the field. According to this calculation the indicator *Number of environmental workshops for children* shows the rise in number of workshops. *Number of thematic days (e.g. Wednesday's nights)* has risen by more than 5 fold in 9 years. This trend shows the popularity and variety of the thematic days organized in the park. Junior Ranger program, which is being conducted in some other Alpine national parks as well, is a success in TNP involving and educating youth form the park or it's immediate surroundings on conservation and sustainable management of the park. The program started in 2002 in TNP, and number of Junior Rangers in TNP continues to rise with the trend of 10 new Junior Rangers per year on average.

Summary of environmental education indicators assessment

In Table 3 we show the indicators importance results clustered in five groups according to their indicators importance and type of information they convey.

Direct environmental education indicators are present in groups 1 – 4. One third of them were evaluated as *essential indicators* being in the group 1 (average 3). Other two *essential indicators* are from the dimension Funds and focus on EU calls for projects and implementation of EU projects. Based on that, we conclude that direct environmental education indicators as well as EU funding are essential for evaluation of environmental education implementation in TNP.

In group 2 (averages 2.99 – 2.76) enter indicators from the following dimensions: Visitors (5), Direct environmental education (4), Events (3), Collaboration in the Alps (2), Work (1). Accordingly indicators for monitoring visitors, events and collaboration in the Alps are of high importance.

We argue that events in TNP are of very high importance for the implementation of environmental education in TNP since in general people are attracted by events and these may be used as outreach opportunities to the broader public. Events attract tourists to the park and at the same time present a possibility for the promotion of local products, services and culture.

From Table 3 we see the 42 indicators are clustered in group 3 (averages 2.75 – 2.51), corresponding to the 47.2% of the indicators being tested. In the third group indicators from all dimensions are present except from dimension Events, which have all been sorted in group 2 and dimension Surveys which have all been sorted in the fourth group.

Indicators group 4 (averages 2.50 – 2.26) contains 23 indicators from eight indicator dimensions. It is important to emphasize that in this group are: 7 out of 12 Publications indicators and 5 out of 10 Promotion indicators.

Indicators *Number of conference publications (abstract, poster)* and *Number of organized recreational activities (e.g. trekking)* have been found less important than the 97.7% of all indicators. These two indicators have been sorted to group 5 (averages 2.25 – 2.00).

Finally, we should state that environmental education indicators are already in use in TNP, but currently there is no publication available that would offer the overview of the indicators in use. On the workshop TNP managers evaluated 37 out of 89 suggested indicators as already being measured in TNP or data are being collected for their assessment, which corresponds to 41.6% of the assessed indicators. Based on this result we conclude that even though data for environmental education indicators are being collected and in use in TNP, systematic approach is needed to use full capacity of this analytical method.

Table 3: Indicators groups and dimensions sorted in five groups based on their averages.

Indicators' dimension (Number of indicators)	**Indicators' group based on averages**				
	1	2	3	4	5
Indicators' importance averages	3.00	2.99 - 2.76	2.75 - 2.51	2.50 - 2.26	2.25 - 2.00
Direct environmental education (15)	5	4	3	3	
Events (3)		3			
Projects (3)			2	1	
Surveys (2)				2	
Guiding (3)			2		1
Publications (12)			4	7	1
Work (9)		1	6	2	
Professional events (6)			6		
Promotion (10)			5	5	
Collaboration in the Alps (5)		2	3		
Courses (2)			2		
Visitors (10)		5	3	2	
Funds (7)	2		4	1	
Eco category (2)			2		

Conclusions

The indicators being developed and tested in this study fall in the following indicators' categories: direct, analytical, objective as they refer to quantitative data, measuring the influence on people and indirectly to their environmental, socio-economic environment, having integrated main dimension and being local, since they evaluate environmental education in Triglav National Park. Still having the potential to be applicated to other protected areas in Slovenia and even to other protected areas in other Alpine countries, spatial scale of environmental education indicators developed and assessed in this study might grow to be national or even global.

We identified seven *essential indicators* which could be used in other protected areas in the Alps to make an overview of environmental educational activities through time across the Alpine space. By analyzing data for four essential indicators, this study identified the trend of significant increase in environmental education activities for children and youth in the park and fivefold increase in thematic events organized by Triglav National Park in decade from 2000 to 2009.

The study provides valuable information for Triglav National Park managers and other stakeholders that are involved in the implementation of environmental education activities in protected areas in Slovenia and abroad. The outcomes of this study are useful for future work on indicators development in other protected areas as well.

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Vertical stratification of xylobiontic beetles in floodplain forests of the Donau-Auen National Park and potential effects of box elder control measures

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Abstract

Xylobiontic beetles represent a substantial fraction of the biodiversity of forest ecosystems and are useful bioindicators for evaluating effects of forest management measures. This study conducted in the Donau-Auen National Park (Lower Austria) sampled xylobiontic beetles in one of the largest remaining floodplain forests in Central Europe. Besides using a standardized method of inventorying the fauna of xylobiontic beetles in two forest strata (understory and canopy layer), we studied how the community of dead wood feeding beetles responds to an abrupt increase of dead wood volume due to measures to control the neophytic Box Elder *Acer negundo*. Therefore, flight interception traps were installed at twelve sites where measures to control the neophytic box elder had previously been taken, as well as at twelve reference sites without removal of box elder trees. At each site one trap was placed in the understorey and one in the canopy. So far, approximately 1/3 of the sampled beetle are sorted and identified to species level. In total 242 species of xylobiontic beetles (of 42 families) were recorded. Species composition of xylobiontic beetles differed significantly between vegetation strata. However, our data does not indicate any effect of box elder control measures on species richness and species composition. Three different factors may account for this observation. (1) The time lag was too short for xylobiontic beetles, even for species feeding on fresh dead wood, to respond to the increased availability of dead wood. (2) Dead wood of the neophytic Box Elder represents a resource of low quality for a large fraction of the native xylobiontic beetles. (3) The sample size was too small to detect effects of box elder removal.

Keywords

Dead wood, floodplain ecosystem, functional groups, neophyte, xylobiontic Coleoptera, vertical stratification

Introduction

The floodplain system along the Danube river between Vienna and the Slovakian border represents one of the largest remaining semi-natural alluvial landscapes in Central Europe (Tockner et al. 1998). The region's floodplain forests are characterized by a high biodiversity and are therefore considered as areas of major conservation concern. Floodplain forests typically contain a high amount of dead wood representing an important microhabitat for xylobiontic insects (Gentry & Whitford 1982; Polit & Brown 1996). Studies from other regions in Central Europe have reported a particularly high diversity of xylobiontic beetle in this forest type (e.g. Bense et al. 2000; Bail 2007).

In this study we sampled xylobiontic beetles in the understory and canopy of a floodplain forest in the Donau-Auen National Park, Eastern Austria. Our study provides a first estimate of the species richness of this ecologically important group for the national park. Besides collecting beetles in two different vegetation strata, we studied effect of measures aiming to control the box elder (*Acer negundo*). The box elder represents a neophyte which already contributes significantly to the vegetation cover of floodplain forests in our study area (Walter et al. 2005). Consequently, management measures (girdling, felling) aiming to control this neophyte produce a significant amount of additional dead wood.

In particular, our study addressed the following questions:

(1.) How does the community of xylobiontic beetles differ between understorey and canopy in floodplain forests of the Donau-Auen National Park? Studies from tropical forests reported a distinct vertical stratification in forest insect assemblages (e.g. Schulze et al. 2001), including beetles (e.g. Charles & Basset 2005, Stork & Grimbacher 2006, Davis et al. 2011, Bouget et al. 2011). We expect that xylobiontic beetles are more abundant and show a higher species richness at lower vegetation levels due to their naturally higher amount of available dead wood.

(2.) How do box elder control measures affect xylobiontic beetles? We expect that the abundance of xylobiontic beetles is higher at forest sites were such measures (girdling and felling of box elder trees) have been implemented due to an increased amount of dead wood. Because the sampling was conducted just after the control measures were applied, we expect that particularly beetles feeding on fresh dead wood will benefit.

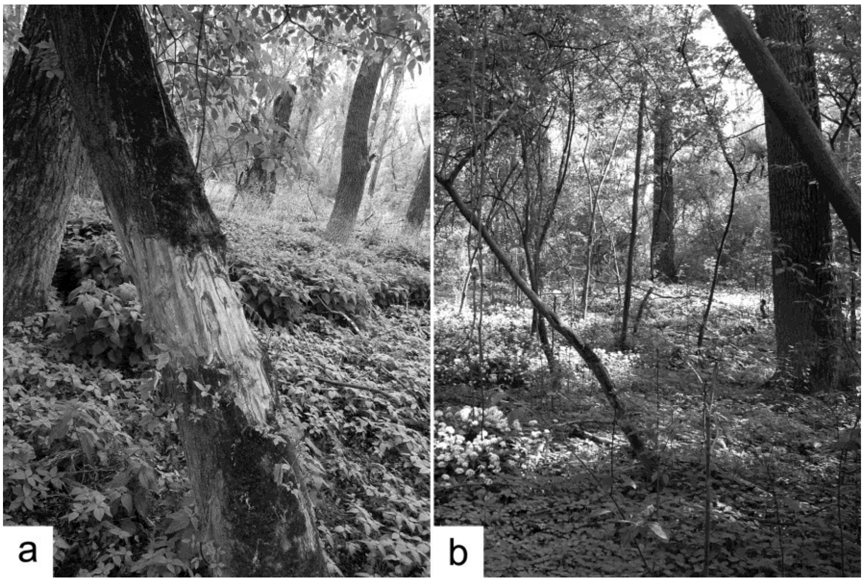

Figure 1: Floodplain forest sites at the eastern part of the Donau-Auen National Park (a) with and (b) without box elder removal (box elder stem in front damaged due to girdling).

Methods

Study area

The study was conducted in the Donau-Auen National Park in Lower Austria, south-east of Vienna in the area "Stopfenreuther Au". The average slope of the Danube is 0.04% and the average discharge in the area of the national park is 1500-1900m^3 s^{-1} (Nationalpark Donau-Auen 2013). The mean annual temperature of the study area is 9.5°C and the mean annual precipitation is 525 $l \cdot m^{-2}$ (averages of years 1971-2000; ZAMG 2013). Our study area was located in the regularly flooded part of the forest (dominated by *Populus*, *Salix* and *Alnus* trees). Assemblages of xylobiontic beetles were compared between forest sites where management measures had been applied to control box elder (AC sites) and forest sites which remained unaffected (R sites) (Figure 1). A total of twelve replicate sites per forest type were selected. All sampling sites were located between E 016°54'31" and E016°56'12" and N 48°09'03" and N48°09'38". The minimum distance between two sampling sites was 200 m. So far samples were sorted and analyzed for the 4 AC and 4 R sites indicated in Figure 2.

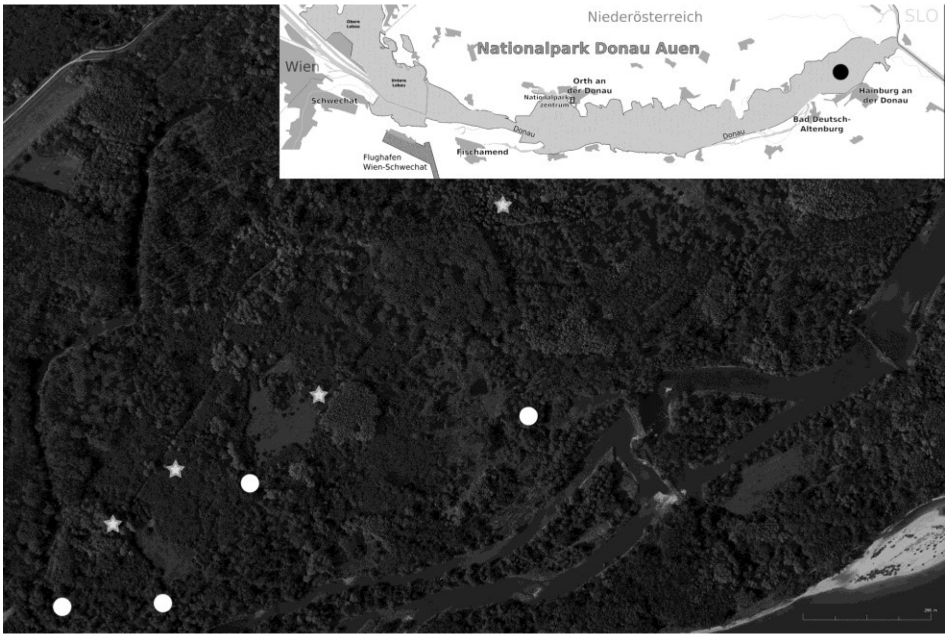

Figure 2: Map of study area indicating sampled with (white circles) and without Box Elder control measures (grey stars). The black spot marks of the study area in the Donau-Auen National Park.

Sampling and identification of beetles

At each study site beetles were sampled with two flight interception traps (e.g. BAIL 2007; see also Fig. 3), one placed in the understorey (at ca. 1.5 m height) and one in the canopy (height: 10 to 15 m). The traps were controlled every 2 to 3 weeks between May and September 2012 resulting in a total of 8 samples per trap. Beetles were identified to species level according to FREUDE et al. (1964-83). Classification of xylobiontic beetles in substrate-guilds was done according to SCHMIDL & BUSSLER (2004).

Figure 3: Flight interception trap used to sample xylobiontic beetles in understory and canopy of floodplain forest.

<u>Data analysis</u>

Species accumulation curves and estimates of total species richness were calculated for the total sample of xylobiontic beetles using the software EstimateS vers. 9 (COLWELL 2013). Samples of individual traps from one sampling round represent the sampling units. Furthermore, abundance-based species accumulation curves (± 95 % CI) were calculated with the software Past (HAMMER et al. 2001) for xylobiontic beetles sampled in canopy and understorey layer by pooling all canopy and understorey sites, respectively, To evaluate the effect of box elder control measures on species richness, abundance-based species accumulation curves (± 95 % CI) were also calculated separately for forest sites with and without applied control measures (by pooling canopy and understorey sites). To test for effects of forest type (AC vs. R sites) and vegetation stratum (canopy vs. understorey) on the total abundance of xylobiontic beetles caught per trap and the relative abundance of beetles feeding on fresh dead wood, a two-way ANOVA was calculated with the software Statistica 7.1 (StatSoft, Inc. 2005).

Bray-Curtis similarities were calculated (using √x transformed abundances) for all combination of traps to evaluate effects of forest stratum and box elder control measures on species composition of xylobiontic beetles. Subsequently, similarity relationships were visualized with a non-metric multidimensional scaling scaling (NMDS) ordination. An associated stress value of <0.20 was considered as reliably displaying the similarity relationships in the resulting two-dimensional ordination (CLARKE 1993). Analyses of similarity (ANOSIMs; with 999 permutations) were calculated with the program Primer v5 (CLARKE & GORLEY 2001) to test for differences in xylobiontic beetle composition between forest types (AC vs. R sites) and vegetation strata (understory vs. canopy).

Results

<u>Abundance and species richness</u>

So far 5,531 of the beetles caught with the flight interception traps were examined (about a third of the whole dataset). These individuals could be assigned to 398 species in 51 families. The majority of beetles were xylobiontic species. They represented 242 species (42 families) and 82% of all trapped beetles. The calculated species accumulation curve for the total sample of xylobiontic beetles indicates a still very incomplete species inventory. The total richness of beetles feeding on deed wood predicted by the richness estimator Chao2 is nearly 400 species (Fig. 4).

The total abundance of xylobiontic beetles per trap did not differ between forest types (AC vs. R sites) and vegetation strata (canopy vs. understorey) (two-way ANOVA: $r_{\text{multiple}} = 0.37$, $F_{2,13} = 1.03$, $p = 0.386$). As indicated by the respective species accumulation curves, species richness was similar between R and AC sites (Fig. 5a) as well as between both forest strata (Fig 5b).

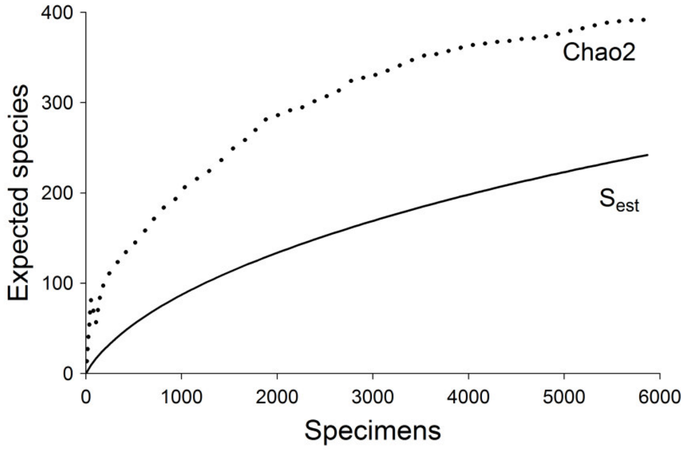

Figure 4: Species accumulation curve for the fauna of xylobiontic beetles collected by 8 understory and 8 canopy traps in floodplain forests of Donau-Auen National Park.

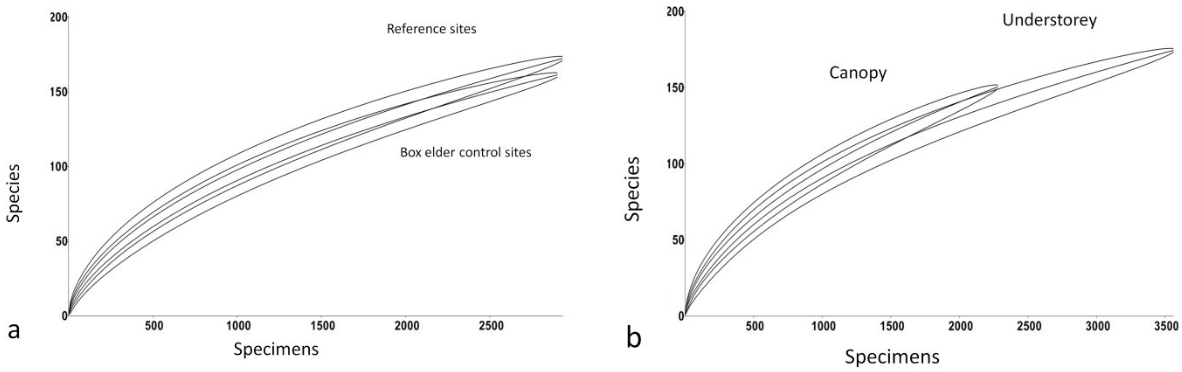

Figure 5: Species accumulation curves for xylobiontic beetles collected at (a) R and AC sites and (b) in understory and canopy.

Species composition

The NMDS ordination (based on Bray-Curtis similarities) visualizing similarity relationships between beetle assemblages sampled by flight interception traps does not indicate an obvious effect of box elder control on species composition. However, a weak difference apparently exists between understory and canopy traps, which are plotted predominantly in the right and left half of the NMDS plot, respectively. Indeed, the calculated one-way ANOSIM indicated a significant effect of vegetation stratum on species composition (global $R = 0.257$, $p = 0.001$).

Functional groups

A two-way ANOVA testing for effects of vegetation stratum (understory vs. canopy) and forest type (AC vs. R sites) on the relative abundance of xylobiontic beetles colonizing fresh dead wood did not indicate any significant effect (Stratum: $F_1 = 0.55$, $p = 0.473$; forest type: $F_1 = 2.05$, $p = 0.175$).

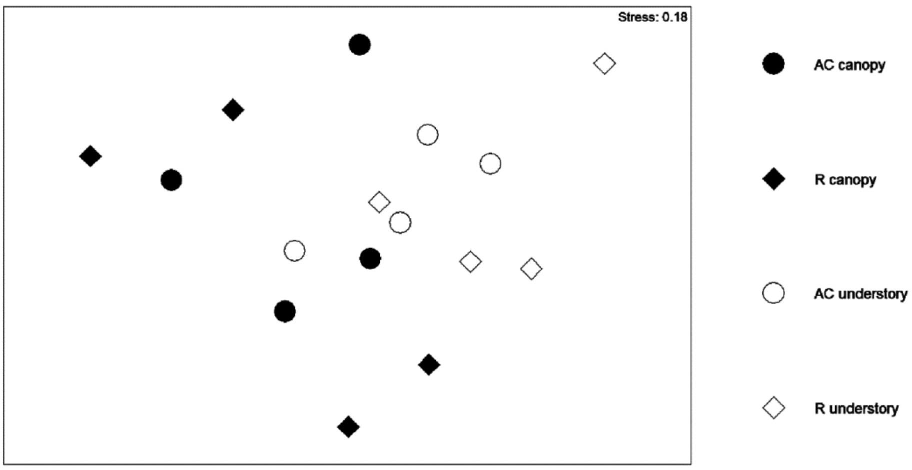

Figure 6: Similarity relationships between xylobiontic beetle assemblages collected with flight interception traps at canopy and understorey layer of sites affected by box elder control measures (AC) and sites without any forest management measures (R). Similarities quantified as Bray-Curtis index values (calculated using √x transformed abundances) are visualized by a non-metric multidimensional scaling ordination.

Discussion

In comparison to other studies on xylobiontic beetles in Central European floodplain ecosystems, our results from a floodplain forest in Donau-Auen National Park indicate an exceptionally high richness of this beetle group with so far nearly 250 recorded species. At other floodplain forest areas in Central Europe only up to <140 species were recorded although not only flight interception traps but also canopy fogging and manual collecting were used to sample xylobiontic beetles (compare Table 5.1-2 in BAIL 2007). To our knowledge, in Europe similar or even slightly higher species numbers of xylobiontic beetles were only found in other forest types, e.g. in a deciduous forests with a high proportion of oaks in Northern France (280 species; BOUGET et al. 2012). However, calculated species accumulation curves and the Chao 2 richness estimator both indicate an even higher richness of xylobiontic beetles in our study area; a total of ca. 400 species was estimated by the Chao 2 extrapolation method.

So far vertical stratification of beetles in temporal forests was rarely considered as factor structuring beetle communities on a local scale. In general, vertical stratification is common in forest arthropods due to strongly differing habitat conditions in understory and canopy layer (ULYSHEN 2011). Our study found partly distinct assemblages of xylobiontic beetles in understory and canopy of the sampled floodplain forest. However, in contrast to studies from other forest types (e.g. BOUGET et al. 2011), neither species richness nor abundance of beetles showed any significant differences between vegetation layers.

ULYSHEN et al. (2010) found that the removal of an invasive shrub from a floodplain forest in Georgia (USA) had far reaching consequences on richness and species composition of beetles. Remarkably, we did not find any effect of box elder control measures in our study area. Perhaps the time lag (less than 1 year) between the control measures and the sampling was too short for xylobiontic beetles (even for species feeding on fresh dead wood) to respond to the abrupt increase of dead wood volume. Furthermore, the neophyte could represent a less suitable resource for xylobiontic beetles than autochthonous relatives of the same genus, as previously shown for beetle assemblages in a floodplain forest in Germany (SCHMIDT et al. 2007). It remains to be seen if effects of box elder removal on beetle assemblages can be detected when a larger dataset will be available for analysis.

Conclusions

Arthropods depending on dead wood constitute an exceptionally diverse ecological group. Unfortunately, they also belong to one of the most rapidly declining groups in Europe (NIETO & ALEXANDER 2010). The high species richness already documented by our preliminary data underlines the conservation value of floodplain forests in the Donau-Auen National Park. In fact, our data indicates that the floodplain forests east of Vienna may have the highest richness of xylobiontic beetles so far recorded in any Central European floodplain forest area. Therefore, further studies on the ecology of this ecologically important group are urgently needed, for example, to evaluate the potentially negative effects of neophyte tree species (such as Box Elder) on the beetle fauna associated with dead wood.

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Planning in England's National Parks

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Abstract

The English National Parks are category V IUCN protected areas. The governance of the Parks is structured to achieve two purposes: 1) to conserve and enhance the natural beauty, wildlife and cultural heritage and 2) to promote opportunities for the understanding and enjoyment of the special qualities. There is also a secondary duty to foster the economic and social well-being of local communities within the Park areas. Planning powers have been used in relation to the two purposes throughout the sixty year history of National Parks in England. However, while historical analysis reviews Park planning limited research has been undertaken in the last two decades. This paper discusses the role that planning powers play in the pursuit of the purposes/duty.

Keywords

England's National Parks, planning powers, relationships with stakeholders

Introduction

The English National Parks system was founded following the 1949 National Parks and Access to the Countryside Act. Seven National Parks were designated in upland England in the 1950s. A lowland area (The Broads) was effectively added in the 1980s with two new Parks designated in the south east of England since 2005. Parks now cover 9.3% of the land area of England. There is no National Parks administration as such. Instead each Park is governed by a free standing, special purpose local authority (or municipality) known as a National Park Authority (NPA). The purposes of the English National Parks are: 1) to conserve and enhance the natural beauty, wildlife and cultural heritage of the Parks and; 2) to promote opportunities for the understanding and enjoyment of the special qualities of the Parks by to public. In pursuing these purposes, the NPAs should seek to foster the economic and social well-being of local communities within the National Parks.

Since the establishment of the National Parks the statutory town and country system has been central to the pursuit of the two statutory purposes. Planning powers are the principal regulatory mechanism that the Authorities can use. While there are various public bodies involved in Park governance NPAs have the lead responsibility for achieving the purposes and duty. NPAs exist alongside conventional local councils who deliver a range of services in the Park areas. The NPAs are legally accountable to the national government department responsible for the environment while the conventional authorities are accountable to the department responsible for communities and local government. All NPAs are responsible for development control (planning decisions) and strategic (or long term) planning in the Park areas, just as conventional local authorities are in the rest of the country. Professional planners work alongside Authority members constituted as a planning committee in the decision making process. However, unlike other local planning authorities NPAs have a statutory duty to prepare, and regularly review, management plans for the Parks. The Authorities deliver these management plans in partnership with a range of other organisations and stakeholders. The governance system for National Parks in England is the result of a complex history that has involved many compromises. Proponents of the Parks system fought hard for NPAs to have planning powers believing them to be vital to conservation. It is therefore important to question the role of planning in achieving the objectives of designation.

In this paper we question, in line with the themes of the 5th Symposium for research in protected areas, the extent to which planning functions assist with achieving the purposes/duty. To achieve this we first review the literature. Drawing on this review and other evidence we then critically analyse the extent to which planning powers help achieve the purposes/duty before turning, by way of conclusion, to the question the future role of planning in Park management.

Insights from the literature

In the run up to the creation of the Scottish National Parks research examined the ways in which design is addressed in planning and development control in the English Parks (LUC 2001). This study found that design standards were very high. The NPAs had sought to protect local character by adopting conservative approaches which precluded the introduction of modern architecture. The overall result was that "...the ethos of restriction in relation to design is often applied, in an uncritical manner, to new development, Planning policy, in relation to design, is rooted in restrictions, rather than in opportunity, and creativity" (p.7). While each Authority had adopted a different approach to public participation officers were concerned that this often meant hearing the views of a vocal group with a strong pro-conservation agenda. Resources were also constraining what NPAs could do with regard to engagement. The report concludes by recommending that NPAs look again at their approach to design and the implications for planning decisions stating that "innovation linked with community needs and economic development need not necessarily reduce the overall quality of a protected area" (p.49).

LLOYD et al. (2004) examined commercial and Industrial Developments in English Parks. They analysed development control statistics for 1997 to 1999. The data suggests consistently low demand for new commercial and industrial development. They argued that there is a general acceptance amongst planners that Park purposes rely on a sound rural economy. But despite this decision makers were often unwilling to conceptualise development as capable of enhancing natural beauty (p.293). LLOYD et al. also found that conservation interests dominated public consultation. They argued for using other ways of communicating with the public to ensure that not just a vocal minority are engaged in the planning process.

Other papers have focused on particular aspects of the planning system. RICHARDS & SATSANGI (2004) examine the policy framework for the provision of affordable housing in National Parks. They begin by looking at the use of the concept of sustainable development to restrict affordable housing development in the English countryside and the adverse socio-economic impacts that have resulted. The paper takes the Peak District National Park. They found ample evidence of housing need in the Peak District but also found that planning policy restricted new development with the only sites allocated for new housing being in the town of Bakewell. Elsewhere routes to provision were very limited. Richards and Satsangi argued that in the Peak District designation had restricted access to affordable housing by inflating house prices and limiting supply of land to exception sites. Furthermore, although the relevant provider of affordable homes understood the design policies of the NPA the public funding available to support building was insufficient to cover the extra costs incurred as a result of the design specifications.

Sustainability and National Park management is the focus of a paper by POWELL et al. (2002). This highlighted the importance of the management planning process concluding that "sympathetic socio-economic activity…was pivotal to sustaining characteristic environments" but that it was vital to maintain a close check on the various 'capitals' within the protected area to ensure that these were being reinforced rather than eroded (p.294).

Other literature on National Parks planning is useful for providing historical context. The MACEWENS (1987;1982) and BLUNDEN & CURRY (1989) both provide a comprehensive overview of the National Parks system, tracing why planning powers have been so significant to Authorities and the limitations of planning in shaping the evolution of Park landscapes. Other historical papers give some insight into particular aspects of planning. BROTHERTON (1982) observed that the planning system in National Parks was the subject of frequent complaint as too restrictive, confusing and inconsistent. He also traces the increasing pressures for development expressed in the growing number of planning applications. PATMORE (1987) argued that Park planning was confused and compromised. He traces how different government agencies were pursuing contradictory objectives that the Committee could do little about.

In 1964 BLENKINSOP published a study of the National Parks of England and Wales. His detailed paper includes a section on the NPAs as planning authorities (p.38), arguing that planning controls had been tightened since designation. Whether National Park designation makes a difference in planning decisions was also the topic of a 1992 paper by Nigel CURRY. He examined time series data on planning applications and refusals. He found that between the early 1960s and early 1970s refusal rates were similar to national trends. During the 1970s and 1980s refusal rates were higher in Parks than nationally (p.116). Today, it is the perception if not the reality, that planning in the Parks is more restrictive.

Planning and the Purposes/Duty

In this section the two purposes and the duty are reviewed to critically analyse the extent to which planning functions assist with achievement:

1) Conservation

There is a strong case for arguing planning has been central to conserving natural beauty if this is interpreted as a the visual appearance of the landscape. Indeed, critics often argue that preserving a particular landscape aesthetic has been so successful that the Parks are being preserved 'in aspic' rather than evolving to reflect changing nature/human interactions. Hence the planning system can also be argued to be effective with regard to cultural heritage if this is interpreted to mean the built heritage. Again, critics highlight this effect in pointing to the lack of innovation in design and the resistance to new development on conservation related grounds. The relationship between planning and biodiversity conservation is more complex. Low levels of new built development mean that controversies over the impact on particular habitats is relatively rare. However, the English system places limits on the regulatory powers of planners in land management. In particular there are few regulatory means of influencing agricultural practices beyond special types of designation and particularly damaging activities. Instead Park staff work outside the statutory planning system to co-operate with farmers and encourage them into positive environmental activities. This is principally through pillar two of the Common Agricultural Policy.

2) Understanding and Enjoyment.

Those who analyse the successes and failures of the English NPs system have often focused on the so-called 'special qualities' of the Parks. The concept that the Parks have an (often ill defined) set of attributes that make them special is even reflected in the legislative framework. As we argued above there are strong arguments that the special qualities have been remain special if you interpret this to mean the landscape has been preserved and large scale development largely prevented. However, planning can not reach as far as directly promoting opportunities for understanding and enjoyment. This purpose is in certain respects beyond the reach of the statutory planning system. Instead the NPAs have needed specialist officers and projects to develop this area of their work. They have also needed wider partnerships of stakeholders including local businesses and community groups. This can be a challenge in terms of planning functions in two respects. The first is a long standing concern that there can be conflict between the two purposes, that creating opportunities has conservation consequences. By the 1970s the Sandford principle was introduced which stated that the first purpose should override the second in cases of conflict. This is a principle that planners must still follow today. The second challenge is that planning functions place regulatory duties on the NPAs while the second purpose and duty simultaneously give them a developmental role. Those who criticise the lack of new development in National Parks also point to the ways in which planning policy can work to the detriment of achieving the second purpose.

3) Economic and social well-being

Two broad bodies of thought on the duty, and the role of the planning system with regard to the duty, can be discerned. These are articulated by NGOs, officers and staff of NPAs, community representatives, politicians as well as researchers and journalists.

Some of those involved in National Parks highlight the tensions between development and conservation. They are often concerned that the duty results in the dilution of the two 'traditional' purposes. Often they voice a fear that developers will attempt to use the duty to override the purposes and damage the special qualities. But those who are cautious about the effect of the duty frequently acknowledged that some forms of development should be accommodated and that socio-economic development in certain forms should be encouraged (although not necessarily as a duty of the NPA). Often those who are cautious are sympathetic to community need but emphasis the economic benefits of the conservation of the special qualities. The first group tend to argue that planning functions should be exercised to maintain a tight control over development. They emphasise the importance of regulation and the historical success of the system. The second group focus on the role of planners in encouraging appropriate business and community development. They tend to have the view that more positive action would mean that the statutory purposes would be promoted through development. While aware of potential tension between purposes this group seek to find complementarities. They take a view of planners and planning which emphasises their collaborative role, the need to work with others to achieve the purposes and the duty.

The duty has been in place since 1995. The idea has always attracted debate and evidence on its impacts is mixed. NPAs can point to evidence that planners and other officers have used the duty to positive effect, in ways which help to achieve the purposes. However, some critics say that too little has been achieved and want the elevation of the duty to a full purpose. Other critics, especially those in the first group remain sceptical that the duty is of value and point to the potential ways in which it can be used by developers. Examining planning statistics and case histories can provide evidence that supports both sets of critics and those who point to the success of the duty.

Discussion and conclusions

Thinking on the objectives and societal role protected areas has changed over the last two decades (MOSE 2007). The English National Parks system designed in the 1950s has evolved to reflect some of these changes but managers must still grapple with the contradictions and limitations of the original 1949 Act especially with regard to the two purposes. The introduction of the duty since the 1990s have brought into sharper focus a debate on the implications of designation and how NPAs should approach the implementation of planning powers. This debate remains active with different Authorities reflecting different mixes of the two bodies of thought outlined above. The debate places planners and planning committees centre stage. Their decisions reflect the broader approach of the NPA and their relations with other stakeholders provide an important context for the work of the wider Authority.

This brief paper has questioned the extent to which planning functions assist with achieving the purposes/duty. Planning powers have been vital to the English NPAs. They give the Authorities substantial responsibilities rendering them a regulator that must be listened to. NPAs have a track record of successes in stopping developments which would be detrimental to the special qualities (however these could be defined). There have, of course, been some notable failures documented in the literature (BLUNDEN & CURRY 1989; MACEWEN & MACEWEN 1987). In 2013 there are times when the ability to say 'yes' or 'no' remains crucial. Planning is a necessary power to the achievement of the purposes and the duty but it is not sufficient to achieve the sustainable development agenda the NPAs themselves wish to pursue. Alongside planning powers Authorities need a range of other tools to address aims that the statutory planning system can not. Areas of work will include recreational development, socio-economic development and advice for farmers and foresters. This point applies to achieving both purposes as well as the duty.

Where planning in the Parks differs from elsewhere is the implementation of management plans. These typically set out and plan the development of relations between the different parts of the NPAs and their wider partners/stakeholders. Analysis of plan content and progress towards achieving the objectives set out in management plans is crucial in building understanding on whether each individual NPA is achieving the purposes/duty.

There is also an imperative to think beyond decision making and the creation of plans. We can see in the debate on the duty a diversity of thinking on the role of the planner and the relationship between them and other stakeholders. As more emphasis is placed on the enabling role of planning so more has been invested in building and sustaining relations. The NPAs are placing more emphasis on partnership and participation. They are realising the challenges of doing this more effectively and collaboratively to include a range of interests.

Increasingly achieving the objectives of designation relies on an understanding of how to use relationships effectively to achieve desired outcomes in addition to more the traditional, but perhaps blunt, exercise of regulatory power.

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Social-Ecological Systems: towards a global approach of biodiversity observation in a Regional natural park of alpine territory

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Abstract

Regional natural parks (PNR) in France were created to protect and enhance the open rural inhabited spaces. PNR are organized around a collaborative project of sustainable development and are marked by complex human-nature relations where integrated management and conservation planning requires cross disciplinary approach. It is impossible to understand nature without society and *vice versa*. The Baronnies Provencales PNR project takes part in the preservation of an Alpine ecological continuum. In the context of climate change we consider adaptive capacities (of nature and human) are favored by a co-constructed observation process of the state and evolution of socio-ecological systems (SES). From conceptual and methodological tools of landscape ecology, we could have a vision about the spatial organization of different components in this territory and understand the interactions between the ecological landscapes organization and structure of biodiversity. By coupling environmental and socioeconomical diagnosis, SES delineations and characterizations could be identified. By the proposed method of territorial study we aims to prove the interest of territories to consider a holistic social, ecological and economical approach based on SES. In making the understanding and the spatial characterization of SES the core of this research, we characterize socio-ecological interdependencies and we tend towards a global approach to biodiversity.

Keywords

Socio-ecological systems, global change, biodiversity, sustainable development, adaptation capacity, observatory

Introduction

The concept of biodiversity initiated between 1986 and 1988 (Wilson 1988) from the contraction of biological diversity was revisited with a social, anthropocentric perspective in the context of sustainable development during the global summit in Rio de Janeiro. The ecological vision of sustainable development (Passet 1979; Cato 2009) presents the economy as a subset of the sphere of humanity-society, which is itself a subset of the biosphere. As explained by Barbault (2011) biodiversity goes through the three circles of sustainable development, linking the economic sphere to the biosphere while including human affairs. This new concept of biodiversity implicates a transversal approach for biodiversity management planning and ownership of related issues involved, including a global vision of the socio-environment. Objectives of biodiversity conservation can no longer be thought by separating biodiversity and society. Systems to be explored are less ecosystems than coupled human-environment systems, also called social-ecological systems (SES) (Berkes et al. 2003). SES are integrated, complex and adaptive systems, associating nature and human society and structured in two sub-systems being: ecological systems and social systems (Liu et al. 2007). This approach considers human as an active component and integrates human-nature interactions.

Regional natural parks (PNR) are in fragile balance territories, with rich but threatened natural and cultural heritage. PNR's specificity relies not only on the complementarities of its objectives of protection and development, but also on the voluntary commitment of all the partners (municipalities, region(s), department(s) and State), to apply the contract that is the Charter of the Park. A PNR contributes to research programs and mission to introduce new procedures and methods of actions that can be taken in any other territory. Challenges of PNR are to promote adaptation planning meeting the challenges of global change and the implementation of an ecological transition to foster good practices. These territories are at the heart of complex human-nature relations, which require the consideration of the socio-ecological dimension of biodiversity. Integrated management planning and biodiversity conservation within PNR requires a cross disciplinary approach and the narrow interweaving between nature and the human societies leads us to consider PNR as SES.

In this prospective study we look at the Baronnies Provencales territory, wishing to be certified as a PNR by 2014. This project of 2,350 km² has nearly 40,000 inhabitants, is spread over 130 communes between two regions: 2/3 in Rhône-Alpes and 1/3 Provence-Alpes-Côtes-d'Azur. This PNR project can be seen as the "missing link" of an alpine ecological continuum of protected areas recognized for their heritage value. In this territory, we seek to explore biodiversity issues through sustainable development logic. Here, we discuss the extent to which a global approach to biodiversity can provide relevant information in order to develop a sustainable management of territories. SES become the core object of our cognitive interest for sustainable development and for an appropriation of biodiversity issues. We hypothesize adaptation capacities (of the environment and humans) within alpine territories - a protected area subject to local and global changes and where the heterogeneity and disparity of natural and human situations dominate, are encouraged by a co-constructed process of observation of the state and dynamics of socio-ecological systems.

Method

To conduct a territorial analysis of SES, knowledge in five areas is needed (Bourgeron et al. 2001a; 2009): (1) characterization of biological component(s); (2) characterization of physical components; (3) characterization of biological-physical interactions; (4) characterization of socioeconomic components and (5) characterization of SES as a whole, including coupling of component and system properties, such as disturbance and resilience.

The method described below has been divided into four steps.

STEP 1 - Database construction

The implementation of a socio-environmental coupled scenario has to deal with heterogeneous quantitative and qualitative biophysical and socio-economical data generated to study human-environment interactions. Information integration to identify SES can be very challenging and involves integrating information across domains (e.g. geomorphology and human values), different sources (e.g. scientific survey and administrative survey), different formats (e.g. qualitative and quantitative survey), and covering the whole study area (Slocombe 2001; Bourgeron et al. 2009). Knowledge about the territory is acquired via the analysis and interpretation of hierarchical database and maps describing environmental component (topography and landform, soil, climate and land cover) and human component (socio-economic census and socio-demographic census). If necessary, the data sources are transformed and georeferenced to make them useful in GIS. For the typology at the first scale level, grid cells are used as spatial unit, defining the grain of the characterization. The variables are integrated to the grid cells by GIS overlay of the data sets and all variables are transposed in continue attributes. For example three types of land cover in one grid cell will be expressed as the dominant surface one in the grid cell.

STEP 2 –Ecological landscape patterns and interactions with biodiversity

From conceptual and methodological tools of landscape ecology (Burel & Baudry 1999), we will highlight patterns and representative identity of the territory. This will show the relationship between the spatial organization of ecosystems/habitats and ecological mechanisms, that underlying the dynamic of biodiversity and ecosystem functioning.

Three studies are conducted on biodiversity to determine: biodiversity hotspots and vulnerable areas (method from Vimal 2010), life history traits and interactions between biodiversity organization and ecological landscape patterns. In spite of several tools and data sources, data on biodiversity are difficult to collect from naturalist organizations which are protecting their intellectual property and fear of making known the geographical position of threatened species. Thus, biodiversity data are often heterogeneous and do not cover the whole territory. Currently, it is not possible to make statistical analyzes with much accuracy because considerable uncertainty remains about the true absence of species. To overcome this problem we will study plant association and species communities.

STEP 3 – Representation of the systems and socio-ecological units

Multivariate analysis (to define the variables acting on the system) and a hierarchical classification (using CAMIN) will be conducted on the environmental and socioeconomical variables in order to characterize environmental and socioeconomical systems. Then, this diagnosis will be applied to the total database to determine socioecological units.

STEP 4 - Socio-environmental coupled scenario for strategic scenario planning

Scenario planning is conducted at the last stages of this study and determines the various implication and tradeoffs of various possible environmental and land use scenarios. Multi-agent systems have features especially suited to integrate social and environmental components under different forms of organization levels (Bourgeron et al. 2009). For this study, Cormas platform will be use to model the interactions dynamics within and between SES and identify resilience and adaptation capacity of SES. The diagnostic approach from Ostrom (2007, 2009) based on resource systems will enable us to analyze interaction and outcomes of resource systems within linked SES. The framework proposed by Paetzold et al. (2010) to assess ecological quality based on ecosystem services will show the overlap between social expectations, and the sustainable provision. In order to take such an approach we need to integrate explicitly human needs and expectations in the assessment of ecosystems.

Prospective Results and Discussion

Towards a socio-ecological approach of biodiversity

Since the preservation of biodiversity and associated ecosystem services are playing an increasingly important role in society and politics, real scientific debates develop on the social and economical dimensions of biodiversity conservation (Czech 2000, Mangel et al. 1996). The design of territorial projects requires a first phase of knowledge following certain rules and having to be extended in the long-term. It will be possible to meet societal demands for integrated management and spatial planning by the global understanding of biodiversity and human-environment interactions.

The first two steps from the method are necessary to better understand the different components within the PNR. In a territory of alpine and Mediterranean influences, in the context of global change, we plan the environment structure to be pronounced and landscape to be in mosaic. After the integration of biological, physical, land use and socio-economical data in a database framework, a correlation relationship would be made among ecological landscape patterns and biological patterns. Here, we hypothesis that landscape units will correspond to functional units.

<u>Socio-environmental adaptation to global change</u>

We consider ecosystems adaptation should go through the conservation of biodiversity and socio-ecosystems by seeking a territorial equity and minimizing processes of inequality, leading to territorial intelligence. Should this happen through the development of an ecology that considers different scales of time and space, functions and dynamics of ecosystems and anthroposystems, including their socio-economical, territorial and legal status? On the basis of this knowledge would it be possible to better meet societal challenges of sustainable development?

The long-term vision places the territory within environmental gradients and ecological transitions allowing changes in species range. By forward-looking vision with a long term society project, we could anticipate risks, changing landscapes and activities, evaluate impacts on the ecological connectivity (interconnected landscape) and support the ability of each of us to act with responsible manner. Understanding the nature and the extent of combined ecosystems and sociosystems vulnerabilities in rural areas is essential in a changing climate, economic and social situation, which is becoming increasingly difficult. Thus, this study will contribute to respond to priority questions relating to the maintenance and restoration of an ecological continuum in the European Alps. (Walzer et al. 2013). Ecologists and biologists can study the imbalances of ecosystems, social scientists those of societies. Making it difficult to manage and anticipate the consequences of their management. How to study the consequences of the vulnerabilities of the two subsystems, social and ecological? We project that the observation and understanding of socio-environmental coupled scenarios promote an adaptive management of the territory. The resilience, the potential of compensation and the interactions (homogeneity and diversity) between SES will be analyzed while running a multi-agent base model. In this context of global change, the territory of Baronnies Provencales must adapt, and the economical development will relies on resources being primarily the agriculture, forest exploitation and tourism. The main issue for PNR is to provide information on the status and evolution of the territory and to promote good practices. It is therefore interesting to see if the socio-economical vulnerability covers ecological vulnerability and if the ecological vulnerability may be a limiting factor for socio-economical development. The study of SES by the resources units will forecast the internal and external dynamics in the SES, determine ecological services and indicate the paths to achieve a sustainable SES (Ostrom 2007, 2009). The interaction between supply and demand from the model proposed by Paetzold et al. (2010) will demonstrate if the supply of ecological environment can support the socio-economical demand.

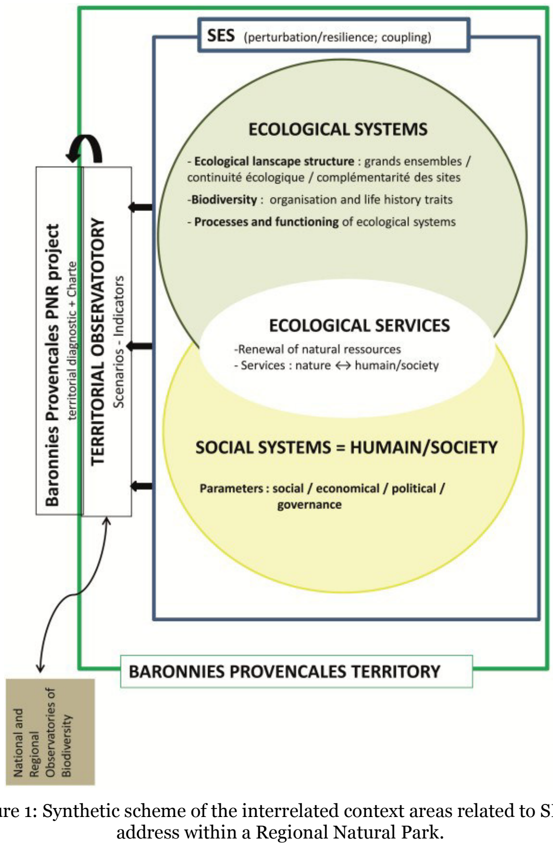

Figure 1: Synthetic scheme of the interrelated context areas related to SES to address within a Regional Natural Park.

<u>A territorial observation tool to develop the link between science and society</u>

To integrate and compare data from various sources over the long term and to study SES, we will implement a territorial observatory within the Baronnies Provencales PNR. This tool aims to help sustainable local development, fosters adaptation capacities and meets the current challenges related to local and global change. The question arises about the appropriateness of a tool "observatory" looking at SES and integrating social and environmental aspect: How to account for the characteristic (and evolution) of ecological and social systems in the observatory? How to address global environmental issues locally and to highlight the global dimension of local issues?

The Observatory is seen as a tool acting as a catalyst of development project, for an adaptive management of socio-ecological systems. Observatory tool has the capacity to transform territorial practices in development and conservation projects. An appropriation of this tool by public policies as well as the society could promote a better approach of biodiversity issues facing global and local change.

For implementing a relevant observation tool we have to:

- Define the relevant spatial unit, time steps and recurrences to observe changes in ecological and social systems.
- Reveal conditions for better coordination between processes located at different time steps: renewal / biodiversity conservation, public policy, technical decisions.
- Establish gateways (conceptual and instrumental) between the approaches and descriptive categories relevant to the action.
- Develop efficient sets of indicators (compositions, structures, functions and evolution) to observe changes in ecological and social systems.

Conclusion

In this study we focus on the social and environmental observation of biodiversity for territorial management planning and to design the construction of an observatory tool addressing the territorial issues. In making the understanding and the spatial characterization of SES the core of this research, we characterize socio-ecological interdependencies and we tend towards a global approach to biodiversity. By this method of territorial study we want to prove the interest for territories to consider a holistic social, ecological and economical approach to biodiversity based on SES. Observation of SES dynamics is particularly important for territories at bioclimatic intersections as they will undergo accelerated changes of biodiversity and of their economy. Given the mission of PNR as to be laboratories for the study of territories capacity to adapt to global change, this work within the Baronnies Provencales presents a more general interest for other territories.

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The role of Hohe Tauern National Park as a Noah's Ark for threatened lichens

Roman Türk

Keywords

Epiphytic lichens

Abstract

In the northern borders of the Austrian Alps – including the calcareous Alps - the lichen flora is threatened by the impact of nitrogen compounds and by aerosols (Türk & Pfleger 2007; Kienesberger et al. 2007; Madl et al. 2010). In particular the most epiphytic lichens with cyanobacterial photobionts, e. g. diverse species of the genera *Collema*, *Leptogium*, *Lobarina*, *Nephroma*, *Pannaria*, *Peltigera*, *Sticta* and the beard lichens of the genera *Bryoria*, *Ramalina* and *Usnea* are extinct in large areas of the Northern Austrian Alps or heavily threatened.

During the past five years in the sections of Salzburg and Carinthia of the National Park Hohe Tauern 986 lichens species were registered. Under the in Austria and Europe severely threatened or very rare lichens 55 epiphytic, 36 terricolous and 35 saxicolous species were found.

Of special interest are the epiphytic lichens which occur in the natural parts of the forest ecosystems of the northern and southern valleys. There exist the very sensitive species like *Lobariapul monaria*, *Lobarina scrobiculata*, *Sticta sylvatica*, *S. fuliginosa*, *Collema nigrescens*, all epiphytic *Nephroma* species, *Pannaria conoplea, Peltigera collina*, *Leptogium saturninum* and *Ramalina thrausta* in a healthy condition with a high vitality. *Dolichousnea longissima* (syn.: *Usnea longissima*) is present only in two sites, whereas it occurred twenty years ago in all northern valleys of the Hohe Tauern. Thus the significance of the National Park Hohe Tauern for the biodiversity of epiphytic lichens and their survival in Austria and Europe is extreme high. Important for the surviving of the cyanobacterial lichens are the presence of old coniferous forests and of old deciduous trees like *Acer pseudoplatanus*, *Fraxinus excelsior* and *Alnus incana*, which should be taken in consideration in the future forest management.

Literature

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Strategies for the sustainable management of salmonid fish populations in Alpine waters with special emphasis on protected areas and national parks

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Keywords

freshwater fish, restoration, management strategies

Abstract

Alpine freshwater fish fauna has entered a crisis phase. In fact, numerous Alpine taxa face a multitude of anthropogenic disturbances, exhibit increasingly restricted distribution areas and are officially ranked in red-list threat categories.Major threats derive from hydro-morphological alterations (e.g. disrupted continuum, flow modification, river regulation) leading to fragmented and oftengenetically isolated subpopulations, in many cases in conjunction with small population sizes and therefore reduced resilience.

Here we try to review existing, and discuss new management strategies to sustain, protect and/or restore natural salmonid fishpopulations in Alpine waters. Special attention is given to rivers and streams in protected areas and national parks. Thepresented concepts focus on brown trout (*Salmo trutta*) and grayling (*Thymallus thymallus*) populations as the two most important key species in Alpine headwaters and middle reaches. When aiming to restore native fish populations it is mandatory (1) to detect and/or define management units based on genetics (i. e. Evolutionarily Significant Units (ESUs) as well as (2) to develop mitigation and restoration concepts to re-establish migration routes and to improve habitat quality. Finally (3), if necessary ecologically sound restocking measures can be developed to recover or rehabilitate native populations and management measures can be setto conserve unique locally adapted populations where endemic/native populations still exist.

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Tourist segments for new facilities in an alpine national park area:
Profiling tourists in Norway based on psychographics and demographics

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Abstract

The pursuit of sustainable tourism may involve development of more facilities in the buffer zones of national parks and other pristine nature areas. Two independent samples of domestic and foreign tourists in Norway were segmented based on their expressed preferences for new facilities in an alpine national park region. The proposed facilities in the survey comprised a diversity of types and sizes, potentially also involving different impacts upon the natural habitat. One sample was recruited in the alpine area while the other was recruited outside the area.

The post hoc market segmentation was carried out by a combined two-stage hierarchical and non-hierarchical clustering of facility quest factors, where factors were identified from a relatively large set of items. The stability of the cluster solutions was assessed by comparing independent sample solutions against the pooled sample. Moreover, we assessed the extent to which the segments differed significantly with respect to demographic characteristics or psychographic characteristics.

Keywords

cluster analysis, post hoc, market segmentation, two-stage clustering

Introduction

The tourism sector has experienced a substantial growth during the second half of the 20th century and the beginning of the 21st (Oh et al. 1995; Gibson & Yannakis 2002; UNWTO 2010), and the nature-based segment has been the most rapidly expanding market within this sector (Nyaupane et al. 2004; Mehmetouglu 2007; UNWTO 2009). Currently, a larger share of tourists have travel experience and they have become more sophisticated with respect to activity organisation and facilitation (Gibson & Yannakis 2002; Pulido-Fernández & Sánchez-Rivero 2010). The tourists' demand creates both challenges and opportunities for tourism business development and for the natural environment (Fredman & Tyrväinen, 2010). A better knowledge and understanding of the expanding number of different types of tourists can lead to more effective management and improved marketing strategies (Lang & O'Leary, 1997; Park & Yoon, 2009).

In this paper we present a market segmentation analysis of domestic and foreign tourists in Norway, based on their expressed preferences for new facilities in an alpine national park region. These proposed facilities comprised a diversity of types and sizes, potentially also involving different impacts upon the natural habitat. The use of facility quest as clustering variables is close to the benefit segmentation idea from Haley (1968), focusing on the benefits that people seek in their consumption, in our case, visiting alpine national park areas in Norway. One purpose of this paper was to test post-hoc market segmentation with the same set of clustering variables between two independent visitor samples, one recruited when leaving Norway by ferry and the other recruited in one of the alpine national park areas. The segmentation was carried out by a combined (two-stage) hierarchical (Ward, to define the number of clusters) and non-hierarchical (partitioning-method) clustering (*k*-means, to actually form these clusters). The clustering was based on facility quest factors, where factors were identified from a relatively large set of items. The stability of the cluster solutions was assessed by comparing independent sample solutions against the pooled sample. Moreover, we assessed the extent to which the segments differed significantly with respect to demographic characteristics or psychographic characteristics.

Theories and methods

Market segmentation approaches

Market segmentation consists of dividing a heterogeneous market into a number of smaller and more homogeneous submarkets (Smith 1956; Park & Yoon 2009). We might assume that even nature-oriented tourists have fairly heterogeneous preferences and therefore have different demands. There are two essential methodological approaches to market segmentation in the literature; *a priori* (or commonsense) and *a posteriori* (*post hoc*, or data-driven). The former utilises pre-defined segments or criteria, and is conceptual and typological, in the sense that the criteria for grouping the respondents are known ahead and is thus the starting point (PLOG 1974; DOLNIČAR 2008); while the latter being empirically driven by the collected data (BAILEY 1994; DOLNIČAR 2002; 2008).

There are various approaches in a post hoc segmentation, with factor- and clustering techniques frequently used (WEDEL & KAMAKURA 1998). DOLNIČAR (2002) provides a review of data-driven market segmentation in tourism, and outlines critical issues that often lead to overestimation of the validity in cluster analysis (e.g. choice of algorithm, number of clusters, algorithm parameters, optimal ratio of variables to sample size, etc.). PULIDO-FERNÁNDEZ & SÁNCHEZ-RIVERO (2010) focus a criterion to ensure the usefulness of the segments obtained, that a segment should be identifiable and targetable, implying that differentiation with respect to observable tourist characteristics are needed. Regarding the use of clustering algorithms, these should be assessed carefully, and the clustering/segmentation process ought to be repeated and re-evaluated to obtain stable clustering solutions (DOLNIČAR 2002).

One specific clustering approach, appropriate for post hoc segmentation, is a two-stage clustering, combining the hierarchical Ward's method for defining the appropriate number of clusters, and then forming these clusters by the non-hierarchical k-means method (MAZZOCCHI 2008; BURNS & BURNS 2008; see also MILLIGAN & COOPER 1985; DIMITRIADOU et al. 2002). An alternative clustering approach is two-step clustering, available in the SPSS statistical package (SPSS, 2001), which also combines partitioning and hierarchical clustering (MOOI & SAARSTEDT 2011). This clustering method is founded on a clustering algorithm presented by ZHANG et al. (1996). The two-step clustering method should not be confused with the two-stage approach (of Ward and *k*-means).

Basis for tourist market segmentation

Selecting clustering variables in post-hoc market segmentation
An important research task for tourism businesses is to obtain the most appropriate and effective basis for market segmentation (LANG & O'LEARY 1997). The basis for segmentation includes various tourist characteristics such as: demographics (e.g. gender, age, nationality, education and income), geographic location (country of origin), behaviour (e.g. activities, choices, habits) and psychographic identifications (e.g. motivations, attitudes, beliefs) (PARK & YOON 2009; PULIDO-FERNÁNDEZ & SÁNCHEZ-RIVERO 2010). Segmentation on the basis of tourists' quest for facilities comes close to traditional benefit segmentation (HALEY 1968), as well as yielding targetable differentiation of homogeneous submarkets (KAMAKURA & NOVAK 1992; MADRIGAL & KAHLE 1994). Segmentation based on the respondents' quest for facilities may apply items/variables like the quest for tourist facilities (QTF) scale proposed by HAUKELAND et al. (2010); to some extent building on survey elements related to visitor preferences monitoring applied to a Nordic nature tourism context (KAJALA et al. 2007). HAUKELAND et al. (2010; 2013) identified four dimensions based on their set of facility quest items, using exploratory and confirmatory factor analysis: "Tracks and signposts", "Infrastructure and service", "Food and accommodation" and "Tours and interpretation".

Profiling identified market segments
Demographics' usefulness as clustering variables in post hoc segmentation has been questioned (MADRIGAL & KAHLE 1994; MCCLEARY & CHOI 1999; PARK & YOON 2009; MEHMETOGLU et al. 2010), but demographic information is of course needed in profiling identified segments to enable targeting the segments by marketing (MADRIGAL & KAHLE 1994; PULIDO-FERNÁNDEZ & SÁNCHEZ-RIVERO 2010). Psychographic characteristics might also be relevant in profiling identified market segments, as an addition to demographics. Personal values and attitudes influence behaviour and can provide explanations of the expressed demand for facilities and the tourist behaviour (KAMAKURA & MAZZON 1991; MULLER 1991; KAMAKURA & NOVAK 1992; MADRIGAL & KAHLE 1994; MEHMETOGLU et al. 2010).[1] Segments with different values may prefer different attributes in a destination or product (MULLER 1991; MCCLEARY & CHOI 1999). Viewing nature orientations as part of the tourists' values imply that this can be applied in order to obtain an understanding of the tourists' quest for facilities. HAUKELAND et al. (2010) identified the following four nature orientation dimensions, applying explorative factor analysis (HAUKELAND et al. (2013, p. 295): "*Inspiration*" (the appreciation of nature and landscape as personal stimulation), "*Recreation*" (the enjoyment of serenity and undisturbed quality of nature), "*Challenge*" (the search for demanding physical activities) and "*Sightseeing*" (the pursuit of touring and comfort).[2]

Survey data

Data from two independent visitor surveys

Two data sets are combined for our analysis. The first data set (i) is based on a survey among German, Dutch and Danish motor tourists leaving Norway by ferry during the summer of 2008 (HAUKELAND et al. 2010). The second data set (ii) is based on a survey among tourists, foreign and Norwegian, recruited in the Nord-Gudbrandsdal region during the summer of 2009, and followed-up in an internet-based survey in the winter of 2009/2010 (HAUKELAND et al. 2013). Both data sets included similar questions about quest for facilities, enabling comparison of post-hoc market segmentation with the same clustering variables between the two samples. They also included similar questions about nature orientations, as well as similar registration of demographics and trip characteristics, e.g. whether they had visited national parks in Norway, most of which are alpine (Figure 1).

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[1] Identified values, beliefs or attitudes might also serve as clustering variables (NOVAK & MACEVOY 1990; KAMAKURA & MAZZON 1991; MULLER 1991; KAMKURA & NOVAK 1992; MCCLEARY & CHOI 1999; MEHMETOUGLU et al. 2010). Personal values can be defined as concepts or beliefs about desirable end states or behaviours, that transcend specific situations, guide selection or evaluation of behaviour and events, and are ordered by relative importance (SCHWARTZ & BILSKY 1987).

2 HAUKELAND et al. (2013) identified the same four dimensions in a different sample (of the Norwegian population), slightly adjusting the items/questions for the purpose of obtaining more items for the latter two dimensions. They also verified the identification of the four dimensions in a confirmatory factor analysis.

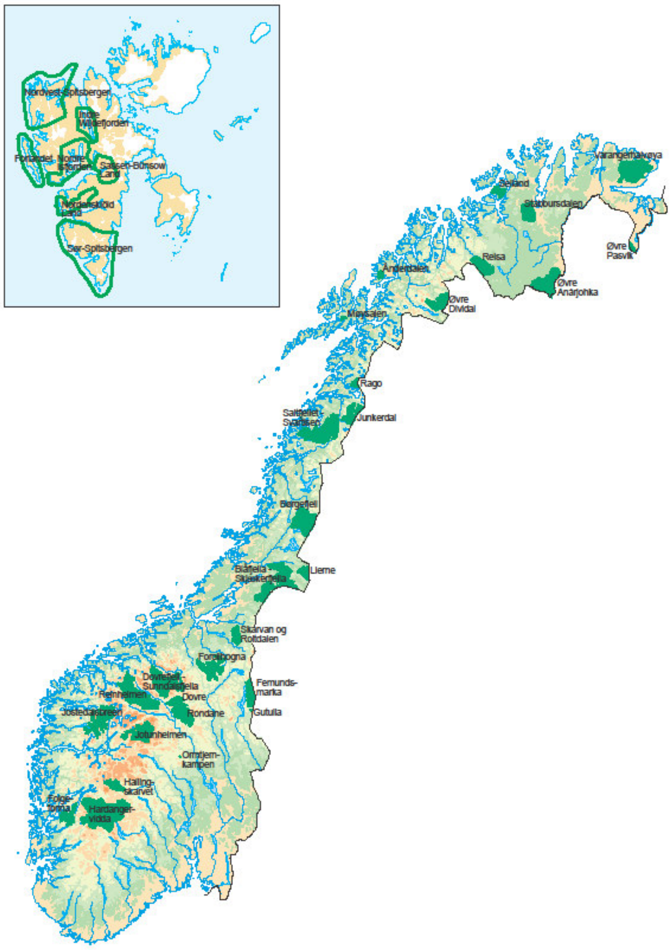

Figure 1: National parks in Norway, 2008-2009 (source: www.dirnat.no)

(i) the first data set – foreign motor tourists leaving Norway by ferry

The sample from 2008 comprised Danish, German and Dutch ferry passengers leaving Norway, on seven out of eight international lines, in four Norwegian harbours (Oslo, Bergen, Kristiansand, and Langesund). The chosen category of foreign motor tourists made up approximately a fourth of all guest nights by international summer holiday visitors in Norway, in 2008. Nineteen departures dispersed throughout the summer season were included in the final sample. A total of 1048 motor tourists were asked to take part in the survey and 986 completed questionnaires were collected, resulting in a response rate of 95 per cent. Self administered fill-in questionnaires were handed out to the motorists waiting in line in their vehicles to embark the ferry, typically using 20-30 minutes to complete, and then the questionnaires were collected by a trained staff of interviewers (HAUKELAND et al. 2010).[3]

(ii) the second data set – domestic and foreign tourists in an alpine national park region

The sample from 2009/2010 comprised tourists of all nationalities, recruited in the Nord-Gudbrandsdal region, a main alpine national park area in the central part of Southern Norway (Figure 2). Approximately 60% were recruited using stratified sampling along the six main roads out of the Nord-Gudbrandsdal region, from the end of June until the end of September, 2009, on 18 rotating weekdays. Only two percent of the tourists refused to be recruited at this stage. The remaining 40% were recruited at 42 accommodation firms in the region (out of 84 firms approached for this purpose), applying similar recruiting forms. These latter participants can be characterised as self-selected. Both approaches provided an introduction to the project in six languages (English, German, Dutch, Swedish, Danish, and Norwegian). In total, 2,719 email addresses were collected, and adjusting for illegible and undeliverable addresses, 2,510 tourists were reached for the follow-up internet survey during the winter of 2009/2010, either in Norwegian, German (for those residing in Germany, Austria and Switzerland) or English (for all other nationalities). The response rate at this stage was 52.5% (1318), and 760 of these answered the questions related to facility quest (while the remaining 278 answered other questions and are deleted from our study). Of those 760, two thirds resided in Norway, 14 per cent in Germany, six per cent in the Netherlands, two per cent each from Denmark and from Sweden, and the remaining eight per cent primarily living in another European country (HAUKELAND et al. 2013).[4]

[3] A pilot test of the sampling procedure and questionnaire was carried out among a small number of Danish motor tourists, in May 2008, and thereafter the final version of the Danish version of the questionnaire was translated into Dutch and German.

[4] Due to a delay in the development of the internet-based survey (using SPSS Dimensions) a planned pilot test was cancelled. However, a small pre test among project partners was carried out, in the autumn of 2009, and considerable parts of the questionnaire was nearly identical to the first data set, from 2008, or copied from other visitor surveys carried out at the Institute of Transport Economics (THRANE & FARSTAD 2010; RIDENG &

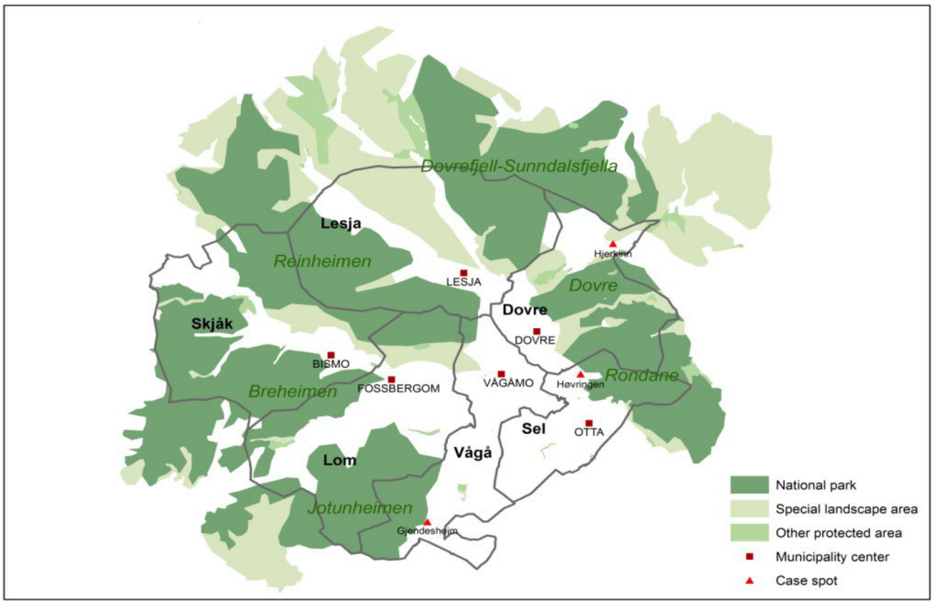

Figure 2: National parks in the Nord-Gudbrandsdal region (source: Norwegian Directorate for Nature Management, www.dirnat.no, own adaptation)

Questionnaires and utilisation of scales

The respondents' *quest for facilities* in and around Norwegian national parks was measured by a range of questions listed in batteries and presented on a five point Likert scale ranging from 1, "not important", to 5, "very important" (HAUKELAND et al. 2010). Table 1 shows the confirmatory factor analysis of the facility quest items, separately for the 2008 (i) and 2009 (ii) data (HAUKELAND et al. 2013).[5] The surveys also included several social background characteristics, such as the respondents' nationality, level of income (qualitatively), level of education, age and gender (Tables 2a and 2b). Questions covering the respondents' *nature orientation* were also listed in batteries and presented on a five point Likert scale ranging from 1, "not important", to 5, "very important". The four dimensions identified by factor analysis will be termed "*Inspiration*", "*Recreation*", "*Challenge*" and "*Comfort*" ("Sightseeing"), following HAUKELAND et al. (2010, 2013). The most important items of the "*Inspiration*" dimension were "obtaining a deeper connection in life", "experiencing nature's magic and mysticism", "finding inspiration in natural surroundings", "feeling connectedness with landscape and nature" and "attaining a feeling of freedom". Within the "*Recreation*" dimension, the most important items were "experiencing tranquillity and peacefulness" and "fresh air, clean water and an unpolluted environment". Regarding the "*Challenge*" dimension, the important items were "searching for challenges with a certain risk" and take an interest in "demanding physical activities in nature". Finally, within the "*Comfort*" dimension the most important item was the enjoyment of "comfort in natural surroundings", but "closeness to co-travellers" and "sightseeing" interests were also important (HAUKELAND et al. 2013).

Clustering algorithms applied

The main approach selected was a two-stage clustering, first applying the hierarchical Ward method, for setting the number of clusters, and then applying the partitioning *k*-means method for forming the given number of clusters. The main clustering variables were the four principal components (factors) identified from the QTF items, where the same four factors had been identified in both datasets: "Tracks and signposts", "Infrastructure and service", "Food and accommodation" and "Tours and interpretation" (HAUKELAND et al. 2010; 2013).[6] The identification of the cluster number was based on assessment of the agglomeration coefficients from the Ward, such that the number of clusters was based on identifying a demarcated change in the agglomeration coefficients, counting from the last step of the agglomeration (BURNS & BURNS 2008, p. 561). This is a simple "elbow test" from which a cluster number can be set. The Ward clustering was first carried out separately for the two datasets, applying the four principal components of QTF as clustering variables, which yielded a cluster number of 4 (or possibly 5) for the first dataset (i) and 5 for second dataset (ii). Then the same Ward clustering was carried out on the joint dataset, which yielded a cluster number of 4 (or possibly 5), just like the foreign ferry-travelling tourist data set.[7] Then the k-means method was applied for forming the given number of clusters, for the separate

GRUE 2008). Related to the remainders some small adjustments were made, primarily amending the allocation to special treatments/questions and eliminating some questions for the sake of shortening the response task.

[5] HAUKELAND et al. (2010) concluded that there is a market potential for developing a number of facilities inside and outside national parks, and that the segments differed in quest for facilities. Based on a *k*-means clustering analysis, they found that the largest market segment demanded all types of facilities, and was the only segment that showed an interest for "Infrastructure & service". One segment did not want any type of facilities, particular not "Infrastructure & service". The two remaining segments preferred either "Tours & interpretation" in combination with "Food & accommodation" or in combination with "Tracks & signposts".

[6] HAUKELAND et al. (2013) present a confirmatory factor analysis of the four facility quest factors, from both datasets.

[7] Although there is some loss of information from the data when applying factors (dimensions) instead of single variables (items), the selection of factors seems more appropriate if we believe factors are better representations of the constructs of interest. However, we also tested clustering based on QTF items instead of QTF factors (for sample sizes well above the $5*2^K$ limit, proposed by FORMANN (1984), where K is number of clustering variables).

datasets as well as for the joint dataset. We test for differences between the clusters (segments) with respect to nature orientations, demographics, and trip-related characteristics; and this testing is based on ANOVA.

Table 1: Quest for tourism facilities (QTF) factors and question items; foreign ferry-based sample, dataset (i), n=947; foreign and national sample in Nord-Gudbrandsdalen, dataset (ii), n=759.

Factor	Item	Dataset (i) exploratory factor analysis	Dataset (i) confirmatory factor analysis	Dataset (ii) exploratory factor analysis	Dataset (ii) confirmatory factor analysis
Infra-structure & service	Increased opportunities for various activities	0.656	0.665***	0.741	0.827***
	Staged experiences for a greater audience	0.666	0.766***	0.725	0.708***
	Gondolas and similar great installations	0.747	0.746***	0.683	0.704***
	Better options for motorboat trips on the lakes	0.659	0.622***	0.681	0.611***
	More service persons	0.594	0.525***	0.597	0.744***
Tracks & signposts	More and improved rambling tracks	0.678	0.710***	0.813	0.751***
	More nature paths for "self-guiding"	0.723	0.722***	0.728	0.740***
	More and better sign posting	0.772	0.774***	0.782	0.814***
	More cycling tracks	0.543	0.692***	0.596	0.699***
	More picnic areas	0.675	0.741***	0.439	0.310***
	More accessible information	0.681	0.622***	0.500	0.458***
Tours & interpre-tation	Guided tour/sightseeing to see animals/ natural attractions	0.794	0.852***	0.770	0.852***
	Guided tour/sightseeing to cultural attractions	0.755	0.842***	0.725	0.860***
	Visitor centres with exhibitions	0.689	0.496***	0.696	0.493***
Food & accommo-dation	Well developed food and beverage facilities	0.754	0.960***	0.719	0.986***
	Abundance of accommodation facilities	0.750	0.591***	0.760	0.585***
	Accommodation with good standard	0.785	0.779***	0.754	0.771***
	Local food specialities	0.586	0.600***	0.511	0.423***

Note: The table includes only the items that were present in both data sets. The number of factors was determined using the variance explained by retained factors. In the 2008 foreign ferry-based sample, tracks & signposts explained 37.9% of the variance, infrastructure & service 9.6%, food & accommodation 7.1%, and tours & interpretation 5.7%. In the 2009 national and foreign Nord-Gudbrandsdal sample, infrastructure & service explained 33.9% of the variance, tracks & signposts 9.1%, tours & interpretation 7.4%, and food & accommodation 6.9% (HAUKELAND et al. 2013).
*** p< .001, ** p< .01, * p< .1

Results

The identified clusters (segments) using QTF factors as clustering variables in a two-stage clustering approach

Tables 2a and 2b show the mean values of the clustering variables (QTF factors) as well as the mean values of various demographic, trip-related, and psychographic characteristics, for dataset (i) and dataset (ii). As there was an "elbow" for both four and five clusters in dataset (i), based on the Ward clustering, we present five-cluster solutions, as five clusters were also indicated for dataset (ii). Moreover, the ANOVA indicated just as good differentiation between five clusters as between four clusters for dataset (i). The k-means clustering was applied for forming the clusters, thus allocating the respondents to the five clusters.

In the sample of foreign ferry-travelling tourists, data set (i), cluster 1 is the cluster with highest factor score on "food and accommodation", thus demanding abundant food and beverage facilities of high standard, possibly including local food specialities. Cluster 1 represents an affluent and highly educated segment, with a high share stating that their income is relatively high compared to the income level in their country, as well as a high share having carried out higher education, or more precisely, "more than four year studies at university level". The nature orientation of the segment is towards comfort, and also recreation. It is the segment with highest share of national park visitors and longest average stay in Norway. We might term cluster 1 a segment of *affluent demanders of high quality food and accommodation* (comprising 31% of the sample). Cluster 2 is the cluster with highest factor score on "tracks & signposts", thus demanding tracks/paths for rambling, cycling or self-guiding, as well as more accessible information and signposting. Cluster 2 has the highest scores on variables representing dimensions of nature orientation as well as relatively high share of national park visitors and relatively long average stay in Norway. It is the cluster with lowest share of university degrees and highest share of people stating relatively low income. We might term cluster 2 a segment of *nature-oriented demanders of tracks and signposts* (comprising 15% of the sample). Cluster 3 is the cluster with highest factor score on "infrastructure & services", thus demanding new facilities/activities adjacent to the national parks (gondolas, motorboats, and staged experiences), or more service persons in the parks. Cluster 3 has the highest score on comfort and a relatively high share of people stating relatively high income. We might term cluster 3 a segment of *comfort-oriented demanders of infrastructure and services* (comprising 22% of the sample). Cluster 5 is the cluster with highest factor score on “tours & interpretation”, thus demanding guided tours/sightseeing to cultural/natural attractions or visitor centres. Cluster 5 has medium scores on most individual characteristics. We might term cluster 5 a segment of *average-type demanders of tours and interpretations* (comprising 16% of the sample). Finally, cluster 4 is a cluster with relatively low scores on all QTF factors, as well as the lowest scores on variables representing dimensions of nature orientation. Cluster 4 has relatively high average age. We might term cluster 4 a segment of *staid, satisfied and saturated* (comprising 15% of the sample).

Table 2a: Mean QTF factor scores, mean scores on variables representing dimensions of nature orientation, and mean values of demographics and trip characteristics, for the five clusters; where colour green indicates the supposedly most desirable (normally highest) value, via yellow for medium values, to red for the supposedly least desirable (normally lowest) value; foreign ferry-travelling tourists, data set (i)

	Cluster 1 n=159	Cluster 2 n=106	Cluster 3 n=222	Cluster 4 n=107	Cluster 5 n=117	Total n=711
“Tracks & signposts”	0.14	1.00	0.01	-1.44	0.21	
“Infrastructure & service”	-0.86	-0.13	1.01	-0.38	-0.28	
“Food & accommodation”	0.75	-0.18	0.38	-0.47	-1.15	
“Tours & interpretation”	0.34	-1.19	0.28	-0.93	0.93	
“Inspiration”***	2.84	2.96	2.85	2.56	2.82	
“Recreation”***	3.27	3.30	3.07	2.91	3.11	
“Challenge”***	2.27	2.50	2.31	2.03	2.21	
“Comfort”***	2.64	2.61	2.68	2.24	2.57	
Visited national park***	0.91	0.82	0.72	0.72	0.76	
Nights travelling***	15.5	14.4	11.2	13.6	13.0	
Relatively high income***	0.36	0.17	0.24	0.16	0.22	
Relatively low income*	0.05	0.14	0.09	0.06	0.06	
University*	0.65	0.48	0.53	0.55	0.52	
Age**	47.7	46.4	44.7	48.3	44.7	
Female	0.31	0.36	0.41	0.36	0.38	
German**	0.62	0.66	0.49	0.58	0.54	
Dutch*	0.25	0.19	0.30	0.18	0.28	
Danish*	0.10	0.13	0.19	0.22	0.17	
Segment	Affluent demanders of high quality food and accommodation	Nature-oriented demanders of tracks and signposts	Comfort-oriented demanders of infrastructure and services	Staid, satisfied and saturated	Average-type demanders of tours and interpretations	

*** p< .01, ** p< .05, * p< .1 (ANOVA)

Table 2b: Mean QTF factor scores, mean scores on variables representing dimensions of nature orientation, and mean values of demographics and trip characteristics, for the five clusters; where colour green indicates the supposedly most desirable (normally highest) value, via yellow for medium values, to red for the supposedly least desirable (normally lowest) value; foreign and Norwegian tourists in the Nord-Gudbrandsdal region, data set (ii)

	Cluster 1 n=147	Cluster 2 n=87	Cluster 3 n=86	Cluster 4 n=281	Cluster 5 n=159	Total n=760
"Infrastructure & service"	-0.66	-0.80	0.19	0.84	-0.54	
"Tracks & signposts"	0.53	-1.52	-0.70	0.04	0.65	
"Tours & interpretation"	-0.96	0.66	-0.99	0.18	0.75	
"Food & accommodation"	0.70	0.37	-1.50	0.37	-0.69	
"Inspiration"***	3.89	4.15	3.88	3.96	4.17	
"Recreation"***	4.31	4.46	4.10	4.20	4.44	
"Challenge"*	2.74	3.01	2.87	2.99	2.90	
"Comfort"***	3.51	3.33	3.36	3.71	3.41	
Visited national park***	0.51	0.47	0.35	0.33	0.35	
Nights travelling***	7.9	10.9	11.3	9.0	14.9	
Relatively high income***	0.44	0.30	0.27	0.24	0.30	
Relatively low income	0.10	0.12	0.13	0.12	0.15	
University***	0.84	0.79	0.63	0.63	0.75	
Age**	47.5	47.7	48.6	48.8	44.8	
Female	0.44	0.41	0.33	0.36	0.39	
German***	0.07	0.20	0.15	0.07	0.30	
Dutch***	0.05	0.02	0.07	0.04	0.12	
Danish	0.02	0.01	0.05	0.01	0.03	
Swedish*	0.01	0.01	0.06	0.02	0.04	
Norwegian***	0.81	0.72	0.56	0.81	0.36	
Segment	Affluent demanders of high quality food and accommodation	Nature-oriented demanders of packages	Staid, satisfied and saturated	Comfort-oriented demanders of infrastructure and services	Nature-inspired demanders of tours and tracks	

*** p< .01, ** p< .05, * p< .1 (ANOVA)

Also in the sample of foreign and Norwegian tourists in the Nord-Gudbrandsdal region, data set (ii), cluster 1 is the cluster with highest factor score on "food and accommodation". Also in this sample, cluster 1 represents an affluent, highly educated segment, having a nature orientation towards comfort. It is the segment with highest share of national park visitors in Nord-Gudbrandsdal, but not the longest stay in the region. We also term this cluster a segment of *affluent demanders of high quality food and accommodation* (comprising 19% of the sample). Cluster 2 is a cluster with relatively high factors scores on "tours & interpretation" and "food & accommodation", representing components of potential tourism packages. Cluster 2 also has the highest scores on variables representing nature-orientation dimensions of challenge and recreation. We might term cluster 2 a segment of *nature-oriented demanders of packages* (comprising 11% of the sample). Cluster 4 is the cluster with highest factor score on "infrastructure & services". Cluster 4 has the highest score on comfort. We also term this cluster a segment of *comfort-oriented demanders of infrastructure and services* (comprising 37% of the sample).

Cluster 5 is the cluster with highest factor score on "tours & interpretation" and "tracks and signposts". Cluster 5 has the highest score on variables representing dimensions of the nature-orientation inspiration, the longest average stay in Nord-Gudbrandsdalen and the lowest average age. We might term cluster 5 a segment of *nature-inspired demanders of tours and tracks* (comprising 21% of the sample). Finally, cluster 3 is a cluster with relatively low scores on all QTF factors, as well as the lowest scores on variables representing dimensions of nature orientation. Cluster 3 has relatively high average age. We also term this cluster a segment of *staid, satisfied and saturated* (comprising 11% of the sample).

For the sample of foreign and Norwegian tourists in the Nord-Gudbrandsdal region (ii), more individual characteristics for profiling were available. These are displayed in Table 2c.

Table 2c: Mean QTF factor scores, mean scores on some additional variables representing mean values of demographics and trip characteristics, for the five clusters; where colour green indicates the supposedly most desirable (normally highest) value, via yellow for medium values, to red for the supposedly least desirable (normally lowest) value; foreign and Norwegian tourists in the Nord-Gudbrandsdal region, data set (ii)

	Cluster 1 n=147	Cluster 2 n=87	Cluster 3 n=86	Cluster 4 n=281	Cluster 5 n=159	Total n=760
"Infrastructure & service"	-0.66	-0.80	0.19	0.84	-0.54	
"Tracks & signposts"	0.53	-1.52	-0.70	0.04	0.65	
"Tours & interpretation"	-0.96	0.66	-0.99	0.18	0.75	
"Food & accommodation"	0.70	0.37	-1.50	0.37	-0.69	
Monthly household income (EUR)**	6,381	6,060	5,561	5,684	5,664	
Total trip cost per person per day (EUR)***	264	311	368	292	484	
Visits to Nord-Gudbrandsdalen**	2.3	2.2	1.9	2.3	1.9	
Nord-Gudbrandsdalen was the main destination**	0.67	0.77	0.59	0.49	0.56	
National park status decisive for choosing destination***	0.13	0.25	0.22	0.12	0.30	
Segment	Affluent demanders of high quality food and accommodation	Nature-oriented demanders of packages	Staid, satisfied and saturated	Comfort-oriented demanders of infrastructure and services	Nature-inspired demanders of tours and tracks	

*** p< .01, ** p< .05, * p< .1 (ANOVA)

The distribution of monthly household income is exactly the same as the distribution of the share stating relatively high income, yet for the foreign visitors these two variables correlated as monthly household income was estimated from the share stating relatively high income (VEISTEN et al. 2013). It is as expected that trip costs are lowest in the segment with the highest shares of Norwegians. The nature-oriented or nature-inspired segments have higher shares stating either the Nord-Gudbrnadsdalen as main destination for their travel or stating that the national park status had decisive influence on their choice of travelling to the region.

Also in the five-cluster solution of the pooled sample, the largest segment was the *comfort-oriented demanders of infrastructure and services*, representing 33% of the pooled sample. The second-largest segments were the *affluent demanders of high quality food and accommodation* and *nature-inspired demanders of tours and tracks*, each representing 21% of the pooled sample. Also in the pooled sample there was a segment of *staid, satisfied and saturated* (comprising 12% of the pooled sample).

Clustering solutions using QTF items as clustering variables

We tried the two-stage clustering applying QTF items instead of QTF factors. The number of clusters defined by Ward's method was two, in the sample of foreign ferry-travelling tourists (i), as well as in the sample of foreign and Norwegian tourists in the Nord-Gudbrandsdal region (ii) and in the pooled sample. The ANOVA test of individual characteristics in the two clusters indicated that the use of QTF items instead of QTF factors yielded far less different clusters, particularly for dataset (ii).

Clustering solutions using the two-step algorithm with QTF factors as clustering variables

We also applied the two-step clustering procedure, in the SPSS software, which also combines partitioning and hierarchical clustering (MOOI & SAARSTEDT 2011). The two-step clustering was applied to the QTF factors and indicated that "tracks & signposts" was the most important clustering variable, then followed "infrastructure & services", "tours & interpretation" (second in the first sample of foreign ferry-based tourists and last in the second sample of foreign and national tourists in Nord-Gudbrandsdal), and then "food & accommodation". The two-step algorithm, like Ward, finds an "optimal" cluster number; that was six clusters for dataset (i) and four clusters for dataset (ii). For the pooled dataset, eight clusters were obtained. The profiling and ANOVA testing indicated that the two-step solution did not produce clusters that differed more clearly in terms of individual characteristics than the k-means solution (with cluster number found by Ward's method). However, for both samples a segment of *affluent demanders of high quality food and accommodation* as well as a segment of *comfort-oriented demanders of infrastructure and services* appeared. The latter constituted 33% in the foreign ferry-based tourist sample and 32% in the foreign and national sample in Nord-Gudbrandsdalen; while the *affluent demanders of high quality food and accommodation* constituted 14% in the foreign ferry-based tourist sample and 33% in the foreign and national sample in Nord-Gudbrandsdalen. However, in the foreign ferry-based tourist sample, there was an additional cluster, comprising 9%, also having high scores on the "food & accommodation" factor and a high share stating relatively high income; and if this could be added to a common segment of *affluent demanders of high quality food and accommodation*, it would reach 23%. Also in the pooled sample there were two segments with high factor scores on "food & accommodation" combined with the highest shares of "relatively high income" and "more than four year studies at university level", together reaching about 23% of the sample.

Discussion and Conclusions

In this market segmentation study, we applied a two-stage clustering, first finding an appropriate cluster (segment) number by use of Ward's hierarchical method, and then applying the partitioning k-means method for forming the clusters (MAZZOCCHI 2008; BURNS & BURNS 2008). We applied factors of quests for tourist facilities (QTF) as clustering variables (HAUKELAND et al. 2010; 2013). We also tried other clustering methods, the so-called two-step clustering of SPSS (MOOI & SAARSTEDT 2011), that mostly yielded a higher number of clusters than in our preferred approach. Finally, we also tried applying QTF items instead of QTF factors, which yielded a lower number of clusters than in our preferred approach.

Applying the two-stage clustering approach, five-cluster solutions were indicated based on an elbow test from Ward's method although a four-cluster solution could also have been applied for the sample of foreign ferry-travelling tourists. Notwithstanding the differences between this sample and the sample of foreign and Norwegian tourists in the Nord-Gudbrandsdal region, various common segment features were found. In both samples the largest segment was a comfort-oriented tourist segment demanding more/better infrastructure and services. Another relatively large segment found in both samples was an affluent and highly educated segment demanding high-quality food and accommodation. Moreover, in both samples was found a relatively small segment that can be characterised as satisfied with current facility offers, obtaining relatively low scores on all QTF factors, as well as relatively low scores on variables representing dimensions of nature orientation.

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Forest management in the Piatra Craiului National Park between economic benefits and ecosystem services

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Abstract

The Piatra Craiului National Park is located in the Southern Carpathians, preserving one of Romania's outstanding mountain ridges. Its exceptional landscape value is given both by the geologic structure of the Piatra Craiului limestone massif, and its complex forest ecosystem. Unfortunately, on medium and long term the Piatra Craiului National Park is dealing with significant difficulties in attempting to preserve the forest and ecosystem services it provides, despite its legal status as a protected area. This essential ecosystem services offer must counterbalance and even prevail in designing the strategic interest and future management of this natural resource. The study bases on the analysis of the contradiction between the National Park's purpose and objectives, on one hand, and economic interests in the area, on the other hand. It brings arguments and explains the causes that underlie the different forest exploitation on the northern and southern sides. The research methods based on GIS techniques for mapping the time-scale deforested areas, and on semi-structured interviews of the local people. The research results show a continuous increasing of clear cut areas after 2000 in the spruce forest, mainly triggered by the permissive and vague legislation and the mismanagement it has been favouring since then.

Keywords

forest management, clear cutting, ecosystem services, national park, Piatra Craiului, Romania

Introduction

Until 1990, Romania's forests were one of the most valuable forests in Europe due to their structure, floristic composition, species richness, functions and efficiency (UNGUR 2009). Afterwards, a constant degradation and destruction occurred, mainly caused by the recently approved law (Land Rule 18/1991 on forest retrocession to former landowners).

The degradation of forests by abusive logging has increased along with the application of the Rule on return of property rights or Lupu's Rule 1/2000 (UNGUR 2008). Besides the abolition of many state forest districts, giving up forest planning on large forestry units and introducing summary studies have triggered a radical change in forest management (UNGUR 2008). Ordinance 64/2001 provides for the authorization of specialized units (private forest districts) to develop summary planning research (Art. 1). Theoretically, they are designed to create the necessary conditions to ensure proper technical and economic solutions to forest planning works. However, in practice does not ensure its sustainable management (Art. 2).

Destruction of the returned forests became catastrophic after the Rule 247/2005 on reforming the property rights and Ordinance 139/2005 on forest management had come into effect (UNGUR 2008: 183). Retrocession has not been ended any far.

Romania's forests are continuously changing especially due to human activities, but also to climate and other physical factors. For providing a good future, the authorities should mainly consider the allocation of funds *„to reduce anthropogenic pressure on forests by granting the small and large landowners in order to reduce illegal logging and provide an adequate forest management”* (Ministry of Environment and Forests 2010).

The ecosystem quality of forest derives from its main functions and features: a web of interactions and interdependencies among the parts, synergy, stability, diffuse boundaries and hierarchical structure (PERRY et al. 2008). Forests have the highest biological diversity of all terrestrial ecosystems on land (UNEP 2013). Their value derives from the biological resources they host (Convention on Biological Diversity 2001).

One of the earliest statements regarding ecosystem services was given by COSTANZA et al. (1997) that forests provide humanity with services, as well as goods like food and timber, which derive from ecosystem functions. According to KÖRNER & OHSAWA (2005) ecosystem services are ”the benefits people obtain from ecosystems”. These could be ecological, economic, social and health benefits (UNEP 2013).

The aim of the study

lies in the analysis of contradiction between the purpose and objectives of the Piatra Craiului National Park and the economic activities in the area. *The main objectives* of the study are: to establish the causes underlying uncontrolled exploitation of forest resources in a protected area, and the perception of both local communities and authorities on the forest economic and ecosystem services.

Study area

The Piatra Craiului National Park is located in the eastern part of the Southern Carpathians, preserving Romania's most spectacular limestone ridge. The massif came under protection as a natural reserve in 1938 to protect rare plant species, some of which are endemic, such as *Dianthus callizonus* (the current symbol of the park), *Hesperis nivea, Minuatia transsilvanica, Leontopodium alpinum,* etc. It was declared a national park by the Rule 5/2000 on protected areas. The significant landscape value derives from the geologic structure of the Piatra Craiului Massif, and the complex forest ecosystem.

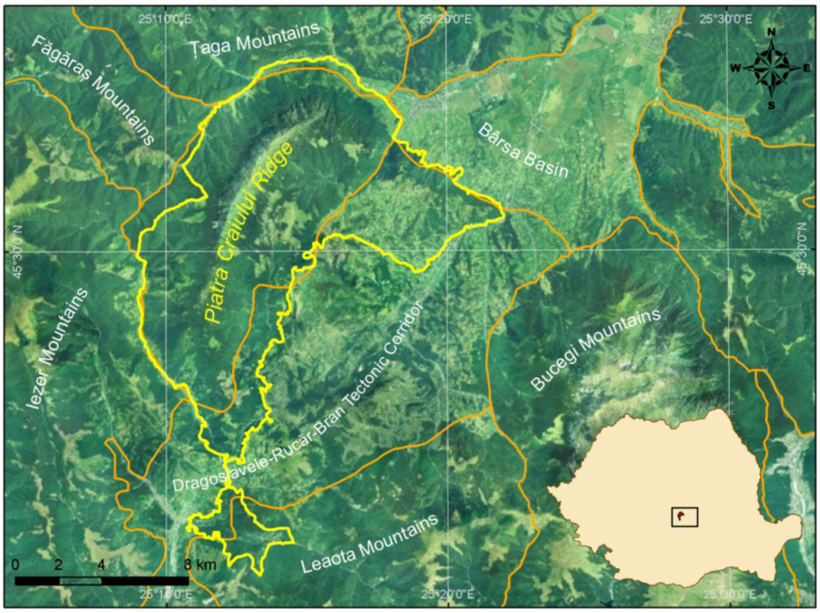

Figure 1: Location map of the Piatra Craiului National Park (orthophotograph – courtesy of ANCPI (National Agency for Survey and Real Estate Advertising)

The exposed rocks of the Piatra Craiului National Park are primarily Upper Jurassic limestone and Cretaceous conglomerate. The massif is synthetically a limestone-conglomerate ridge with a NNE-SSW orientation and 25 km long. Elevation reaches over 2000 m (Piscul Baciului 2,238 m). Its general structure is monoclinal with various inclinations. The southern part is a typical cuesta, whereas the central and northern define a hogback. Strata plunge towards east and south-east, generating a gentler slope, comparatively to the steeper, western scarp slope bordered by continuous talus scree. Forest covers a large area of the park. The main floristic associations are: pure mountain beech forest *(Fagus sylvatica),* mixed forest, pure spruce forest *(Picea abies)* joined by patches of yew *(Taxus baccata),* and isolated pine groups *(Pinus sylvestris)* (IORAȘ et al. 2001).

Figure 2: The eastern slope of Piatra Craiului limestone ridge (Photo by Laura Tîrlă, 2008)

Data, materials and methods

The main datasets used in the study enter the following categories: land use and land cover change data (area and percentage); number of respondents; vector data (county and protected area boundaries; settlement boundaries; rivers; roads; different-generation clear-cuttings). Materials used:2005 and 2009 orthophotographs (courtesy of ANCPI), 1980 topographic map; forest maps for validation. Research methodology is based on both using GIS techniques to identify and graphically represent the deforested (clear cut areas, and investigation (semi-structured interviews). Digital mapping helped to delimit different land cover types (forest, historically and recent deforested areas, bare limestone, settlements, roads, rivers), and boundaries (landforms, counties, national park). Maps superposing was useful in identifying the different time-scale extent of the deforested areas (2000, 2005 and 2009). To understand the perception of local communities on the economic and environmental dimension of the forest, the authors conducted a series of semi-structured interviews during the fieldtrips in July, August and September 2012. The target group included the following socio-professional categories: mayor, priest, ranger, forestry engineer, teachers, students, local entrepreneurs and farmers. Interviews focused Dâmbovicioara village, the most affected area by forest exploitation.

Results and discussion

In the Piatra Craiului National Park clear cutting was initiated right after the retrocession of the forest areas to former owners had begun, once the following legislation came successively into effect: Rules 18/1991, 167/1997, 1/2000, 247/2005, and Ordinance 139/2005. This permissive legislative has created the favourable framework to extension of uncontrolled logging in the park's area; the most damaged was the pure spruce forest *(Picea abies)*.

Consequently, the type of ownership stood behind the differential exploitation of timber in the two counties whose territory the park area extends – Argeş and Braşov. In Braşov County, forest belongs to legal forms of ownership (municipalities, churches). In Argeş County private ownership, which greatly expanded after retrocession, predominates.

Digital mapping allowed pointing out some essential time-scale issues of clear cutting in the area. The high-resolution aerial photographs of 2005 and 2009 were the base imagery we used in this analysis. Until 2000, most clearings resulted by deforestation were very old. An accurate dating of these clearings was not possible; it is only known that they were generated in historical time for the needs of local communities. They represent a consequence of their traditional land use, particularly for grazing. People used timber in households for heating or as a building material. In Braşov County, much of the cleared area was converted to grassland within the household structure.

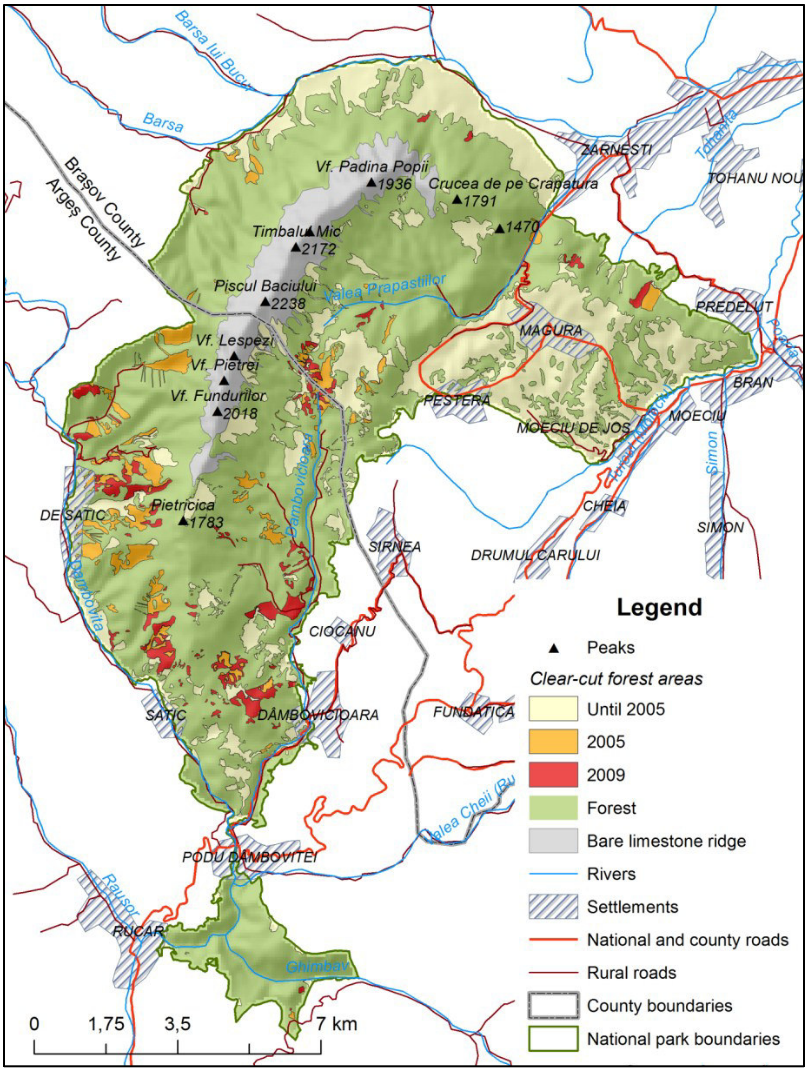

Figure 3: Clear cutting areas in the Piatra Craiului National Park

In 2004 the first summary planning studies made by ITRSC Vâlcea came under approval (Order 64/2001). Then the clear cutting started, complying with the national park status of the area they were practiced. Map in Figure 3 shows a clustering tendency (prevalence) in the upper basins of Dâmboviţa River (in the Sătic commune) and Dâmbovicioara, as well as on the steep heads of Valea Prăpăstiilor. Some deforested areas appear isolated in Braşov County, on Bârsa Valley and near Predeluţ village.

The situation maintained thereafter. The analysis performed on the 2009 orthophotographs allowed identifying other deforested areas within the national park; they usually cluster around the older cuttings, causing a significant extension thereof (Figure 3). This proves that the same land owners continued to clear cut the forest. Deforested areas sum 3.84 km², most of them in Argeş County. Percentage distribution is shown in Table 1.

Overall, the highest rate of deforestation practiced after 2000 record in Argeş County by 81%, and the remaining 19% in Braşov County. Therefore, the forest area within the national park has sequentially decreased from 108.42 km² in 2000 to 104.58 km² in 2005, then finally to 95.31 km² in 2009, losing a total of 12.1%. The detailed results of the mapping analysis are included in Table 1.

Table 1: Land cover change in the Piatra Craiului National Park based on clear cutting area detection

Year	**Argeş County**		**Braşov County**		**Total clear-cut forest area**	
	(km²)	*(%)*	*(km²)*	*(%)*	*(km²)*	*(%)*
Until 2005	7.34	22.14	25.80	77.86	33.15	22.43
2005	4.25	78.13	1.18	21.87	5.44	3.68
2009	3.26	84.90	0.58	15.10	3.84	2.60
Total	**14.85**	**35.00**	**27.56**	**65.00**	**42.43**	**28.71**
Total protected area	**67.46**	**45.64**	**80.35**	**54.36**	**147.81**	**100**

Local communities' perception on forest benefits. The results of semi-structured interviews revealed a number of conflict issues regarding the local communities' perception on economically productive and environmentally protective role of forest ecosystems in the Piatra Craiului National Park. Field survey demonstrates that, in respondents' opinion, economic benefits prevail over ecosystem services. A synthesis of the interviewees' perception is shown in Table 2. Most local community members believe that the forest is rather a profitable economic good than a vital source for the sustainable development of human settlements in the studied area. Therefore, the safest way to sustainable forest management in the national park is developing awareness of local communities, including both ordinary citizens and those situated on the highest rungs of social hierarchy (GIURGIU 1995; UNGUR 2008).

Table 2: Local communities' perception on forest benefits (frequent answers)

Economic benefits	**Ecosystem services**
Fuel for heating homes: *firewood;*	Oxygen producing: *clean /fresh air;*
Building material;	Aesthetic landscape: *beautiful view, "I like the landscape";*
Timber: boarding wood;	*Smell of fir-tree branches("cetină"), fresh scent;*
Berries and edible mushrooms: raspberries, blackberries, blueberries; mushrooms: "mitărci", milky sponges, "ghebe", and "vineciori"; Hunted: deer, wild boars, foxes;	*Clear, clean water;* Protection against flooding: *"It stops the water from taking away our homes, gardens, and fields"; "No more high waters coming";*
Herbs: *rosehip, hawthorn, rattle, yarrow, and "ţintaur".*	Protection against soil erosion and landslides: *"It does not let the land go downhill";* Prevents avalanches: *"no more snow coming upon us";* Reduces noise: *"It is very silent, much tranquillity in the forest".*

(Excerpt from semi-structured interviews conducted in Dâmbovicioara village in 2012)

Conclusions

The permissive and vague Romanian legislation has favoured the chaotic exploitation of national forest, regardless of its status, and the most affected were and still are the forests in protected areas. In the Piatra Craiului National Park, the spruce forest (*Picea abies*) was the most affected. In the two counties where the park area extends (Argeş and Braşov), the type of property form stood behind the different size of timber exploitation.

In 2004 the first massive clear cuttings started, following the approval of the first summary studies of forest planning. These destructive actions are not compatible with the national park legal status of the area. In 2009 the previously clear cut areas extended, which demonstrates that the same landowners practiced further this action.

Overall, after 2000 the highest rate of deforestation recorded in Argeş County (81%), and the remaining in Braşov County (19%). Consequently, the forest area has lost 12.1%.

The results of semi-structured interviews revealed a number of conflict issues regarding the local communities' perception on economically productive and environmentally protective role of forest ecosystems. Most of them believe that the forest is rather a profitable economic good than a vital source for the sustainable development of human settlements in the studied area. This is a warning on the need to raise the local communities' *forest conscience* in order to develop a sustainable forest management in the Romanian national parks.

Figure 4: Clear-cutting driven ecological disaster in the Piatra Craiului National Park (2008 and 2012)

Recommendations

- Organizing thematic workshops with stakeholders in the forests social management to raise the local communities' awareness of its role as a „living natural resource" (UNGUR 2008: 295);
- Sensitization on the conservation and maintenance of biodiversity;
- Popularization of practical knowledge accessible to all socio-professional classes (forestry education);
- Projecting educational movies in order to draw attention to ecological disasters in different parts of the world, caused by forest overexploitation;
- Cultural actions to develop the public forest consciousness.

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From Research of the Carpathian Beech Virgin Forests to the World heritage

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Abstract

The history of complex ecological research of Carpathian Primeval Forests started on beginning of 20. century in Transcarpathia Region (former Czechoslovak Republic), due to the inititive of Czech professor Alois Zlatník. The Zlatník´s stationary plots in virgin forest represents a model position of the geobiocenoses type. As a permanent research area it represent natural biotopes of the research object. The characteristic of the geobiocenoses contains the description of the ecotopes, phytocenoses, development stages and productivity. Stationaries enable to perform repeated researches and to compare the evolution and changes of the biocenoses under changing of ecological conditions. For centuries much of the Carpathian mountain forests remained untouched. Virgin forests constitute a natural heritage of global significance. In 2007 the Primeval beech forests of the Carpathians (Slovakia, Ukraine) were added to UNESCO´s World Heritage List. The paper is aimed at the presentation of long-term research and utilise the results to the nominantion process of World Heritage. The part of nomination project are principles of the Integrated Management Plan. Ultimate goal is to achieve that management and socio-economic sustainable development practices are in harmony with primary objectives of the World Heritage protection, biodiversity conservation, ecosystem and landscape stability, rational use of natural resources, ecotourism development and with potential of the landscape in largest possible extend. The paper present also a future research project.

Keywords

Research, Primeval Beech Forests, Ecological Processes, Integrated Management Plan; World Heritage.

Introduction

Europe´s beech forests are deciduous forests which are dominated by the European Beech (*Fagus sylvatica* L.) (Barna et al. 2011). The beech is endemic to Europe and beech forests are limited to Europe (Gömöry et al. 2011). Such forests therefore share the fate of all deciduous forests of the northern hemisphere´s nemoral zone (Bohn & Neuhäusl 2003). They have been exposed to an enormous development pressure (settlement, utilisation) for centuries so that natural forests have become scarce (Britz et al. 2009; Kozak et al. 2007).

Beech is one of the most important elements of forests in the Temperate Broad-leaf Forest Biome (Udvardy 1975) and represents an outstanding example of the re-colonisation and development of terrestrial ecosystems and communities after the last ice age, a process which is still ongoing (Knapp 2011; Magri et al. 2006; Manos & Stanford 2001). Forest communities built up and dominated by the beech are widespread across major parts of Central Europe (Brädli & Dowhanytch 2003; Hamor & Commarmot 2005).

The Primeval (Virgin) temperate forests are rare in Europe due to the long-lasting, continuous human use of forests and due to high human population densities (Knapp 2011).

The Carpathian Mountains in Europe are a biodiversity hot spot, harbor many relatively undisturbed ecosystems, and are still rich in primeval, natural, and seminatural, traditional landscapes (Björnsen-Gurung et al. 2009). The Primeval Beech Forests of the Carpathians are indispensable to understanding the history and evolution of the genus *Fagus*, which, given its wide distribution in the Northern Hemisphere and its ecological importance, is globally significant. These undisturbed, complex temperate forests exhibit the most complete and comprehensive ecological patterns and processes of pure stands of European beech across a variety of environmental conditions and represent all altitudinal zones from seashore up to the forest line in the mountains (Brang 2005; Britz et al. 2009).

Valuable knowledge concerning dynamics of primeval beech forests in Carpathians has been obtained during the past 85 years. Thanks to the Czech professor Zlatník, the primeval beech forests of the Transcarpathian Ruthenia (1918-1944 former Czechoslovak Republic, since 1945 Ukraine) has been surveyed and evaluated in 1928 – 1938 (Zlatník 1934, 1935, 1936; Zlatník et al., 1938). Since 1947 Ukrainian researchers continued the investigation and research of this virgin forests (Brändli & Dowhanytsch 2003; Hamor & Commarmot 2003; Stoyko 2002; Stoyko et al. 1982; Stoyko & Tasenkevitch 1993). The research of natural and primeval beech forests worked up in Poland mainly Jaworski (Jaworski et al. 1994a, 1994b; Jaworski & Kolodziej 2004), in Slovakia numerous authors (Barna et al. 2011; Bublinec & Pichler 2001; Korpeľ 1982, 1989, 1995; Saniga 2011; Saniga & Schütz 2001, 2002; Saniga & Sklenár 2003, Saniga & Klimeš 2004; Vološčuk 1992, 1994, 1995, 1999, 2003), in Switzerland Leibundgut (1978, 1982, 1993), Brang (2005), in Germany Assmann et al. (2008), Britz et al.

(2009), DÖRFELT (2008), PRETZSCH (2003), KNAPP (2011), in Austria ZUKRIGL et al (1963), and in Romania GIURGIU et al. (2001). Over the past decade the generality of processess observed in individual studies have been the subjects of considerable discussions. The model of the main natural successional phases occuring in primeval forests of Central Europe was evaluated as: growing-up stage, optimal stage and decaying stage (DRÖSSLER 2006; DRÖSSLER & LUPKE 2005; KOOP & HILGEN 1987; KORPEĽ 1995, MEYER 1999; OHEIMB et al. 2005; ZUKRIGL et al. 1963). In the growing-up stage, trees are found in all three layers – upper, middle and lower, and the crown closure is dense. As there is low mortality in trees of this age, there is little dead wood (KORPEĽ 1995; SANIGA & SCHÜTZ 2002). In the end phases, however, the competition between individuals is so great that strong dying off of juveniles occours. In the following optimal stage, the maximum timber stock is reached, but the number of trees per area unit is low. With the lack of an understorey (SANIGA 2002, 2003), the attainment of maximum height and a closed canopy, the forest in this phase is known as „hall-forest“, being reminiscent of the interior of a cathedral or great hall, and also bears some resemblance to a commercial forest. During the transition to the decaying stage, tree vitality decreases and the proportion of dead wood increases considerably. In this phase, the number and size of gaps between tree clustes increases and regeneration of climax tree species starts again (KORPEĽ 1982).

A significant feature of the beech forests is decline in floristic diversity (FALKENGREN-GRERUP & TYLER 1991; BARBIER et al. 2008) which is a result of the history of flora and vegetation, from the former glacial refuges in Southern and Southeastern Europe up the northern and northwestern subterritories (MÖLDER et al. 2008). Old beech trees can form a highly diverse habitat for fauna (BRANG 2005). The beech is a key species which creates its own internal forest climate and crucially influences soil formation, regeneration cycle, food chains and structures reveals an stonishingly specific diversity of plants, vertebrates, insects, molluscs and fungi (DIERSHKE & BOHN 2004; DÖRFELT 2008). This diversity is described in terms of its ecological role in the ecological processes of beech forest ecosystems – trees and schrubs, mycorrhizae, geophytes, other herbaceous plants, lianas, herbivores, carnivores, dead wood inhabitants, destruens, etc. (ASSMANN et al. 2008; CAPOTORTI et al. 2010).

The Primeval Beech Forests of the Carpathians (Slovakia and Ukraine), have been inscribed on the World Heritage List on June 28, 2007 under criteria of outstanding universal value (COMMARMOT et al. 2000; BUBLINEC & PICHLER 2001; BRÄNDLI & DOWHANYTSCH 2003; HAMOR & COMMARMOT 2003; PICHLER et al. 2007a, 2007b; PLACHTER et al. 2008). The results from geobiocenological research of virgin forests was utilized for practical forest and conservation management.

The Decision of the 35. Session of the World Heritage Committee, Paris 25 June 2011, approved the extension of the Primeval Beech Forests of the Carpathians (Slovakia and Ukraine), to include the Ancient Beech Forests of Germany, and becomes the Primeval Beech Forests of the Carpathians and the Ancient Beech Forests of Germany (Slovakia, Ukraine and Germany), on the basis of criterion: outstanding examples representing significant on-going ecological and biological processes in the evolution and development of ecosystems and communities of plants and animals (BRITZ et al. 2009). The German extension in 2011 is another major step towards transboundary protecting this unique ecosystem for the long term (TURNOCK 2002).

The ecological process is understand as a continuous action or series of action that is governed or strongly influenced by one or more ecosystems (a system of plants, animals and other organisms together with the non-living components of their environment). Natural ecosystem is understand as an ecosystem where since the industrial revolution (say 1750) human impact (1) has been no greater than that of any other native species, and (2) has not affected the ecosystem´s structure. Human impact excludes changes of global extent, such as climate change due to global warming (IUCN/UNEP/ WWF 1991).

The World Natural Heritage with beech ecosystems in Europe comprising 15 components – 10 in Slovak – Ukrainian Carpathians and 5 in Germany. The World Heritage Sites in Slovakia are situated in strict protected nature reserves - IUCN Category I of Poloniny National Park - IUCN Category II, and in nature reserves of Vihorlat Protected Landscape Area - IUCN Category V (DUDLEY & PHILLIPS 2006; IUCN 1994; EUROPARK & IUCN 2000; BISHOP et al. 2004; HOCKINGS et al. 2006, LOCKWOOD et al. 2006; PHILLIPS 2002; THOMAS & MIDDLETON 2003, VOLOŠČUK 1999). The World Heritage Sites in Ukraine are situated in territory of Carpathian Biosphere Reserve, which is the strict protected category in Ukraine (by IUCN it is Category I) (HAMOR & COMMARMOT 2005) and in nature reserves of Uzhansky National Nature Park - IUCN Category II (KRICSFALUSY et al. 2001). In Germany the World Natural Heritage Sites are situated in national parks - IUCN Category II (BRITZ et al. 2009).

The Principles of Joint Management Plan

Long-term protection and management of the Protected Areas and especially of the World Heritage Sites is ensured through national legal protection as national parks or core areas of a biosphere reserves (COONEY 2004; IUCN WCPA 2000; KUEMMERLE et al. 2008; LEVREL 2007; LOCKWOOD et al. 2006; STOLTON & DUDLEY 1999; SYNGE 2004; THOMAS & MIDDLETON 2003; WILSHUSEN et al. 2002; ZBICZ & GREEN 1997). Effective implementation of the integrated transboundary management plan and the trilateral integrated management system is required to guide the planning and management of this World Heritage Sites.

The general objectives of the Integrated Management Plan are (PICHLER et al. 2007a, 2007b) :

- To ensure the most effective conservation of the WHS properties with all their abiotic and biotic components, geo- and biodiversity and ecological processes. To secure a lasting homeostasis and self-reproduction of the respective ecosystems and their protection both against anthropogenic factors (ČEŘOVSKÝ 1996; DENISIUK & STOYKO 2000; HAMILTON et al. 1996; HAMILTON & MCMILLAN 2004; PHILLIPS 2000; STOLTON et al. 2012; SYNGE 2004).

- To maintain and expand the existing, ecologically connected complex of primeval and natural beech forests that encompass the WHS within the corridors connecting the WHS. Supporting the succession of managed beech semi-natural forests (Bennett 1994, 1998; Bishop et al. 2004; Sandwith et al. 2001; Stolton et al. 2003, Pichler et al. 2007b).
- To use WHS for scientific research in order acquire knowledge transferable and applicable on the level of sustainable (Vološčuk 1992, 1994, 1995, 2003; Otto 1994). To use WHS for enhancement of landscape ecological stability and resilience (Peterson et al. 1998).
- To use WHS for enhancement of ecological and environmental education, awareness of primeval forests – chosen to maintain integrity and conservation of the existing sites, to preserve their naturalness and uniqueness (Stolton & Dudley 1999; Turnock 2002).
- To support of traditional crafts, products and ecotourism (Ceballos-Lascuráin 1996; Eagles et al. 2002; Gebhard et al. 2007; Pichler & Soroková 2005; Balandina et al. 2012; EUROPARC Federation 1993).

Common elements of an effective management system could include: a) a thorough shared understanding of the property by all stakeholders; b) a cycle of planning, implementation, monitoring, evaluation and feedback (Hocking et al. 2000, 2006; IUCN WCPA 2000), c) the involvement of partners and stakeholders (EUROPARK Federation 1993; Synge 2004), d) the allocation of necessary resources; e) capacity-building; and f) an accountable, transparent description of how the management system functions (Levrel 2007).

New research project of the World Heritage Beech Forests Ecological Processes

Based on several studies over the past decades the current status of Beech Forests World Heritage Sites in the Carpathians need identifies knowledge gaps, and suggest avenues for future research. In December 2012 the 15 scientists from Matej Bel University in Banská Bystrica and Technical university in Zvolen elaborated a new project „Research of Dynamics of the World Natural Heritage Ecological Processes in the Eastern Carpathians and Vihorlat Mountains“. Project is aimed at the research of unique ecological processes dynamics in ecosystems in model areas of World Natural Heritage in Eastern Slovakia, on the Slovak-Ukraine border: flysch of the Poloniny National Park (Stužica and Havešová Reserves) and Vihorlat Mts. volcanos (Morské oko and Vihorlat-Nežabec Reserves). Evaluated also will be the development of these model areas. Hydric potencial of the region and natural hazards of the connecting corridors, futher the phytoecological processes dynamics of development stages of ecosystems, functional relations of bryoflora, mycoflora and epigeic communities in relation to the dead wood, research of biomass, activity and diversity of soil organisms, nutrient cycling and the soil physical-chemical characteristics in relation to the herb layer and dendroflora structure. Part of this research is also aimed at the ecological complexity and derivation of the resilience macroscopic indicators of natural ecosystems. Knowledge on unbalanced ecosystems thermodynamics will be aimed at the solar energy transformation by ecosystems, in order to derive the ecological sustainability indicator of ecosystem processes and landscape-ecological potential. Ecosystem services and ecological stability will be studied in relation to the research of complexity and resilience of ecosystems. The problem of environmental, scientific, tourism-recreational potential and ecological sustainability of ecosystems and World Natural Heritage lendscapes will be also solved.

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Developing sustainable tourism in sensitive mountain areas
Challenges for the sustainable management of leisure motived mobility in the UNESCO world heritage site of the Dolomites

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Keywords

Sustainable Tourism, Leisure Mobility, Management, Mountain areas, UNESCO

Abstract

Since 2009 the nine sites of the Italian mountain range of the Dolomites are part of the Natural World Heritage List of the UNESCO due to being widely accepted as among the most attractive mountain landscapes in the world. Yet, as already declared in the evaluation by the International Union for Conservation of Nature (IUCN), this landscape attractiveness has led to significant tourist flows directed to some specific destinations within the area.

The poster presents selected results of a research project, during which a strategy for sustainable tourism in the UNESCO Dolomites is developed. Linked to the diverging dynamics of tourist flows, also the status-quo for road and rail transport in the world heritage area faces the similar problem of a very heterogeneous development and distribution. However, the environmental effects especially by road traffic are myriad and contrary to the idea of protected areas.

The World Heritage Site of the Dolomites faces an interprovincial reality of a serial mountainous site, since the nine component sites forming the heritage area are located on five different provinces, which are part of three Italian regions. The poster illustrates the main challenges for stakeholders in managing and creating a consistent mobility system against this background. The poster identifies three areas as main challenges for stakeholders: the availability of consistent data, the management of road traffic and the public transport offered.

One future main challenge is to provide harmonized data on the traffic development for all five provinces to achieve a common base for the consistent analysis of past and present transport situation in the area. During the analysis none of the requested indicators on road and rail traffic, air pollutant and greenhouse gas emissions could be retrieved from each of the five provinces. As lowest common denominator for the road at least the annual average daily traffic could be retrieved for three of the five provinces of which two could provide disaggregate data sufficient for a more in-depth analysis. This is mostly due to the fact that monitoring of road traffic and its effects is primarily accomplished in more densely populated areas. This fact also indicates how much attention is currently paid to leisure-related traffic in some areas, which so far are not considered hotspots of traffic development.

The values for road traffic volume for most areas of the Dolomites significantly are below values registered for other more densely populated areas outside the mountains, where leisure-motivated traffic is overlaid e.g. by long-distance and commuter traffic. Then again, the average daily traffic counted in summer season score numbers (up to 6.000 vehicles/day) similar to other parts in the area not serving for leisure motivated traffic only.

Furthermore these peaks reflect e.g. arrivals and departures of tourists in their destination, and the traffic towards the access points. It therefore often concentrates in small time segments, where for instance on mountain passes more than 700 vehicles per hour are counted. This development is worrying since these values currently undergo constant growth over the last five years. Even more when we see that several road segments of local and regional importance cross the buffer and core zone of the world heritage site. Reducing these specific peaks is a major aspect for leisure-oriented traffic management in the area.

On the other hand the poster depicts the inconsistent development for public transport offered in the area as a major topic for the future, nonetheless to go against the issues arising from road traffic. The results of the analysis of public transport in the area primarily show a fragmented offer with differing service levels for each province; a fact mainly due to few services oriented towards leisure-traffic (e.g. on Sundays) towards the access points of the Dolomites in the single provinces. The more, it is challenging for the management to achieve a commonly organized public transport offer between the five provinces. So far each province autonomously organizes its own public transport, only marginally considering connections towards the neighboring province. This situation results in a fragmented network of little basic service with only few trans-provincial connections. This situation one the one hand becomes manifest in the fact that transfer to buses of the other province at the provincial border are very rarely coordinated. Furthermore no common tickets to simplify trips across the provincial borders in the area of the Dolomites are available. At last, so far no common information system on all public transport lines exists for the area, possibly joining the different offers of public transport on road and rail.

Summing up, the poster identifies the main challenges for stakeholders the UNESCO world heritage site of the Dolomites in the reduction of leisure-related road traffic on several hotspots on the one hand and in the creation of a harmonized interprovincial offer on public transport (tickets, timetables, connections). It outlines the stakeholders' responsibilities in coping with different dynamics in order to guarantee a sustainable development in the area, for example when public bodies have to unify the aforementioned fundamental elements. The poster shorty outlines strategies developed for the world heritage site to overcome these challenges for organizing leisure-related traffic in a classical dual strategy. It therefore proposes a mix of short-, medium and long-term push- and pull-measures to render individual road transport less attractive on the one hand and pull-measures on the other which are to foster environmentally friendly transport systems.

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Swiss Parks of National Importance: Potential Topics and Research Perspectives

Astrid Wallner & Marcel Hunziker

Abstract

In Switzerland, legislation enabling the creation of parks of national importance has been in force since 1 December 2007. Within only five years, 15 new parks have been established and two more regions carry the label "park candidate".

From a scientific point of view this boom of new protected areas within a short time presents a unique opportunity to study the development of these diverse regions in comparative studies. At the same time, the parks depend on scientific results in order to take adequate measures for valorisation and development of their areas. Therefore, this presents an excellent starting point to encourage the dialogue between science and practice. The Swiss Research Commission on Parks of National Importance (Parkforschung Schweiz) developed for this reason a catalogue of potential research topics.

Keywords

Switzerland, parks, comparative research topics, transdisciplinarity

Introduction

Until 2007 the list of protected areas in Switzerland encompassed one national park. A partial revision of the Federal Act on the Protection of Nature and Cultural was necessary in order to create the legal basis enabling the creation of further parks of national importance.

With 15 new parks in operation and two more park projects in the phase of establishment within only five years after the new legislation has come into force, the question regarding research perspectives of the concerned parks and potential research topics arises.

From a scientific point of view this boom in the establishment of parks of national importance within a short time presents a unique opportunity to accompany these parks and to establish a long-term evaluation in order to assess the changes in and the impact of these areas. From a management point of view, parks depend on scientific results in order to take adequate measures for valorisation and development of their areas. Taken together these are exceptional prerequisites for enhancing the dialogue between science and practice.

In order to promote the dialogue and to concurrently coordinate research related to more than one park, the Swiss Federal Office for the Environment (FOEN) facilitated the appointment of a coordinating office for research on parks. The office is supported by a group of experts. This Research Commission on Parks drew up a thematic catalogue of relevant research topics for comparative research on Swiss parks. Thereby, the focus is on a transdisciplinary research approach based o the exchange between science and society and supports the quest for science-based answers to questions regarding the impact, aims and governance of Swiss parks. Thus, research on parks contributes essentially to the sustainable development of park regions and the enhancement of a Swiss parks politics.

Potential Research Topics

To identify potential research topics we consulted park managers of the concerned parks and developed a short description of topics, which could be of interest for comparative research on several parks. These were discussed in a wider circle of the research community and park managers as well as representatives from governmental agencies.

The discussions showed that the focus on research on parks covers the following three areas:

- establishment of parks;
- operation of parks;
- impact of parks inside and outside of the park region.

Based on these results we further developed the proposed research topics and came up with seven topics. These fall within the classical sustainability triangle of ecology, economics and society (see Figure 1).

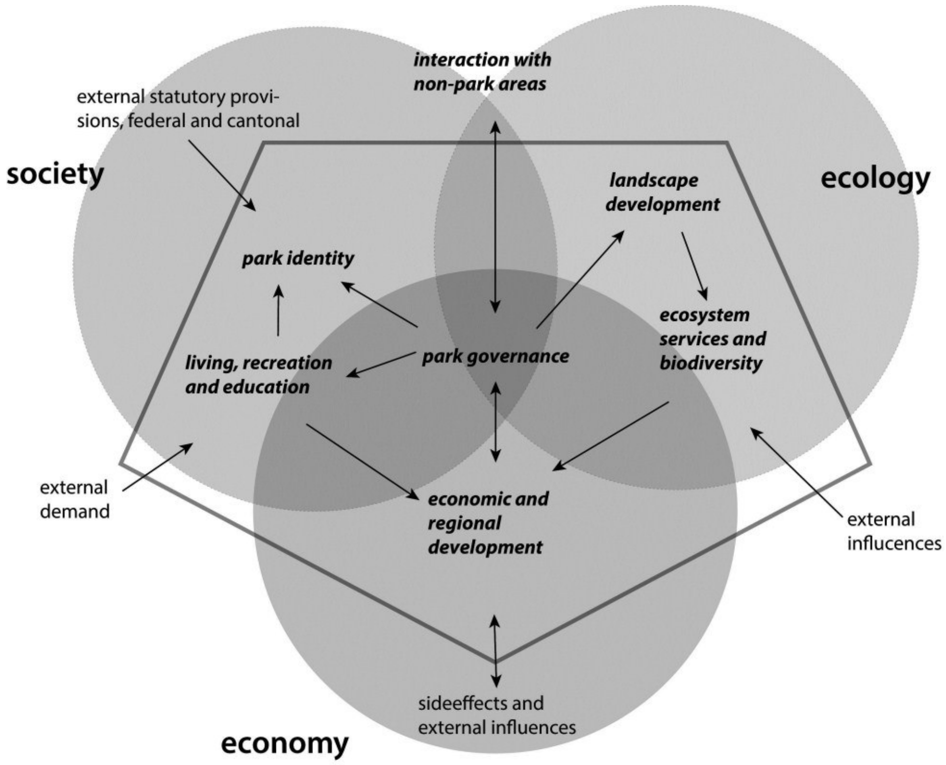

Figure 1: Potential research topics for parks of national importance (within the grey line) situated within the sustainability triangle.

Park identity

Parks of national importance in Switzerland are based on regional initiatives. They are the result of democratic, participatory processes that take several years and involve a number of stages. As such parks are established not on the drawing boards of administrators, but in the hearts and minds of the local people. The latter must give the impetus for the creation of a park. Only then will the federal government support a park project and award it the park label – provided all requirements are fulfilled. The local communes play a considerable role in the park authority, making strategically important decisions about the park. In this sense, the creation of a park is a political as well as societal process. This is the basis for various research questions regarding issues such as motivation, acceptance and regional identity.

Park governance

The park is a new actor in an already complex environment. Local and regional institutions and structures as well as national regulations form the framework within which the park has to function. At the same time, the local population has great expectations of the park administration. However, the park as such usually does not form a political or regional or administrative unit and therefore has no official legal mandate. In this realm research can contribute by analysing the opportunities of park administrations to influence political sectors such as agricultural policy and transport policy.

Economic and regional development

The establishment of a park is seen by many as an opportunity to encourage regional economic development. Opportunities mentioned include promoting local products, creating added value by supporting local resource cycles, encouraging new choices for tourists. However, the impact of any action on nature and landscape has to be observed, since the protection and enhancement of exceptional natural habitats or landscapes of outstanding beauty is the main goal of the Swiss parks' politics. Therefore, it will be interesting to investigate for example into the question, how parks promote synergies between different economic sectors such as tourism, agriculture and trade.

Landscape development

In recent decades, political awareness has turned towards the topic landscape development. Landscape can be considered as a collective resource with the characteristics of a public good instead of an individually usable good. In this way landscape becomes the central issue of a democratic process. Since preserving and enhancing the natural values of the landscape is the highest priority of the parks in Switzerland, it is logical to apply this concept of landscape also to parks. Research studies could investigate for example whether the acceptance of a park does imply a change in the appreciation of nature and landscape.

Ecosystem services and biodiversity

The various parks of national importance present a great variety of landscapes. These landscapes not only provide an important basis for different recreational activities and regional value creation. They also offer essential services such as air quality, water purification and flood prevention.

Parks also play an important role in biodiversity conservation since they include numerous areas under cantonal or national protection. The relationship between biodiversity and ecosystem services is undisputed. However, research results could be used for displaying the services of biodiversity and ecosystems and to implement them in the long run as quality criteria in land use planning.

Living, recreation and education

Many rural areas are affected by emigration and decline. Areas carrying the label 'park of national importance' commit themselves to encouraging sustainable regional development and see the park as an instrument to counteract migration losses. Outside their area, such regions promote the special quality of living that comes from handling natural resources and from the landscape. Overall, this is a transformation process, which depends on local knowledge and includes a re-orientation within the local population. Educating local people and visitors and making them aware of this special quality are vital in this process. Comparative studies can focus on local and expert knowledge of specific natural and cultural places and on how they can be integrated into educational programmes.

Interaction with non-park areas

A park interacts continuously with its surrounding region, with positive and negative mutual influences. For example, the creation of new visitor attractions in the park can lead to an increase in overnight stays outside the park. Or, as a negative example, intensification of land use in the vicinity of a park might impact on the ecological and landscape qualities of the park. Research can analyse these interactions and evaluate the effect of protected areas on their surroundings.

Research Perspectives

This catalogue of potential research topics is an essential step for enhancing the dialogue between science and practice regarding protected areas. So far, the topics have not been prioritized. At the moment it is important that parks authorities formulate their own research needs based on their experiences and the proposed topics.

Studies on parks are essential for identifying changes in protected areas over the time and to predict the impact of the parks. While certain studies related to the establishment and the operation of parks already exist, studies related to the impact of parks will only be possible once the parks have been in operation for several years. Comparative studies further support the analyses of the question whether it is actually the park itself that has led to the changes observed.

Future predictions on the development and impact of protected areas depend on long-term studies. These must be factored in already at the beginning of a comparative research approach and will be of great importance for carrying out a long-term impact assessment.

The full catalogue of research topics is available in German and French at: www.parkforschung.ch

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Park Assessment in Switzerland: from controlling of single parks to a systematic evaluation across all parks

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Abstract

The Swiss federal authorities support regional initiatives for the establishment and operation of parks of national importance by providing financial aid and awarding the park label. An evaluation is needed in order to assess whether the parks met the commitments made regarding the award of the label. This is an evaluation in the sense of a controlling of each park. Supplementary, a long-term evaluation is crucial in order to assess the changes in the parks and the impact of the parks in the regions.

Under a mandate of the Federal Office for the Environment (FOEN) we elaborated a concept for assessing the effects of the parks on nature, economy and society. The focus was on developing a systematic long-term impact assessment of all parks of national importance in Switzerland.

Keywords

Switzerland, parks, park assessment, evaluation, monitoring

Introduction

The first national park in the Alps was established in Switzerland in 1914, almost 100 years ago. Various monitoring programs concentrating on specific issues such as forest monitoring, ungulates movements, spring monitoring and others have been initiated.

However, unlike in other European countries, no further protected areas such as national parks or regional parks with a national label have been created. A partial revision of the Federal Act on the Protection of Nature and Cultural Heritage (NCHA) was needed for setting the legal basis enabling the creation of parks of national importance. Since 2007, the Swiss federal authorities support regional initiatives for the establishment and operation of parks of national importance by providing financial aid and awarding a park label. The aim is thus to promote regions characterised by high natural and landscape values, which are pursuing sustainable development and meet the specified criteria.

According to the Ordinance on the Protection of Nature and Cultural Heritage, the Swiss Federal Office of the Environment (FOEN) shall conduct success evaluations to check that the legally required measures have been implemented and to assess their suitability. This applies also to the issue of parks of national importance. In practice this implies an assessment to evaluate whether the predetermined goals of the parks legislation are met. However, as parks legislation in Switzerland is relatively new, no long-term evaluation instrument for the assessment of parks of national importance exists so far. Therefore, the FOEN mandated a group of experts for drafting an evaluation instrument for parks of national importance (WALLNER et al. 2013).

Long-term and large-scale evaluation of protected areas

Evaluation is based on observation. The continuous observation of protected areas is necessary in order to detect changes and therewith to identify the dynamics of and within these areas. This information is necessary in order to assess whether the observed changes are within natural levels of variability or may be the result of unwanted influences (FANCY & BENNETS 2012).

Since protected areas worldwide have certain reporting obligations – be it to national agencies or be it within the frame of international programs such as MAB (Man and Biosphere) or CBD (Convention of Biological Diversity) and others – they all discuss similar issues such as the selection of indicators, data management, analysis and reporting procedures. However, only a few national large-scale evaluation programs allowing for the evaluation of several protected areas within one country have been established so far. The US National Park Service has initiated a long-term ecological monitoring program for 32 eco-regional networks containing more than 270 parks with significant natural resources (FANCY et al. 2009). In Canada, a long-term ecological change monitoring program has been developed for parks in the province of British Columbia (WRIGHT & STEVENS 2012). In Germany, an integrative monitoring program for large-scale conservation areas has been developed just recently (PLACHTER et al. 2012).

For the elaboration of a long-term evaluation instrument for Swiss parks of national importance, which shall assess whether the predetermined goals of the parks legislation are met, it was indispensable to adopt a large-scale approach. Therefore, the mentioned large-scale monitoring programs in the US, Canada and Germany were of great importance for us. However, while the long-term monitoring program in the US National Park Service as well as the one in Canada clearly focussed on ecological aspects of parks, we followed the way of the German model, which includes also economic as well as social aspects of parks and therewith tackled all three dimension of sustainability.

The Swiss model of long-term evaluation of parks

Since most of the parks of national importance in Switzerland are only in operation for a few years, we could not rely on long-term monitoring programs and evaluations of single parks as a basis for the development of an overall evaluation instrument for all parks.

The US National Park Service defined seven basic steps for designing a long-term ecological monitoring program (NPS 2007). We consulted these recommendations and started by defining the goals and objectives of the evaluation program. In our case, the strategic goals of parks formulated in the Federal Parks Strategy served as starting point of our considerations. Each goal was analysed with regard to existing monitoring programs and potential indicators. Thereby it became obvious, that it was crucial to differentiate between the terms evaluation and controlling. According to our understanding evaluation encompasses the assessment of the impact of certain measures in the regions under consideration where as controlling refers to the supervision of task fulfilment. Most of the strategic goals formulated in the Federal Parks Strategy referred to evaluation of the impact of the parks. However, some of these goals were formulated rather as controlling objectives than evaluation of the impact. It therefore was important to create a common understanding of these terms between the scientific experts and the representatives of the federal agency.

Figure 1 displays the difference of the terms evaluation and controlling and of the terms output and impact. The strategic, superordinate goals of parks formulated in the "Federal Parks Strategy" are at the core of the considerations. For example, parks shall contribute to the *conservation and enhancement of natural habitat quality*. The parks have to define their own specific goals related to this overall goal (example: stable populations of species relevant for each park). Practical measures are then defined in order to achieve the parks' specific goals (example: supporting and implementing species recovery programmes). The parks have to perform services to implement the defined measures (these services are called the output), which should have an impact in the region. Controlling refers to the supervision of task fulfilment. The assessment of the impact (intended as well as unintended changes), which occurs as a result of the implemented measures, is subject of evaluation.

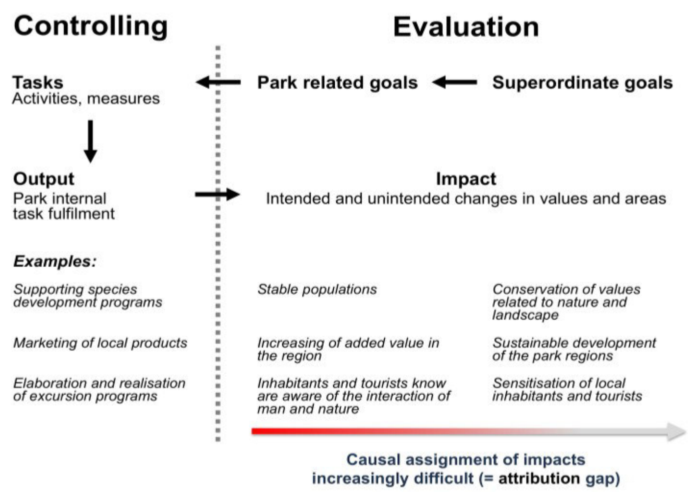

Figure 1: Components of the parks-evaluation program explaining the difference between controlling and evaluation. Adapted illustration from WIESMANN 2009.

The evaluation instrument we developed is clearly focussing on the achievement of the superordinate goals and therewith on the monitoring of the intended and unintended changes in the park regions. Therefore, each goal defined in the Federal Parks Strategy was analysed with regard to potential indicators. The goals were grouped into themes and sub-themes (Table 1).

For each goal and therewith for each subtheme various indicators were defined. We tried to use as many indicators from existing monitoring programs as possible. Therewith it is possible to keep down the costs for gathering and analysing data. However, since we partially rely on monitoring programs not yet fully in progress, some of the selected indicators might have to be replaced if the concerned monitoring program is not coming into force.

Conclusion

The overall aim of the long-term evaluation program on Swiss parks of national importance is to assess the achievements of the goals defined in the Federal Parks Strategy. The parks in Switzerland not only help to protect and enhance exceptional natural habitats or landscapes of outstanding beauty. At the same time, these parks promote the sustainable economic development of the regions concerned, as well as allowing visitors to experience nature and offering environmental education. Therefore it is crucial to establish a long-term evaluation program, which not only focuses on the ecological aspects of the parks but also on economic and social issues. However, selecting and analysing social and economic data is often time consuming and cost-intensive since surveys have to be conducted and analysed.

Table 1: Themes and sub-themes of the Swiss parks-evaluation program

Themes	Subthemes
Nature	Habitat Species
Landscape	Beauty Uniqueness and character
Economy	Added value Product marketing Recreation and tourism Agriculture and forestry
Society	Demographic development Quality of life Identity Mobility Participation
Communication	Sensitisation Environmental education Knowledge transfer Research

Knowing the status and trends and therewith understanding the dynamics of parks is not only fundamental with regard to the question of fulfilment of parks legislation goals. It also forms the basis for an early warning system concerning natural hazards or threats and thus for sensitizing the public to specific issues and problems. Furthermore, the knowledge gained through this long-term evaluation instrument shall also assist park managers in developing a broad-based understanding of the dynamics of parks. This is fundamental for management and decision-making aimed to maintain, enhance or restore the ecological, economic and social integrity of parks.

At the moment, the long-term evaluation instrument for Swiss parks of national importance is being discussed by the Federal Office of the Environment. Decisions regarding the scale of the program as well as the timeframe for implementation are not yet defined.

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Challenges for mountain protected areas in Central and Eastern Europe. Examples from Poland and Ukraine

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Abstract

The aim of this paper is to present challenges faced by mountain protected areas in post-socialist countries on the example of Polish and Ukrainian Carpathians. Although both countries are not very mountainous, the Carpathian Range plays an important role in the culture and identity of both nations and first mountain protected areas were created there yet before the World War II. However, it is during the communist times, when most of them gained their contemporary shape. For about two decades they function in a new economical and institutional reality, facing new challenges related to this transformation:

- environmental conflicts on the local level, usually resulting from insufficient consultation and different visions of development
- a rising pressure on creating large-scale ski resorts and recreational centres
- problems with maintaining cultural landscapes due to insufficient incentives for traditional activities
- problems with land ownership structure and inadequate compensations for lands formerly included into protected areas
- problems with implementation of international nature protection rules into local contexts

Apart from many historical similarities, Poland and Ukraine represent two different transformation cases. Ukraine - nowadays independent – after the WW II was a part of the totalitarian Soviet Union. Poland after the war remained under communist regime but was (at least formally) an independent country, and since 2005 is a member of the EU. By choosing case studies from these two countries, my aim is to provide a more complete image of the abovementioned problems and opportunities for the nature protection in Central and Eastern Europe.

Keywords

protected areas, Carpathians, nature conservation, summer farming

Introduction

Throughout Europe, there is a growing interest in a role that protected areas can play in stimulating regional development. Some authors even state that nowadays we observe a paradigm shift from a selective towards integrative approach to nature conservation (Mose & Weixlbaumer 2007). However, such statements are usually based on the experiences of the Western countries and in case of mountain protected areas – especially on the Alpine examples. When it comes to the East Central Europe countries, however, the knowledge about the nature of the challenges they face when it comes to the transition towards this new approach, seems to be rather generalized. Countries of the former Soviet bloc are often seen as one homogenous category, whereas in fact they differ in many aspects no lesser than the Western ones. These differences also touch the organization and functioning of the protected areas. I am going to show this variety on the Carpathian examples from Poland and Ukraine. These countries obviously share some common experiences connected with living under a totalitarian regime as well as the painful transition from the command market towards market economy, but at the same time represent two quite different contexts for this study.

Aim and the area of study

The aim of this study is to show actual challenges for the mountain protected areas through case studies of Ukrainian protected areas (with a special accent on the highest mountain range they cover - the Chornohora): the Carpathian Biosphere Reserve (CBR) and the Carpathian National Nature Park (CNNP), compared to the situation in my home country, Poland, based on the example of the Babia Góra National Park (BGNP) and the Tatra National Park (TNP).

The basic features of these sites are the following:

1) The two Ukrainian protected areas in question are compatible with administrative borders, which in this case means a division of the Chornohora range between them, as the border of the oblasts' (regions) goes along the range. Such situation is quite an abstract thing in Poland. Nature does not know the human-made borders,

does it? However, the latter approach has disadvantages, too as it can lead to overlapping of several types of protected areas. The consequences of this situation will be commented on later in this paper.

2) The Carpathian Biosphere Reserve is characteristic for its division in eight separate parts while the Babia Góra National Park is characteristic for its relatively little size: 33,93 km2 (Rodzaje ochrony…). Such circumstances surely provide challenges for an effective management and especially for reaching conservation goals, e.g. when it comes to protection of animals that need large territories like a brown bear (Ursus arctos) or a grey wolf (Canis lupus).
3) The two Ukrainian sites have been under protection for much shorter time compared to the Polish ones, which is symptomatic and could be explained by this country remaining a part of the totalitarian Soviet Union until 1991. Although the tradition of nature protection here is shorter, there is an opportunity that more solutions based on experiences from Western countries can be directly implemented without repeating their mistakes.

Materials and methods

The main methods of this study included:

- field observations in all four protected areas in question
- interviews with local inhabitants and other actors (e.g. protected areas' workers) in case of the Ukrainian protected areas and two interviews in the seat of the BGNP
- Studies of literature, internet sources, maps etc.

The field research was conducted systematically from 2009 to 2012 during 10 field trips to Ukraine, 5 visits to the BGNP and 3 visits to the TNP. The stress is made here on Ukrainian examples, Polish cases serve for a comparison that helps to show the variety of nature protection approaches that countries from behind the former 'Iron Curtain' choose.

The interviews did not follow a fixed structure but were modified according to the background of the respondent and the knowledge he/she was expected to have. Interviews' topics concerned the perception of the protected area, good and bad practices both in nature protection and land use such as grazing, local development and quality of life, tourism etc.

The main written sources included most of all the materials provided by the protected areas: monographs, reports, conference proceedings, brochures, maps and plans, websites, etc. The idea is to confront these sources with opinions of different local actors as well as other scientific works when possible.

Main results

Among the main findings there should be mentioned:

1) <u>Problems with implementation of international nature protection rules and standards into local contexts</u>

The two Ukrainian cases, CBR and CNNP showed a quite different approach towards the relationship between the nature conservation and human activities like tourism and summer farming. This is especially visible in the Chornohora mountain range where these two protected areas border. In CBR we can observe not only a greater 'tolerance' for tourism, but also attempts to manage it by creating 'soft' infrastructure (marked trails, tourist shelters, camp sites). The interview in CBR showed that the authorities of the Reserve are trying to become a leader of the 'green' branches of tourism for the whole region, gathering together smaller local initiatives. However, in view of some local actors and potential partners in such cooperation, CBR is perceived without too much confidence and plans of its area's enlargement even provoked a conflict with the local community. But at the same time, apart from undertaking actions that enhance tourism, CBR also allows grazing on traditionally communal (in the Soviet times – collective farms') pastures that are situated in its buffer zone. On the other side of the range, the CNNP presents a much more conservationist approach. Although active in some development projects for the local inhabitants (e.g. connected with water management system), it seems to be totally passive when it comes even to some basic tourist amenities within the Park. The most striking example here is the area around the Lake Nesamovyte – a little post-glacier lake, one of the symbols of the Chornohora. Its location very close to the main range makes its a frequently visited, though illegal – camp place. One of the most popular trekking trails in the Chornohora is to walk along the range. However, as it takes 2-3 days and as there are no tourist huts along the way, tourists often choose (and in case of bad weather sometimes have to choose) to camp near the lake. When asked about this place, the CNNP authorities claim that they try to change the category of a small parcel of land near the lake in order to create there an official camp place or even to build a tourist hut. But as the area is situated within the strict protection zone, they have to wait for the permission of the Ukrainian Parliament. The situation remains and remains, in spite of the fact that in the neighboring CBR 'soft' tourist infrastructure exists even in the strictly protected core zone.

As for the grazing, the Park allows it on some lower situated meadows (called polonynas), while most of the old pastures are left abandoned facing reforestation or dwarf pine expansion (SITKO & TROLL 2008).

This duality of approach within one mountain range obviously brings challenges in keeping the goals of these two protected areas. And moreover, makes it harder to find a cohesive strategy for the whole region especially if such a strategy was to be based on nature protection, as the modern paradigm states (HAMMER 2007).

By contrast, in Poland a great challenge is the overlapping of several (sometimes contradictory in their priorities) types of protected areas. Although this is not exclusively a Polish problem (HAMMER et al. 2007), it can be very well shown on the Babia Góra National Park example. This relatively little protected area (created to protect well developed altitudinal zonation of the highest peak of Poland outside the Tatras) is at a time:

- a national park - under the Polish law
- a UNESCO MaB Reserve - under international, UN regulations
- a Natura 2000 both SPA (Special Protection Area - for birds) and SAC (Special Area of Conservation - for habitats) - under EU regulations

Although all these 4 sites have different borderlines (e.g. the Biosphere Reserve's transition zone in 100% covers area around, but outside of the National Park), they all contain the BGNP in their core. As a result, the fundamental question occurs: which protection type has the biggest priority in the Babia Góra range? For example: in the zone of strict protection of the national park, in fact no human intervention is allowed in order to let the natural processes work. But what to do if at the same time Natura 2000 imposes maintenance of a certain type of habitat there, impossible to preserve without e.g. some forestry actions? Park workers admit facing such dilemmas.

Although Tatra National Park is in analogical situation, its greater challenge seem to be connected with massive tourism and in consequence, among other things, a very high density of marked trails (their total length is 275 km with the total Park area almost 212 km2). Being the only mountain range of alpine landscape in Poland and therefore having a deep meaning in Polish culture and tradition, the Tatras are extremely popular tourist destination. There are around 2,5 mln visitors entering the Tatra National Park each year (Turystyka piesza...). Thanks to cable cars linking the town of Zakopane with Kasprowy Wierch (1987 m.a.s.l.), even the highest parts of the range are quite easily accessible for massive tourism and for skiing, which poses many environmental (as well as safety) questions. One of the most visible evidences of tourist pressure are degradation of trails (FIDELUS 2008) and garbage.

2) Problems with maintaining cultural landscapes due to some protection regulations and insufficient incentives for traditional activities

Cultural landscapes both in Polish and in Ukrainian Carpathians are especially connected with grazing and use of natural (alpine) and semi-natural meadows as pastures. In Poland, starting from the 1960s, grazing was forbidden in the mountain national parks, which reduced not only the abovementioned cultural values, but also the biodiversity as many lower situated meadows reforested (e.g. Hala Czarna in the Babia Góra range is an example of an almost full reforestation). Moreover, the process of establishment the national parks as well as the removal of summer farming from their territory was conducted in an extremely top-down manner. This caused a strong resistance of the local communities and until today influences the Parks-people relationships. Due to environmental as well as social reasons, programs of reintroduction of seasonal grazing - though on a limited scale and with a limited success - have been developed yet in the 1980s.

In Ukraine grazing remained and even flourished in the communist period – obviously not on the basis of private property, but within the collective mountain farms in a re-shaped, 'industrial' form. Nowadays some people continue individual pasture activity in a pre-war style despite the fact that without any program of institutional support this occupation is nowadays dramatically low cost-efficient.

3) Problems with land ownership, inadequate compensations for land (formerly) included into protected areas

These problem can be especially well seen on the Tatras' examples. Around 22,30 km2 of TPN in Western Tatras (mainly forests and some semi-natural meadows) is not only owned but also in fact managed by a cooperative of inhabitants of eight villages situated in the neighborhood. The cooperative's history dates back to the first half of the 19th century, so it is much older than the park (Historia...) . Even though its territory is formally included in the national park, the cooperative can run forestry and business, use meadows for pastures, sell tickets at the entrance and to some extent develop tourism infrastructure. This situation brings environmental concerns as nature protection obviously is not the main goal of the cooperative.

Another type of the problem connected with property rights - inadequate compensations for land – was in the core of the conflict around using alpine (natural) and semi-natural pastures in the Tatras after the establishment of the National Park. The local people were not only frustrated by the prohibition of the land use they had been practicing there for generations, but also by the far inadequate (in their view) price the state proposed for the pasturelands they owned.

Such conflicts were possible in the post-war Poland where despite of the socialist regime, private property rights were maintained (which was quite unusual in the former Soviet Bloc). They were however impossible in the totalitarian Soviet Union after the forced and brutally executed collectivization of land. Protected areas in the Ukrainian Carpathians were established on the basis of lands formerly taken away from the people and currently through these protected areas, they remains the property of state. Therefore it is not surprising that the local people there treat protected areas with a very limited confidence – which was observed by other scholars, too (WALLNER et al. 2007).

4) Environmental conflicts on the local level, usually resulting from insufficient consultation and different visions of development e.g. a rising pressure for creating large-scale ski resorts and recreational centres

On the Ukrainian side the main conflict around protected areas is the one between the CBR and the authorities of the Rakhivskiy rayon. The core of the dispute is situated in the Lazeshchyna village where the local community stepped against enlargement of the Reserve that was to cover forests and alpine zone on the north-west slopes of Goverla (2061 m.a.s.l.), the highest peak of the Chornohora range (and the whole Ukraine), until now unprotected. This seems to be in fact a conflict for control over good quality forests. Despite the presidential decree signed in 2010, that set the new borders of the CBR, until now (end of 2012) the status of the area of conflict is still pending (TROLL & WARCHALSKA-TROLL 2013).

Polish mountain protected areas are familiar with similar circumstances, too. For instance, a quite new conflict in Zawoja was based on opposition of the local community towards designation of the new Natura 2000 sites in the village surroundings situated outside of the national park. Keeping past conflicts with the park in mind, the people and especially the local authorities acted against including even more of the district's area into protected areas. The crisis was deepened by the fact that the designation of the Natura 2000 sites was not consulted with the community and that not enough of basic knowledge about this new type of protected area was provided before its implementation. Out of despair, in 2008 local authorities organized a referendum (even though it could not have a legal force in such case). It was preceded by a campaign 'Capercaillie or You' (the main reason for creating Natura 2000 near Zawoja was to protect the habitat of the western capercaillie Tetrao urogallus) through which they tried to persuade the inhabitants to vote against Natura 2000. At present, the conflict is ceased and the Natura 2000 sites remain, but what is worth to be mentioned, problems of the perception of this new type of protected areas by local communities are much broader and still actual (GRODZIŃSKA-JURCZAK & CENT 2011) as well as discussed not only in the Polish context (HIEDANPÄÄ 2002; HIRSCHNITZ-GARBERS & STOLL-KLEEMANN 2011).

Finally, tensions around the protected sites in the area of interest result from quite a constant pressure on developing tourism, recreation and sports infrastructure in order to attract more visitors. Conflicts between nature conservation and tourism are obviously very common around the world (see for instance Nolte 2007 for case studies from the Poland's and Ukraine's neighbor - Slovakia). Many mountain communities see such direction as natural and even the only possible path of economic grow, and the interviews conducted within this research confirmed this. The pressure on creating ski resorts and extending ski infrastructure is especially rising. Our Ukrainian example - the Chornohora range – is until current times free from large-scale ski infrastructure. To some extent, this is surely caused by the presence of the protected areas described in this study. But at the same time, this could be simply a result of weak accessibility of this mountain range especially because of the bad quality (or lack) of roads. In the recent years two large, modern ski resorts – Bukovel and Dragobrat - emerged in its very neighborhood, raising questions about the future of the highest Ukrainian mountain range, too. In Poland, disputes around ski infrastructure in the TNP return regularly, e.g. in 2007 when the existing cable car to Kasprowy Wierch was modernized. In contrast, the BGNP is until now free from cable cars and ski lifts. However, plans of the construction a chairlift reaching the main range of Babia Góra (in the core zone of the Biosphere Reserve) still remain in the official strategy of development the Zawoja commune (Strategia…), marking a moot point in the park - local community relationships.

Conclusion

In conclusion, we can state that in both countries mountain protected areas face challenges that are to some extent similar. They include: adaptation of international standards to a complex local reality, problems with finding a right place for the traditional (especially pastoral) activities and balance between the human activity and biodiversity maintenance, high (or rising) number of visitors, pressure on extending sports and recreational infrastructure. These challenges sometimes lead to conflicts which are harder to resolve when the memory of a previously experienced injustice (e.g. related with inadequate or lack of compensations for land as well as limitations that the protected area imposed) remains in their background. Such feelings are (potentially) much stronger in Ukraine, where people faced collectivization of land. Also finding an adequate, both 'nature-friendly' and 'human-friendly' way of managing the rising amount of tourists seems to be ahead of the Ukrainan side, especially CNNP. On the other hand, Ukrainian cases discussed here have at least two advantages comparing to the Polish ones:

1) they do not overlap with other types of large protected areas so therefore can more freely follow their main goals and tasks (provided that they cooperate with each other when it comes to the strategy for the Chornohora range where they border)
2) having a shorter protection history they can still take advantage of good practices and experiences from the Western countries and not to repeat some mistakes like the prohibition of grazing in the semi-natural meadows (and by so to maintain both their environmental and cultural values).

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Density estimations of Eurasian lynx (*Lynx lynx*) from long term camera trap data in the Bohemian Forest Ecosystem

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Keywords

Lynx lynx, monitoring design, camera trap, spatial capture-recapture (SECR), desity estimation

Abstract

Protected areas have to fulfil monitoring standards for conservation status of listed species such as the Eurasian lynx (Annex II, Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora). This data outcome is the basis for national management decisions. Camera traps have been successfully used for population estimates of individually recognisable felids like lynx, thus making themideal candidates for capture-recapture surveys. We first aim to optimize the study design; therefore we focus on finding the adequate session lengthfor monitoring lynx in forest habitats using camera traps.The goal is to deliver a stable amount and quality of datafor robust density estimates.In a second approach, we aim to reveal lynx population density estimates out of long term camera trap dataderived from spatial explicit capture-recapture models (SECR).

We sampled data within the Bavarian forest National Park (BFNP),where we installed two opposing cameras on 60systematically selected sites in a study area of 780 km² (BFNP + Šumava National Park) during three successive winters. Additionally, 30 sites were maintained for two successive years on 240 km² (BFNP). This sampling revealed a number of at least sixteen independent lynx.

The lynx is an elusive species which is hard to monitor, makinganalysis of population dynamics and demographic parameters challenging. We calculated the demographical closure and the amount of recaptures for the adequate session length using sliding windows over the recorded time frame.

Currently SECR models have moved into focus due to their innovations of incorporating movement and supplying the effective area sampled, which offers a more preferable way for reliable density estimates. Therewith,we aim to analyse three successive winter sessions of the cross border lynx monitoring to revealdensity estimates from long term data.

The combination of standardized camera trap sessions on a regular basis and long term data, offer the information of life histories and population trends. Our results allow implications toimprove future monitoring programs and density estimates requested from protected areas and wildlife managers in Europe.

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EMaRT – possibilities for the use of innovative web technologies in monitoring of Natura 2000 territories

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Abstract

A project of two years (2010-2012) entitled "Gathering basic information on habitats and species of collaborative interest in Austria" was announced by the 9 Federal States for implementing the Flora-Fauna Habitats Directive in Austria. A WebGIS tool called EMaRT (Expert Monitoring and Reporting Tool) was developed during the project in order to support long-term monitoring. EMaRT is an open source tool which was developed with 3 main aims: 1) to update habitat and species distribution maps and to ease the monitoring process of habitats and species, 2) to merge data in a central multi-user spatial database, and 3) to support the article 17 reporting process on actual distribution and evaluation of the conservation status of species and habitats to the European Commission. Data capturing, data management, data preparation, data processing and visualisation are big challenges for the projects with multiple users and a large amount of data. We discuss suggestions to solve these challenges in this paper. Based on the habitat with the FFH-Code 7240, it is shown how innovative web technologies were used in the project to solve these challenges and how these technologies can be used to update distribution maps, monitor and report data.

Keywords

WebGIS EMaRT, FFH-Code: 7240, distribution map, monitoring article 11, article 17 reporting

Introduction

A major goal of the Flora-Fauna-Habitat Directive is to conserve and restore biodiversity. This goal should be achieved by the development of the European Natura 2000 network of protected areas. The continuous monitoring of the implementation of the FFH-Directive and the documentation of the conservation status of selected habitats and species is an important component of the directive. All Member States of the European Union have to provide the results of conservation status for the European Commission with the so-called Article 17 report every six years. For improving the knowledge about habitats and species of community interest in Austria, a project of two years (2010-2012), entitled "Gathering basic information on habitats and species of collaborative interest in Austria", was announced by the 9 Federal States. The contractors are three landscape planning companies (REVITAL Integrative Naturraumplanung GmbH, freiland Umweltconsulting ZT GmbH, eb&p Umweltbüro GmbH), Interfaculty Department of Geoinformatics (Z_GIS) of the University of Salzburg and a group of external experts. In the project, 40 selected species and habitats of the FFH-Directive have been studied and the monitoring was prepared. The list of monitored species and habitat in the project covers almost all listed priority species and habitats of Austria in annex I and II of the FFH-Directive and all habitat types and species of community interest in annex I, II and IV, whose status was classified as unknown in the national report 2007 for Austria. For these species and habitats, distribution maps were updated during the project by using existing data and extensive field surveys. The future monitoring for these species and habitats of community interest was prepared according to article 11 of FFH-Directive. A description of the article 11 monitoring in Austria can be found in MOSER & ELLMAUER 2009.

For central and efficient data management of species and habitat in Austria, an open source WebGIS tool called EMaRT (Expert Monitoring and Reporting Tool) was developed during the project. EMaRT is an open source tool which was developed with 3 main aims: 1) to update habitat and species distribution maps and to ease the monitoring process of habitats and species, 2) to merge data in a central multi-user spatial database, and 3) to support the article 17 reporting process on actual distribution of data and maps of species and habitats to the European Commission. A description of the article 17 reporting can be found in European Commission 2013.

Nature conservation projects that manage a large amount of data and involve a lot of experts are challenging. Challenges can be found mainly in data capturing, data management, data preparation, analysis and visualisation (WEINKE & RAGGER 2012). We discuss suggestions to solve these challenges in this paper. Based on the habitat with the FFH-Code 7240, it is shown how innovative web technologies were used in the project to solve these challenges and how these technologies can be used to update distribution maps, monitor and report data. Discussed ideas from the project and expert workshops are presented in this paper.

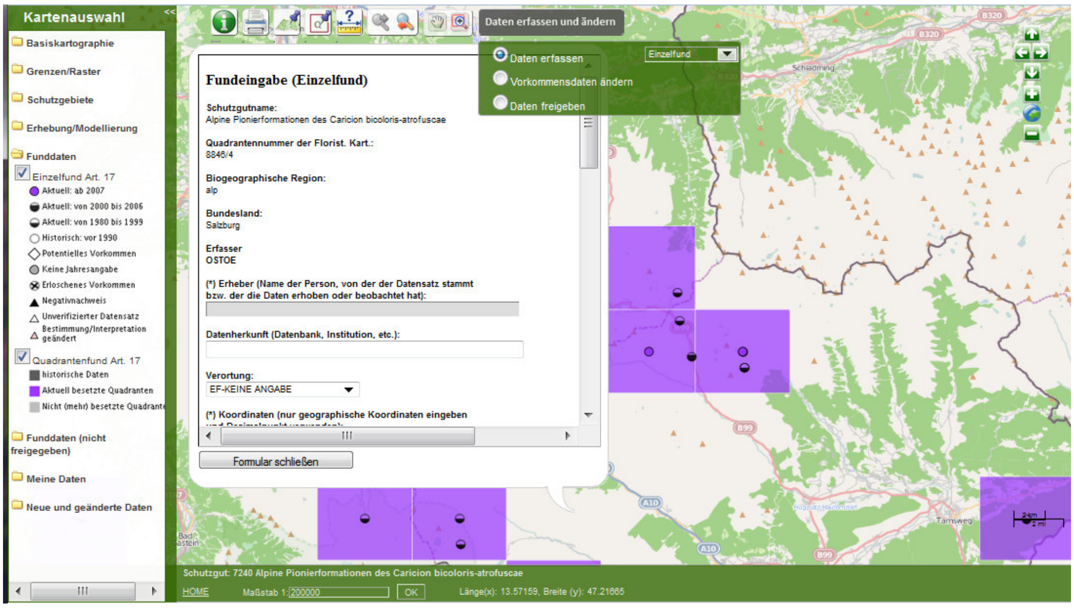

Figure 1: EMaRT-map viewer with an open online form. Single finds are visualised as points; Grid cell finds are visualised as filled quadrants;

Challenges

Challenges of managing a large amount of data and include multi users can be found mainly in visualisation, data capturing, data management, data preparation and analysis. These topics will be discussed in the following chapters.

Data visualisation

Even today in small and large nature protection projects all experts visualise data in a preferred geographic information system (GIS) on their own computer. In many cases, experts must transform data in needed coordinate systems or change data formats on their own. This fact requires at least basic knowledge in geoinformatics.

In the project a WebGIS map viewer was implemented to prepare a map viewer for specific requirements, datasets, tools and functions. The user can concentrate on data capturing and updating and do not lose time with data preparation problems etc. The map viewer can be used for four purposes 1) to get an overview of all data, 2) to prepare for mapping in terrain, 3) to get quick information of different datasets and 4) for data collection with a quality check. All habitat and species are visualised in its own map viewer. The map viewer includes general background maps and specific data of each habitat or species type. Background maps are, for example, the ÖK50, OpenStreetMap, the orthophoto service of GeoImage Austria, Nature 2000 areas, biogeographic regions and grid cells. Furthermore, specific data of each habitat (e.g. biotope mapping and modelling results for possible species distribution) are visualised in the map viewer.

Figure 1 shows the map viewer. The map viewer provides important navigation tools (e.g. Pan and Zoom), an information-button and scale tools.

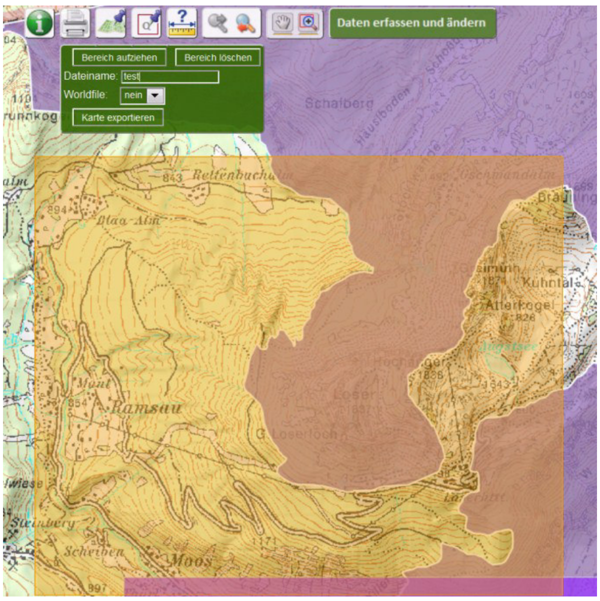

Figure 2: EMaRT Menu bar with open printing window

In addition, the viewer has a geoname search area, zoom functionality to the grid cells, a print function for fieldwork preparation, a tool to measure distances and areas and a tool for data capturing (see figure 2). For a detailed description of the data collection see chapter “Monitoring”. Furthermore, the layer of content is shown on the right side, which can be turned on and off (see figure 1 left).

Data capturing

In national and regional conservation projects large amounts of data are recorded in different data qualities, formats and projections. This leads to the fact that datasets of different projects are incompatible and only with great effort data can be merged. In the project, data was collected through the digitization of geometries in a map viewer and / or by entering different parameters in online forms. All online forms include a date quality check before saving. All spatial data were saved in the coordinate system WGS-84. In the three processing steps (starting with update of the distribution maps till monitoring and reporting), data was collected in different ways. These different types are listed in the following subchapters.

Distribution maps – Data update
The distribution map was updated based on grid cell finds and single finds. Single finds are digitized as point geometries. Single finds which do not have an exact description of their location are aggregated. Aggregated single finds are visualised as grid cells with a centroid on the map. Grid Cell finds are often results of literature search. Such finds cannot exactly be located on the map. For each find, specific parameters have to be captured with an online form in addition (see figure 1).

Monitoring (Article 11)
For the monitoring of each habitat or species, specific methods were chosen. Therefore, a method for the selection of sample areas and a specific method to monitor monitoring-sites for fieldwork were defined. Points, Lines and Polygons can be digitized and updated in the map in the monitoring process. Depending on whether it is a sample area or a monitoring-site, different parameters can be captured. After digitizing a geometry, a form appears. The user can put in parameters and upload a photo. Additionally, existing datasets (e.g. inventory of biotopes) can be visualised for the digitizing process. Existing geometries of these datasets can be accepted and attributes can be defined. Figure 3 shows a monitoring-site and a sample area of habitat 7240.

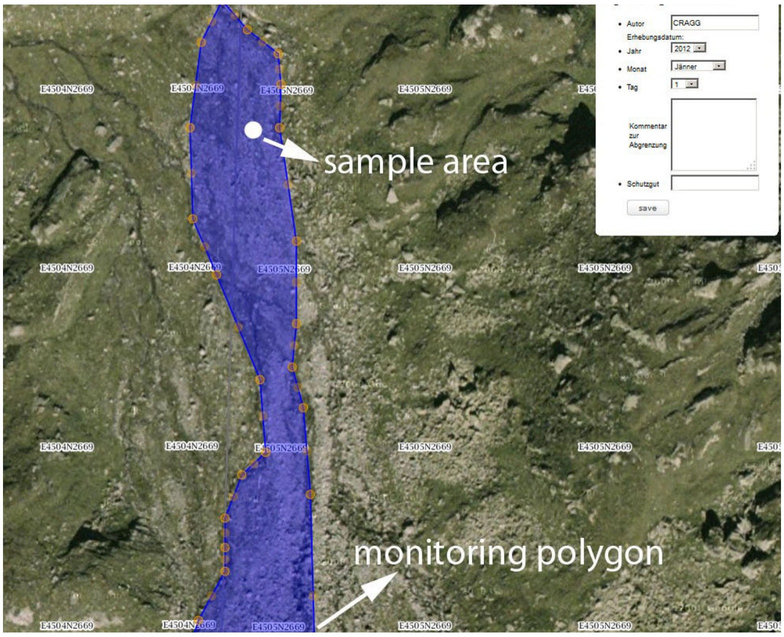

Figure 3: Visualisation of a monitoring-site and a sample area. Monitoring sites are visualised as polygons; Sample areas are visualised as points;

Reporting (Article 17)
To collect data for the reporting process a platform with online forms and data quality checks was implemented. Therefore the Access-Reporting-Tool of the European Union was implemented as web platform. In the reporting process just non-spatial data was captured. The reporting web interface contains the same parameters as the reporting tool of the EU (EIONET 2013). One advantage of the non-Access solution is that all data (monitoring and reporting data) are in the same database and queries can be easily done.

Data management

Even nowadays in nature protection projects data are usually stored and managed in various proprietary database solutions. In many cases, these are Access database solutions that do not allow central access to the current data sets. In addition in some cases, spatial and non-spatial data are managed still separately in databases. Many data are saved redundantly because of different data management solutions. Through this management of equal data in different databases a complete update of the data is nearly impossible.

In the project for data management a central, multi-user, spatial database was developed. Therefore, the data management system Postgres with its spatial extension PostGIS was used. The project is based on the monitoring concept of the Federal States and the Federal Environment Agency (see MOSER & ELLMAUER 2009). In the year 2007 the Federal Environment Agency collected data and saved these data in an Access database. All datasets of this period were incorporated in the spatial project database. During the project, the data model was changed for saving and managing data of the 3 processes: 1) updating distribution map, 2) monitoring and 3) reporting. Background data and expert data (e.g. Natura 2000 areas) were either saved in files or in the database on a server. This data can be updated by authorized users with ArcGIS using ArcSDE. Recorded data of species and habitats can be updated e.g. with online forms in the web viewer.

Data preparation

Like visualisation of spatial and non spatial data experts normally preprocess all data in a geographic information system (GIS). In many cases experts must transform data in specific coordinate systems or change data formats on their own. This process is time-consuming, costly and error-prone and experts must have some basic knowledge of geoinformatics at least e.g. to correctly process coordinate transformations.

In the project, all data that are visualised in the map viewer are prepared in a standard format. Therefore, data are provided as WMS and WFS services. Data are published with Geoserver and are centrally provided on the server. During preparation process data were projected, error-treated and transformed in defined format. Complex and large Datasets were prepared as caches and were provided with Geowebcache as tiled WMS (WEINKE et al. 2012).

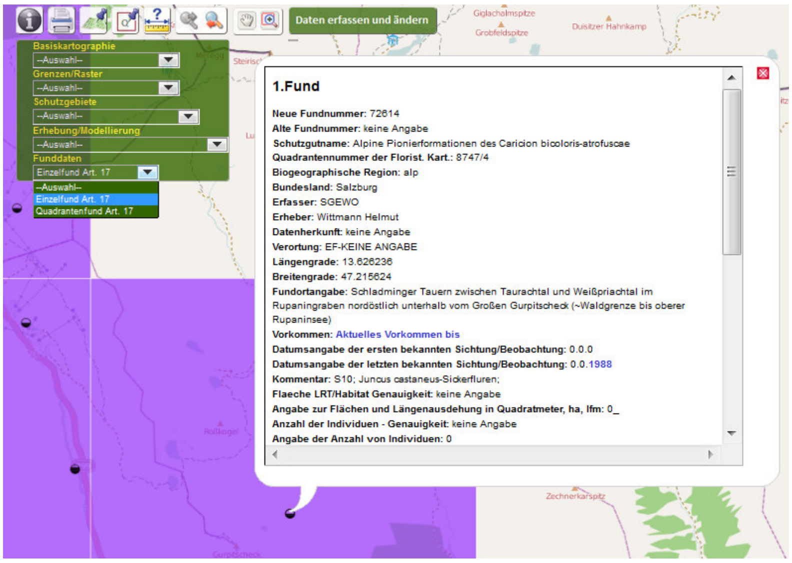

Figure 4: Information query of single find

Queries, data interpretation and data analysis

Usually the analysis of data sets is also carried out by each expert on its data resources on the local computer. Due to the single-user applications, the individual experts do not have the current datasets for data analysis. In EMaRT there are different possibilities to query data.

With the information button in the map viewer, the user gets current information of each dataset (see figure 4). All relevant information of the habitats and species (finding and distribution maps) can be exported and visualised via the web interface of EMaRT. Different criteria can be defined for the data queries and export. In addition, there is the possibility to export distribution maps in a PGN format (see figure 5). Reporting data can be exported in xml or html-format.

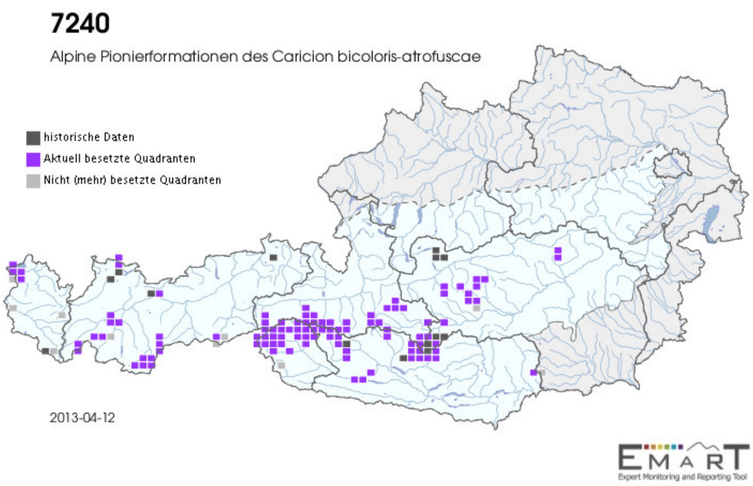

Figure 5: PNG-Export of distribution map of habitat 7240

Discussion

By visualising the entire data in a WebGIS map viewer, the entire database and actual data is available for each user. In the project, all data were prepared in a standard format by one project partner. Data were provided as Web map services. This saved a lot of time and costs in the data processing. All recorded datasets were saved centrally in a database; consequently, each expert has an overview of all data and actual recorded data of other experts. As a consequence, there was no danger that redundant data were stored. Data sets like Natura 2000 sites can be updated centrally. As a consequence, all experts and users can use the updated datasets after the modifying process. Another advantage of EMaRT is the multi-user access. All project partners and experts can use and collect data at the same time and have access to the latest distribution maps. Through online forms, a quality check of inserted data is possible to just allow accepted data and mandatory fields of the forms have to be filled out.

Conclusion

In this paper, we introduced the open source tool EMaRT. EMaRT was developed within a two-year national Austrian project and enables data collection, monitoring and reporting of protected habitat types and species in Austria. EMaRT allows managing a large amount of data in a central database and can be used from several users parallel. Because of the use of innovative web technologies, data visualisation, data capturing, data management and data analysis are not a big challenge in the EMaRT system. EMaRT enables an improvement of data quality because of quality checks of recorded spatial and non-spatial data. Data in EMaRT are centrally managed on a server; therefore, EMaRT provides improved availability and up-to-date datasets. In EMaRT, every user can see all data; therefore, the system has a high degree of data transparency. Through the use of EMaRT, the costs can be minimized because EMaRT e.g. provides a central data preparation and data availability, a central platform to capture data with quality check and each user can prepare its own printing maps.

A disadvantage of the online web platform is that users need to have internet access to capture data. In alpine and mountain areas, data recording is not possible. As a conclusion, the web viewer can be used to get an overview of distribution maps, for data preparation for field work and can be used to capture data if internet is provided. A combination of an online and offline mobile app would allow experts to capture data also in offline modus and synchronize data if internet is provided. EMaRT can be extended easily to other protected habitats and species. Also the number of parameters can be extended to record habitats and species with other requirements. In general a web tool like EMaRT could ease and improve the process of monitoring and conservation of habitats and species inside of Nature 2000 sites. An important fact is, that for nature protection, standards should be defined to ensure data quality and to enable rapid linking of databases of different projects. The availability of a central platform could help to standardise data capturing in the future for national and regional projects.

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The influence of tree species, stratum and forest management – a case study from the Schwäbische Alb

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Keywords

deadwood enrichment , guild composition, vertical stratification

Introduction

The Biodiversity Exploratory Project (www.bioexploratories.de) investigates the relationship between biodiversity and ecosystem functioning on scales ranging from enzymes to species communities. The project has been established in three areas in Germany comprising the biosphere reserves Schwäbische Alb, Chorin Schorfheide, and the Hainich National Park. The initial focus is how biodiversity, ecosystem function and land use mutually influence each other. In our research we use saproxylic beetles as a model system. Dead wood has become a rare resource in managed forests (BIOBEC 2002) As a consequence the diversity within feeding guilds of saproxylic species (e.g. xylophages, mycetophages and predators) has decreased greatly. This loss of species is expected to also influence ecosystem function for example by lower rates of wood decomposition (JACTEL et al. 2009) or by less control of potential pest species. We initiated a comprehensive field experiment by accumulating large amounts of freshly cut deadwood in the canopy of *Fagus sylvatica*, *Picea abies* and *Pinus sylvestris* trees to directly investigate the importance of deadwood. We also accumulated deadwood on the ground beneath the study trees for comparison. Our research aims at disentangling the importance of the environmental factors tree species, stratum (canopy-ground), season and deadwood quality (measured by wood of different diameter) and forest management on the community composition of saproxylic beetles

Methodical approach

Deadwood was installed in the canopy by using an elevation platform. Attracted species were sampled by Flight Interception Traps (FITs) which were installed in front of the artificially deadwood enrichments. In all study trees we installed three bundles of deadwood of different diameter: 0 – 5cm; 6 – 10cm; 11 – 20cm. In total 20 trees per research area, representing different management types were selected for the deadwood enrichment experiments in the canopy. The same set-up was used for the ground deadwood. All FITs were were emptied monthly from May to October in 2009. Beetles were sorted and identified to species.

Results

The results derived from saproxylic beetles suggest substantial complementarity (in respect to species diversity, assemblage composition, guild composition) between tree species as well as between canopy-ground assemblages. Furthermore, there is evidence that forest management influence distribution patterns of individual beetle species. However, there was no influence of forest management on guild composition, neither did we find that deadwood size was of importance.

Conclusion

Our deadwood enrichment experiment confirms the importance of freshly cut deadwood for beetle diversity adding evidence that this resource is limited in managed forests in Germany. Differences between the factors tree species, forest strata and season were evident, while wood size did not significantly influence assemblages.

Differences in guild composition are attributed to differences in micro climate conditions (VODKA et al. 2009). In contrast evidence of forest management was less clear. Whether deadwood also affects guild composition is subject of future studies which will also analyze how beetle-assemblage diversity and composition change during the process of wood decay over several years.

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Formation of glacial lakes - a recent dynamic process in the Hohe Tauern National Park

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Abstract

Due to climate change in high alpine environments, the surface-topography in the vicinity of glaciers changes very rapidly and in the case where glaciers expose natural basins after their retreat, "new" glacial lakes emerge.

These dynamic processes are quite obvious in the Hohe Tauern Mountain Range, especially in the Stubach Valley and the Obersulzbach Valley, both situated in the Salzburgian part of the Hohe Tauern National Park.

Two proglacial lakes, Unterer Eisboden See and Obersulzbach See, have consequently been monitored by the Hydrological Service of Salzburg in cooperation with Salzburg University, Department of Geography & Geology since the early 90s.

Modern and classical methods e.g. multi-temporal (aerial) photography, orthophoto interpretation, repeated terrestrial laser-scanning, ground penetration radar as well as bathymetry were used in an interdisciplinary approach to document the development of the lakes in front of the termini of Stubacher Sonnblickkees and Obersulzbachkees.

Additionally, parameters like precipitation, temperature, water level, discharge and conductivity were registered in order to analyze the dominant on-going processes in the water cycle. Regular daily water level fluctuations and even a glacial lake outburst flood (GLOF) in July 2006 were monitored at Unterer Eisboden See.

In order to calculate suspended and solute sediment fluxes at Obersulzbach See, gauging stations to measure sediment concentrations and turbidity were also installed.

As both lakes also represent the development of new ecosystems, hydrobiological probing and monitoring were also started.

In order to estimate the maximum possible extension of the two pro glacial lakes, ground radar measurements were carried out and surface models were combined with bathymetry.

This interdisciplinary work on both the above mentioned lakes offers various possibilities to understand dynamic processes (e.g. the influence on the downstream hydrological and geomorphological system due to discharge modifications, suspended sediment trapping, decoupling effects and long term sediment storage) in protected areas under global change conditions.

Keywords

Proglacial, lake, climate change, discharge, sedimentation, Hohe Tauern, glacier

Introduction and aim

One of the main tasks of the Hydrological Service, which was founded in 1893, is to monitor and to analyse various components of the water cycle, including glaciers and lakes in high alpine regions.

In the Salzburgian part of the National Park Hohe Tauern a total of 191 lakes of various sizes (max. 270 ha) and depth (max. 56, 8 m) were identified and mapped. Approx. 50 % of these lakes are situated between 2,200 and 2,500 m above sea level, and only 11 are situated above 2,600 m a.s.l. Since the middle of the 19^{th} century 37 new lakes have emerged where glaciers exposed natural basins after their retreat (SEITLINGER 1999).

However, opposite developments have been observed too, e.g. at Keesboden in the Obersulzbach Valley, where a shallow lake, discovered in 1880, disappeared in 1897 (RICHTER 1888, RUDEL 1911). More recently "Eissee", situated near to Hochfilleck (2,943 m) in Stubachtal, which has existed at least since the end of the 50s (SLUPETZKY 1997c), disappeared in very recent time (2012).

These on-going dynamic processes in the Stubach Valley and the Obersulzbach Valley have been monitored by the Hydrological Service of Salzburg in cooperation with Salzburg University, Department of Geography & Geology since the early 90s. (SLUPETZKY 1997a, 1997b, 1998, 2007; WIESENEGGER & SLUPETZKY 2009).

As new proglacial lakes have a great influence on the downstream hydrological and geomorphological system, due to discharge modifications, decoupling effects, sediment trapping and long term sediment storage, Unterer Eisboden See and Obersulzbach See have been investigated in order to monitor the proglacial lake development, to analyze associated impacts on the hydrological and geomorphological system (mainly Obersulzbach See) and to predict potential future developments (mainly Unterer Eisboden See).

Study sites

Obersulzbach Valley, situated in the south-west of the Province of Salzburg in the National Park Hohe Tauern, is drained by Obersulzbach, a north-facing tributary to the River Salzach. In this valley 11 lakes of various sizes are to be found within the limits of National Park Hohe Tauern (SEITLINGER 1999) and *Obersulzbach See* (Fig. 1 Map C), first described and named by H. Slupetzky in 1989, is located in the uppermost part of the Obersulzbach Valley. Around 60 % (2009) of the lake's total catchment (17.8 km²), which ranges from 2,200 to 3,662 m.a.s.l, are covered by glaciers (WIESENEGGER 2013).

Stubach Valley is also located in the south-west of the Province of Salzburg and altogether 21 lakes are situated within the boundaries of National Park Hohe Tauern (SEITLINGER 1999). The first signs of this new proglacial lake*Unterer Eisboden See* (Fig. 1 Map D), situated in the surroundings of Stubacher Sonnblickkees, were recognizable in 1987 and in 1990 it was surveyed by M. Kiskemper, Neubrandenburg and outlined on the map "Granatspitze" scale 1 : 5000 (SLUPETZKY 1997). Around 70 % (2009) of the lake's total catchment (1. 66 km²), which ranges from 2,500 to 3,088 m.a.s.l, are covered by glaciers (WIESENEGGER & SLUPETZKY 2009).

Methods

In order to monitor and analyze the ongoing processes at Unterer Eisboden See and Obersulzbach See, the following modern and classical methods were used:

- Multi-temporal (aerial) photography and orthophoto interpretation to map the spatio-temporal evolution of lakes following glacial retreat
- Geodetic survey to determine lake surface area (Unterer Eisboden See 1994)
- Repeated terrestrial laser-scanning (Obersulzbachkees since 2001, Stubacher Sonnblickkees since 2003) to quantify changes of the shore line as well as changes of other parameters (surface area).The spatial pattern of the retreat and the subsequent development of the lake were documented by means of terrestrial laser scanning and high resolutions DEMs were calculated.
- Repeated GPS surveys of the terminus of Stubacher Sonnblickkees and the shoreline of Unterer Eisboden See
- Measurement of yearly length variations of the glaciers within the long range program of the Austrian Alpine Club (ÖAV)
- Simple bathymetry by means of a perpendicular (Eisbodensee 1998)
- Bathymetry (echo sounding) using dGPS (Trimble Pathfinder ProXH) and echo-sounders (Furuno 4600) mounted on an inflatable boat to determine the max. lake-depth as well as the underwater geometry (Obersulzbach See 2009) and bathymetry combined with terrestrial laser scanning (Unterer Eisbodensee 2010)
- Subglacial DEMs based on ground penetrating radar measurements of Stubacher Sonnblickkees, terrestrial laser scans of the lake's shoreline and level as well as bathymetry carried out in 2010 in order to model the potential maximum lake surface
- Ground penetrating radar (GPR) to estimate sediment storage within the lakes, identify bedrock and thickness of glaciers (subglacial surface DEMs)
- Water temperature, water level and discharge registration at automatic gauging stations in order to analyze hydrological behavior of the lakes.
- Installation of a new automatic gauging station (named "Türkische Zeltstadt") at the outlet of Obersulzbach See, registering water level, water temperature and conductivity by the Hydrological Service in June 2009 in order to complement the already existing gauge "Kees" further downstream
- Hydrological sampling to assess sediment yields and synchronous sampling of sediment entering and leaving the lake. Suspended and solute sediment fluxes from the proglacial zone of the retreating Obersulzbachkees were quantified within a 20 month monitoring period (Jan 2010 to Sept 2011)
- Hydrobiological sampling to assess biocenosis and ecosystem development (currently only at Unterer Eisboden See)

Results

<u>Obersulzbach See</u>

Since the late 1980's ,due to the continuous retreat of Obersulzbachkees, which has receded more than 1,5 km in the last 60 years, a large and glacial over deepened bedrock basin has been exposed (GEILHAUSEN et al. 2012).

A shallow lake was first observed in 1989 at the glacier snout. The following lake development was heterogeneous, due to irregular retreat and downwaisting of the tongue of Obersulzbachkees (Fig 2) but the position of the lake's outflow remained constant.

A comparison of terrestrial laser scans shows that between 2009 and 2011 the surface area of the lake still increased in size (approx. 22,930 m²), mainly due to further glacial retreat at its southern end.

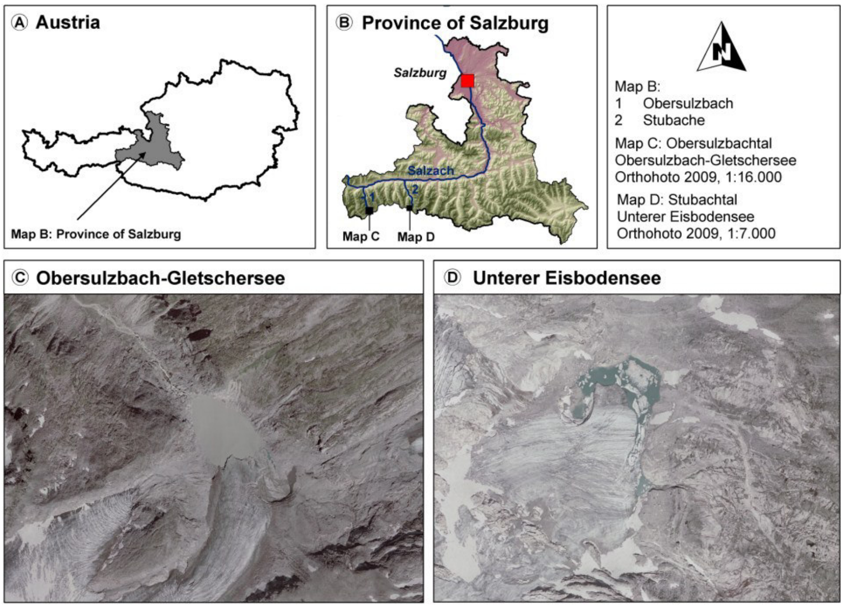

Figure 1: Location of the study sites

By means of the above mentioned methods, a maximum depth of 42 m and a volume of more than 2 Mio. m³as well as a surface area of approx. 95,000 m² were recorded. Other characteristic figures were: Max. length 460 m, max. width 295 m, mean depth 22 m, rel. depth (max. depth to mean diameter ratio) 12 (figures >4 indicate small deep lakes).

Below the water line the lake is characterized by steep slope gradients up to a depth of 30 m which then become less steep. Two flat basins, separated by a distinct ridge of 6 – 7 m in height, form the lake floor (KUM 2010).

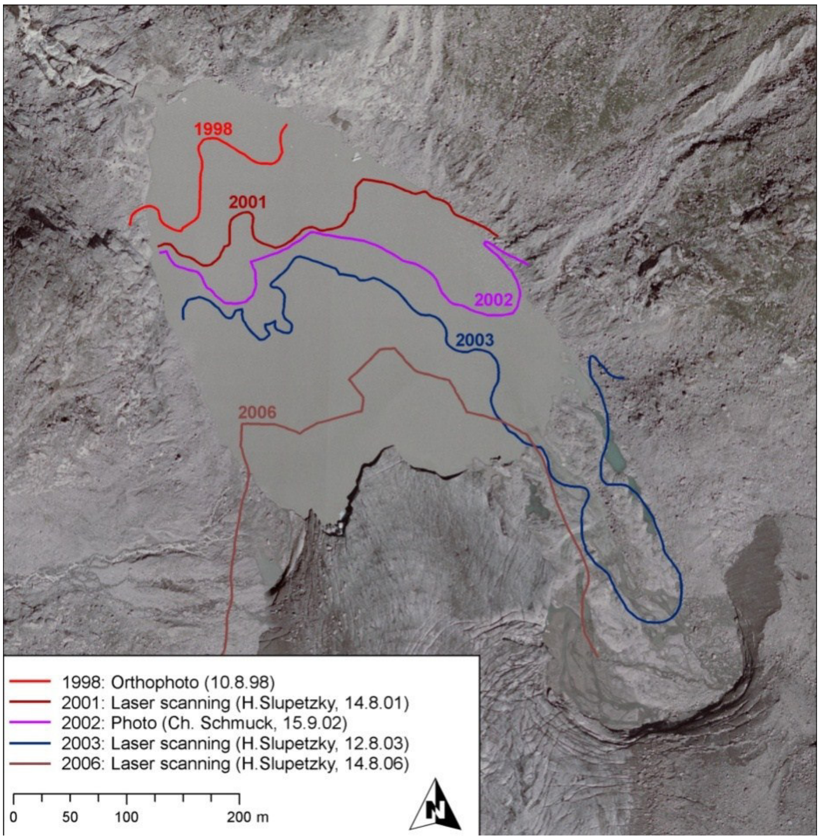

Figure 2: Glacier termini of the Obersulzbachkees, base map: orthophoto 2009

Figure 3: Bathymetry survey, Obersulzbach See July 2009, view to south.

GPR survey and lake floor morphology indicated that sediment storage in the lake is possible. The 20 month sediment monitoring showed that Obersulzbach See decouples coarse sediment transport and reduces the connectivity between glacial sediment production and downstream sediment fluxes. It diminishes suspended sediment concentrations (SSC) up to 88-95 %, prevents considerable decrease of SSCs at very low discharge and can shift its function within the suspended sediment cascade from a sink to a temporal source due to rain fall induced hill slope sediment supply (GEILHAUSEN et al. 2012a).

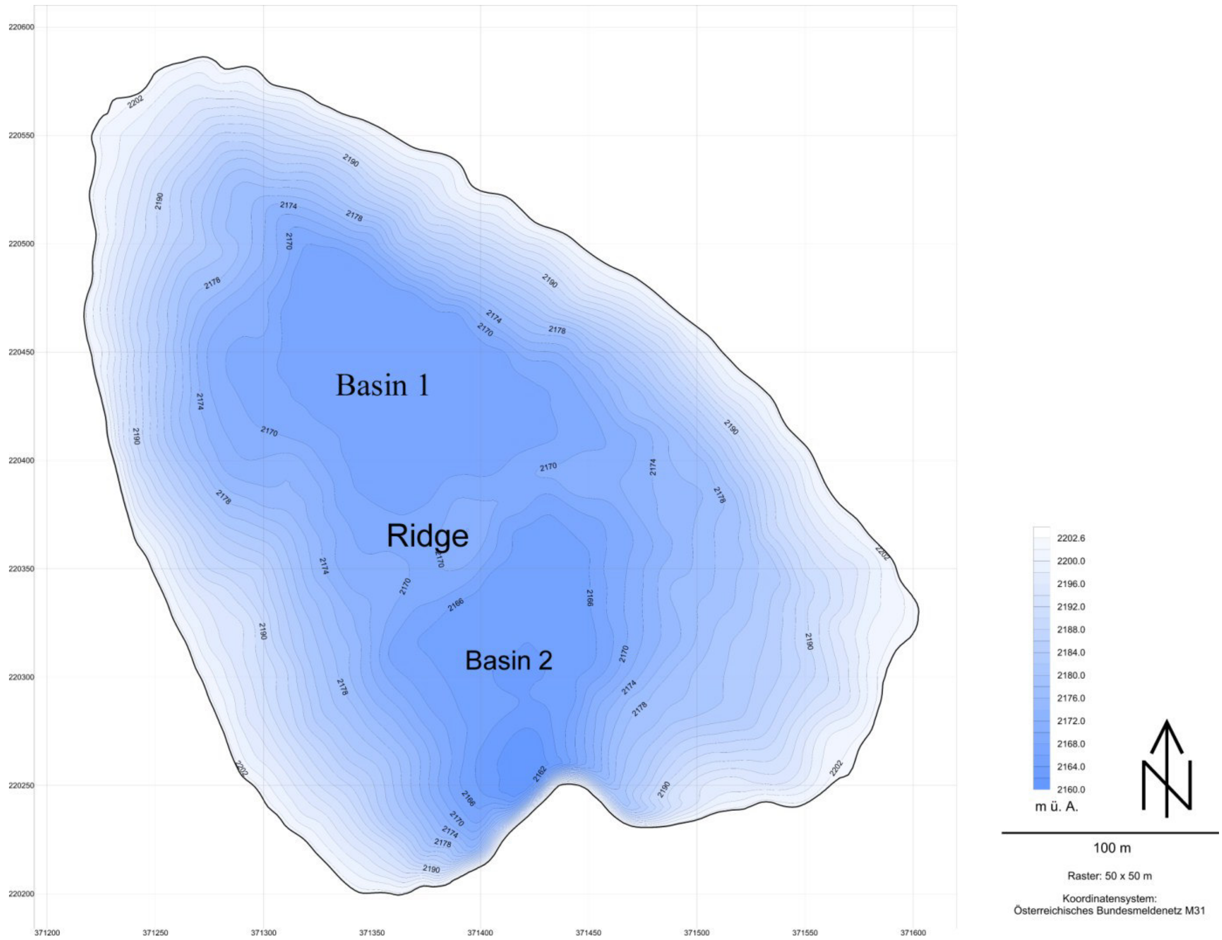

Figure 4: Bathymetry map of Obersulzbach See

Unterer Eisboden See

Due to glacial retreat, Unterer Eisboden See continuously increased its size during the following years (Fig. 5). The hydrological system of the lake was rather complex, in summer the water level was situated at 2,499 m a.s.l and the lake was mainly drained by its eastern outlet "Eislbach", which functioned like an overspill. In autumn and winter, due to reduced meltwater intake from the glacier, the lake was mainly drained subglacially. Its level was lowered and "Keesbach", situated at its southern end and approx. 6 m lower than Eislbach, functioned as the main outflow during this period.

In July 2006 a glacier outburst flood (GLOF), releasing approx. 100,000 m³ within 3 days, was monitored. The outlet shifted subglacial to its present position and the water level of the lake dropped approx. 6 m (WIESENEGGER & SLUPETZKY 2009).

Results of the 2010 bathymetry, which was carried out to the order of the Hydro-logical service, showed a maximum depth of 20,3 m, mean depth 4,5 m, rel. depth (max. depth to mean diameter ratio) 10,2 (figures >4 indicate small deep lakes), a volume of approx. 140,000 m³ and a surface area of approx. 31,000 m².

Below the water line the lake is characterized by steep slope gradients in the narrow southern part, whilst at the northern end slope gradients are very moderate (KUM 2011).

Table 1: Temporal development of characteristic figures of Unterer Eisboden See

	1994	1998	2003	2005	2008	2010
max. length [m]	80	132	200	200		370
max. width [m]	30	62	112	125	90	206
area in ha	0,470	0,627	1,417	1,90	2,0	3,10
max. depth [m]		7,8				20,3
volume [m³]		12,340				138,550

A comparison of terrestrial laser scans shows that between 2010 and 2011 the surface area of Unterer Eisboden See still increased in size (approx. 8,000 m²) and its shoreline (approx. 35 % consists of ice) became 100 m longer.

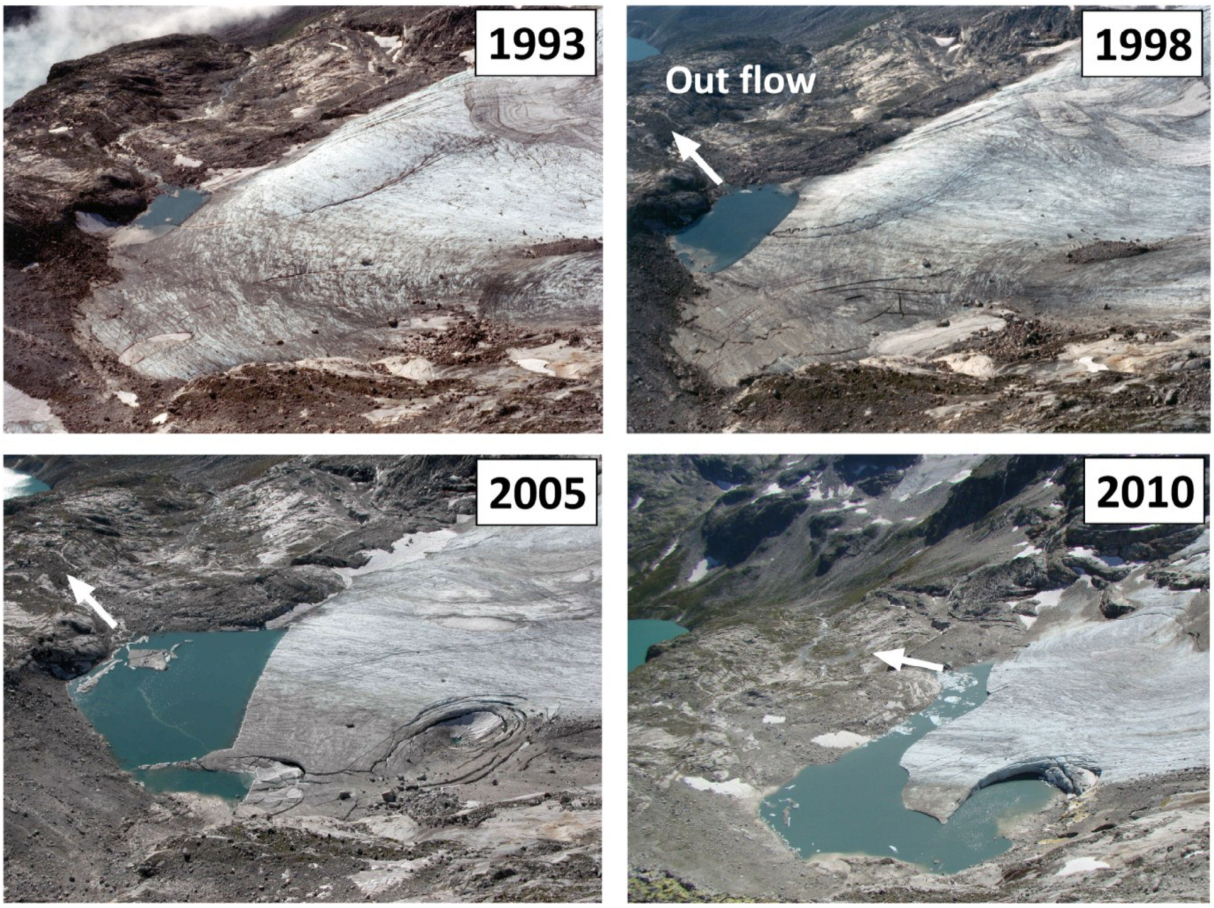

Figure 5: Spatio-temporal evolution of Unterer Eisboden See within the proglacial zone of the Stubacher Sonnblickkees (view to south-east). Note the shift in the outflow location between 2005 and 2010

In order to estimate the maximum potential lake surface area (Tab.2), two models, based on subglacial DEMs (Fig. 6) interpolated from GPR data and bathymetry, were used (GEILHAUSEN 2011).

Table 2: Possible future development of Unterer Eisboden See

Parameter	2010	Bedrock model	Sediment model
max. shoreline [m]	**1,362**	**1,480** (+111/-45)	**1,495** /+7/-5)
max. area [m²]	**31,050**	**74,790** (+644/-991)	**71,730** (+802/-824)
max. depth [m]	**20,3**	**22,3** (+/-0,4)	**22,3** (+/-0,4)
max. volume [m³]	**138,550**	**533,900** (+3920/-7735)	**497,130** (+5510/-5760)

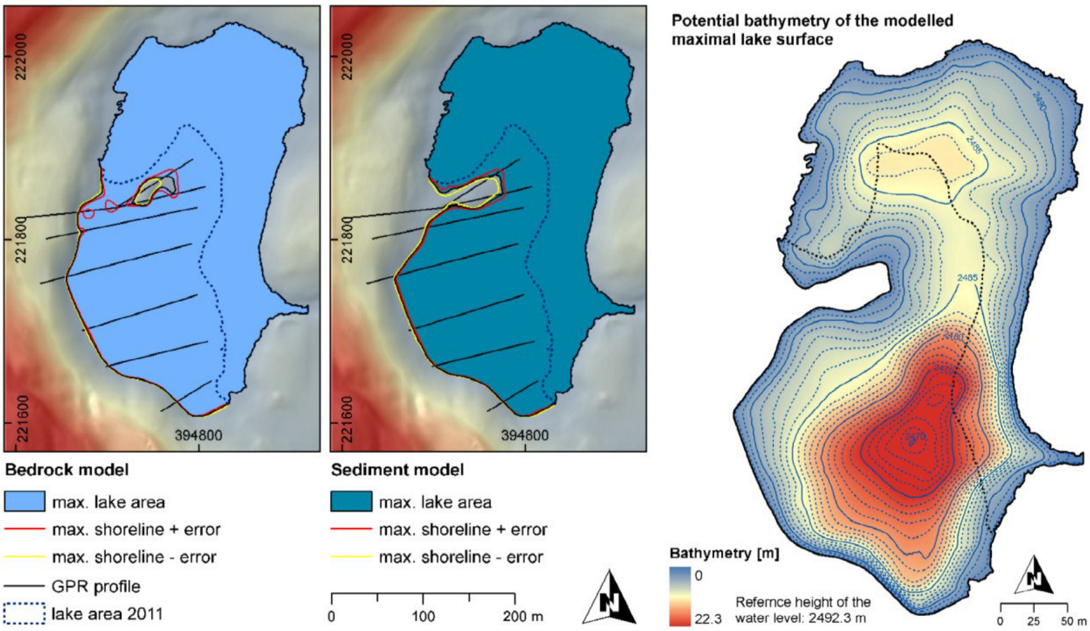

Figure 6: maximum potential lake area based on subglacial DEMs interpolated from GPR data and bathymetry.

Conclusion and perspectives

Obersulzbach See

At the moment, it is not clear whether Obersulzbach See has already reached its maximum size. On the one hand glacial outwash sands propagate into the lake and lake aggradation seems to be taking place, but on the other hand, the glacier is still retreating at the south end of the lake. Therefore, GPR measurements combined with high resolution terrestrial laser scanning are intended to clarify the course of the bedrock below the terminus of Obersulzbachkees, thus enabling an estimation of the possible maximum size of Obersulzbach See.

The monitoring of water temperature, conductivity, water level and discharge registration in order to analyze changes in the hydrological behavior of Obersulzbach See will be prolonged and hydrobiologicalmonitoring to assess the development of Obersulzbach See is planned.

At present, Obersulzbach See significantly reduces the connectivity between glacial sediment production and downstream sediment fluxes. The lake will be filled at least partly by sediments in the next decadesthereby changing its function in the sediment cascade from a sink to sediment storage with passage. In order to assess its potential trap efficiency on suspended sediments as well as to estimate the future development of the storage capacity, a two dimensional turbidity and velocity model, using on- site measurements along defined profiles in Obersulzbachsee, are intended. Furthermore, repeated bathymetry surveys in the near future are planned.

Unterer Eisboden See

Unterer Eisboden See showed interesting hydrological behavior and it took some time to understand the ongoing processes (sublacial drainage, shift of outlets, glacier outburst flood, rhythmical water level changes etc.).

The lake has achieved its permanent outlet situation and water level at 2,493 m a.s.l but it has not yet reached its potential maximum size. Model results show, that the lake could develop a max. area up to double the present size and contain 3 times as much water than at the moment. At present, the glacier is retreating at the south end of the lake but as GPR measurements show, there is still up to 35 m of ice which will be diminished by melting or calving in a view years.

The hydrological monitoring in order to analyze changes in the lake's behavior will be prolonged and hydrobiological monitoring and sampling will be repeated.

Unterer Eisboden See acts as a sediment trap and reduces the connectivity between glacial sediment production and downstream sediment fluxes. The volume of the lake will gradually be reduced by sediments in the next decades, but due to the Gneis bedrock and the morphology of the catchment, not as much as at Obersulzbach See. Repeated bathymetry surveys in the near future are planned to check this process.

Proglacial lake development

It is generally assumed that climate change and accelerated glacier melt will raise sediment discharge from proglacial zones. In the light of our findings, we address the topographic consequences of climate change with basin exposure and proglacial lake formation in expanding proglacial zones. A number of proglacial lakes have formed during the 20th century as a result of glacial retreat.

We, therefore, hypothesize an increasing likelihood that natural bedrock basins, capable of forming proglacial lakes, will be exposed in the Hohe Tauern National Park in the near future because many glaciers have receded in convergence zones of combining ice flows from multiple directions where glacier-bed over deepening is quite common.

As sediment load is both supply and hydraulically controlled and as such a sensitive parameter of environmental change, this raises the question of how the proglacial zone will take control on sediment yields if sediment production sites will be disconnected from the sediment transfer system. Scenarios of future sediment flux from any proglacial zone would depend critically on the potential development of a proglacial lake.

GIS based modelling of the subglacial topography in the Austrian Alps is subject to recent research and the National Park Hohe Tauern is certainly a point of interest.

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Remote sensing signals of erosion and plant diversity in the Kazbegi national park region (Greater Caucasus, Georgia)

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Keywords

multispectral, hyperspectral, field spectrometer, overgrazing, vegetation

Abstract

In the Greater Caucasus alpinegrasslands have been used as pastures and meadows for centuries.An increasing demand for pasture land has supported clear-cuts and gradually lowered the tree line (NAKHUTSRISHVILI et al. 2006). In the subalpine zone most forestswere replaced by agricultural ecosystems. Over the centuries the grazing management created heterogeneous landscapes with high plant diversity. During Soviet period intensive sheep husbandry had a long lasting effect to some sensitive mountain areas. High grazing intensitydamaged the vegetation cover and its root soil system. On steep slopes the overgrazing had strong negative impacts on soil stability (DIDEBULIDZE & PLACHTER 2002). Today's vast erosion gullies originate from smaller damage spots during that period (KÖRNER 1980).

As a former country of the Soviet Union, Georgia has experienced an immense transformation since the restoration of national independence in 1991 (DIDEBULIDZE & URUSHADZE 2009). Structural and societal changes have resulted in a transformation of the agricultural system and Georgian land use (VOLZ et al. 2011). Since 1991 the loss of cheap energy supply from the Soviet Union is substituted by illegal logging (FUCHS et al. 2010). Clearance of protective forests increases the risk of mass wasting events. Climate change has an increasing effect on temperature and precipitation in Georgian mountain ecosystems (FAO 2009). Heavy rainfall events and snow meltingenlarge gully erosions in the Kazbegi area (CAPREZ et al. 2011). These facts indicate continuation of erosion processes.

The Caucasus is among our planet's biologically most diverse and endangered ecoregions (MYERS et al. 2000). In the Greater Caucasus land degradation is considered as one of the main threats to plant diversity (NAKHUTSRISHVILI et al. 2009). Species loss is most evident at erosion edges with only about four species (Caprez et al. 2011), whereas up to 47 plant species per 25 square metre may occur in nearby grasslands (NAKHUTSRISHVILI et al. 2006).National and international policy and scientists have set up plans to protect the region's biodiversity (CEPF 2004, NBSAP 2005, SPEHN et al 2010). Within this process, a red list assessment stated 60 % of the 2,950 Caucasian endemic taxa as being threatened (SCHATZ et al. 2009).

Mt. Kazbek (5043 m/16,541 ft.) is situated in the northern part of the Greater Caucasus, close to the Russian border.Kazbegi national park ranges from 1,400m up to 4,100m a.s.l. (Agency of protected areas 2013). Within the Kazbegi regionsome villages are highly exposed to the risk of eroded slopes. Our area of interest is located on the north facing slopes next to Mleta. This village has already experienced severe events of land degradation. Sample plots are located within a 10km² area which is composed of a homogenous geological layer of slate.

This study investigates the impact of erosion events on plant diversity in the Greater Caucasus with the use of remote sensing techniques. Remote sensing methods provide suitable techniques for inaccessible mountainous terrain. We aim to test relationships between plant diversity, nutrient availability, vegetation cover and canopy reflectance.Canopy reflectance can be used to determine floristic gradients in grasslands (SCHMIDTLEIN & SASSIN 2004).

In summer 2012, 50 plots were sampled with a handheld field spectrometer. Data was collected along gradients of land degradation and inclination. With a subset of three subplots we were able to define inner plot variation. Hyperspectral data will be related to vegetation data. The results can be of use for an early detection of erosion events via hyperspectral remote sensing. Soil samples were collected for further chemical analyses.

In summer 2013, more vegetation data will be collected from different stages of land degradation. Field data will be related to multispectral data of satellite images. Analyses to map fields of different plant diversity follow work done by FEILHAUER & SCHMIDTLEIN (2009).

Former Soviet Union countries like Georgia or eastern European countries have experienced tremendous transformations. To protect natural dynamic functions and diversity, research between environmental and

societal processes is necessary (WALDHARDT et al. 2011). In 2010 the interdisciplinary research project AMIES (Analysing Multiple Interrelationships between Environmental and Societal Processes in Mountainous Regions in Georgia) started at the University of Giessen. That project is studying the interrelationships between changes in land use, life quality, climate, erosion and biodiversity for the Kazbegi region. Further information available on http://www.amies-net.org

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Effects of spruce bark beetle calamities on the faunistic biodiversity of mountain forests in the Alpine Berchtesgaden National Park

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Keywords

Natural disturbances, *Ips typographus L.*, Arthropoda, forest succession, conservation

Abstract

The European spruce bark beetle *Ips typographus* L. (Coleoptera, Scolytinae) is an important element of spruce forest ecosystems and one of the most destructive pests affecting Norway spruce (*Picea abies* (L.) Karst). Forest management has been aiming to eliminate natural disturbance dynamics in anthropogenically altered forest ecosystems over the last centuries. However, natural disturbances such as storm, fire and biotic impacts such as bark beetle calamities are important drivers for many ecosystem processes of European forests. Bark beetle calamities create spatial patterns in forests that alter microclimate and nutrient conditions within a short time. In addition large amounts of deadwood are produced. Changes in habitat structures are closely related to altered occurrence and abundance of forest species.

The Alpine National Park Berchtesgaden was founded in 1978. In contrast to managed forests where most often active control, salvage logging and regeneration measures are conducted during and following bark beetle calamities, no manipulation of natural forest dynamics takes place on approximately 6,000 ha of forest land in the core zone of the National Park. Although already in the early 1990s several bark beetle outbreaks occurred in the Parks forest following the storm *Wiebke* in 1990, spruce bark beetles caused a significant die-off of spruce stands not before the winter storm *Kyrill* in 2007.

To assess the impact of large-scale disturbances on unmanaged mountain forest ecosystems and their further development, a research project was started addressing the following questions:

- Which functional groups of species react (in terms of density and diversity) on the changed forest ecosystem following bark beetle outbreaks?
- Does the change of forest structure induced by the bark beetles lead to an increase of faunistic diversity in the mountain forests?
- Do the effects of spruce bark beetle calamities on the faunistic biodiversity of mountain forests already start to level off 20 years after the disturbance?

Over 50 study plots were established in three different stages of forest succession characterizing a chronosequence of unmanaged forest dynamics following spruce bark beetle attack. The three stages are: undisturbed spruce stands potentially susceptible to bark beetle infestation (*reference forest*), stands affected by bark beetles within the last five years (*early succession*) and those being infested in the early 1990th (*late succession*). Each category is represented on different altitudinal zones (montane - subalpine) on south- and north-facing sites with three replicates each. Arthropods were sampled during 2012 (May-September) using two pitfall traps and one flight interception trap per plot. Determination to species level was conducted for Coleoptera, Arachnida, Collembola, Aculeata and Heteroptera.

First preliminary results indicate significant differences in diversity between the three successional stages showing highest abundances on the early succession plots but highest species richness on the late succession sites when analyzing all investigated species groups commonly. Furthermore, advanced succession is characterized by the highest β-diversity. Light- and flower-demanding species and species depending on advanced wood decomposition were selected by an indicator analysis as species typically occurring on the late succession sites. On the landscape scale, the bark beetle induced spruce die-back leads to a mosaic of different forest structures modifying the faunistic species composition and initiating an overall increase in species diversity in the National Park. As a next step functional and phylogenetic diversity of arthropods will be analyzed with respect to possible successional pathways in the mountain forest.

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Vegetation Survey of Thayatal National Park – status and first results

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Abstract

Austria´s smallest nationalpark is known for its high diversity in flora and vegetation. This is due to specific ecological conditions in the narrow inserted valley of the Thaya-river. With the forests, meadows and meadow-fallows as well as the forest-free dry grasslands the most important terrestrial habitats of the Thayatal National Park could be documented with respect to their plant communities in the period from 2000 to 2006.In doing so, a knowledge gap existing for the Austrian section of this important nature area was closed, after the Czech Podyjí National Park had already been thoroughly investigated starting from 1989. The complete field survey of all meadows and meadow-fallows as well as all forest-free dry grasslands was accomplished after previous aerial photo interpretation. In a second phase, the investigation of the expanded forests was based on a stratified random sample. After classifying the whole nationalpark by means on geodata, representing its high lithological and geomorphologic variety, 200 points were selected. For all habitats, altogether 534 vegetation relevees were taken and classified with the help of multivariate procedures. As a result 54 vegetation types could be differentiated and 37plant communities on the level of association and/or subassociation could be identified. For 17 types no suitable literature references were found and in these cases a provisional description was given and a syntaxonomic allocation was suggested. Based on the regional distribution of species and plant comminities, the spatial patterns of vegetation diversity was analysed aiming at the identification of “hot” and “cold spots”. Furthermore, a monitoring system was established to allow for the controlling of management interventions in grassland and forest habitats. The latteris pointing at further research need, particularly within habitats which are currently submitted to successional changes in species composition.

Keywords

Thayatal National Park, vegetation ecology, plant communities, meadows, fallow meadows, dry grasslands, deciduous forests, syntaxonomy, monitoring

Introduction

The smallest among Austria´s nationalparks is situated in the “Thayatal “at the northeastern stateborder and forms an important international transboundary protected site together with the nationalpark Podyje in the Czech Republic. Botanical research in this region has a long tradition since a number of rare plants can be observed due to the occurrence of specific geological, geomorphological and microclimatological conditions and the resulting diversity of habitats (OBORNY 1879, HIMMELBAUER & STUMME 1923). After the Second World War, the area became part of the socalled iron curtain and was largely unaccessible from Moravia, whereas the Austrian side showed only marginal economic activities. After the “velvet revolution” the river gorge and its adjacent forests became freely accessible and received growing attention from naturalists, leading to the establishment of the nationpark Podyje by Czech authorithies and yielding a series of scientific publications regarding flora and vegetation (CHYTRY 1991, CHYTRY & VICHEREK 1995, CHYTRY et al 1997). In Austria, the nationalpark was founded ten years later, after a period of intensive discussion and planning. Driven by the need for scientific foundation for management measures and zonation, surveys of main vegetation types were commissioned by the Nationalpark management and were then conducted by the lead author and his colleagues.

Thus, research on habitats and plant communities in the nationalpark Thayatal is aiming at

- Contributing to biodiversity research in Austria
- Stocktaking of “nature values” by a systematic inventory in the protected area and its environs
- Detection of spatio-temporal patterns of (phyto)biodiversity in the unique Thayatal landscape
- Deriving a reference for the evaluation of conservation efforts and respective management interventions in forests and grassland habitats
- Establish a baseline for ongoing and planned monitoring activities, including an early warning system for priority setting

Material and methods

During the years 1999–2012, different studies were conducted on behalf of the Thayatal National Park by the lead author (WRBKA et al. 2001a, 2001b, 2010, WRBKA & ZMELIK 2006). They were all aimed at filling gaps in knowledge of ecology, species composition and spatial distribution of different ecosystem types and natural habitats in this region. Given the extent of the investigation area (approxm. 13km²) and the intended completeness of the survey, two different sampling methods were applied: for the open habitats (meadows, dry grassland, rock outcrops) an interpretation of CIR-orthofotos was applied, followed by a field visit of all patches that were idintified as being forest-free. This procedure was feasable, as only 10% of the nationalpark is covered by dry grassland, meadows and abandoned grassland. On the other hand, forest is the dominant habitat type covering more than 10 km² and could therefore not been surveyed with the same rigour. In this case a statistical sampling design was applied based on a stratification of the whole investigation area, derived from a classification of available gedodata. Similar to the approach decribed by REITER & GRABHERR (1997), a digital terrain model and digital thematic maps (geological map: ROETZEL et al. 2004; potential natural vegetation: CHYTRY & VICHEREK 1995) was used to group grid cells of 25x25m into "ecotopes" according to their similarity in site variables. As a cluster-algorithm, the K-means method as implemented in the S-Plus 2000 software proved as the most appropriate procedure, followed by a random selection of an equal number of sample sites from the 20 ecotope-classes (Fig.1).

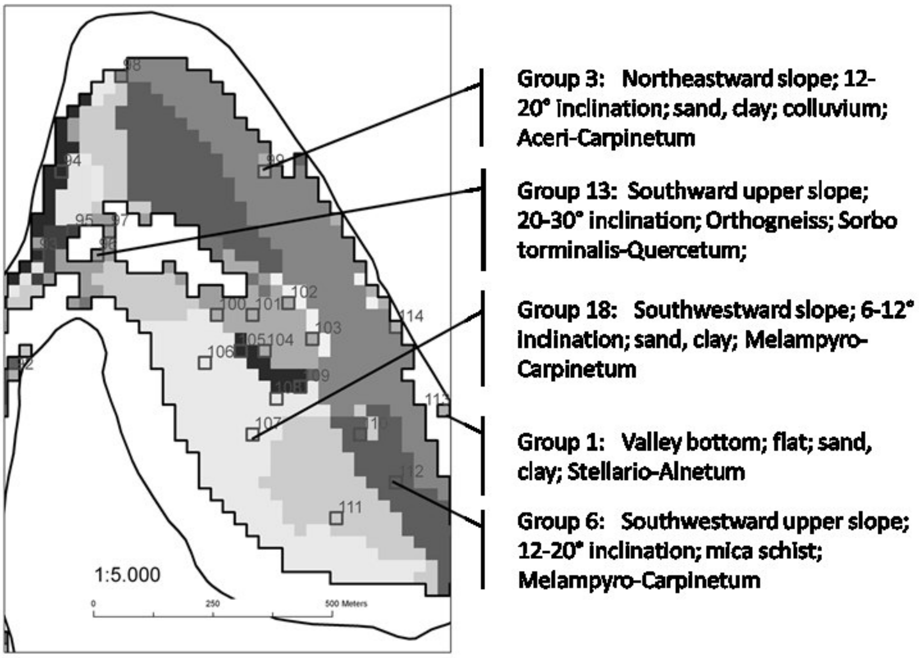

Fig.1: Nationalpark Thayatal, Region „Umlaufberg"; classification of ecotopes and forest types

Detailed investigation of vegetation types (forests, meadows, fallow and xeric grasslands) was performed by combining the traditional phytosociological Braun-Blanquet approach with modern numerical methods like divisive cluster analysis (TWINSPAN; HILL 1979) to classify and identify plant communities and setting up a database with syntaxonomical classification, GIS coordinates and photographic documentation. Identification of plant communities was done by consulting the relevant sections of the standard text book on Austrian plant communities regarding natural vegetation of non-wooded habitats (BALATOVA-TULACKOVA et al. 1993, GRABHERR & MUCINA 1993, MUCINA & KOLBEK 1993a, b, c), anthropogenic vegetation of non-wooded habitats (MUCINA et al. 1993, ELLMAUER & MUCINA 1993, ELLMAUER 1993) and forest vegetation (WILLNER & GRABHERR 2007). To better depict the regional context, published literature and unpublished theses and reports with high regional relevance was used additonally (CHYTRY 1991, CHYTRY et al. 1997, CHYTRY & VICHEREK 1995, LICHTENECKER et al. 2003, BASSLER 1997, TICHY et al. 1997, THURNER 2000). Plant identification and taxonomy was based on FISCHER et al. (2005).

Results

With respect to non-wooded open habitats, 26 communities of xeric grassland and 21 communities of managed mesic meadows and pastures could be identified and scientifically described. In detail, the regarding vegetation types could be assigned to the following phytosociological classes: Phragmito-Magnocaricetea (4 communities), Molinio-Arrhenatheretea (8 communities), Galio-Urticetea (5 communities), Trifolio-Geranietea (5 communities), Calluno-Ulicetea (3 communities), Festuco-Brometea (9 communities), Koelerio-Corynephoretea (3 communities), and Rhamno-Prunetea (5 communities).

As a detailed list and description of all vegetation types is given in WRBKA et al. 2010, here only few examples are briefly mentioned: two outstanding plant communities of the class Festuco-Brometea are domintated by feathergrass (*Stipa*) species and appear to be confined partly to natural forest gaps on the south-facing upper portions of cliffs, but also partly to secondary habitats. The lnulo oculi-christi Stipetum pulcherrimae *Vicherek et Chytr*y 1996 (Festucion valesiacae) is a dry grassland on basic soils, particularly on marble and carboniferous shists in warmer parts of the study area. The Genisto tinctoriae-Stipetum joannis ass.nova (Festucion valesiacae) is a dry grassland vicariating with the lnulo oculi-christi-Stipetum pulcherrimae in cooler and wetter areas. Its localities are concentrated on amphibolite, marble and limestone, harbouring the rare species Stipa dasyphylla. Forest fringes with thermophilous tall herb-communities are among the most spectactular vegetation types in the nationalpark Thayatal, represented by the newly described Iris variegata-Elymus hispidus (Geranion)-association. This plant community is frequently occuring in the famous “Umlaufberg” region and harbours rare species like Melica altissima and Hesperis sylvestris.

In addition to the survey, a monitoring programme of non-wooded habitats in the open landscapes was initiated. 40 monitoring sites in representative habitats have been established with permanent plots and have been revisitated in 2012. As expected, this control procedure revealed ongoing secondary succession in abandoned meadows, but yielded quite satisfying results in the managed grasslands pointing at good management practise. Few exceptions to this observation are notable, especially regarding increased disturbance caused by wild boar and red deer in some specific localities.

The second part of the vegetation survey was dealing with woodland ecosystem types. As a result, 19 forest plant communities have been described in the context of a complete revision of the syntaxonomical system of forest vegetation in Austria and a map of the potential natural vegetation has been actualized accordingly. Taking advantage of the statistical sampling procedure, the spatial pattern of forest types was modelled for 25x25m gridcells. Thus not only the expected eological gradients in altitude and bedrock were revealed, but also the ecological niche of main forest types could be described in great detail. Beech forests are represented by the association Galio odorati-Fagetum typicum and are mainly occuring in the western part of the national park with an altitude greater than 340 m above sea level. Dominant forest types are oak-hornbeam communities, belonging to the Galio sylvatici-Carpinetum with three different subassociations, one on mesic sites (subass.typicum), a second one on warmer and Ca-rich sites (subass.primuletosum veris), and a third one on sites with low ph-value (subass.luzuletosum). Oak forests are represented by two acidophilic associations, Luzulo-Quercetum petraeae and Genisto pilosae-Quercetum. Steep slopes in the rivergorge are inhabitated by communities formed by Tilia and Acer species, identified as Aceri-Tilietum platyphylli and harbouring a surprisingly rich flora of oreophytes. Finally forests on sites with prononunced environmental resources should be mentioned. The Lithospermo-Quercetum pubescentis is occuring on dry rocky slopes and extraordinarily rich in species due to its open character and forest-steppe like transitions to thermophilous fringes and dry grassland patches. The Stellario nemorum-Alnetum glutinosae is forming small woodland stripes along the Thaya river, thus representing the group of alluvial forests.

As 20% of the forest area consists of spruce and larch plantations and are gradually transformed to decidous forest types, this ecological restoration measure was also documented by a subset of vegetation releves. In some parts of the forest the influence of historic forestry measures like intensive coppicing is still visible, resulting in dense, species poor Hornbeam stands. Based on these scientific findings, a short interpretation guide for identifying forest plant communities was produced to serve educational purposes as well.

In addition, “hot” and “cold” spots of vascular plant biodiversity could be identified and visualized by combining the data of all vegetation studies for the whole national park. The spatial pattern of alpha- and gamma- diversity could be interpreted in line with modern ecological theories. In essence, the distribution and richness pattern of vegetation types appeared to be congruent with the occurance of calcium rich rock types (eg. marble, carboniferous shists) and a pronounced microtopography (eg. Steep south-facing slopes). Cold spots of phytodiversity could mainly be found on plateaus with low topographical variance and underlying acidic bedrock (eg. Thaya-granite).

Conclusion and outlook

An overview of the plant communities for all major habitat types in the nationalpark Thayatal could be given based on a systematic survey. Nevertheless, some knowledge gaps are remaining regarding plant communities found on screes and rocks dominated by mosses and lichens. Furthermore the few examples for habitats with strong and regular anthropogenic should be studied to complete the list of syntaxa, but also to account for a potential source of ruderals and invasive species in the area. Monitoring activities will be continued for all habitats including forest, and will focus on the influence of disturbances caused by red deer and wild boar, aiming at setting tresholds for wildlife management.

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Species inventory, ecology and seasonal distribution patterns of Culicidae (Insecta: Diptera) in the National Park Donau-Auen

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Abstract

Culicidae are known as hosts for a variety of pathogens and are therefore considered as nuisance and as vectors of human diseases, such as malaria, dengue and yellow fever. Until recently mosquito ecology had been neglected although they play an important but poorly understood role in food chains. In order to understand the ecological function of Culicidae it is imperative to investigate species distribution patterns and the factors controlling it. Abiotic parameters such as water level, nutrients, oxygen concentration and conductivity as well as biotic parameters (Culicidae and potential predators) were monitored from March to October 2011 at 20 sampling sites in the National Park Donau Auen. A total of 34 eggrafts, 1927 larval, 80 pupal and 221 adult Culicidae were collected. We detected 15 Culicidae species belonging to 6 genera (*Anopheles, Culex*, *Culiseta*, *Coquillettidia*, *Aedes* and *Ochlerotatus*), with*Oc. geniculatus* (68 %) and *Cx. territans* (13%) being most frequent, followed by *Cx. pipiens* and *Ae. vexans* with approximately 5% and 4% of total abundance. Biometrical data were used to reconstruct life cycles; *Cx. pipiens* and *Cx. territans* were bivoltine and *Oc. geniculatus* multivoltine in the study area. Based on abiotic and biotic parameters, sampling sites were grouped into 4 separated clusters. Water level and persistence, pH, electric conductivity and phosphate concentrations significantly influenced species distribution patterns and revealed that flood plain dynamics are a key factor for the seasonal and spatial distribution of mosquito larvae in the National Park Donau-Auen.

Keywords

Culicidae, species inventory, phenology, ecology, Nationalpark Donau-Auen

Introduction

Worldwide, more than 3,500 mosquito species have been recorded and more than 40 species are known to be endemic in central Europe (BECKER et al. 2010). The species inventory of Austria consists of 43 published Culicidae species belonging to 7 genera (*Aedes*, *OchlerotatusAnopheles*, *Culex*, *Coquillettidia*, *Culiseta* and *Uranotaenia*) (MOHRIG & CAR 2002, SEIDEL et al. 2012, LEBL et al. 2013). Culicidae are mainly known as vectors for medically important pathogens and parasites and as transmitters of diseases.The ecology of Culicidae has been neglected with exception of some investigations on population and community ecology of invasive Culicidae species like *Ae. albopictus*, which is considered as a major threat to public health (MEDLOCK et al. 2006). Studies on mosquito life-strategies and distribution patterns gain importance again since global change supports the arrival of invasive, non-indigenous Culicidae species and new emerging vector-borne diseases in Europe. A main topic of mosquito research was pest control; i.e. reduction of culicid populations by using methods like *Bacillus thuringiensis* ssp. *israelensis* (*Bti*) to protect people from mosquito-borne diseases, whereas 200 tonnes of *Bti* are used annually for mosquito control worldwide (BECKER 1998). Since 1990 the effects of *Bti* on target (mosquitoes and black fly larvae)and non-target organisms were investigated,the results showed that nematoceran species, such as Ceratopogonidae and Chironomidaeare susceptible to *Bti* (GARCIA et al. 1980, BOISVERT & BOISVERT 2000). Meanwhile it is known that the usage of *Bti* has negative effects on breeding success of birds. POULIN et al. 2010 showed that the clutch size and fledging survival was lower at the Bti treated siteswhen compared to control sites in southern France. In contrast,no negative trophic effects could be attributed to the change in the insect community by a 3 year study in wetlands of central Minnesota (NIEMI et al. 1999). These studies underline the necessity for long-term investigations to fully predict the consequences of mosquito control on floodplain communities. Despite increasing interest in mosquitoes there is a lack of information on species inventoriesand distribution patterns in Austria and the bordering countries (European Centre for Disease Prevention and Control 2012).The National Park Donau-Auen, one of the last remaining large wetlands in Central Europe was chosen for this study, because it provides many different habitats for the larval development of mosquitoes. The goal of this study was to update the information on species inventory, ecology and spatial distribution patterns of mosquitoes in the area of the National Park Donau-Auen, which serves as a basis for further investigations in this region.

Methods

From 1 March to 31 October, 2011, the 20 study sites (phytotelmata, one artificial pond, temporary and stagnant water bodies) at Orth an der Donau were sampled at regular intervals (Fig.1). Culicidae (eggrafts, larvae and pupae) and their potential aquatic predators were sampled every third day using a catch per unit effort (CPUE) method (KREBS 1989). Adults were caught strictly above the water surface of their breeding habitats with a handnet (20 cm in diameter,200 µm). Phytotelmata were sampled at the same intervals using a syringe (20 ml). The catch was preserved in vials containing ethanol (75%). Pre-imaginal stages and adults were identified using the key of BECKER et al. (2010). Head widths and body lengths were measured to identify the four larval instars and to provide basic data for life cycle reconstruction. Dyar's rule was used to ensure instar definition (MCDONALD et al. 1977). Abiotic parameters (dissolved oxygen, pH, conductivity, water temperature, nutrients, total and carbonate hardness) were measured every second week and additionally after flood and heavy rainfall at each sampling site. Hydrological connectivity, water level and persistence were noted additionally. These were used to characterize the breeding habitats employing cluster analysis based on euclidean distances. A Canonical Correspondence Analysis (CCA) was employed as an unimodal method to explain species data by environmental data.

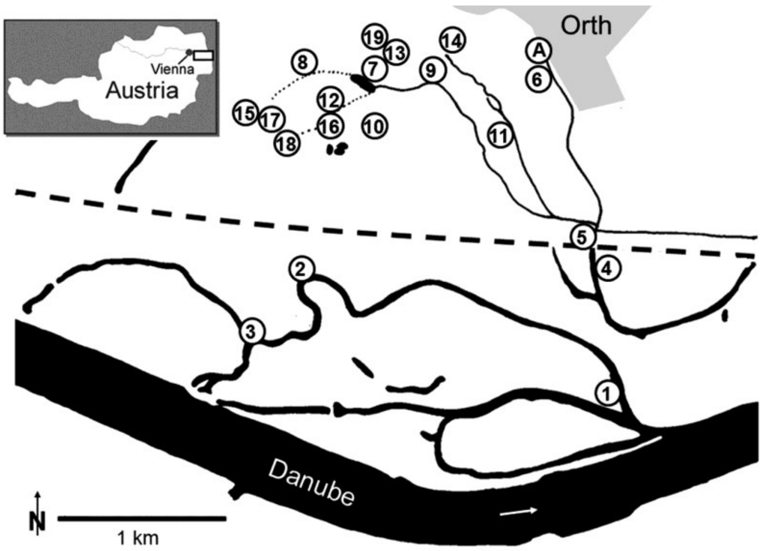

Figure 1: Map of the study area in the National Park Donau-Auen at the northern bank of the Danube near the city of Orth, showing the sampling sites covering a wide range of water body types (large permanent waters: sites1 – 3 (Große Binn, kleine Binn); intermediate permanent waters: sites 4 – 6 (Fadenbach); small permanent (7) and temporary (8) waters: sites 7 – 8 (Wachtelgraben); small temporary waters: sites 9 -13; phytotelmata: sites 14 – 19; plastic container: site A). Dotted line: dam for flood control. The upper left insert indicates the location of the National Park Donau-Auen within the borders of Austria.

Results

A total of 34 eggrafts, 1927 larval, 80 pupal and 221 adult mosquitoes (3 males, 218 females) were collected, belonging to 15 Culicidae species (including two morphologically difficult species pairs). The species inventory consisted of 6 genera: *Aedes, Anopheles*, *Coquillettidia*, *Culex*, *Culiseta* and*Ochlerotatus.Oc. geniculatus* was most abundant (64.1%) in the larval stage, followed by larvae of *Cx. territans* (18.7%), *Cx. pipiens* (6.9%) and *Ae. vexans* (2.8%) (Tab.1). The remaining species represented 7.5% of the total catch. Adults of*Oc. geniculatus* (40.3%) were most abundant, followed by *Cx. pipiens* (23.1%), *Cq. richiardii*(19.9%) and *Cx. territans* (10.4%) (Tab.2). A total of 679 larvae, pupae and adults of *Cx. pipiens* were collected with the majority of the aquatic stages originating from the artificial pond (Figure 1, A).Two generations emerged in May/June and July with a possible spring generation in March/April. *Cx. territans* had two generations emerging in May/June and June/July 2011; a possible third generation was not completed as sampling sites dried up in October.*Oc. geniculatus* had two generations emerging in May and July/August. As sampling sites dried up at the end of September, a third generation was unable to emerge. A Cluster analysis was performed in order to explore the effect of environmental parameters on Culicidae species distribution.Four groups of habitats were extracted. Group 1 consisted of temporary water bodies (sites 8-13) and one phytotelma (site 18) with the highest amount of larval Culicidae (1044 individuals out of 8 species). These breeding sites were characterized by a low water level (0.5 to 10.5 cm), very lowoxygen concentrations (0.80 to 10.10 mgl^{-1}) and the highest loads of chloride (10.99 to 78.60 mgl^{-1}) and sulphate (7.65 to 193.12 mgl^{-1}) of all groups. Group 2 combined phytotelmata (sites 14-19 except site 18). These temporary water bodies had a very low water level (only 3.0 – 9.0 cm), the lowest conductivity (214 to 574 μScm^{-1}) and the highest amounts of nitrate (1.22 to 32.44 mgl^{-1}) ofall groups. A total of 871 larvae of two tree-hole species, *Oc. geniculatus* and *An. plumbeus*,were detected. Group 3 consisted ofsampling sites of two permanent, large water bodies, the Kleine Binn (sites 2 and 3) and the Große Binn (site 3), characterized by comparatively high oxygen concentrations ranging from 7.16 to 10.17 mgl^{-1} and lower nutrient concentrations. The species inventory consisted of *Cx. territans*, *An. maculipennis* and *Cs. annulata*. Group 4 consisted of the sampling sites located along the Fadenbach (sites 4-6) and one sampling site at the Wachtelgraben (site 7), characterized by water persistence, a nearly constant water level during the entire sampling period, high conductivity ranging from 408 to 999 μScm^{-1} and chloride concentrations ranging from 18.86 to 68.44 mgl^{-1}.The high predator density at these breeding habitats resulted in only 25 larval Culicidae. To detect habitat parameters associated with the distribution of Culicidae species, a Canonical Correspondence Analysis was performed. Habitat parameters likeconductivity, pH, phosphate concentrations, water level and persistence significantly (CCA, $p<0.05$) influenced larval distribution of Culicidae species (Fig. 2). In total, the model explained 99.8 % of the variance of the five selected variables. In general the results of the Canonical Correspondence Analysis of environmental variables (Fig. 2b) support the results of the Cluster analysis.The first axis discriminated between species in short-living temporary water bodies and species in stagnant water bodieswith high water levels (Figure 2a). In fact, aquatic stages of *Cx. territans* were found in high abundances in stagnant water bodies (sites 1, 3, 5) where water levels ranged from 46 to 103 cm, and only in very low abundances in temporary water bodies. *Oc. geniculatus* and *An. plumbeus* were found in phytotelmata (14-19) where concentrations of PO_4 were high, ranging from 1.10 to 16.18 mgl^{-1}. Larvae of *Oc. annulipes/cantans* and *Ae.vexans*are constricted to short-living temporary ponds. *Cx.pipiens*, on the other hand, was abundant at a variety of sampling sites, ranging from slowly-flowing running waters to phytotelmata and temporary water bodies.

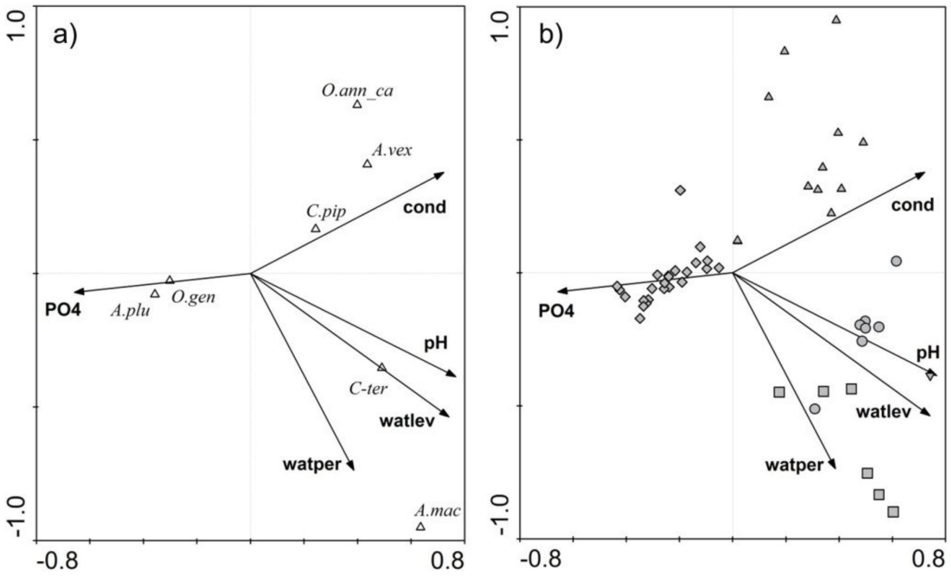

Figure 2: a) Canonical Correspondence Analysis biplot of five significant (P<0.05) environmental variables versus Culicidae species abundance. Arrows indicate environmental variables; cond = conductivity, watper = water persistence, watlev = water level, PO4 = phosphate concentration; A.plu = *Anopheles plumbeus*, A.mac = *Anopheles maculipennis* complex, C.ter = *Culex territans*, C.pip = *Culex pipiens*, A.vex= *Aedes vexans*, O.gen = *Ochlerotatus geniculatus*, O.ann_ca = *Ochlerotatus annulipes / cantans*. b) Canonical Correspondence Analysis biplot of monthly means of five significant (P<0.05) environmental variables versus sampling sites. Down triangles = Wachtelgraben sampling sites (7 - 8); up triangles = temporary water bodies (9 - 13); diamonds = phytotelmata (sites 14 - 19); circles = Kleine Binn and Große Binn sampling sites (1 - 3); squares = Fadenbach sampling sites (4 - 6).

Discussion

In our study at the National Park Donau-Auen the detected Culicidae species inventory is equivalent to 36% of the Austrian species inventory (MOHRIG & CAR 2002; SEIDEL et al. 2012; LEBL et al. 2013). Species like *Ae.vexans*, *Ae. sticticus*, *Ae. cinereus*, *Ae. rossicus*, *Oc. rusticus*, *Oc. annulipes* and *Oc. cantans*, which are typical for frequently inundated areas were detected in unexpected low numbers (5.9 % of total abundance). Larvae of tree-hole species (*Oc. geniculatus*, *An. plumbeus*) (66.4 % of the total) were most abundant in our study, followed by species which are associated with urban areas such as *Cx. pipiens* and *Cx. territans* (26.6 % of total larval abundance). In contrast, RÖTZER (1995) detected 12 species belonging to 5 genera in the Danube Floodplain at Stockerau (Lower Austria) with floodplain species being predominant. The low flood frequency in 2011 with only one spring flood is presumably the reason why we lacked many floodplain species, since floodplain dynamics are known to be a key factor for Culicidae species composition(ŠEBESTA et al. 2012; SUDARIĆ BOGOJEVIĆ et al. 2009). The most abundant species in the larval stage were tree-hole species (*Oc. geniculatus and An. plumbeus*),because suitable breeding habitats were present throughout the sampling period. Species like *Cx. pipiens* and *Cx. territans* which are often associated with urban areas were present from early spring to September. Therefore, two generations of these specieswere observed in 2011 with two further generations terminated by desiccation of the breeding habitats. In contrast, RÖTZER (1995) reported only a low amount of *Cx. territans* in the Danubean floodplain in Stockerau; *Cx. pipiens* was completely lacking in this study. *Oc. cantans*, *Oc.cataphylla* and *Oc. rusticus* were detected in temporary ponds in March and had only one generation in 2011. The results of the Canonical Correspondence Analysis revealed that conductivity, water level, water persistence, pH and phosphate concentrations contributed significantly ($p < 0.05$) to species distribution. Aquatic stages of floodplain species were mainly detected at temporary water bodies; this is in accordance with their lifecycle strategy where females select oviposition sites during dry seasons and larvae hatch after flooding. The small number of floodplain species can be explained by the unavailability of adequate breeding habitats in 2011. Concurrently, Culicidae species that hibernate in the adult stage and that are strongly bound to human settlements (BECKER et al. 2010) occurred in high abundances. Aquatic predators which are also used as biocontrol agents (CHANDRA et al. 2008) were sampled in our CPUE sampling method.Sampling sites at the Wachtelgraben and the Fadenbach (Group 4) were characterized by a high predator densityresulting in only 25 mosquito larvae sampled. In habitat group 3 (Grosse and Kleine Binn sampling sites) high predator densities, but only 78 larval mosquitoes were detected. However, highest larval mosquito densities of 1044 specimens were recorded at temporary water bodies although invertebrate predators were present. Newts and fish might play an important role, since fish generally lack in temporary waters. A high number of Culicidae (871 larvae) were recorded in predatorless phytotelmata sampling sites; here the larval density was regulated by habitat size and water persistence, not by predator pressure.

Table 1. Culicidae species inventory (larvae and pupae; n and percentage) collected from March to October 2011 at 19 sampling sites within the National Park Donauauen.

Species	**Larvae / pupae**	**%**	**Phenology**
Anopheles maculipennis complex	11 / 0	1.0	May – August
Anopheles (*Anopheles*) *plumbeus* Stephens, 1828	12 / 3	2.3	August
Aedes (*Aedes*) *cinereus* MEIGEN 1818 / *rossicus* Dolbeskin, Gorickaja & Mitrofanova, 1930	3 / 0	0.3	April
Aedes (*Aedimorphus*) *vexans* (Meigen, 1830)	30 / 0	2.8	June – July
Ochlerotatus (*Finlaya*) *geniculatus* (Olivier, 1791)	648 / 36	64.1	April – September
Ochlerotatus (*Ochlerotatus*) *cantans* (Meigen, 1818) / *annulipes* (Meigen, 1830)	27 / 0	2.5	March – April
Ochlerotatus (*Ochlerotatus*) *cataphylla* Dyar, 1916	2 / 0	0.2	March
Ochlerotatus (*Ochlerotatus*) *flavescens* (Müller, 1764)	3 / 0	0.3	April
Ochlerotatus (*Rusticoidus*) *rusticus* (Rossi, 1790)	3 / 0	0.3	March
Culex (*Culex*) *pipiens* Linnaeus, 1758	65 / 9	6.9	April – September
Culex (*Neoculex*) *territans* Walker, 1856	167 / 32	18.7	April – September
Culiseta (*Culiseta*) *annulata* (Schrank, 1776)	6 / 0	0.6	May, July
Total	**977 / 80**	**100.0**	

Table 2: Culicidae species inventory (adults; n and percentage) collected from March to October 2011 at 19 sampling sites within the National Park Donauauen.

Species	**males / females**	**%**	**Phenology**
Anopheles maculipennis complex	0 / 1	0.4	May
Aedes (*Aedimorphus*) *vexans* (Meigen, 1830)	0 / 1	0.4	August
Ochlerotatus (*Finlaya*) *geniculatus* (Olivier, 1791)	0 / 89	40.3	March – September
Ochlerotatus (*Ochlerotatus*) *annulipes* (Meigen, 1830)	0 / 3	1.4	July – August
Ochlerotatus (*Ochlerotatus*) *cataphylla* Dyar, 1916	0 / 3	1.4	April
Ochlerotatus (*Ochlerotatus*) *excrucians* (Walker, 1856)	0 / 2	0.9	May
Ochlerotatus (*Ochlerotatus*) *sticticus* (Meigen, 1838)	0 / 4	1.8	July
Culex (*Culex*) *pipiens* Linnaeus, 1758	3 / 48	23.1	April – September
Culex (*Neoculex*) *territans* Walker, 1856	0 / 23	10.4	April – September
Coquillettidia (Coquillettidia) richiardii (Ficalbi, 1889)	0 / 44	19.9	June – August
Total	**3 / 218**	**100.0**	

Conclusion

Floodplain areas are dynamic systems with distinct Culicidae species pools. However, the yearly composition of the culicid speciesinventory varies, depending on hydrological conditions, weather (especially the amount of precipitation and possible dry seasons), water level fluctuations and flood frequencies (ŠEBESTA et al. 2012; SUDARIĆ BOGOJEVIĆ et al. 2009). Species abundance is further influenced by intraspecific competition and predator pressure (SUNAHARA et al. 2002). In order to fully elucidate these complex interactions, long-term studies in floodplain areas such as the National Park Donau-Auen are strictly necessary.

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Effects of gravel mining on the surface-active arthropod fauna of ephemeral gravel-bed stream valleys in the National Park Gesäuse (Styria, Austria)

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Abstract

In the National Park Gesäuse (Austria, Styria), several tributaries of the Enns river are ephemeral streams that have accumulated large amounts of gravel in the broadened stretches of their valleys. In two of these valleys, gravel mining has been performed until recently. With the establishment of the National Park, these activities have been terminated and the gravel fields have been restored. It remains unclear, however, whether gravel mining has affected the surface arthropod assemblages and whether the restoration measures have re-established a natural arthropod community in those valleys.

A randomised, replicated, controlled study was performed between 4 May 2012 and 30 September 2012. In a BACI-type design, ten samplings areas were compared, with sites from impacted valleys and control valleys above, within and below the gravel extraction areas. Each sampling site was visited seven times; during each visit, arthropods were collected by hand catch for the duration of one hour. Additionally, environmental variables were recorded. The sampling visits were randomly allotted to the sampling areas; within the sampling areas, transect positions perpendicular to the stream channel were also located randomly.

Detrended Correspondence Analysis and Nonmetric Multidimensional Scaling showed a clear differentiation between the ephemeral gravel valleys and typical riverbanks of Johnsbach and Enns in the region. The gravel valleys showed an arthropod fauna impoverished in species numbers and dominated by a single species, the wolf spider *Pardosa saturatior*. Gravel valleys impacted by gravel mining showed a more diverse fauna with a higher proportion of trivial species and with assemblages that were more closely related to assemblages of banks and shores of perennial rivers. While the assemblages of the upstream areas were rather similar between impacted and control valleys, the lower valley stretches differed increasingly in their species composition towards the mouth of these valleys.

Comparison of a quality index calculated for the sampling areas showed lower values for the impacted areas, but the differences were not significant (ANOVA). It may be concluded that gravel mining has affected the assemblages of surface-active arthropods, but the changes are relatively small. Most of the typical species are still present in the valleys affected by gravel mining, which offers good prospects for the further restoration of these valleys. In summary, alpine gravel valleys with ephemeral streams appear to be a conspicuous yet poorly researched mountain habitat type with a distinct fauna of highly specialised species that are able to tolerate the harsh conditions between catastrophic inundation and dryness.

Keywords

Ephemeral streams, gravel mining, *Pardosa saturatior*, karst, multivariate ordination

Introduction

Limestone and dolomite are rocks that are easily weathered. Their decomposition products – debris, scree and gravel – are important landform elements in calcareous mountain systems. The limestone material with its fractures, fissures and pores favours percolation and infiltration of large amounts of water. Mountain streams entering valleys filled up with calcareous sediments thus often disappear in the gravel bed and flow underground within the pore system. During periods of high precipitation, however, e.g. after snow melt, rainy periods or thunderstorms, the capacity of the pores might be exceeded and peaks of violent surface runoff may be generated. During such phases, large parts of the mountain valley may become flooded, the dramatically increased stream capacity may transport large amounts of material downstream and powerful erosion and sedimentation processes may substantially transform the entire streambed landscape.

With their alteration between the terrestrial and the aquatic phase, all types of floodplains represent challenging environments for surface-active arthropods. Species unable to withstand or to avoid the unsuitable phase cannot live in floodplain biotopes (Adis & Junk 2002), others require particular survival strategies to survive under such harsh conditions (Adis 1992). Among the various kinds of floodplains, ephemeral mountain stream valleys are probably those with the most extreme conditions. During large parts of the year, the valleys are completely dry, typically lack any vegetation and are nearly sterile, except for small amounts of organic material deposited in some pockets of low flow velocity. Ephemeral streams lack the resource supply of ordinary perennial streams, which continuously deposit organic material and aquatic organisms along their beaches and also provide humidity and water all year round (Hering & Plachter 1997). During flash floods, arthropods in karst valleys are not only affected by high water levels and large-scale inundation of their terrestrial habitats, but also by high flow velocity and extremely high mechanical disturbance, with large amounts of rock and gravel material moving downstream with the water flow.

Most research on ephemeral streams seems to have been focused on aquifers in arid, semiarid and Mediterranean-type climates (e. g. Camarasa Belmonte & Segura Beltrán 2001). Information on the ecological conditions and the assemblages of ephemeral karst streams seems to be very limited in general (Meyer & Meyer 2000), and in particular on karst streams from alpine regions.

In the National Park Gesäuse in the Austrian Alps, several side valleys of the Johnsbach and Enns river systems area sediment troughs with stream channels lying dry throughout the year and surface runoff only during extreme weather events. Until recently, two of these valleys have been used for gravel mining and asphalt production, but these uses have been terminated with the establishment of the National Park. In both valleys, production facilities have been de-assembled and removed, and the surface has been restored (Holzinger et al. 2011). It is not clearhowever, to what extent the mining activities have affected the original surface-active arthropod assemblages of those ephemeral stream valleys and whether the restoration measures have successfully re-established the typical environmental conditions and the associated arthropod assemblages of the gravel fields. Thus, the study presented here had two goals: (1) Tocharacterise and delineate the arthropod assemblages of the karst valleys in comparison with ordinary riverbank assemblages of the Johnsbach and Enns rivers. (2) To assess the effect of the gravel mining impact on the arthropod assemblages, measured by multivariate ordination techniques and two assemblage quality indices.

Material & Methods

The study compared ten study areas in the National Park Gesäuse from four valley systems (Weißenbachlgraben, Haindlkar, Gsenggraben and Kainzenalplgraben) situated in altitudes between 500 and 800 m with regard to their arthropod assemblages in a BACI-type sampling design (Underwood 1996). Six of the ten sampling areas were located in valleys impacted by gravel mining; four were situated in control valleys. Within each impacted valley, one sampling area was located upstream, one within, and one downstream of the former gravel mining area. Areas in control valleys were at corresponding altitudes as their counterparts in the impacted valleys. Within each of the sampling areas, seven sampling transects perpendicular to the channel direction were located using random distances from a pre-defined reference point at the lower border of the sampling area. The sampling sequence of all 70 transects was randomised to avoid any bias due to season, weather conditions or post-inundation stage. Each transect was examined for one hour by turning stones and collecting all surface-active arthropods belonging to ground beetles (Carabidae), rove beetles (Staphylinidae), spiders (Araneae), millipedes (Diplopoda and Chilopoda) and woodlice (Isopoda terrestrial) with an aspirator. The material was stored in a mixture of 80% alcohol and diluted acetic acid for later identification in the laboratory. Individuals were typicallyidentified to the species level, however, only some of the juvenile spiders could be assigned to species by comparing them with adults sampled at the same locality; others could only be identified to the family level.

The assemblages were analysed using the ordination techniques Detrended Correspondence Analysis and Nonmetric Multidimensional Scaling, the latter being based on the Renkonen similarity index (Legendre & Legendre 1998). The relationship between assemblages from the ten sampling areas, assemblages from two reference stream bank sites sampled for comparison and assemblages from two earlier studies conducted at the Johnsbach and Enns river banks (Brandl 2005, Fritze et al. 2007) was visualised in ordination plots. For DCA, the software CANOCO 4.5 was used (ter Braak & Šmilauer 1998), for NMDS the procedure PROXSCAL 1.0 in SPSS 10.0.5 was applied (SPSS, Inc.). Renkonen similarity numbers were calculated using an Excel (Microsoft Corp.) spreadsheet with array formulas.

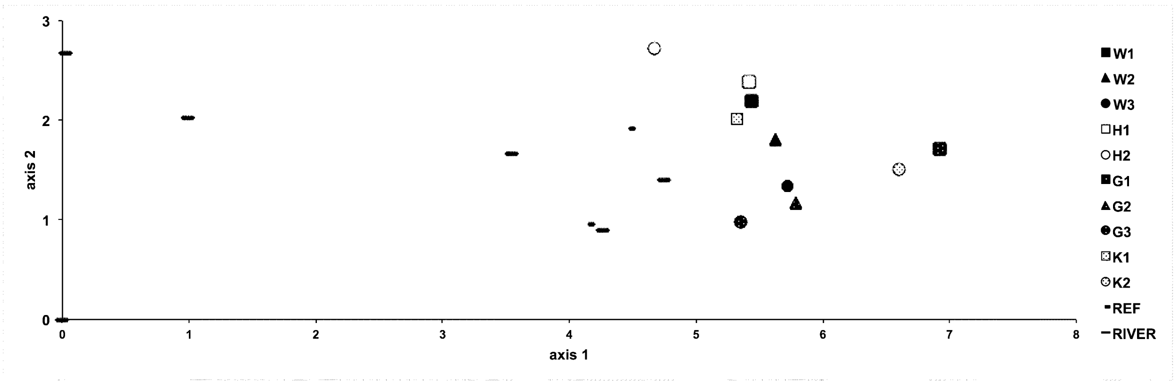

Figure 1: Detrended Correspondence Analysis ordination of the ground beetle (Carabidae) assemblages of the 10 sampling areas, two reference areas (perennial streams, Weißenbachlgraben) and six assemblages from an earlier study on the river banks in the National Park Gesäuse (Fritze et al. 2007). Quadratic symbols: upstream sampling areas, round symbols: downstream areas, triangular symbols: areas of gravel mining. Black and dark grey symbols: valleys impacted by gravel mining. White and light grey symbols: control valleys. W...Weißenbachlgraben, H...Haindlkar, G...Gsenggraben, K...Kainzenalplgraben, REF...Reference areas (two downstream sampling areas in Weißenbachlgraben with perennial flow), RIVER...assemblage data from Fritze et al. 2007).

The quality of the assemblages from the sites was (a) assessed as the number of individuals of threatened species and (b) as the percentage of the individuals of threatened species. Since no current Red Lists were available, the threat status assignment was based on personal experience and record count statistics from a personal faunistic database.

Results

The sampling yielded 795 spider individuals of 30 species, 235 ground beetle individuals of 25 species, 190 rove beetle individuals of 11 species and 111 individuals of eight identified harvestmen, woodlice and millipede species. With 598 individuals, the wolf spider *Pardosa saturatior* was the dominant species of the assemblages. Among the ground beetle assemblages, *Bembidion cruciatum* was abundant in valleys modified by gravel mining. *Bembidion longipes* was less numerous and predominantly found in non-impacted valleys.

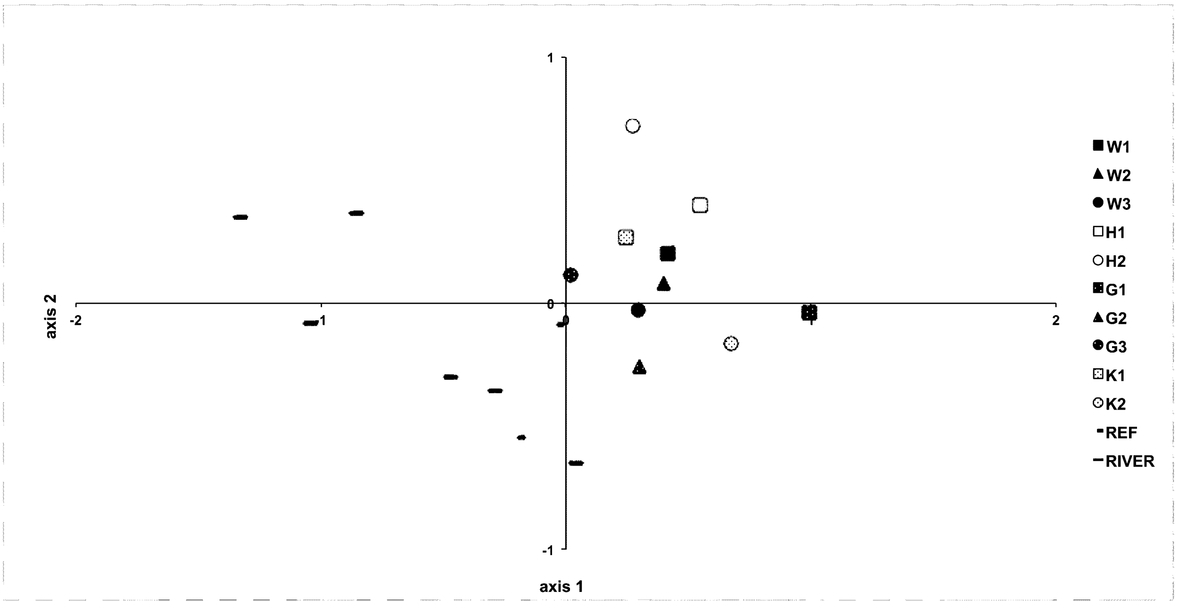

Figure 2: Nonmetric Mutidimensional Scaling ordination of the ground beetle (Carabidae) assemblages of the 10 sampling areas, two reference areas and six assemblages from an earlier study on the river banks in the National Park Gesäuse (FRITZE et al. 2007). Symbols as in Fig. 1.

Detrended Correspondence Analysis (Fig. 1) and Nonmetric Multidimensional Scaling (Fig. 2), two numerically different approaches to assemblage ordination, produced very similar plots for the ground beetle assemblages. Both plots showed a clear separation between ephemeral stream assemblages and perennial riverbank assemblages.

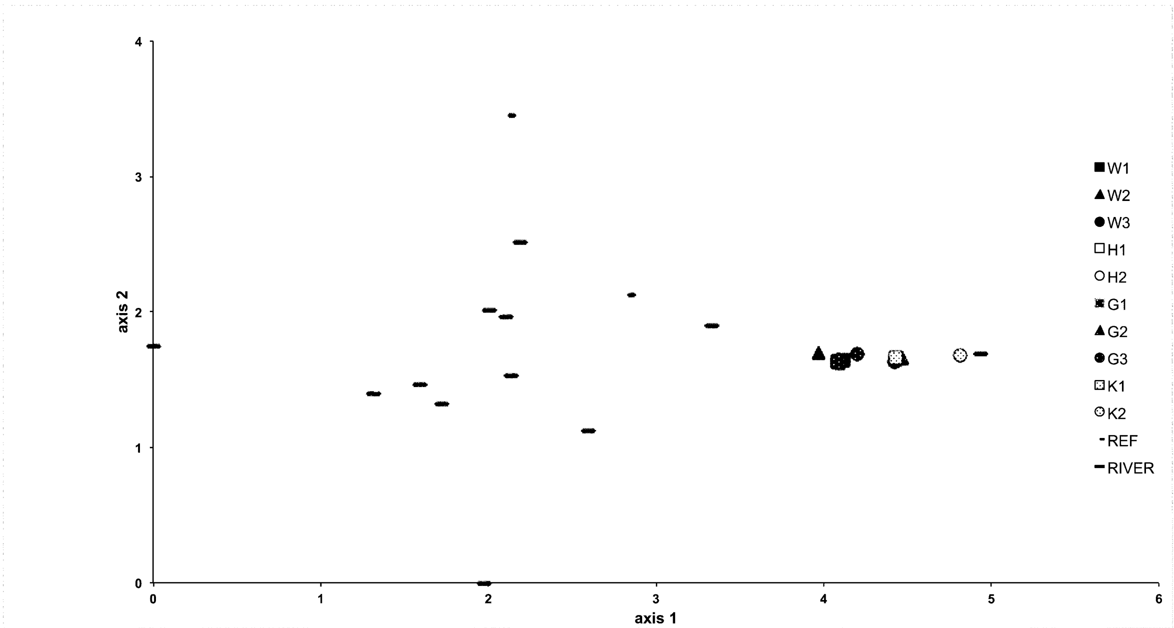

Figure 3: Detrended Correspondence Analysis ordination of the spider assemblages of the 10 sampling areas, two reference areas (perennial streams, Weißenbachlgraben) and 12 assemblages from an earlier study on the river banks in the National Park Gesäuse (BRANDL 2005). Symbols as in Fig. 1.

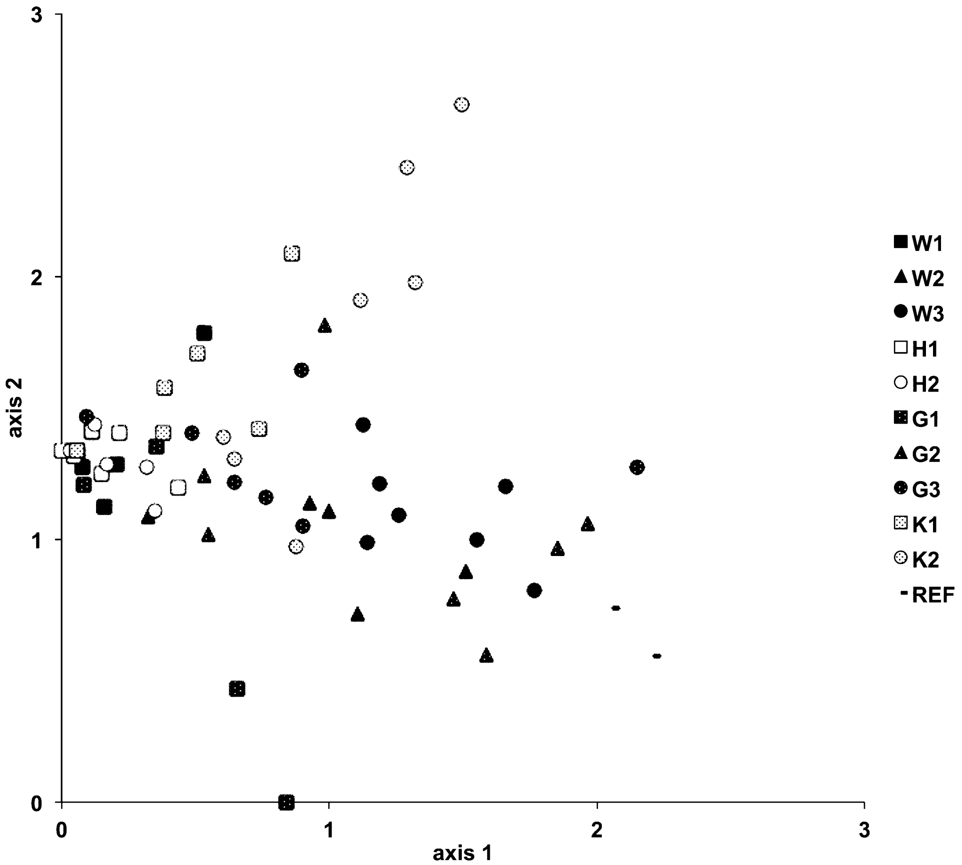

Figure 4: Detrended Correspondence Analysis ordination of the arthropod assemblages of all 70 samplings plus two reference samplings with perennial flow. Symbols as in Fig. 1.

Spider assemblages from riverbanks displayed considerably more variety than assemblages from the ten ephemeral stream sites (Fig. 3). The latter formed a closely packed cluster together with one of the assemblages from an earlierreference study (Langgrießgraben, BRANDL 2005). A multivariate assessment of all 70 sampling transects obtained in the present study (plus two reference samplings) based on all arthropod taxa revealed a high similarity of the upstream assemblages from all four valleys (left part of the plot, Fig. 4). Downstream assemblages show some differentiation between gravel mining impacted valleys and one of the control valleys characterised by several natural gravel banks (right part of the plot, Fig. 4). Assemblages from the downstream stretches impacted by gravel mining are similar to assemblages from the perennial reference sites.

Table 1: Individuals of threatened species in the ten sampling areas.

Before-After	Impact Weißenbachlgraben	Control Haindlkar	Impact Gsenggraben	Control Kainzenalplgraben
Upstream	65	99	44	58
Mining Area	48		51	
Downstream	55	104	63	56

In most cases, sampling areas affected by gravel mining showed lower assemblage quality numbers than control areas, regardless whether assemblage quality was measures based on individuals of threatened species (Table 1) or based on their percentage in the total catch (Table 2). However, the differences were small and statistically insignificant both for individual numbers (ANOVA based on ln (x+1)-transformed values, P = 0.57 for the difference between Before and After, P = 0.19 for the difference between Control and Impact, P = 0.76 for the interaction term) and for percentages (ANOVA based on arcsin√-transformed values, P = 0.18 for the difference between Before and After, P = 0.75 for the difference between Control and Impact, P = 0.53 for the interaction term).

Table 2: Percentage individuals of threatened species in the total catch.

Before-After	Impact Weißenbachlgraben	Control Haindlkar	Impact Gsenggraben	Control Kainzenalplgraben
Upstream	90,3%	91,7%	53,1%	60,9%
Mining Area	58,0%		25,3%	
Downstream	29,7%	92,0%	52,8%	39,2%

Discussion

Mountain streams in debris-filled trough valleys may form a specific type of floodplain environment with extreme environmental conditions. To date, the study of the fauna of such floodplain environments seems to have been largely neglected. In the present investigation it became clear that gravel fields with ephemeral streams differ consistently form ordinary perennial river or stream banks in their ground beetle and spider assemblages. One reason for these differences is the dominance of *Pardosa saturatior,* a conspicuous large wolf spider that comprised large parts of the catch, particularly in upstream areas. Most identification keys on Central European spiders characterise *Pardosa wagleri* and *Pardosa saturatior* as sibling species, with *Pardosa saturatior* being larger and occurring in higher altitudes than *Pardosa wagleri,* typically above 1000 m. However, BUCHAR (1981) reports occurrences of *Pardosa saturatior*i n limestone scree at altitudes between 700 and 800 m in Tyrol and DAHL (1908) already characterised *Pardosa saturatior* as a species of ephemeral alpine torrents regardless of altitude.

The gravel mining had detectable influences on the arthropod assemblages, which was not only apparent from the qualitative assemblage comparison in the ordination plots, but also from the assemblage quality index numbers. However, a statistically significant reduction in assemblage index numbers was not detected. This may have several reasons. Firstly, replication at the treatment level was limited since only two impacted and two control valleys were compared, consequently, the statistical power of the test was limited as well. Secondly, local peculiarities of the valleys influenced the assemblage quality to a substantial degree. For example, narrow valley channels often led to spillover of trivial forest species, which reduced the assemblage quality index numbers. Thirdly, after the rainy period in July 2012, erosion processes re-created a runoff channel in one of the impacted valleys (Weißenbachlgraben) that approached the ecological conditions in the mining-impacted valley closer to those of the control valleys. Fourthly, even in valley stretches strongly transformed by the gravel mining, the typical and characteristic species of ephemeral gravel valleys were still present, albeit in lower proportions than in non-impacted valleys. This offers good prospects for the further development of the valleys, as debris reshuffling, erosion and sedimentation processes might restore the valleys to a more natural state over time.

Conclusions

The transport of large amounts of scree and debris material is an important landscape-forming process in alpine regions. Protected areas allow the unfolding of such natural processes, even if they imply large-scale inundations and landscape transformation in the stream valleys. Ephemeral streams are side effects of debris accumulation in limestone mountain regions. They house species-poor yet specialised arthropod assemblages. The results of the present investigation highlight the need for a detailed investigation of the ecological and faunal consequences of natural landscape formation and erosion processes. In the valleys of the Gesäuse National Park, earlier impact from mining activities left traceable effects on the arthropod assemblages, but restoration to a fully natural state seems feasible.

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