Conference Volume	6th Symposium for Research in Protected Areas 2 to 3 November 2017, Salzburg	pages 369 - 372

Springs in the Bavarian National Parks as indicators for climate change

Gabriele Leonhardt, Linda Seifert, Reinhard Gerecke, Jörg Müller, Ralf Hotzy, Annette Lotz

Abstract

Springs are unique habitats colonized by particular, sensitive organismic communities. In protected areas, they remain mostly unaffected by disturbing factors other than the potential impact due to global warming. Based on long-term knowledge of spring recording and observation in Bavaria, in particular in the lime stone dominated Berchtesgaden National Park, we are developing a monitoring guideline for detecting the impact of a changing climate on springs. In order to check efficiency and applicability of the elaborated tools, the method is transferred to the Bavarian Forest National Park, where springs emerge from crystalline bedrock.

Keywords

spring, monitoring, climate change, National Park, Germany, Bavaria

Introduction

A spring is a characteristic element of the water balance and also a unique habitat for specialized biota. The emerging ground water is influenced by many factors: important are mineral composition, geologic stratification, altitude, storage conditions in the bedrock, the amount and distribution of precipitation in the catchment (Fig. 1). Of course, slope, substrata and flora in the immediate surroundings also impact the unique biotopes. All these factors form habitat conditions for particularly adapted species, often with restricted distribution areas. Particularly represented taxonomic groups are Acari, Mollusca, Microcrustaceans, or the Insect orders Trichoptera, Diptera, and Coleoptera (GERECKE & FRANZ, 2006; GERECKE et al., 2012).

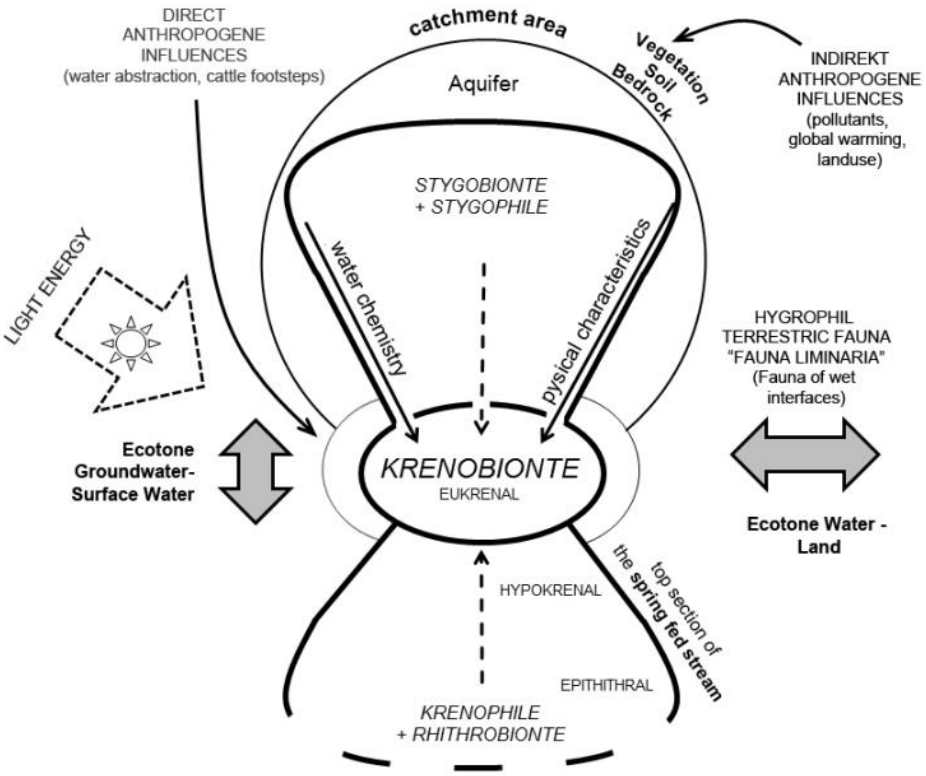

Figure 1: Factors influencing a spring habitat. The spring as an ecotone between groundwater and stream (after MARTIN et al, 2015)

Due to melting of permafrost, fluctuation of precipitation patterns, temperature shift and similar alterations potentially caused by changing climate (BAYERISCHES STAATSMINISTERIUM FÜR UMWELT UND VERBRAUCHERSCHUTZ, 2015, JYVÄSJÄRVI et al., 2015), spring waters and related invertebrate communities may also be affected in the future.
To detect changes in springs due to a possible climate change, a standardized monitoring method is required. Until now, no systematical methodology for documentation and long-term monitoring has been proposed for these unique habitats (CANTONATI et al, 2006). In order to fill this gap in our knowledge, we propose a set of tools to use the sensitivity of springs for indicating changes in climate. Such studies are best conducted in protected areas, where these habitats remain mostly unaffected by disturbing factors other than the potential impact due to global warming. The aim is to synthesize the previous knowledge and to develop a monitoring guideline.

In the Berchtesgaden National Park (BNP), hydrologists and biologists examined spring locations all over the area in the course of numerous research projects over a long time (GERECKE & FRANZ, 2006 and unpublished data) In the Bavarian Forest National Park (BFNP) locations of springs are known, but they were investigated under ecological aspects. Our methodology is developed mainly on the base of data available from a wide variety of springs at all elevations in BNP. In parallel, for verifying applicability and the potential for comparison of geologically differing areas our tools are applied in springs in all catchments of the BFNP. The process is accompanied by the Landesbund für Vogelschutz in Bayern e.V. (LBV), experienced over more than 20 years in spring monitoring and project leader of 'Aktionsprogramm Quellen', resulting in the development of a method to describe the structure of spring (BAYERISCHES LANDESAMT FÜR UMWELT, 2008a, 2008b)(Fig. 2).

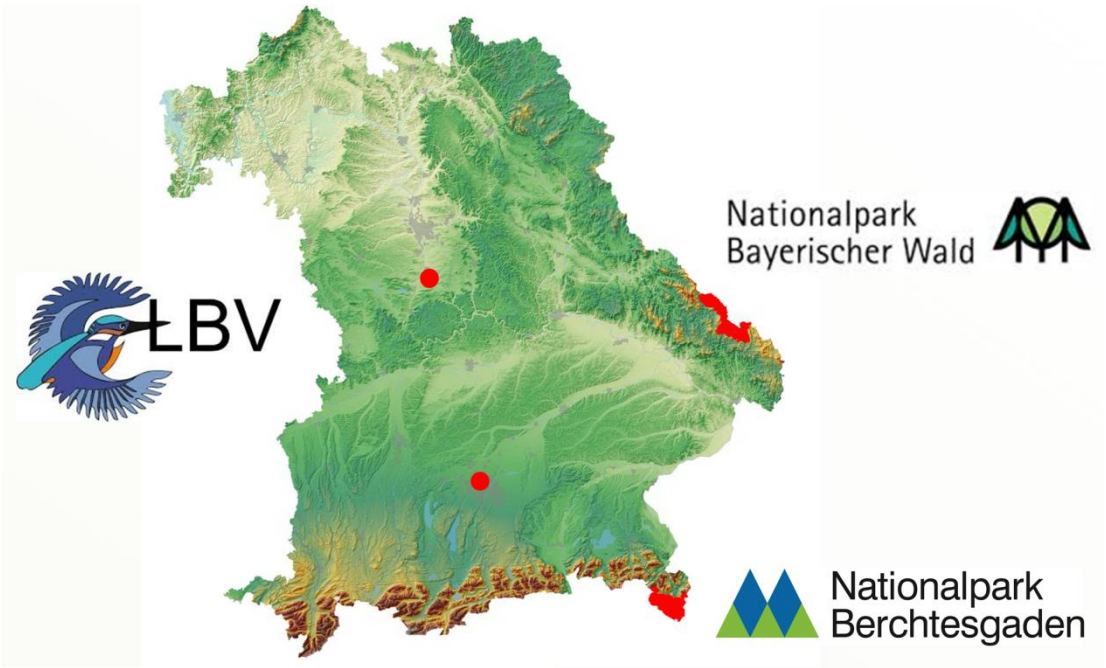

Figure 2: Project partners: Landesbund für Vogelschutz in Bayern e.V. (LBV), Berchtesgaden National Park (BNP) and Bavarian Forest National Park (BFNP). Data Source: FIN VIEW. Bayerisches Landesamt für Umwelt, www.lfu.bayern.de, Geobasisdaten @ Bayerische Vermessungsverwaltung, www.geodaten-bayern.de.

Methods

In BNP over 300 springs are recorded, for more than 100 locations information on structure, water quality and organismic communities is available. A synthesis of results from numerous research projects and time series of physicochemical data helps to develop a list of criteria for choosing the locations which are most significant for the life conditions in the area. Principal criteria are water quality parameters, structure and geographical altitude, discharge characteristics, but also accessibility. In a second step, information on genetic diversity of invertebrate communities which reflects all these parameters will be decisive for selecting a subset of the habitats most suitable for monitoring.

In BFNP, based on the existing knowledge of the river network, a set of 30 springs was selected for documentation. For each habitat, physical parameters, structural shape and fauna are examined. In a second step, based on the criteria elaborated in BNP, a subset of springs will be chosen.

Besides the morphological and molecular work of taxonomists to provide updated lists of the species occurring in the studied habitats, also metabarcoding techniques are used to describe the genetic diversity in both National Parks. From several taxonomic groups, species will be identified as indicator species on which future biogeographic work should concentrate. In this regard, particular ecological relations to spring habitats and specific distribution patterns are the principal criteria.

Our study will result in a general monitoring guideline for springs. The recommendations will encompass a list of criteria for choosing best suitable sites and their related indicator species, and proposals for setting up the monitoring in both National Parks. Furthermore a database model will be prepared to ensure sustainable future data management. After adaptations concerning the sets of indicator species, the guideline will be applicable also in other parts of Central Europe, and with regard to its principal elements also in all other parts of the continent.

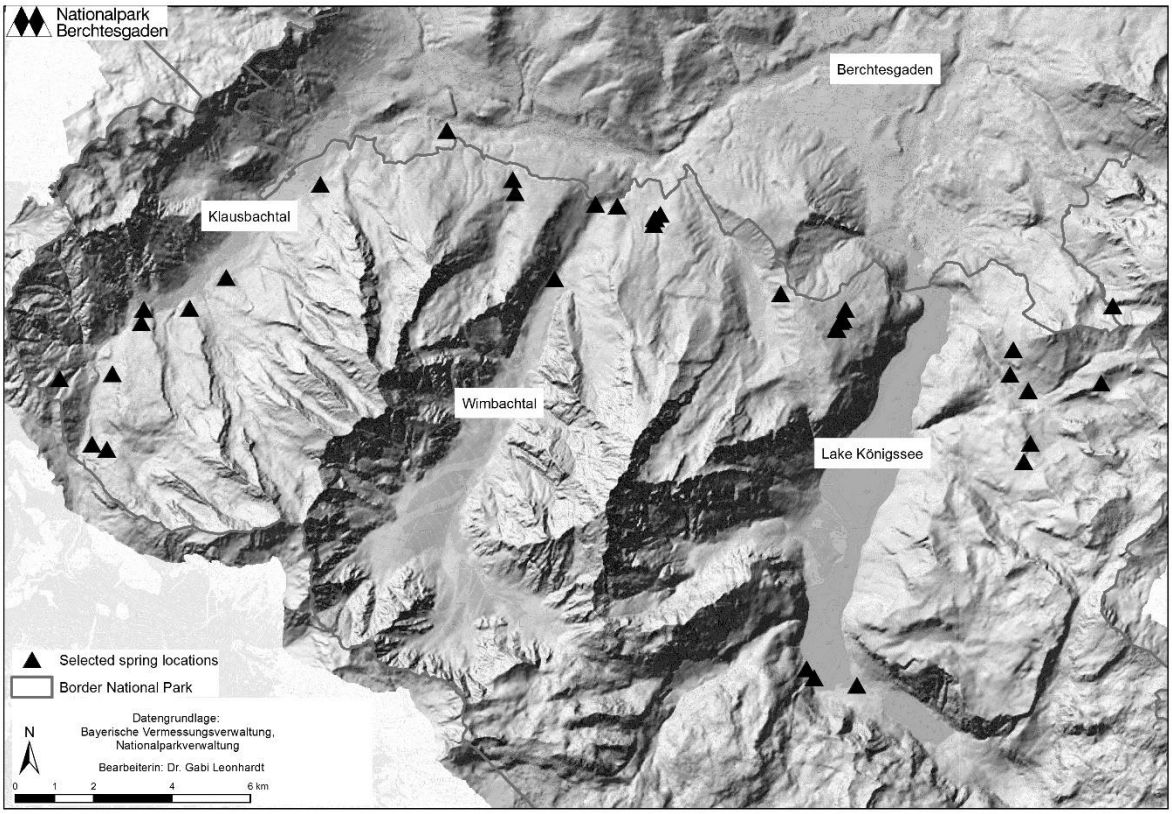

Figure 3: Selected springs in the Berchtesgaden National Park (Leonhardt).

Preliminary Results

For the field work in 2017, a set of 30 springs has been selected in the BNP and in BFNP. Fig. 2 shows the distribution of the springs chosen in the BNP. Principal factors for the selection were the availability of data from previous research projects and the extension of ongoing time series of data, respectively, but also structure, discharge, accessibility. The spring locations cover the three main valleys Klausbachtal, Wimbachtal and Königsseetal and are located at elevations from 600 to 1560 m asl. They are very heterogeneous regarding discharge stability of flow, structure and surrounding land use. As the next following step, based on the results of the taxonomic work including metabarcoding, a subset of 15 springs will be chosen for long term monitoring, and the database model will be set up. Based on the same abiotic and biological data, a subset of 15 springs will be identified in the BFNP as well.

Conclusion and Outlook

Springs are not only important elements in water balance, but also unique habitats inhabited by specialized biota. Possible climate change may cause an alteration of the habitat in the future, with potential effects on distribution patterns of many species. The aim of this project is to define standardized methods for selecting and observing springs in a given area suitable for a monitoring of these effects. The application of this monitoring guideline will produce a time series of selected parameters which later allow a statement about alterations and their possible connection to climate change. The method is developed in the Berchtesgaden and Bavarian Forest National Parks, but it is shaped in a manner that will allow its application also in all other areas of the Alps and Prealps.

References

BAYERISCHES LANDESAMT FÜR UMWELT, Hrsg. (2008a): Aktionsprogramm Quellen in Bayern. Teil 1: Bayerischer Quelltypenkatalog. Erarbeitet von RALF HOTZY und JULIA RÖMHELD vom Landesbund für Vogelschutz Bayern e.V (LBV) Bayern.

BAYERISCHES LANDESAMT FÜR UMWELT, Hrsg. (2008b): Aktionsprogramm Quellen in Bayern. Teil 2: Quellerfassung und -bewertung. Erarbeitet von RALF HOTZY und JULIA RÖMHELD vom Landesbund für Vogelschutz (LBV) Bayern.

BAYERISCHES STAATSMINISTERIUM FÜR UMWELT UND VERBRAUCHERSCHUTZ (STMUV), ed. (2015): Klima-Report Bayern 2015 - Klimawandel, Auswirkungen, Anpassungs- und Forschungsaktivitäten.

CANTONATI M., GERECKE R. & BERTUZZI E. (2006). Springs of the Alps – sensitive ecosystems to environmental change: from biodiversity assessments to long-term studies. – Hydrobiologia 562: 59-96.

GERECKE R. & FRANZ H., eds (2006): Quellen im Nationalpark Berchtesgaden. Lebensgemeinschaften als Indikatoren des Klimawandels. Forschungsbericht 51 der Nationalparkverwaltung Berchtesgaden.

GERECKE R.: HASEKE H.; KLAUBER J. MARINGER A., eds (2012): Quellen. Schriften des Nationalparks Gesäuse, 7 (Weng im Gesäuse): 1-391.

MARTIN, P.; GERECKE, R. & CANTONATI, M. (2015): Quellen. – pp. 49-132 in: BRENDELBERGER, H.; MARTIN, P.; BRUNKE, M. & HAHN, H.J. (eds): Grundwassergeprägte Lebensräume. Eine Übersicht über Grundwasser, Quellen, das hyporheische Interstitial und weitere grundwassergeprägte Habitate. Limnologie aktuell 14, Schweizerbart (Stuttgart)

JYVÄSJÄRVI J., MARTTILA H., ROSSI P., ALA-AHO P., OLOFSSON B.; NISELL J., BACKMAN B., ILMONEN J,. VIRTANEN R.; PAASIVIRTA L.; BRITSCHGI R.; KLØVE B. & MUOTKA T. (2015): Climate-induced warming imposes a threat to north European spring ecosystems. Global Change Biology 21 (12): 4561-4569.

Contact

Gabriele Leonhardt, Annette Lotz
gabriele.leonhardt@npv-bgd.bayern.de
Berchtesgaden National Park
Doktorberg 6
83471 Berchtesgaden
Germany

Linda Seifert, Jörg Müller
Bavarian Forest National Park
Freyunger Straße 2
94481 Grafenau
Germany

Ralf Hotzy
Landesbund für Vogelschutz in Bayern e.V.
Eisvogelweg 1
91161 Hilpoltstein
Germany

Reinhard Gerecke
Universität Tübingen
Institute of Evolution & Ecology
Auf der Morgenstelle 28
72076 Tübingen
Germany