Conference Volume	5th Symposium for Research in Protected Areas 10 to 12 June 2013, Mittersill	pages 789 - 794

From Research of the Carpathian Beech Virgin Forests to the World heritage

Ivan Vološčuk

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.

Acknowledgements

This study was supported by the grant from the Agency for Science and Research APVV No 0190-12 and Grant Agency for Science VEGA No 1/0172/12.

References

AKEROYD, J. R. 1993. Fagus L. In: TUTIN, T. G., HEYWOOD, V. H., BURGES, N. A., VALENTINE, D. H. & D. M. MOORE eds. Flora Europea, Vol. 1. 2nd Ed. Cambridge, UK: Cambridge University Press. 72 pp.

ASSMANN, T., DREES, C., SCHRODER, E. & A. SSYMANK 2008. Low species diversity of beech forests – a myth. In: KNAPP, H. D. (ed.), Beech Forests – a German contribution to the global forest biodiversity. Bonn: Bundesampt für Naturschutz (BfN), Federal Agency for Nature Conservation, Skripten 233: 25-31.

BALANDINA, A., LOVÉN, L., OSTERMANN, O. & R. PARTINGTON 2012. European Charter Parks – a growing network for sustainable tourism development in Protected Areas. PARKS, the International Journal of Protected Areas and Conservation. Volume 18: 2, Gland, Switzerland: IUCN. ISSN 0960-233X.

BARBIER, S., GOSSELIN, F. & P. BALANDIER 2008. Influence of tree species on understory vegetation diversity and mechanisms involved - A critical review for temperate and boreal forests. Forest ecology and management 254 (1): 1–15.

BARNA, M., KULFAN, J. & E. BUBLINEC (eds). 2011. Buk a bukové ekosystémy Slovenska [Beech and Beech Ecosystems of Slovakia]. Bratislava: VEDA vydavateľstvo Slovenskej akadémie vied. 636 pp. ISBN 978-80-224-1192-9.

BENNETT, G. (ed.). 1994. Conserving Europe´s Natural Heritage: Towards a European Ecological Network. London: Graham and Trotman, UK, 334 pp.

BENNETT, A.F. 1998. Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation. IUCN, Gland, Switzerland and Cambridge, UK. 254 pp. ISBN 2-8317-0221-6.

BISHOP, K., DUDLEY, N., PHILLIPS, A. & S. STOLTON 2004. Speaking a Common Language. The uses and performance of the IUCN System of Management Categories for Protected Areas. Cardiff University, IUCN – The World Conservation Union and UNEP – World Conservation Monitoring Centre. 191 pp.

BJÖRNSEN GURUNG, A., BOKWA, A., CHELMICKI, W., ELBAKIDZE, M., HIRSCHMUGL, M., HOSTERT, P., IBISCH, P., KOZAK, J., KUEMMERLE, T., MATEI, E., OSTAPOWICZ, K., POCIASK-KARTECZKA, J., SCHMIDT, L., VAN DER LINDEN, S. & M. ZEBISCH 2009. Global Change Research in the Carpathian Mountain Region. Mountain Research and Development 29 (3): 282-288. doi: 10.1659/mrd.1105.

BOHN, U. & R. NEUHÄUSL 2003. Karte der natürlichen Vegetation Europas – Masstab 1 : 2 500 000. Hrsg. Bundesamt für Naturschutz, Bonn-Bad Godesberg.

BRÄNDLI, U.- B. & Y. DOWHANYTSCH (eds.). 2003. Urvälder im Zentrum Europas. Birmensdorf, Switzerland: Eidgenössische Forschungsanstalt WSL; Rakhiv, Ukraine: Karpaten-Biosphärenreservat. Bern, Stuttgart, Wien, Haupt. 192 pp. ISBN 3-905621-09-6.

BRANG, P. 2005. Virgin Forests as a Knowledge Source for Central European Silviculture: Reality or Myth ? Forest Snow and Landscape Research, 79 (1/2), p. 19 – 31.

BRITZ, H., DIECKMANN, O., ENGELS, B., FREDE, A., GEISEL, T., GROSSMANN, M., KAISER, K., KNAPP, H. D., LUTHARDT, M. E. & J. SEURING 2009. Nomination of the "Ancient Beech Forests of Germany" as Extension to the World Natural heritage "Primeval Beech Forests of the Carpathians". Nationale Naturlandschaften, Federal Republic of Germany. Specialised editing Cognitio Kommunikation & Planung, Niedenstein. 180 pp.

BUBLINEC, E. & V. PICHLER 2001. Slovak Primeval Forests - Diversity and conservation. Zvolen: Ústav ekológie lesa SAV, 196 pp.

CAPOTORTI, G., DEL VICO, E., LATTANZI, E., PERSIANI, A.M., RAVERA BLASI, C., MARCHETTI, M., CHIAVETTA, U., ALEFFI, M., AUDISIO, P., AZZELLA, M.M., BRUNIALTI, G., S., TILIA, A. & S. BURRASCANO 2010. Multi-taxon and forest structure sampling for identification of indicators and monitoring of old-growth forest. Plant biosystems 144 (1):160–170.

CEBALLOS-LASCURÁIN, H. 1996. Tourism, ecotourism and protected areas: The state of nature based tourism around the world and guidelines for ist development. IUCN, Gland, Switzerland, and Cambridge, UK. 301 pp. ISBN: 2-8317-0124-4.

COMMARMOT, B., DUELLI, P. & V. CHUMAK 2000. Urwaldforschung – Beispiel Biosphärenreservat Transcarpatien. Birmensdorf, Switzerland: Naturwerte in Ost und West. Publ. zur Tagung "Forum fuer Wissen", WSL, p. 61–68.

COONEY, R. 2004. The Precautionary Principle in Biodiversity Conservation and Natural Resource Management: An issue paper for policy-makers, researchers and practitioners. IUCN, Gland, Switzerland and Cambridge, UK. 51 pp.

ČEŘOVSKÝ, J.(ed.). 1996. Biodiversity Conservation in Transboundary Protected Areas in Europe. Praha: ECOPOINT Foundation. 107 pp.

DENISIUK, Z. & S. STOYKO 2000. The East Carpathians Biosphere Reserve (Poland, Slovakia, Ukraine). In: BREYMAYER, A. & DABROWSKI, P. (eds.): Biosphere Reserves on Borders. Warsaw: National UNESCO – MAB Committee of Poland, p. 79–93.

DIERSCHKE, H. & U. BOHN 2004. Eutraphente Rotbuchenwälder in Europa. Tuexenia 24: 19-58.

DÖRFELT, H. 2008. Fungi of beech forests. In: KNAPP, H. D. (ed), Beech Forests – a German contribution to the global forest biodiversity. Bonn: Bundesampt für Naturschutz (BfN), Federal Agency for Nature Conservation. Skripten 233: 33-36.

DRÖSSLER, L. 2006. Stand structure and gaps of virgin beech forests in Slovakia. In: Beech sylviculture in Europe´s Largest Beech Country. Proceedings of IUFRO Conference, Poliana Brasov, 4. – 8. 9. 2006, p. 18-20.

DRÖSSLER, L. & B. LUPKE 2005. Canopy gaps in two virgin beech forest reserves in Slovakia. J. For. Sci. 51: 446-457.

DUDLEY, N. & A. PHILLIPS 2006. Forest and Protected Areas: guidance on the use of the IUCN protected area management categories. IUCN, Gland, Switzerland and Cambridge, UK. 58 pp.

EAGLES, P.F.J., MCCOOL, S.F. & Ch.D. HAYNES 2002. Sustainable Tourism in Protected Areas: Guidelines for Planning and Management. IUCN Gland, Switzerland and Cambridge, UK. 183 pp.

EUROPARK Federation. 1993. Lowing Them to Death? Sustainable Tourism in Europe´s Nature and National Parks. Revised and Republished 2001, by EUROPARK Federation, Grafenau, Germany.

EUROPARK and IUCN. 2000. Guidelines for Protected Area Management Categories – Interpretation and Application of the Protected Area Management Categories in Europe. EUROPARK and WCPA, Grafenau, Germany. 48 pp.

FALKENGREN-GRERUP, U. & G. TYLER 1991. Dynamic floristic changes of Swedish beech forest in relation to soil acidity and stand management. Vegetatio 95:149-158.

GEBHARD, K., MEYER, M. & S. ROTH 2007. Sustainable tourism Management Planning in Biosphere Reserve – A methodology guide. Ecological Tourism in Europe, Bonn, Germany and UNESCO MAB, 63 pp.

GIURGIU, V., DONITA, N., BÂNDIU, C., RADU, S., CENUSA, R., DISSESCU, R., STOICULESCU, C. & A. IOVU 2001. Les Forêts Vierges de Roumanie. Asbl. Forêt Wallonne. 206 pp.

GÖMÖRY, D., KUKLA, J. & B. SCHIEBER 2011. Taxonómia, fylogenéza a rozšírenie buka v Európe a na Slovensku [Taxonomy, phylogeny and distribution of beech in Europe and in Slovakia]. In: BARNA, M., KULFAN, J., BUBLINEC, E. (eds.), Buk a bukové ekosystémy Slovenska [Beech and Beech Ecosystems of Slovakia]. Bratislava: VEDA vydavateľstvo Slovenskej akadémie vied, p. 19-36.

GROSSMANN, M., HAMOR, F. & I. VOLOŠČUK 2012. UNESCO World Natural Heritage Site „Primeval Beech Forests of the Carpathians and the Ancient Beech Forests of Germany". BfN Skripten, 33-43. Bonn – Bad Godesberg.

HAMILTON, L. S., MACKAY, J. C., WORBOYS, G. L., JONES, R. A. & G. B. MANSON 1996. Transborder protected area cooperation. Canberra: Australian Alps Liaison Committee, IUCN, 64 p. ISBN 0-642-26412-0.

HAMILTON, L. & L. MCMILLAN 2004. Guidelines for Planning and Managing Mountain Protected Areas. IUCN, Gland, Switzerland and Cambridge, UK. 83 pp.

HAMOR, F. & B. COMMARMOT (eds.). 2003. Natural Forests in the Temperate Zone of Europe – Values and Utilisation. International Conference in Mukachevo, Transcarpathia, Ukraine, October 13 – 17, 2003. Rakhiv, Ukraine: Carpathian Biosphere Reserve, Birmensdorf, Switzerland: Swiss Federal Research Institute WSL. 276 pp.

HOCKING, M., STOLTON, S. & N. DUDLEY 2000. Evaluating Effectiveness: A Framework for Assessing the Management of Protected Areas. IUCN, Gland, Switzerland and Cambridge, UK. 121 pp.

HOCKING, M., STOLTON, S., LEVERINGTON, F., DUDLEY, N. & J. COURRAU 2006. Evaluating Effectiveness: A Framework for Assessing the Management of Protected Areas. 2nd edition. IUCN, Gland, Switzerland and Cambridge, UK. 105 pp. ISBN: 97-2-8317-0939-0.

IUCN/UNEP/WWF 1991. Caring for the Earth. Gland, Switzerland, 228 pp.

IUCN 1994. Guidelines for Protected Area Management Categories. CNPPA with the assistance of WCMC. IUCN, Glang, Switzerland and Cambridge, UK. 261 pp.

IUCN WCPA 2000. Financing Protected Areas. IUCN, Gland, Switzerland and Cambridge, UK. 58 pp.

JAWORSKI, A., SKRZYSZEWSKI, J. & M. PACH 1994a. Characteristic of Acer pseudoplatanus L. and Fagus sylvatica L. virgin type forests in Bieszczady National Park. In: VOLOŠČUK, I. (ed). Research and Management of the Carpathian Natural and Primeval Forests. Ustrzyki Gorne, Poland: Bieszczady National Park, Association of the Carpathian National Parks and Protected Areas, p. 40-49.

JAWORSKI, A., KACZMARSKI, J., SKRZYSEWSKI, J. & W. SWIATKOWSKI 1994b. Structure and dynamics of lower subalpine timber stands of Carpathian Mts of primeval character. In: VOLOŠČUK, I. (ed). Research and Management of the Carpathian Natural and Primeval Forests. Ustrzyki Gorne, Poland: Bieszczady National Park, Association of the Carpathian National Parks and Protected Areas, p. 23-39.

JAWORSKI, A. & Z. KOLODZIEJ 2004. Beech (Fagus sylvatica L.) of a selection structure in the Bieszczady Mountains (southeastern Poland). Journal of Forest Science, 50: 301-312.

KNAPP, H. D. 2011. European beech forests and their biogeographical position. In: KNAPP, H. D. & FICHTNER, A. (eds). Beech Forests. Joint Natural Heritage of Europe. Bonn: Bundesampt für naturschutz (BfN), Federal Agency for Nature Conservation. Skripten 297: 9-14. ISBN 978-3-89624-032-3.

KOOP, H. & P. HILGEN 1987. Forest dynamics and regeneration mosaic shift in unexploited beech (Fagus sylvatica) stands at Fontainebleau (France). For. Ecol. Manag. 20: 135-150.

KORPEĽ, Š. 1982. Degree of equilibrum and dynamical changes of the forest on example of natural forests of Slovakia. Acta Fac. Forest. Zvolen 24:9-30.

KORPEĽ, Š. 1989. Pralesy Slovenska [The Primeval Forests of Slovakia] . Bratislava: VEDA, 332 pp. ISBN 80-224-0031-9.

KORPEĽ, Š. 1995. Die Urwälder der Westcarpaten. Stuttgart: Fischer Verlag, 310 pp.

KOZAK, J., ESTREGUIL, C. & P. VOGT 2007. Forest cover changes in the northen Carpathians in the 20th century: A slow transition. Journal of Forest Research 126: 77-90.

KRICSFALUSY, V., IVANEHA, I., LUGOVOJ, A., BUDNIKOV, G., MEZŐ-KRICSFALUSY, G., MATELESHKO, A., POPOV, S., SYVOKHOP, J., PAVLEJ, J. & I. LESJO 2001. Uzhanskyi National Nature Park. Uzhgorod: Karpaty, 117 pp. ISBN 966-7781-08-9.

KUEMMERLE, T., HOSTERT, P., RADELOFF, V.C., VAN DEN LINDEN, S., PERZANOWSKI, K., & I. KRUHLOV 2008. Cross-border comparison of post-Socialist farmland abondonement in the Carpathians. Ecosysterms 11: 614-628.

LE GOFF, J. (ed.) 1990. Medieval Callings. London: The Chicago University Press, Ltd., 392 pp.

LEIBUNDGUT, H. 1978. Über die Dynamik europäicher Urwälder. All. Forstzeitschr., 24: 686-690.

LEIBUNDGUT, H. (1982). Europäische Urwälder der Bergstufe. Bern/Stuttgart: Haupt. 306 pp.

LEIBUNDGUT, H. 1993. Europäische Urwälder: Wegweiser zur naturnahen Waldwirtschaft. Verlag Haupt. Bern und Stuttgart. 260 pp.

LEVREL, H. 2007. Selecting indicators for the management of biodiversity. Institut francais de la biodiversité, Paris, France, 93 pp.

LOCKWOOD, M., WORBOYS, G.L. & A. KOTHARI 2006. Managing Protected Areas: A Global Guide. London, UK: IUCN and Earthscan.

MAGRI, D., VENDRAMIN, G. G., COMPS, B., DUPANLOUP, I., GEBUREK, T., GÖMÖRY, D., LATALOWA, M., LITT, T., PAULE, L., ROURE, J. M., TANTAU, I., VAN DER KNAAP, W., O., PETIT, R., J., DE BEAULIEU, J., L. 2006. A new scenario for the Quaternary history of European beech populations: paleobotanical evidence and genetic consequences. New Phytol., 171: 199 – 222.

MANOS, P. S. & A. M. STANFORD 2001. The historical biogeography of Fagaceae: tracking the Tertiary history of temperate and subtropical forests of the northern hemisphere. Int. J. Ol. Sci., 162: 77 – 93.

MEYER, P. 1999. Determination of development phases and diversity of forest texture. Allgemeine Forst und Jagdzeitung 170: 203-211.

MÖLDER, A., BERNHARDT-RÖMERMANN, M. & W. SCHMIDT 2008. Herb-layer diversity in deciduous forests: Raised by tree richness or beaten by beech? Forest Ecology and Management 256:272–281

OHEIMB, G., WESTPHAL, C., TEMPEL, H. & W. HARDTLE 2005. Structural pattern of a near-natural beech forest (Fagus sylvatica) (Serrahn, North-east Germany). For. Ecol. Manag 212: 253-263.

OTTO, H. 1994. Waldökologie. Stuttgart: Verlag Eugen Ulmer.

PETERSON, G., ALLEN, C.R. & C.S. HOLLING 1998. Ecological Resilience, Biodiversity, and Scale. Ecosystems, 1, p. 6-18.

PHILLIPS, A. (ed.). 2000. Financing Protected Areas. Guidelines for Protected Area Managers. IUCN, Gland, Switzerland. 58 pp.

PHILLIPS, A. 2002. Management Guidelines for IUCN Category V Protected Areas, Protected Landscapes/Seascapes. IUCN, GLand, Switzerland and Cambridge, UK. 122 pp.

PICHLER, V. & M. SOROKOVÁ 2005. Utilisation of natural Forests for Ecotourism: Matching the goals and Reality. Forest Snow and Landscape Research, 79, 1/2, pp. 185–194.

PICHLER, V., HAMOR, F., VOLOŠČUK, I. & D. SUKHARYUK 2007a. Outstanding universal value of the ecological processes in the primeval beech forests of the Carpathians and their management as World Heritage Sites. Acta Ecologica. Bratislava: VEDA, 62 pp. ISBN 978-80-224-0993-3.

PICHLER, V., VOLOŠČUK, I. & E. BUBLINEC 2007b. Designation of corridors connecting primeval forests properties within the East Carpathian Biosphere Reserve (Slovak Part). In: GUZIOVÁ, Z. (ed). Priorities for Conservation of Biodiversity in Biosphere Reserves in changing conditions. Proceedings from the International Conference, Stará Lesná, Tatry Biosphere Reserve, Slovakia, 2-6 June. Bratislava: Slovak National Committee for UNESCO MAB Programme, p.121-126. ISBN 978-80-89325-00-9.

PLACHTER, H., HOFFMANN, A., PANEK N. & P.A. SCHMIDT 2008. European Beech forests as a Natural site on the World Heritage List of UNESCO. In: KNAPP, H. D. (ed.), Beech Forests – a German contribution to the global forest biodiversity. Bonn: Bundesampt für Naturschutz (BfN), Federal Agency for Nature Conservation. Skripten 233: 53-60.

PRETZSCH, H. 2003. The elasticity of growth in pure and mixed stands of Norway spruce (Picea abies [L.] Karst.) and common beech (Fagus sylvatica L.). Journal of Forest Science, 49 (11): 491-501.

SANDWITH, T., SHINE, C., HAMILTON, L. & D. SHEPPARD 2001. Transboundary Protected Areas for Peace and Co-operation. IUCN, Gland, Switzerland and Cambridge, UK. 111 pp.

SANIGA, M. 2002. Štruktúra, produkčné pomery a regeneračné procesy bukového pralesa Rožok [Structure, production conditions and regeneration processes of the beech virgin forest Rožok]. Banská Bystrica: Ochrana prírody 21: 207-218.

SANIGA, M. 2003. Štruktúra, produkčné pomery a regeneračné procesy bukového pralesa Havešová [Structure, production conditions and regeneration processes of the beech virgin forest Havešová]. Banská Bytrica: Ochrana prírody 22: 179-190.

SANIGA, M. 2011. Primeval beech forests. In: BARNA, M., KULFAN, J., BUBLINEC, E. (eds). Beech and Beech Ecosystems of Slovakia. Bratislava: VEDA, p. 209-226. ISBN 978-80-224-1192-9.

SANIGA, M. & V. KLIMAŠ 2004. Štruktúra, produkčné pomery a regenerácia bukového pralesa Stužica v 4. lesnom vegetačnom stupni [Structure, production conditions and regeneration processes of the beech virgin forest Stužica in 4. forest vegetation stage]. Acta Fac. For. Zvolen 46: 93-104.

SANIGA, M. & J. Ph. SCHÜTZ 2001. Dynamik das Totholzes in zwei gemischten Urvädern der Westkarpaten in pflanzengeographischen Bereich der Tannen-Buchen und der Buchenwälder in verschidenen Entwicklugsstadien. Schweitz. Z. Forstwes. 152: 407- 416.

SANIGA, M. & J. Ph. SCHÜTZ 2002. Relation of dead wood course within the development cycle of selected virgin forests in Slovakia. J. For. Sci., 48, p. 513 – 528.

SANIGA, M. & P. SKLENÁR 2003. Štruktúra, produkčné a regeneračné procesy bukového pralesa v Národnej prírodnej rezervácii Oblík [Structure, production and regeneration processes of the beech virgin forest in National Nature Reserve Oblík]. Acta Fac. For. Zvolen 45: 169-178.

STOLTON, S. & N. DUDLEY (eds.). 1999. Partnership for protection. Earthscan, London, UK.

STOLTON, S., DUDLEY, N. & SHADIE, P. 2012. Managing Natural World Heritage. UNESCO, ICCROM, ICOMOS, IUCN. Gland, Switzerland. ISBN 978-92-3-001075-1.

STOLTON, S., HOCKINGS, M., DUDLEY, N., MACKINNOM, K. & T. WRITTEN 2003. Reporting Progress in Protected Areas. A site-Level Management Effectiveness Tracking Tool. World Bank Washington, USA/WWF Alliance for Forest Conservation and Sustainable Use. Gland, Switzerland, 21 pp.

STOYKO, S. 2002. Pralisovi ekosystemy Ukrajiny, jich polifunkcionalne znacenja dlja ochorony pryrody. [The Virgin Ecosystems of Ukraine, their polyfunctional significance for nature protection]. Lviv, Ukraine: Naukovi praci Lisivničoji akademii nauk Ukrajiny, p. 27-31.

STOYKO, S., SAYIK, D.S., TATARINOV, K.A., TRETYAK, P.R., TASENKEVITSCH, L.O., MALINOVSKIJ, K.A., SCHEWTSCHENKO, S.V., SUKHARIUK, D.D., MILKINA, L.I., KOMENDAR, V.I., MILLER, M.P. & M.P. MANYIKO 1982. The Carpathian Reserve. Uzhgorod, Ukraine: Karpaty, 128 pp.

STOYKO, S. & L. TASENKEVITCH 1993. Some aspects of endemism in the Ukrainian Carpathians. Fragm. Flor. Geobot. Suppl. 2 (1): 343-353.

SYNGE, H. 2004. European Models of Good Practice in Protected Areas. IUCN, Gland, Switzerland and Cambridge, UK an the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management. 32 pp.

THOMAS, L. & J. MIDDLETON 2003. Guidelines for Management Planning of Protected Areas. IUCN Gland, Switzerland and Cambridge, UK, 79 pp.

TURNOCK, D. 2002. Ecoregion-based conservation in the Carpathians and the land use implications. Land Use Policy 19: 47-63.

UDVARDY, M. 1975. A Classification of Biogeographical Provinces of the World. IUCN Occasional Paper No.18. IUCN, Morges, Switzerland.

VOLOŠČUK, I. 1992. Biological diversity in the Carpathians. Oecologia Montana, 1992, No.2: 43-47.

VOLOŠČUK, I. 1994. Conservation and Rational Use of Forest ecosystems in Carpathian Mountains. In: VOLOŠČUK, I. (ed.). Research and Management of the Carpathian Natural and Primeval Forests. Ustrzyki Gorne, Poland: Bieszczady National Park, Association of the Carpathian National Parks and Protected Areas, p. 5-10

VOLOŠČUK, I. 1995. Long-term Ecological Research and Monitoring on Carpathian National Parks and Biosphere Reserves. In: HAMOR, F., VOLOŠČUK, I. (eds.). Metods o monitoring of the nature in the Carpathian National Parks and Protected Areas. Rakhiv, Ukraine: Carpathian Biosphere Reserve, Association of the Carpathian National Parks and Protected Areas, p.10-22.

VOLOŠČUK, I. (ed.). 1999. The National Parks and Biosphere Reserves in Carpathians. The Last Nature Paradises. Tatranská Lomnica, Slovak Republic: ACANAP. 244 p. ISBN 80-88680-31-X.

VOLOŠČUK, I. 2003. The geobiocenological research in the natural forest ecosystems of the Carpathian protected areas. The Monographical Studies on National Parks 3. Tatranská Štrba, Slovak Republic: State Nature Conservancy, Tatry National Park Administration. 122 pp.

WILSHUSEN, P.R., BRECHIN, S.R., FORTWANGLER, C.L. & P.C. WEST 2002. Reinvesting a Square Wheel: Critique of Resurgent „Protection Paradigm" in International Biodiversity Conservation. Society and Natural Resources, 15, p. 17-40.

ZBICZ, D.C. & M.J.B. GREEN 1997. Status of the world´s transfrontier protected areas. Parks, 7 (3), pp. 5 – 10.

ZLATNÍK, A. 1934. Studie o státních lesích na Podkarpatské Rusi. Díl první. Příspěvek k dějinám státních lesů a lesnictví na Podkarpatské Rusi. [The Study of the State Forests in Transcarpathian Ruthenia. First Volume. The Contribution to the history of state forests and forestry in Transcarpathian Ruthenia]. Praha: Zborník výzkumných ústavů zemědělských ČSR, Ministerstvo zemědělství republiky Československé, sv. 126, 109 p.

ZLATNÍK, A. 1935. Studie o státních lesích na Podkarpatské Rusi. Díl druhý. Přírodní podmínky státních lesů a polonin na Podkarpatské Rusi. Díl třetí. Vývoj a složení přirozených lesů na Podkarpatské Rusi a jejich vztah ke stanovišti. [The Study of the State Forests in Transcarpathian Ruthenia. Second Volume and Third Volume]. Praha: Sborník výzkumných ústavů zemědělských ČSR, Ministerstvo zemědělství republiky Československé, sv. 127, 206 p.

ZLATNÍK, A. 1936. "Lužanský prales" na Podkarpatské Rusi, největší československá pralesová reservace. [Luzhanskyi Virgin Forest in Subcarpathian Ruthenia, the largest Czechoslovakian Firgin Forest]. Praha: Krása našeho domova, ročník 28, p. 110 – 118.

ZLATNÍK, A. & A. HILITZER 1932. Přehled přírodních reservací a jejich návrhů v Podkarpatské Rusi [The Review of Nature Reserves and their proposals in Transcarpathian Ruthenia]. Praha: Sborník Masarykovy akademie práce, VI, No. 2, p. 33-84.

ZLATNÍK, A., KORSUŇ, F., KOČETOV, F. & M. KSENEMAN 1938. Průzkum přirozených lesů na Podkarpatské Rusi. Díl první. [The Investigation of Natural Forests in Transcarpathian Ruthenia. First Volume]. Brno: Sborník výskumných ústavů zemědělských ČSR, Ministerstvo zemědělství republiky Československé, sv. 152, 525 pp.

ZUKRIGL, K., ECKHARDT, G. & J. NATHER 1963. Standortskundliche und waldbauliche Untersuchungen in Urwaldresten der niederösterreichischen Kalkalpen. Mitteilungen der forstlichen Bundesversuchsanstalt. Wien.

Contact

Prof. Dr. Ivan Vološčuk
ivoloscuk@azet.sk

Matej Bel University
Faculty of Natural Sciences
Institute for Research of Landscape and Regions
Cesta na amfiteáter 1
974 00 Banská Bystrica
Slovak Republic