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Bridging the research-practice gap: conservation research priorities in a Central and Eastern European country

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Abstract

Halting biodiversity loss is a critical aim for the forthcoming decades, but is hindered by the gap between research and practice. Bridging this gap is a significant challenge in the countries of Central and Eastern Europe, where, compared to Western European countries, biodiversity is higher but the research budget is lower. Approaches to address bridging this gap include participatory research prioritizing exercises. These demand-driven collaborative ranking processes have proven to be a useful tool in providing a research agenda derived from a review of critical challenges based on stakeholder engagement. However, for research agendas to be effectively realized, they are best developed and implemented at the operative level of research financing and implementation. This paper shows the process and the outcome of an exercise conducted in Hungary aiming to compile the most important conservation research questions at the country-level and outlines a set of further measures and tools required for dissemination and advocacy for the research agenda. During the process 792 research questions were collated from conservation practitioners and natural resource managers based on interviews and via an online questionnaire; the final 50 most important questions were identified by practitioners and policy makers during an expert workshop. Questions are embedded in global and EU biodiversity targets and imply a pragmatic approach with the aim of identifying research that supports policy- and decision-making regarding habitat management, land-use and regional development, while also focussing on conflicting issues. The outcome of the process includes the potential for lobbying, therefore post-publication activities and dissemination strategies are outlined as an integrated part of the exercise.

Keywords: participatory research; research priority; conservation management; interdisciplinarity; dissemination strategy.

Introduction

Although the knowledge generated by conservation science has increased exponentially over recent decades (Rands et al. 2010), biodiversity loss has still not been halted, despite the ever-growing amount of evidence regarding its importance (Balmford & Cowling 2006, Butchart et al. 2010; Cardinale et al. 2012). One of the main reasons for this failure is the gap between conservation research and practice, as identified by an escalating number of papers in recent years (Arlettaz et al. 2010, Braunisch et al. 2012, Laurance et al. 2012, Pullin et al. 2004, Pullin et al. 2009). The recent development of systematic reviews and synopses (e.g. Dicks et al. 2013, Pullin & Knight 2009, Sutherland et al. 2004, Williams et al. 2013) help bridge the gap between academics and practitioners by providing critically reviewed, reliable and easily accessible information for evidence-based conservation practice, management and policy (Habel et al. 2013, Knight et al. 2008). In addition to ensuring the availability of scientific knowledge to practitioners by facilitating information flow from the scientific community to the practitioners, there is also a need for a reverse information flow from the practitioners towards the academics to increase the relevance of research. This can be achieved by initiating a participatory research agenda setting involving practitioners and stakeholders with a degree of academic' input (Sutherland et al 2011). In these participatory exercises research needs of practitioners (i.e. gaps in their knowledge) are taken into account when identifying research priorities, thus the research agenda setting process becomes more responsive to actual knowledge demands (Sutherland et al. 2009). Participatory methods have gained increasing recognition in identification of research priorities in conservation science since the first such exercise, carried out in the UK by Sutherland et al. (2006). In the past decade a number of similar initiatives have been conducted globally (Parsons et al. 2014, Sutherland et al. 2009) and regionally in the United States (Fleishman et al. 2011), Canada (Rudd et al. 2011), the Alps (Walzer et al. 2013) and in Switzerland (Braunisch et al. 2012). In addition to these ranking exercises, thematic and sectoral research priorities have been identified in the fields of forest management (Petrokofsky et al. 2010), agriculture (Pretty et al. 2010), invasive species (Matzek et al. 2013) and paleo-ecology (Seddon et al. 2014).

As demand-driven research prioritizing can contribute to a more effective allocation of research funding to address real-life problems in conservation (Stroud et al. 2014), it promises significant social and economic benefits at a range of scales and levels. In order to realize these benefits, research agendas *i)* have to be developed at the operative level of research financing and implementation and *ii)* have to be successfully channelled into research finance and strategic development. Thus, while thematic, regional and global research agenda setting exercises are invaluable in providing a comprehensive review of critical challenges, these large-scale research strategies have to be realized at an operative administrative scale, most probably at the country-level. However, although the popularity of this approach is growing, there have been few participatory identification of research priorities within individual countries. Furthermore, although effective dissemination of the results should be an integral part of these exercises (e.g. Braunisch et al. 2012), in many cases this is not described in the published studies leaving it unclear as to the extent to which dissemination occurs.

This method especially needs applying in Central and Eastern European countries where research and development expenditures are substantially below the EU average (Abbott & Schiermeier 2014). Moreover, within the post-soviet countries, Hungary is behind Slovenia, Estonia and the Czech Republic in terms of research and development expenditures in the proportion of GDP, and far behind other CEE countries in the employment in research and development (as the proportion of the whole population) as presented by Płoszaj & Olechnicka (2015). Furthermore, the state support for nature conservation is increasingly constrained (Kovács et al. 2014). The gap between research and practice in conservation in Hungary has been identified in a few studies in recent decades (Margóczi et al. 1997, Mihók & Standovár 2001). Research collaboration between academics and practitioners

has been successfully established in different regions, and at various scales, and is further facilitated by the launch of the Hungarian Conservation Biology Conference series (see for example Báldi et al. 2009). There is, however, a lack of a national-scale assessment of the research needs in Hungary, based on a wide involvement of conservation practitioners, decision-makers and managers. Improved management of biodiversity in Hungary would be desirable, as biodiversity is still relatively diverse and relatively unaffected by the agricultural intensification that has dominated many western European countries.Thus less management efforts are required to attain high benefits for nature – similar to other countries in the region (Kleijn et al. 2009).

With the aim of addressing the above challenges, and to present a case study from the CEE region, this paper reports on a participatory research prioritizing exercise conducted in Hungary focusing on the gaps of knowledge in conservation. The project had the objective of compiling the 50 most important research questions for the next five years necessary to conserve biodiversity at a country scale. In addition to the research agenda compilation, we also present a dissemination and advocacy strategy and outline a set of further measures and tools required for realizing the research agenda.

Methods

We applied a four-step participatory method based on the ecological or conservation research priority-setting exercise described by Sutherland et al. (2011). During these steps a broad range of research questions were identified and collated by the potential users of the research results (policy makers, natural resource managers working for the state, private or NGO sectors), then prioritized by participants of a stakeholder workshop.

Stakeholder interviews

At the beginning of 2013 the main stakeholder groups relevant for biodiversity conservation in Hungary were identified by conducting a stakeholder analysis (Reed et al. 2009). These main stakeholder groups included governmental organizations and institutions (e.g. Ministry of Rural Development, national park directorates), main state and non-state economic entities and natural resource managers (e.g. forestry companies, farmers) and non-governmental organizations (NGOs) involved in conservation management and policy. Sixteen semi-structured individual or, in some cases, group interviews (Patton 2002) were conducted with 21 representatives of the main stakeholder groups. The specific aims of the interviews were to refine the scope of the research, to collect the first set of research questions and criteria for prioritisation, to enhance engagement, and to prepare for the national on-line survey. Interviews lasted 1.5-2 hours each and were extensively documented.

Online survey

Between May and September 2013 a nation-wide on-line survey was carried out to collect research questions identified by the stakeholders. The survey was made available for invitees via emails and allowed them to submit a maximum of the five research questions they considered as important for the conservation of biodiversity in Hungary. The email list of invitees was compiled based on the information derived from the interviews and the stakeholder analysis. The addressee database included the contact details of high-level state officers, national park directorates, natural resource users, important NGOs and umbrella organizations. No research institution was invited at this stage. The e-mails were sent to either individuals, or to institutional contact persons and network “hubs” (i.e. contacts in a key position in distributing the invitation to further participants). The questionnaire was anonymous, but information on field of expertise, affiliation and position of the respondents were registered. Only one questionnaire per person was accepted.

Filtering and grouping of questions

A total of 792 research questions were collected with 683 from the online survey and 109 from the interviews. The questions were reviewed and were excluded if: 1) there was another completely similar question; 2) their focus was beyond or different from biodiversity conservation; 3) their focus was too generic (e.g. "How much biodiversity is enough?") or too specific (targeting a particular location e.g. a village surrounding). Similar or overlapping questions were also merged. The remaining 478 questions were coded separately by a natural and a social scientist to identify the central focus and issue (management, habitat, social interface, etc.) of each question. Finally 33 codes were identified and grouped into 12 main themes through iterative discussions between the coders (number of questions indicated in the brackets): Agriculture (25); Basic research (77); Economic, legal and institutional context (53); Freshwater and wetland ecology, water management (48); Forest ecology and management (85); Game management (19); Grassland ecology and management (21); Habitat and landscape management and abiotic assets (50); Impact of artificial structures on biodiversity (28); Invasive species (23); Nature and society (21) and Species conservation (28).

Stakeholder workshop: prioritization of the research questions

Research questions were prioritized during a one-and-a-half-day stakeholder workshop in February 2014, resulting in a consensually agreed list of 50 questions. Twenty-four participants from the most important stakeholder groups (state administration, NGOs, natural resource managers) were invited to the workshop. Background, expertise and geographical location of the workshop participants were carefully assessed in order to represent major fields (botany, vertebrate and invertebrate zoology, hydro-, agro- and forest ecology, cave biology) and regional interests. Prior to the workshop, each participant received questions assigned to three of the twelve thematic groups (see above) for scoring. Questions were scored according to their importance and the top-ranked upper third of the questions were submitted to the workshop for further deliberation. In the first day of the workshop, following an opening plenary, participants deliberated the questions in three consecutive sessions during the day (one 2.5-hour session in the morning, two 1.5-hour sessions in the afternoon) in four parallel groups. Each group was dedicated to one of the 12 main themes. During the sessions participants discussed each research question and decided by consensus which questions should be included in the final list. If consensus could not be reached, voting was carried out. Invited academics (2-3 researchers per groups) provided assistance to the participants in describing the research context (i.e. to provide information on already existing knowledge) and in formulating research questions appropriately (that can be answered by a usual-sized research project in Hungary). Academics, however, did not contribute to ranking. Discussions were facilitated by experienced members of the organising research team. By the end of the day 50 questions were chosen, but were not prioritised. In the morning of the second day the participants screened the final list of questions and refined their wording. Results and the process of the prioritization exercise were also discussed and evaluated and possible follow-up activities were identified by the participants including the researchers. After the workshop the list of questions were circulated among the participants for final editing.

Results and discussion

The 50 most important research questions for the conservation of biological diversity in Hungary

Table 1 here.

Table 1 summarizes the question list compiled during the participatory process. In order to place the Hungarian research priorities in a global context, the question list of Sutherland et al. (2009) and the Hungarian list were compared by collating the main thematic groups and assigning the Hungarian

question to the global categories and questions (where possible). We used Sutherland et al. (2009) as a basis of comparison since this is the most relevant prioritised research agenda with similar scope but a larger scale.

As Table 1 shows, some of the collated research priorities in Hungary can be placed within categories of the global exercise either by being almost identical to a global question or by having a more specific local focus within a context of a global question. Many of the Hungarian questions identified a specific habitat-type, such as floodplain forests (question number 1), wetland restoration (question 37) or semi-natural grasslands (question 50) or an explicitly expressed economic perspective with the pragmatic aim to support decision making, such as impacts of forest management practices (question 4) or valuation of non-timber products (question 6). Surprisingly, a large number of questions related to Game management, Invasive species, Species conservation or Basic research that were difficult to match with the global research agenda so indicating country-specific conservation issues. Some questions in the Hungarian list addressed gaps of knowledge in close connection with land-use and regional development (e.g. questions 13, 14), whereas other research questions highlighted the need for further basic data on species and habitats (e.g. questions 25-31) as a prerequisite of proper decision making. Ecosystem service concept on the other hand was indicted only in a few Hungarian questions in contrast with the distinct global category.

Embeddedness of the research agenda in the global conservation context is indicated in Table 1 by listing the particular Aichi Target to which each research question contributes. Aichi Targets were formulated within the framework of the Conventon on Biological Diversity and set the path for the global biodiversity conservation policy for the coming decades (CBD2010). Cross-cutting Aichi Target 19 aiming to improve, develop and share the knowledge base for conservation is considered relevant for all the research questions and the participatory exercise itself as well. Different Aichi Targets, however, are manifesting by various degrees within the research agenda: e.g. Aichi Target 4 addressing sustainable production can be connected to thirteen research questions, while Target 14 with an explicit human wellbeing focus is difficult to relate directly to any of the questions.

Hungarian priorities in a wider policy context

Central and Eastern European countries managed to preserve and sustain large areas of extensive farming and semi-natural habitats and brought biodiversity rich areas under European Union (EU) legislation when joining the EU in 2004 (Henle et al. 2008, Stoate et al. 2009, Young et al. 2005). As socio-political transformations are especially critical periods for biodiversity conservation - as seen for example in a Romania by Ioras (2003), the stakes in the conservation arena in these countries are high. Conservation practitioners and policy makers have to formulate strategies and have to make prompt decisions in relatively newly established socio-economic and legal systems still under transition and under the increasing pressure of market-based economy (e.g. Pe'er et al. 2014; Pullin et al. 2009). Although there was substantial increase in the area and number of protected areas after the political transformation both in Hungary and in other CEE countries, this does not necessarily mean a straightforward solution to protect biodiversity in the region as Ioja et al. (2010) demonstrates in a case study from Romania. In this context basic research results (e.g. habitats and species distribution, conservation status) are increasingly important for effective and pro-active conservation activities (e.g. Sutcliffe et al. 2014). However, in Hungary, similarly to the Romanian case (see Ioja et al. 2010) spatially explicit and long-term monitoring data are very limited or not widely available and population biology of several important and threatened species are poorly known. Outcomes of basic conservation research focusing on conservation policy and management objectives (e.g. species distribution and abundance, spatially explicit information on habitat conservation status) are often considered incompatible with the pursuit of a successful academic career (i.e. these results are considered to have little international relevance or novelty). At the same

time, however, a research entity dedicated primarily to generate such background knowledge (in a spatially explicit way) does not yet exist in Hungary.

Numerous research questions in our list imply a pragmatic approach with the aim to provide knowledge to support policy-making and decision-making in management, land-use and regional development. Similar research questions comprise a distinct group in the Swiss country-based prioritizing exercise (Braunisch et al. 2012) and the Canadian list (Rudd et al. 2011), however, the Hungarian questions targeted more specific issues, similar to the 'hot topics' submitted to the 44 questions in the Swiss study (Braunisch et al. 2012, Appendix B). At the same time integration of conservation interests in land-use policy requires the exploration of local interests, perspectives and values, which is a crucial step especially in CEE countries as Niedziałkowski et al. (2014) discusses in the case of the Białowieza National Park in Poland. They conclude that in the Central and Eastern European region democratisation led to the increase of local authorities' and stakeholders' influence and changes in the ownership structure put a strain on conservation efforts' effectiveness (Niedziałkowski et al. 2014).

Appearance of economic arguments (e.g. cost-benefit analyses) in particular questions clearly shows the increasing pressure of market-based economy on natural resources and the need to harmonize economic and conservation interests. These perspectives are largely similar to the outcome of the Swiss research prioritizing process: Swiss practitioners gave highest priority to questions addressing species-specific knowledge and methods for reconciling biodiversity conservation with societal and economic constraints (Braunisch et al. 2012). These constraints are especially pronounced in Hungary in relation to agriculture, forestry, game management and water management. As almost 60.3% of the country is characterized as an agricultural area and 20.7% of the country is covered by forests or forest plantations (CBD Report 2014), agriculture and forestry have a profound effect on biodiversity. The introduction of the Common Agricultural Policy has a complex effect on agro-ecosystems: while some of the agri-environment schemes might have a positive effect (Kovács-Hostyánszki & Báldi 2012), farmland birds in Hungary had a declining trend indicating the deteriorating effect of agricultural intensification generated by CAP subsidies (Szép et al. 2012). Rigidity of the CAP regulations and the top-down approach applied in the agri-environmental schemes furthermore can have a counter-productive effect in areas where traditional small-scale management practices are still in use, as for example in Hungary or in Romania. Babai et al. (2015) in their recent paper (referring to a Hungarian and a Romanian case study) claim that there are cases when even "the problems caused by such regulations in many times were bigger than their positive influence on the maintenance of management through payments". Evaluation of the effect of EU payments and incentives are therefore especially crucial in this region, as often these are the only available resources for farmers, while they have a complex and controversial effect on biodiversity in agri-ecosystems.

Longstanding conflicting issues challenge the harmonization of game management interest with other sectoral interests (including conservation) (e.g. Horváth et al. 2010), and further studies are needed to reveal, for example, the relationship between agricultural intensification and game density (Báldi & Faragó 2007). Finally, water management practices – mainly drainage and river regulation – in the last two centuries played a considerable role in the destruction of large areas of floodplain habitats and wetlands, especially in the lowlands (Varga et al. 2013). In the light of the predicted increase in drought frequencies (Christidis et al. 2015) in the region as a consequence of climate change, finding the best solutions in water management practices in terms of conservation is an urgent task. Particular questions in the Hungarian list contribute to these above mentioned controversial issues related to natural resource management by providing data related to the conservation impact of management and information on the feasibility of management practices. The need for integrated research is therefore a well-recognizable feature of the priority list similar to the other national exercises (e.g. Fleishman et al. 2011, Rudd et al. 2011). No wonder, that almost half of

the questions require an interdisciplinary approach: economics; engineering; law; and, regional studies are the most frequently associated disciplines (beside natural sciences) in addition to psychology, sociology and historical ecology (see e.g. Swetnam et al. 1999).

The above mentioned key features of the research agenda, namely *i)* the expressed need for basic research and monitoring data, *ii)* the research supporting the integration of biodiversity values into pragmatic land-use planning and *iii)* the emphasis on sustainable natural resource management can be directly linked to the Aichi Targets and the EU Biodiversity Targets, revealing the interconnectedness between the local (national) and the global and regional conservation arena while reflecting the importance of the cross-cutting issues such as development of knowledge base and partnership in conservation. The compiled research agenda can be considered therefore as the local implementation of gaining scientific support for achieving the global and regional targets. While all the EU Biodiversity Targets are covered by the agenda, it is not straightforward to relate each and every global Aichi Target to the Hungarian priorities. Aichi Target 16, 17 and 20 are policy and implementation-oriented aims, therefore they can only be linked to the research agenda in a broad and implicit way. Interestingly, however, Target 14 with a strong human well-being and service provisioning perpective could not be recognized in the list of Hungarian research questions. Moreover, contrary to the global list with a set of different research questions related to ecosystem services (e.g. Daily et al. 2009; de Groot et al. 2002; Farber et. al. 2002), ecosystem services in general and in specific was not among the most highlighted issues neither in the submitted questions, nor during the workshop. We assume that in Hungary human well-being aspect of conservation and the ecosystem service concept itself is largely an academic issue and still not in the practitioners' arena. Although an increasing number of researchers focus on ecosystem services, nation-wide assessment or other directly policy-related assessment results are not yet available. Therefore, its relevance in conservation policy and practice may not have been widely recognized. As the ecosystem services concept and assessment is a key topic recently at both the global (e.g. Intergovernmental Platform on Biodiversity and Ecosystem Services, IPBES) and EU scales (e.g Mapping and Assessment of Ecosystems and their Services, MAES), we encourage the use of this approach within the practitioner sector.

Compared to the global conservation research agenda presented by Sutherland et al (2009), specific emphasis was put in particular habitats and species in the Hungarian list: floodplain forests; Pannonic forests-steppes (habitats of Community Importance); and, invasive species. These key areas are covered under EU Biodiversity Targets 1 aiming at the full implementation of the European Directives and Target 5, addressing invasive species. Floodplain forests, once characteristic habitat of the Carpathian basin, have experienced an enormous loss in the recent centuries (e.g. Haraszthy 2001, Bartha et al. 2005, Standovár 2006) and the remaining stands are endangered by both destructive forest management practices and invasive species so resulting in reduced naturalness (Bartha et al. 2005, Bölöni et al. 2008, Molnár et al. 2008). Maintenance of the remaining patches needs enhanced efforts towards finding the best practice that supports the multifunctional role of this ecosystem in biodiversity conservation, flood management and recreation. Pannonic forest-steppe is a unique habitat in Europe, representing the Western edge of the Eurasian forest-steppe vegetation zone (Varga et al. 2000, Molnár et al. 2012). While this habitat provides the last location for numerous species, it is also a cultural and historical heritage of the past socio-ecological systems in the Carpathian Basin. However, most of the forest-steppe vegetation has been converted into arable land in the previous centuries and the current pressure (e.g. conversion, drought, invasive species) on the remaining patches is still high (Molnár et al. 2012). Invasive species, and their effect on natural habitats, is of great concern in Hungary, especially in recent decades as large-scale land abandonment of formerly managed agricultural area led to the apparent increase in abundance of invasive species Forest-steppe habitats and their species, for example, are threatened by the extensive plantation of *Robinia pseudo-acacia* in the lowlands of Hungary, as planting has taken

place either in place of former oak-dominated stands or in non-forest lands that often have high conservation value. More than 200,000 hectares have been planted since 1990 and spontaneous spread from plantations is almost inevitable (e.g. Botta-Dukát 2008).

Towards the realization of the research agenda

Besides the enhanced data and information as an expected outcome of the research questions, a further advantage of this project is the collaborative process itself, namely that it provided an opportunity for the participants to recognize and reflect upon the 'cultural difference' between academics and practitioners (Roux et al. 2010). Furthermore, the significance and strength of the exercise lies in the fact that it is based upon a participatory and interactive process involving a wide audience (Sutherland et al. 2009, 2011). Outcomes derived from the process have a 'lobbying power' that should be used and directed towards academic and research financing institutions in order to have an actual impact (e.g. Balmford & Cowling 2006; Braunisch et al. 2012). Similarly to other cases (Arlettaz et al. 2010, Braunisch et al. 2012), the Hungarian participants also stressed the importance of interaction and further collaboration between the stakeholders in bridging the research-practice gap. Several participants also articulated their expectations in continuing the process. Engagement is an inherent and strategic part of this exercise, therefore we placed emphasis on identifying the target audience of dissemination and calibrating the channels of effective information flow towards them. Table 2. shows the main elements of the dissemination strategy summarizing the main target groups, tools of outreach, the expected outcome and the indicators assessing the real impact of the process.

Table 2 here.

The target audience of the recent project includes academics and researchers (not necessarily from academic institutions) and those who are involved in research financing and strategic decisions. As an initial step of the dissemination phase, the 50 questions and the suggestions were compiled into three Hungarian publications, including the priorities and the context of their implementation in Hungary along with the workshop message, a paper addressing questions related to forest management and ecology (Mihók et al. 2014a, Mihók et al. 2014b) and a policy brief designed for distribution among decision-makers and wider non-expert audience. The publication targeting Hungarian conservation professionals was among the most frequently downloaded papers of the journal in 2015. Beside the publications, the process and the outcomes were presented in the 9th Hungarian Congress of Conservation Biology, November 2014 and the implications discussed in an evening workshop. Further regional and/or thematic exercises are planned for the following period.

As an outcome of the debates and group discussions, the establishment of boundary organizations (i.e. organizations acting as interface between academics and practitioners) or personnel was raised as it could facilitate the reciprocal knowledge transfer in line with the suggestions by Braunisch et al. (2012). These actors could make the connection between the academic arena and the practice, being aware of the constraints and the potentials related to each side. Investment into this type of human resource could be a strategic direction, to which this prioritizing exercise is able to provide the essential input.

Further outlook on shaping the science-policy interface

The involvement of knowledge holders in the decision making process greatly increases the societal acceptance of outcomes (Baker et al. 2014, Beck et al. 2014), allows the emergence of different perspectives (Young et al. 2014) and the brainstorming contributes to the identification of emerging

issues in scientific research (Sutherland et al. 2011). Responses to the research questions identified in this study can help to generate knowledge that can be better used to support environmental decision-making (Cowell & Lennon 2014). The integration of different knowledge types (practitioner and science-driven knowledge) hold out for enhanced ecosystem governance (Tengö et al. 2014). A specific area where integration and co-production of knowledge (by academics and different stakeholders) essentially contributes to natural resource management is, for example, the adaptive management (AM) framework which deals with management problems related to complex systems with high level of uncertainty in a systematic way (Salafsky et al. 2002). Salafsky et al. (2002) emphasise that AM connects pure science and pure practice building on collaboration and consultation with different stakeholder groups (Schreiber et al, 2004). Although its relevance is profound at the site or project level (e.g. in evaluation of the effectiveness of protected areas, see Hockings et al. 2000), it can also contribute to outlining and fine-tuning a conservation research agenda (see Salafsky et. al 2002). As a further advancement, applying the framework proposed by Salafsky and his colleagues (2002), the Hungarian agenda could be the first element of an effective adaptive policy-making process in a longer term.

Conclusions

The complexity of biodiversity issues and the continuing loss of biodiversity calls for more inclusive and holistic methods for knowledge production at the science-policy interface (Jolibert & Wesselink 2012). The approach used in this study is a first step to enhance practitioner, decision-maker involvement in shaping research in a post-socialist county, where the legacy of participatory mechanisms are weak, and biodiversity governance is still heavily influenced by the top-down approach of the past (Kluvánková-Oravská et al. 2009, Kluvánková-Oravská et a. 2013.) This results in a challenging but also in an inspiring situation when introducing participatory methods in the conservation arena according to the experiences gained in the recent work.

The knowledge gaps exposed in this exercise identify the country-specific conservation challenges and potential for future work, and contribute to awareness raising on the special features and societal constraints of nature conservation issues in the Pannonean eco-region. Research prioritising should be fine-tuned at the country levels (or other adequate operational levels) in order to effectively contribute to research strategy development. Considering the multi-scale nature of ecological processes, it is even more important to support EU conservation strategies by implementing a country-based research strategy, which recognizes the importance of historic/geographic context and can be embedded in a multi-scale design of conservation priorities (Battisti & Fanelli, 2015).

In addition to mapping the research needs, we contend that it is important to use the indirect impacts of such an exercise in building partnerships and co-creating of knowledge between research and practice. Furthermore, it can be concluded that “post-publication” period is especially important in projects aiming to bridge the research-practice gap, thus we propose careful planning and adaptive actions of this period for future collaborative research agenda setting exercises in order to step far beyond the academic realms.

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Tables

Table 1. The 50 most important research question, their relation to the priority list compiled by Sutherland et al. (2009), contribution to global and EU biodiversity targets and their interdisciplinary aspects

	Research priorities in the twelve main themes	**Global category (and question) by Sutherland et al. (2009) to which the question is related**	**Compared to the global priority (Sutherland et al. 2009):**	**Contribution to Aichi Targets** (*note: all questions are linked to Target 19, aiming to improve science base and apply knowledge)*	**Contribution to EU Biodiversity Targets** *(note: all questions are linked to horizontal target aiming to improve science base)*	***X: interdisciplinary***
Forest ecology and management						
1.	What are the impacts of continuous cover forestry management (CCFM) and how can CCFM be effectively applied in floodplain forests?	Ecosystem management and restoration	More specific, focusing on floodplain forests	Aichi Target 4: Sustainable consumption and production, Aichi Target 7: Sustainable agriculture, aquaculture and forestry	EU Target 3: More sustainable agriculture and forestry	
2.	How does climate change affect forest ecosystems and their services and at what pace will forest ecosystems transform due to climate change?	Climate change	More specific	Aichi Target 10: Pressures on vulnerable ecosystems reduced	EU Target 2: Better protection for ecosystems and their services	X
3.	How does natural forest dynamics influence species composition and stand structure and what are the lessons learnt to be applied in managed forest?	Ecosystem management and restoration (34)		Aichi Target 4: Sustainable consumption and production Aichi Target 7: Sustainable agriculture, aquaculture and forestry	EU Target 3: More sustainable agriculture and forestry	X
4.	What are the differences between the ecological and the economic impacts of different forest management practices including conservation management?	Ecosystem management and restoration (31)	Economic aspects included	Aichi Target 4: Sustainable consumption and production Aichi Target 7: Sustainable agriculture, aquaculture and forestry	EU Target 3: More sustainable agriculture and forestry	
5.	What are the main characteristics of stand dynamics and what are the possibilities of continuous cover forestry management in economically important oak forests?	Ecosystem management and restoration (34)	Economic aspects included	Aichi Target 4: Sustainable consumption and production Aichi Target 7: Sustainable agriculture, aquaculture and forestry	EU Target 3: More sustainable agriculture and forestry	x
6.	What is the value of forest additional benefits and non-material services and what is the most appropriate method to evaluate these benefits and services?	Ecosystem function and services	More specific, referring only to valuation	Aichi Target 2: Biodiversity values integrated	EU Target 2: Better protection for ecosystems and their services EU Target 3:	

					More sustainable agriculture and forestry	
Game management						
7.	How to assess the impact of game on habitats and what are the possibilities of impact-dependent regulation of game management?	(Terrestrial ecosystem)	More specific focusing on game management	Aichi Target 2: Biodiversity values integrated	EU Target 3: More sustainable agriculture and forestry	
8.	How do wild boars and other predators affect populations of ground-nesting birds and small games and how their impact can be mitigated by management?	-				x
9.	How can hare and grey partridge populations (as bio-indicators) be increased by habitat management practices in agri-environment?	-				
Invasive species						
10.	What new adaptive methods can be developed to effectively combat invasive woody plants (*Ailanthus altissima, Prunus serotinus, Acer negundo, Fraxinus pennsylvanica, Amorpha fruticosa, Robinia pseudoacacia, Celtis occidentalis*) adaptable to various situations in line with conservation goals?	Species management (60)	More specific on invasive species	Aichi Target 9: Invasive alien species prevented and controlled	EU Target 5: Tighter controls on invasive alien species	
11.	What is the distribution and dispersal pattern of invasive aquatic animal species in Hungary, and how can management and conservation action plans combat them?	-		Aichi Target 9: Invasive alien species prevented and controlled	EU Target 5: Tighter controls on invasive alien species	
12.	What preventive and alternative methods can be recommended to combat invasive species based on practical tests (e.g. isolation, buffer zone, breeding and immunization)?	Species management (60)	More specific on invasive species	Aichi Target 9: Invasive alien species prevented and controlled	EU Target 5: Tighter controls on invasive alien species	
Economic, legal and institutional context						
13.	Based on the available knowledge what methodologies can be applied to assess conservation and ecosystem service values of different areas at the appropriate scale of land use decision-making?	-		Aichi Target 2: Biodiversity values integrated	EU Target 2: Better protection for ecosystems and their services EU Target 6: A bigger EU contribution to averting global biodiversity loss	
14.	What sanctions can effectively be applied for the restriction of greenfield investments based on conservation and ecosystem services valuation?	-		Aichi Target 2: Biodiversity values integrated	EU Target 2: Better protection for ecosystems and their services EU Target 6: A bigger EU contribution to averting global biodiversity loss	x
15.	What are the economic and social impacts of conservation restrictions (based on cost-benefit analysis)?	(Protected areas (29))		Aichi Target 3: Incentives reformed	EU Target 6: A bigger EU contribution to	x

					averting global biodiversity loss	
16.	What are the expected and unexpected conservation impacts of relevant EU payments?	Societal context and change (79)		Aichi Target 3: Incentives reformed	EU Target 6: A bigger EU contribution to averting global biodiversity loss	x
17.	How are nature conservation criteria being integrated into other sector's regulatory systems, in which areas does policy integration of nature conservation need to be strengthened?	Ecosystem function and service, (3)		Aichi Target 2: Biodiversity values integrated	EU Target 6: A bigger EU contribution to averting global biodiversity loss	
Impact of artificial structures on biodiversity						
18.	What are the direct and indirect effects of renewable energy production (e.g. wind farms, solar farms, hydroelectric power stations) on ecosystems and landscapes?	Technological change (24)		Aichi Target 4: Sustainable consumption and production	EU Horizontal Issue: Partnership for Biodiversity	
19.	What are the consequences of the energy production by energy crops and biomass in terms of environmental impacts, invasive potentials and land-use conflicts?	Technological change (26)		Aichi Target 4: Sustainable consumption and production	EU Horizontal Issue: Partnership for Biodiversity	x
20.	What cumulative impacts do gravel mines have (e.g on water resources) and how can these impacts be modelled?	-				
21.	What technological and engineering solutions are available to lessen the negative ecological impacts of linear infrastructure (wire, railway, roads)?	-	Related to Q. no. 36. but more specific on roads and technological solutions	Aichi Target 2: Biodiversity values integrated	EU Target 6: A bigger EU contribution to averting global biodiversity loss	x
Nature and society						
22.	What mechanisms could facilitate the engagement of local people, farmers and resource users in nature conservation?	Impacts of conservation interventions (98)		Aichi Target 1: Awareness increased	EU Target 1: Full implementation of EU nature legislation to protect biodiversity	
23.	What innovative tools could make awareness-raising on conservation issues more effective within different target groups?	Impacts of conservation interventions (98), societal context and change (83)		Aichi Target 1: Awareness increased	EU Target 1: Full implementation of EU nature legislation to protect biodiversity	x
24.	How much pressure can be put on protected areas considering visitors' demands?	-		Aichi Target 11: Protected areas increased and improved	EU Target 1: Full implementation of EU nature legislation to protect biodiversity	x
Basic research						

25.	What data and decision support models are needed to resolve the problem of „What to conserve: succession or a particular state"? (Specification of succession pathways; description of the natural state of particular succession stages; identification of sustainable patch size; impact of human or natural drivers on the rate of succession or on the lack of succession.)	-			EU Horizontal issue: Building on the Biodiversity knowledge base	
26.	What are the taxonomy and conservation status, life history traits and ecological needs of threatened and/or less–studied species of national or EU-importance?	-		Aichi Target 12: Extincton prevented	EU Target 1: Full implementation of EU nature legislation to protect biodiversity EU Target 6: A bigger EU contribution to averting global biodiversity loss	
27.	What meta-databases or methodology development are needed to support conservation decision making, compliance with IUCN categories and conservation of Hungary's biological diversity?	-		Aichi Target 12: Extincton prevented	EU Target 1: Full implementation of EU nature legislation to protect biodiversity EU Target 6: A bigger EU contribution to averting global biodiversity loss	
28.	Which less-known species should be inventoried to support high-priority conservation decisions, and what is their distribution and abundace?	-		Aichi Target 12: Extincton prevented	EU Target 1: Full implementation of EU nature legislation to protect biodiversity EU Target 6: A bigger EU contribution to averting global biodiversity loss	x
29.	What is the present state and dynamics of the Pannonian forest steppe concerning its distribution, diversity and endangerment?	-		Aichi Target 5: Habitat loss halved or reduced, Aichi Target 11: Protected areas increased and improved	EU Target 1: Full implementation of EU nature legislation to protect biodiversity EU Target 6: A bigger EU contribution to averting global biodiversity loss	
30.	What is the distribution, area and conservation status of habitats with special attention to 'ex lege' wetlands, sodic lakes, the Natura 2000 habitat types and habitats of protected areas in Hungary?	-		Aichi Target 5: Habitat loss halved or reduced, Aichi Target 11: Protected areas increased and improved	EU Target 1: Full implementation of EU nature legislation to protect biodiversity	

					EU Target 6: A bigger EU contribution to averting global biodiversity loss	
31.	What kind of standardized indicators, measurement options or metrics could be developed for the assessment of various impacts, damages and hazards affecting habitats (e.g. game pressure, land-use, mis-management) to support realistic decisions?	-		Aichi Target 2: Biodiversity values integrated	EU Target 2: Better protection for ecosystems and their services EU Target 6: A bigger EU contribution to averting global biodiversity loss	
Species conservation						
32.	Which are the most important 5-10 plant species to be conserved by *ex situ* methods and what are the main factors influencing their propagation, transplantation and reintroduction success?	-		Aichi Target 12: Extincton prevented	EU Target 1: Full implementation of EU nature legislation to protect biodiversity EU Target 6: A bigger EU contribution to averting global biodiversity loss	
33.	What habitat needs do characteristic species of sub-montainous small watercourses have and what habitat restoration measures are needed in order to conserve these species' population with special attention to the linear dispersal along watercourses?	Freshwater ecosystems (55)		Aichi Target 12: Extincton prevented	EU Target 1: Full implementation of EU nature legislation to protect biodiversity EU Target 6: A bigger EU contribution to averting global biodiversity loss	
34.	What are the main characteristics of domestic pollinators' populations, what are the reasons behind changes of their population and how do these pollinators affect the survival of endangered plant species?	Species management (65)		Aichi Target 12: Extincton prevented	EU Target 1: Full implementation of EU nature legislation to protect biodiversity EU Target 6: A bigger EU contribution to averting global biodiversity loss	
35.	What are the most important criteria to be met when introducing endangered animal species into suitable new (or restored, reconstructed) habitats using a viable population as a source?	-		Aichi Target 12: Extincton prevented	EU Target 1: Full implementation of EU nature legislation to protect biodiversity EU Target 6: A bigger EU contribution to	

					averting global biodiversity loss	
Habitat and landscape management and abiotic assets						
36.	What are the effects of nature conservation management practices (e.g. grazing, mowing, burning, reed harvesting) on biodiversity, using comparative and systematic methods based on studying multiple taxa?	Terrestrial ecosystems, protected areas (41)	More specific on management	Aichi Target 4: Sustainable consumption and production Aichi Target 7: Sustainable agriculture, aquaculture and forestry	EU Target 3: More sustainable agriculture and forestry	
37.	What differences can be obtained between the technical alternatives of wetland restoration and their biological impacts based on the results of comparative and systematic multiple taxa studies?	Ecosystem management and restoration (33)	More specific on wetland restoration and technology	Aichi Target 15: Ecosystems restored and resilience enhanced	EU Target 2: Better protection for ecosystems and their services	
38.	What are the characteristics of large-scale (structural and functional) changes of agricultural landscapes (pattern of land-cover types, extension of temporary water-covered areas), and what are the effects of these changes on the populations of species affiliated to agricultural habitats (assessment of key factors)?	-		Aichi Target 4: Sustainable consumption and production Aichi Target 7: Sustainable agriculture, aquaculture and forestry Aichi Target 15: Ecosystems restored and resilience enhanced	EU Target 2: Better protection for ecosystems and their services EU Target 3: More sustainable agriculture and forestry	
39.	How much pressure can be put on caves in terms of recreation, research and advanture tourism based on biological, hydrological and climatological data?	-		Aichi Target 15: Ecosystems restored and resilience enhanced	EU Target 2: Better protection for ecosystems and their services	
40.	How to designate new areas for development without increasing the rate of habitat fragmentation (e.g. development of thematic indicator maps for supporting regional planning)?	Ecosystem management and restoration (36)	More specific on infrastructural development and decision-support	Aichi Target 2: Biodiversity values integrated	EU Target 6: A bigger EU contribution to averting global biodiversity loss	x
Freshwater and wetland ecology, water management						
41.	What are the effects of different water storage and management schemes on biodiversity and on the fragmentation of habitats in different running water habitat types and what are the best practices concerning nature conservation?	Freshwater systems	More specific	Aichi Target 4: Sustainable consumption and production	EU Target 2: Better protection for ecosystems and their services EU Horizontal Issue: Partnership for Biodiversity	
42.	What is the ecological water requirement of aquatic and semi-aquatic (i.e. wetland) communities considering the integration of nature conservation purposes and the determination of technical standards?	Freshwater ecosystems (55)		Aichi Target 4: Sustainable consumption and production	EU Target 2: Better protection for ecosystems and their services EU Horizontal	x

					Issue: Partnership for Biodiversity	
43.	Based on cost-benefit analysis what changes would be appropriate in flood and water management practices which contribute to conservation as well?	Freshwater ecosystems (58)		Aichi Target 4: Sustainable consumption and production, Aichi Target 15: Ecosystems restored and resilience enhanced	EU Target 2: Better protection for ecosystems and their services EU Horizontal Issue: Partnership for Biodiversity	
44.	What kind of interventions are necessary to maintain the favourable ecological state of backwaters and oxbows?	-		Aichi Target 15: Ecosystems restored and resilience enhanced	EU Target 2: Better protection for ecosystems and their services EU Horizontal Issue: Partnership for Biodiversity	x
Agriculture						
45.	What non-direct effects do subsidies promoting competitiveness and intensification of agriculture have on biodiversity, on protected and endangered species?	Societal context and change (79)		Aichi Target 3: Incentives reformed	EU Target 6: A bigger EU contribution to averting global biodiversity loss	
46.	What impacts do different agricultural systems (e.g. industrial, integrated, ecological, traditional-small scale, nature-friendly, permaculture) have on biodiversity?	Terrestrial ecosystem (41), societal context and change (74)	More specific on specific agricultural management systems	Aichi Target 4: Sustainable consumption and production, Aichi Target 7: Sustainable agriculture, aquaculture and forestry Aichi Target 18: Traditional knowledge respected	EU Target 3: More sustainable agriculture and forestry EU Horizontal Issue: Partnership for Biodiversity	x
47.	How can landraces and old, native cultivated plant and animal species contribute to conservation goals and how can these species be integrated into the system of nature conservation?	-		Aichi Target 2: Biodiversity values integrated, Aichi Target 4: Sustainable consumption and production, Aichi Target 13: Genetic diversity maintained	EU Target 3: More sustainable agriculture and forestry EU Horizontal Issue: Partnership for Biodiversity	
48.	What impacts do chemical substances (pesticides and fertilisers) used in agriculture have on wild living organisms?	Terrestrial ecosystem (40)		Aichi Target 8: Pollution reduced	EU Target 2: Better protection for ecosystems and their services	
Grassland ecology and management						

49.	What are the reasons behind the changes of grassland area, what factors led to their decrease and to the shift of grassland management to other land-use types?	-		Aichi Target 3: Incentives reformed, Aichi Target 4: Sustainable consumption and production	EU Target 2: Better protection for ecosystems and their services	
50.	What are the conservation and economic possibilities for grassland restoration, and what methods can be applied to restore grasslands?	Ecosystem managament (33)	More specific on grasslands	Aichi Target 15: Ecosystems restored and resilience enhanced	EU Target 2: Better protection for ecosystems and their services	x
						x

Table 2. Proposed framework for dissemination and outreach strategy: target audience, outreach tools and activities towards their engagement and indicators to assess the impact of the project.

Target group	**Outreach tools and steps**	**Indicators for assessing the impact of the exercise**
Academics (research institutions, groups)	Publications (academic and policy brief) Electronic dissemination of publications through contact lists, email servers, website Presentation in conferences, meetings Groups discussions, electronic debates (on applied research and research questions)	Citations No. of research projects addressing the research priorities New individual and/or institutional research collaborations associated with the priorities No. of meetings, events, workshops associated with the priorities
Research financing institutions	Policy brief Presentation Lobbying	Increase in budget allocation to research priorities in the next five years No. of calls in the next 5 years related to the priorities
Natural resource managers and conservation managers	Policy brief Presentation Electronic dissemination	No. of new individual and/or institutional research collaborations associated with the priorities Establishment of research budget within the sectorial resources