Targets for biodiversity beyond 2010: research supporting policy

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Fiona Grant, Juliette Young and Allan Watt CEH Edinburgh Bush Estate Penicuik EH26 0QB UK	Centre for Ecology & Hydrology NATURAL ENVIRONMENT RESEARCH COUNCIL
Peter Bridgewater Joint Nature Conservation Committee Monkstone House City Road Peterborough PE1 1JY	JOINT NATURE CONSERVATION COMMITTEE

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Social-ecological systems for transdisciplinary biodiversity research

Diana Hummel, Institute for Social-Ecological Research (ISOE), Germany

Summary: This contribution argues for a transdisciplinary approach to biodiversity research, based on a specific perspective of social-ecological systems (SES).

Biodiversity is not only a result of biogeochemical dynamics, but also of human action. E.g. the relatively high occurrence of common beech, *Fagus sylvestris*, in the deciduous forests of Central Europe is directly linked to the land-use activities of settlers from the Neolithic era onwards. But up to now research for setting and monitoring biodiversity targets is conceptualized mainly in the ways of natural science.

Biodiversity management has problems to reach the defined targets because socio-economic action and ecological effects are closely intertwined. These interactions, and the uncertain knowledge base, complicate the assessment of the requirements for practical action. Given this hybrid problem structure, new research issues emerge in biodiversity science, requiring a transdisciplinary research concept that supports an integrated, problem-oriented understanding of the subject.

In the last decade Holling and other authors established the concept of social-ecological systems (SES) which offers an adequate conceptual framework for analyzing biodiversity dynamics including its social side, for identifying biodiversity targets as well as for developing biodiversity management strategies. According to the SES approach, ecosystem's responses to societal utilization of natural resources and the reciprocal response of people to changes in ecosystems constitute coupled dynamic systems. In order to manage biodiversity one has to understand the combined functioning of the social-ecological system.

For a better understanding of biodiversity dynamics and management, it is useful to focus on supply systems developed by societies to satisfy the basic needs of their population. These systems provide food, water, or energy; they are based on ecosystems and influence biodiversity via land-use. Supply systems are regulated by societies and depend at the same time on natural conditions and are affected by their variability. Given this perspective, the connection between natural resources and their utilization comes to the fore (cf. Hummel et al. 2008). Natural resources and their users can be regarded as the major components in such a supply system (being a specialization of SES). In opposition to the conventional land-use approach different user groups (peasants/foresters, industrial producers/utilities and consumers) are in the focus of research; their relations are understood to be an integral part of supply systems. Moreover, processes of resource utilization are determined in particular by knowledge forms (scientific and every-day knowledge), institutional frameworks (e.g. legal conditions), social practices and technology. These factors specify how biodiversity is changing, and they determine the success and options of biodiversity management as well as its adaptability, vulnerability and scope.

RE: Social-ecological systems for transdisciplinary biodiversity research

Vladimir Vershinin - Institute of Plant and Animal Ecology, Russia

For a better understanding of biodiversity dynamics and management we surely need to use both traditional and modern methods. Traditional means morphology, cytogenetic, cariology, albumine electrophoresis, immunological test e.t.c. Modern methods means PCR, DNA sequencing, and others. There is a great deal to be gained by integrating databases and sharing knowledge.

For a synthesis of modern and traditional methods we need to remove gaps between knowledge and understanding before we can increase the complexity of investigations. I agree with Diana Hummel that biodiversity needs a transdisciplinary research concept. In the field of ecological science the relationship between biodiversity and ecosystem functioning (functional ecology) has emerged as a major scientific issue (Loreau, 2000). Researcher's realization within the framework of the concept of functional groups and functional diversity seems to now be perspective (MacGillivray et al., 1995; Lavorel et al., 1997; Hulot et al., 2000). The underestimation of the role that biota play in the process of regulation and substances transformation that forms geochemical parameters of the environment (Vernadsky, 2001) is dangerous under the effect of fast global changes of the biosphere (Ostroumov, 2005).

It is impossible to use any common law to describe interconnections between biodiversity or efficiency, by a transforming degree and stability – variability depends on environmental "context" (Cardinale et al., 2000). So we need investigations for various types of a landscape. Environmental fragmentation can lead to the appearance of new interspecies competitive or mutual relations (Dale, 2000). The anthropogenic transformations of a landscape can lead to serious biodiversity reductions and decreasing of species number as a result of certain loss of landscape elements (Shealagh et al., 2000).

Ecosystem conservation is impossible without preservation of species diversity, because only concrete species, forming biotic and abiotic relationships determine ecosystem functioning. Hence, biodiversity is the main parameter of the biosphere's state and the ecosystems composing it (Alimov, 2006).

The increase of ecosystem biodiversity due to new species invasion is a natural process that is accelerated as a result of anthropogenic influences. In many cases invasive species do not influence the main ecosystem balance and function, but sometimes invasive species can essentially change the functional ecosystem characteristic. Thus, the appearance of new species in an ecosystem is capable of completely reconstructing food circuits or can result in the creation of new circuits and chains (Golubkov, 2000). The study of invasive species ecology allows us to determine the important factors and dependencies between a variety of community resources and the width of a niche and probability of invasion success (Byers, Noonburg, 2003). Both the increase and the decrease of biodiversity can induce functional changes in a community and influence its equilibrium. Parasites play a very important role in the functioning and maintenance of ecosystem stability. Parasite complexes can seriously impact on morphogenesis processes (Ruth, 1987; Johnson et al., 1999, Glanz, 1999), and also mediate natural selection processes that seriously influence the genetic diversity of a population (Mitchellet al., 2005).

The morphogenesis processes are a very important link between functional biology and evolution (Gilberts et al., 1997). So, ontogenesis stability investigation allows us to control environmental stability and can help in understanding the mechanisms of morphological evolution (Cherdantsev, 2003). A physiological approach in functional ecology of populations allows us to explain adaptability efficiency under the effect of environmental destabilization (McCoy, Harris, 2003). Thus, an integrative approach using modern technology and methods to investigate biodiversity gives the possibility to leave traditional phenomenology for understanding biological meanings and to reach some prognostic conclusions.

As N.V.Timofeev-Resovsky stated – we have a problem of adjustment of a correct exchange of substances between biosphere and human society on a planetary scale. The decision of these problems is possible only under the condition of development of theoretical biology (Timofeev-Resovsky, 2009). The same opinion was argued by Ferdinando Boero - we need more theoretical research – that's the way we need to solve the problems.

That's why our bullet point is to unite information about all hierarchical levels of biodiversity from molecular up to the biosphere. This will help us to develop a new point of view on the evolution process and create a more balanced system of biodiversity conservation.

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