EUROPEAN SCIENCE FOUNDATION
SETTING SCIENCE AGENDAS FOR EUROPE

Exploratory Workshops Scheme

Standing Committee for Life, Earth and Environmental Sciences (LESC)

ESF Exploratory Workshop on

Large-scale and long-term functional biodiversity research in Europe

Scientific Report

Werder, Germany, 2 - 4 June 2008

Convened by:

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Co-convened by

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Wolfgang W. Weisser *(Institute of Ecology, University of Jena, DE)*

Co-sponsored by

biodiversity exploratories functional biodiversity research

Deutsche Forschungsgemeinschaft DFG

1. Executive Summary

This ESF supported exploratory workshop "Large-scale and long-term functional biodiversity research in Europe" was hosted by the steering committee of the Biodiversity Exploratories together with its coordination office at the University of Potsdam, Germany. The convenor was Markus Fischer, co-convenors were Simone Pfeiffer from Institute of Biochemistry and Biology, University of Potsdam, Elisabeth Kalko from the Department of Experimental Ecology, University of Ulm, Karl Eduard Linsenmair from the Biozentrum, University of Würzburg, Ernst-Detlef Schulze from the Max-Planck-Institut of Biogeochemistry, Jena, and Wolfgang Weisser from the Institute of Ecology, University of Jena.

In addition to the funding from ESF, financial support was provided by the DFG funded project "Biodiversity Exploratories" and the University of Potsdam which will cover travelling costs for some of the participants.

The workshop programme lasted from Monday noon to Wednesday noon on 2 – 4 June, 2008. The meeting was held at the 'Rittmeister Hotel' in Werder, near Potsdam and Berlin, Germany.

Currently, biodiversity experiences a general decline due to ongoing large- and small-scale changes in land use. Moreover, the study of functional consequences of biodiversity change for ecosystem processes and services is a top research priority. There are quite developed studies of effects of land use and global change on biodiversity in real landscapes, but the consequences of changing diversity for ecosystem processes have almost exclusively been studied in model experiments, mainly in microbial, algal, or grassland communities.

Recently, the German Science Foundation DFG started to support the establishment of three, exemplarily large-scale and long-term, research sites for biodiversity and ecosystem researchers, the "biodiversity exploratories" (www-biodiversity-exploratories.de). There, relationships between landscape change, diversity of genes, species and biological interactions, and ecosystem processes and services are studied through combinations of monitoring approaches and measurements of functional diversity with designed experiments in real landscapes.

There is a tremendous potential for an international effort merging functional biodiversity and ecosystem research, monitoring and experimentation, and forest and open-landscape research in landscapes representative for most or all of Europe. At the same time there is the danger that the research approaches emerging in different countries diverge and therefore compromise comparability and generalisation. We therefore brought together relevant scientists to work towards a European research agenda.

The workshop aimed at presenting ongoing large-scale activities on drivers and functions of diversity. Moreover, a consensus on common research questions and needs for successful further functional biodiversity research needed to be reached. Furthermore, the participants aimed at identifying potential project shapes and corresponding funding instruments. Finally, further steps and the formation of task forces needed to be discussed.

To achieve these goals it was essential to bring together leading European experts from multiple disciplines to present and discuss the current status of biodiversity research. In total 25 participants from 11 European countries and Switzerland took part in this meeting. Most presentations were limited to 20 minutes to also allow a short discussion in conjunction with the talk. The workshop was characterised by a very constructive atmosphere with a high level of involvement from all participants. After the first part consisting of presentations and their discussion several further round table discussions concentrated on required facilities for a European-scale long-term project, a common research agenda and concrete tasks for a

proposal. The presentation and the commitment in discussions by the ESF representative, Constantin Doukas, during the whole workshop was highly appreciated by all participants.

Finally, the participants agreed on a research agenda including the

- Quantification and prediction of interactions between biodiversity, human impacts such as land-use and climate change, and ecosystem processes and services
- Establishment of a multi-scale European set of research sites building on previous activities
- Studies of mechanisms across many taxa, hierarchical levels of biodiversity and at different spatial and temporal scales
- Studies in temperate and tropical regions to provide references and offer scenarios
- Provision of the scientific basis for mapping the value of ecosystem services as a function of biodiversity across Europe

This workshop was highly explorative in the sense that only by crossing boundaries of each discipline represented by the participants the main objectives for a common proposal could be identified. The merging of yet separate national activities of diversity and biogeochemical assessments would be a significant step forward. By defining experimental standards for long-term functional biodiversity research a meta-analysis across Europe could be initiated. Furthermore, an assessment of biodiversity-ecosystem functioning relationships could be carried out joining researchers of different disciplines.

The presentation by Constantin Doukas and possibilities for national funding pointed out by various participants resulted in a list of funding instruments to be explored over the next months. Parallel to the financial tasks, all participants agreed to assess the possibilities for establishing research platforms in their home countries. They will identify most relevant ecosystem/habitat/land use types, essential and desired taxa, biodiversity levels, and biotic interactions. Furthermore, essential and desired ecosystem processes and services as well as most relevant experimental manipulations (land use, disturbance, climate change, biodiversity change) will be documented at all suitable sites. Once this information has been gathered, further steps will be taken as agreed.

2. Scientific Content of the Event

After a short welcome note by the convenor **Markus Fischer** (University of Potsdam, Germany), he presented the aims of this meeting. The broad interest in biodiversity issues in science and politics can be seen in many ongoing and recently started initiatives. However, because they are scattered there is a necessity for a comprehensive discussion on research gaps and a joint application in a European context.

Constantin Doukas of the ESF Standing Committee for Life, Earth and Environmental Sciences presented several initiatives currently being undertaken by ESF which can be of relevance to the participants of this workshop.

Session I: Large-scale and long-term functional biodiversity research platforms

In the first talk of this session **Markus Fischer** introduced the participants to the rationale and design of the Biodiversity Exploratories in Germany. He pointed out that large-scale and long-term monitoring and experiments are needed to reveal causal relationships between land use, biodiversity change and ecosystem functions. The established land use gradients in forest and grassland at three representative sites in Germany will allow a meta-analysis of the role of land use management for biodiversity of different taxa and levels and ecosystem processes. The design with a selection of 100 experimental plots out of a larger set of observational monitoring

plots in each exploratory could well be a model to be considered for extension to a European scale.

Wouter Los of the University of Amsterdam, the Netherlands, was invited to present the work of Life Watch. He pointed out that the understanding of biodiversity functions requires the analyses and modelling of large data sets to identify patterns and underlying processes. Largely distributed observatories, databases and computer facilities should share their ecosystem, species-level and genomics data via a community driven e-infrastructure. Currently the major user sector is being identified; a user platform will be established as well as training programmes and a service center. Support is offered by countries, scientific networks like AlterNET, BioCASE or EDIT, data networks and international infrastructures.

The ALARM initiative was introduced by its coordinator **Josef Settele** (Helmholtz Center for Environmental Research in Halle, Germany). On the basis of natural and disturbed landscape plots in different countries standardised methods were used by more than 35 partner institutions to conduct scenario studies. Plant and animal distribution maps inform about the expected wins and losses of suitable habitats in Europe beyond 2050. Land use, climate change, invasion, pollination and pollution are considered in the dispersal of species and species interactions. Large-scale transplanting experiments gave first insights into the potential widening of species ranges.

Wolfgang W. Weisser (University of Jena, Germany) presented the recently started ANAAE initiative – a European Research Infrastructure for the Analysis and Experimentation on Ecosystems. It aims for an integrated experimental infrastructure to analyse, predict and manage human impacts such as global change. The Montpellier European Ecotron is an example for an appropriate infrastructure. Further, suitable field sites combining above and belowground studies are considered to become ANAEE Infrastructure. Research teams can work in these infrastructures and share their knowledge in common data bases. Prof. Weisser invited the participants of this workshop to attend an ANAEE workshop in September in Paris.

In the round-table discussion after the first session two thirds of the participants supported the idea of creating a network between research groups. However, it was acknowledged that while a network helps with the logistics for monitoring biodiversity it will not necessarily lead to new scientific discoveries. Then it was discussed whether the synthesis of ongoing projects would be a sufficient task to be discussed in the convened group. However, most participants preferred to go further and to rather discuss a new project idea once clear research questions have emerged in the course of the discussion of further presentations.

Session II: Drivers of taxonomic, structural, functional, and hierarchical levels of biodiversity

Opening the second session, **David Kleijn** from Alterra, University of Wageningen, the Netherlands, presented biodiversity effects of ecological compensation measures. He pointed out that agri-environmental schemes are the most important tools to counteract adverse effects of farming on the environment. In a bird census at nine national sites no positive effect of management could be shown. The study was extended to more taxa and to other European countries. In four of five countries it could be shown that agri-environmental schemes locally reducing farming intensity enhanced biodiversity. However, most implemented schemes do not benefit endangered species. He concluded that conservation initiatives should focus on species-rich extensively managed sites.

Jan Bengtsson (University of Uppsala, Sweden) briefly reviewed the drawbacks of biodiversity-ecosystem functioning research. He argued that there is too little interest in real ecological theory being tested in human-dominated landscapes. He therefore gave theoretical background information on biodiversity studies in agricultural landscapes, in particular on organic farming. A Swedish study comparing organic with conventional farms on a landscape level showed that the effects of landscapes are larger than the ones of farming, but that organic farming is more relevant in homogeneous landscapes. Increased local habitat quality and higher beta-diversity was found in fields of organic farming.

Following-up on the topic of integrating biodiversity and ecosystem function research **Peter Manning** (Imperial College London, UK) provided insights to global change biology and missing links to modelling. In order to combine both fields, biodiversity should be considered as both response and effect variable. Furthermore, direct (physicochemical and physiological) and indirect (compositional) effects of global change are relevant when studying ecosystem functions. He presented several studies illustrating and emphasizing these points. He concluded that the understanding of how biodiversity responds to global change and how these changes affect the ecosystem requires an integrated and advanced approach combining a variety of methods and interdisciplinary collaborations.

Simone Pfeiffer (University of Potsdam, Germany) showed first results from such an advanced approach – the Biodiversity Exploratories. At their newly established field sites extended assessments of plant and animal diversity are already being conducted. A common pattern of all three exploratories is that the number of vascular plant species is positively correlated with the number of moss species but not with the number of lichen species. Fertilization had different effects on grassland diversity across the three exploratories demonstrating the necessity of replicated landscapes and, for interpretation of results, of studies on soil and biogeochemical processes. The forest inventories showed management effects on productivity (e.g. differences in compact wood volume) in natural versus intensively used forests. Trophic interactions between birds, bats, arthropods and their food plants were revealed in several pollination observations and predator exclusion experiments.

Overall, the presented studies showed the necessity of detailed studies on the interactions of land use, biodiversity and ecosystem processes including social aspects. As very important turned out a combined approach including all scales from habitat to landscape level.

Session III: Studying biodiversity effects on ecosystem processes concerning pools and fluxes of nutrients and water, and concerning stability, resistance and resilience towards environmental (land use and global) change

In his talk **Stephan Haettenschwiler** of the CEFE-CNRS in Montpellier, France, concentrated on the role of biodiversity across trophic levels for litter decomposition and nutrient cycling. After giving impressive background information on the importance of decomposition for the carbon cycle, he revealed the lack of convincing functional concepts of diversity effects for plant litter and soil organisms. His studies of rain forest tree species in French Guyana show interesting first results of litter mixture effects on decomposition, but the mechanisms are still not understood. BIOCYCLE - a European-wide network currently investigates the interactive effects of plant litter diversity and decomposer diversity on carbon and nutrient cycling across a gradient of paired terrestrial and aquatic ecosystems running from the subarctic to the tropics. Further studies are required to understand the high diversity of soil organisms and its significance for soil processes and ecosystem functioning.

Ana-Cristina Cardoso from the Joint Research Centre, Ispra, Italy, introduced the EU Water Framework Directive. An inter-calibration network of 1500 sites (coastal, lake and river sites) identifies good water quality sites. Increasing environmental pressures can be analysed compared to these reference conditions. In this framework also socio-economic aspects are linked to ecosystem responses. The talk showed broad parallels to studies conducted at terrestrial sites with similar research questions and approach. However, the collaboration between terrestrial and freshwater researchers is still very limited and requires more efforts in joining these disciplines.

Wolfgang W. Weisser from the University of Jena, Germany, presented results from the long-term project “Jena Experiment”. In 2002, a grassland community experiment was set up with a species-richness and functional-group gradient. Whereas shoot biomass was positively correlated with species richness, this root biomass was independent of species richness. The microbial response to plant diversity became relevant after several years showing the importance of long-term studies. Currently all available data are joined for a synthesis. He pointed out the lessons to be learned from this experimental site showing the future potentials and limits. Currently, foreign scientists are interested in using this field-based experimental platform but encounter difficulties in getting funded. Therefore, European funding opportunities are desirable.

In the concluding presentation **Ernst-Detlef Schulze**, director of the Max-Planck-Institute for Biogeochemistry, Jena, Germany, reviewed the CarboEurope project. It aimed at understanding, quantifying and predicting the terrestrial carbon balance of Europe from local to continental scales. In this large-scale and long-term research project both bottom-up and top-down approaches were used to estimate the carbon balance. Many processes in the carbon cycle are better understood now, but the microbial activity in the soil layer remains a black box. Comprehensive monitoring and experiments above and below ground as well as up-scaling from local to regional scales are therefore crucial to understand ecosystem pools and fluxes of carbon.

Three discussion sessions on required facilities and structures for a large-scale and long-term functional biodiversity research, on a common research agenda and a concrete European research proposal formed the second part of the workshop. The very fruitful and enthusiastic participation of everybody confirmed the great potential for a common approach. The participants agreed on a design similar as the one of the Biodiversity Exploratories. The group reached the consensus that each participant will evaluate suitable sites and define particular research questions in the home countries. It became very clear that the implementation of a large-scale and long-term European project is an enormous task, not only logistically but also financially. We therefore appreciated very much the support by C. Doukas in discussing suitable financial instruments. Several options will be considered in the coming weeks and concrete plans are made to apply to available funding sources.

3. Assessment of the Results

Overall, the aim of promoting interactions between biodiversity and ecosystem researchers has been fulfilled very successfully. The participants of the workshop vividly discussed future research questions and it was a real pleasure to sense the motivation of joining national project experiences to an integrative European large-scale and long-term study. All agreed on the necessity of formulating common research questions, establishing a joint data base, applying modern tools for meta-analysis and developing standardized experimental and measurement protocols for facilitating future data synthesis. The discussions aimed at developing future collaborative actions with a European approach.

Special attention was given to variables that should be considered in a European approach. Different diversities should be assessed, including plant, fungal, and genetic diversity. Especially, functional aspects of diversity and trait data are highly important. Furthermore, a meta-genomic assessment would answer open questions concerning microbial communities. Variables describing ecosystem processes and services such as productivity, invasion resistance, decomposition and other components of C and N cycle should be examined. The study of hydrology should be added in this comprehensive ecosystem approach. Integrating applied studies with links to economics and nature conservation, such as ones addressing pest control, would be highly valuable. However, the main overall importance lies in a common long-term and large-scale approach under consideration of spatial heterogeneity and temporal dynamics.

A first step for the establishment of a European research platform is the assessment of suitable sites. The participants therefore agreed to identify most relevant ecosystem/habitat/land use types, essential and desired taxa, biodiversity levels, and biotic interactions in their home countries. Furthermore, essential and desired ecosystem processes and services as well as the regionally most relevant experimental manipulations (land use, disturbance, climate change, biodiversity change) will be documented at all suitable sites.

The workshop ended with a discussion regarding different follow-up activities on fundraising. The convenor had put together a compilation of current calls and national funding instruments. All participants agreed to follow several avenues of funding possibilities as the discussed project idea can not be financed by only one source.

In conclusion, the workshop was highly constructive. The main outcome may be summarised in two items. First, an agreement was reached on research questions, observational and experimental approaches to be followed, variables to be measured, and joint analyses to be performed, was reached. Second, concrete homework was taken on by all participants to put these ideas into practice by identifying research sites, regional peculiarities to be included, and funding possibilities to be inquired in each country.

4. Final Programme

Monday, 2 June 2008

12.00-12.30 *Arrival and registration*
12.30-13.30 *Lunch at the hotel* (optional)

13.30-13.45 **Presentation of the European Science Foundation, Constantin Doukas** (ESF Standing Committee for Life, Earth and Environmental Sciences)

13.45-13.55 **Introduction: workshop aims, Markus Fischer**

13.55-16.20 **Large-scale and long-term functional biodiversity research platforms**
13.55-14.20 Introduction to Rationale and Design of the Biodiversity Exploratories (Large-scale and long-term exploratories for functional biodiversity research in Germany), **Markus Fischer**
14.20-14.45 LIFE WATCH; a new Biodiversity Research Infrastructure in Europe, **Wouter Los**

14.45-15.05 Coffee Break

15.05-15.30 ALARM - experiences for large-scale assessments, **Josef Settele**
15.30-15.55 The ANAAE initiative, **Wolfgang Weisser**
15.55-16.20 Discussion

16.20-18.40 **Drivers of taxonomic, structural, functional, and hierarchical levels of biodiversity**
16.20-16.45 Biodiversity effects of ecological compensation measures, **David Kleijn**
16.45-17.10 The role of different farming systems for biodiversity research, **Jan Bengtsson**

17.10-17.30 Coffee Break

17.30-17.55 Integrating biodiversity and ecosystem function research with global change biology, **Peter Manning**
17.55-18.20 Exemplary results of the Biodiversity Exploratories, **Simone Pfeiffer**
18.20-18.40 Discussion

19.00-20.00 *Dinner*
Evening free for individual discussion

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Tuesday, 3 June 2008

09.00-12.00 **Studying biodiversity effects on ecosystem processes concerning pools and fluxes of nutrients and water, and concerning stability, resistance and resilience towards environmental (land use and global) change**

9.00-9.25 The role of biodiversity across trophic levels for litter decomposition and nutrient cycling, **Stephan Haettenschwiler**

9.25-9.50 Water framework directive ecological assessment and biodiversity, **Ana Cristina Cardoso**

9.50-10.15 The Jena Experiment: biodiversity effects on element cycling and trophic interactions, **Wolfgang W. Weisser**

10.15-10.40 Lessons from CarboEurope, **Ernst-Detlef Schulze**

10.40-11.00 *Coffee break*

11.00-12.00 Discussion and synthesis of input presentations

12.00-14.00 *Lunch*

14.00-15.30 **Discussion of required facilities and structures for large-scale and long-term functional biodiversity research**

15.30-16.00 *Coffee break*

16.00-18.00 **Discussion of a common research agenda to be implemented in new biodiversity platforms (Exploratories) in many European countries**

18.00-19.00 *Dinner*
Evening free for individual discussion

Wednesday, 4 June 2008

09.00-11.00 **Discussion of the outline of a concrete research proposal and establishment of a task force for its detailed preparation and further follow-up activities**

11.00-11.15 *Coffee break*

11.15-13.00 **Discussion continued**

13.00 **End of Meeting**

13.00-14.00 *Lunch at the hotel (optional) and departure*

5. The Final List of Participants

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6. Statistical information on Participants

Repartition by country of work:

Czech Republic	1
Denmark	1
Estonia	1
France	1
Germany	8
Greece	2
Italy	1
Netherlands	2
Portugal	2
Sweden	1
Switzerland	3
United Kingdom	1

Repartition by gender:

Male	18
Female	6

Total umber of participants: 24
(not including the ESF Representative)