Policy brief

The ability of scenarios to develop cross-sectoral capacities, and support foresight and anticipatory governance in ensuring ecosystems resilience.

Main findings

Scenarios can be used to understand, raise awareness and inform how to move forward when navigating the complex pressures on biodiversity and ecosystem services. Future pathways may have positive or possibly negative outlooks, but scenarios can provide a holistic view of how to approach challenges, while granting a better understanding around different types of uncertainties. They can be used to develop capacities for anticipation, decision-making and collective organisation, providing useful tools for management.

Key findings from projects where scenarios were run across different environments, drivers of biodiversity loss and scales of intervention emphasise how models and scenarios can help map potential pathways to ensure ecosystem resilience.

Decision-makers and other end users can use scenarios of biodiversity and ecosystem services to enable decision-making around strategies for adaptation on local, regional, national or international scales. Advanced modeling across habitats and scales allows for plausible mid- and long-term intervention implementation with inclusion of costs and benefits as well as social impacts. Informed management supported by these scenarios can cost less than the damage caused by inaction or non-adequate actions.

Key messages

○ **Better integration and recognition of scenarios and models into EU policies would be warranted**, such as the Kunming-Montreal Global Biodiversity Framework and models can be useful in local to EU and global policy, including across scales, and are key tools to inform the implementation of the Kunming-Montreal Global Biodiversity Framework and EU Nature Directives, but also for more localised decision making.

○ While the models used to derive the scenarios can show uncertainties, **they are useful tools to open deliberations on possible options**. Understanding well-informed options for future priorities and pathways assists with decision making.

○ **Scenarios provide an opportunity to consider participatory processes in the context of decision making.** They are key tools in enabling the participative development of priorities on local, national and regional levels that explicit trade-offs and help meet the varied interests of stakeholders.

○ **The possible outcomes presented via scenarios can help frame ecosystem servics in socio-economic contexts,** and enable discussions of these outcomes and needs to help reach consensus on common goals and targets.

Context

Our world faces various pressures, including climate change, wildfires, habitat destruction, pollution, land-use changes, and biological invasions. Biodiversity plays a crucial role in maintaining healthy ecosystems and benefiting wildlife and human wellbeing. It also supports agriculture, water management, resilience to natural hazards, tourism, and infrastructure.

Managing ecosystems requires collaborative management despite uncertainties. Scenarios help assess future implications, develop adaptive strategies, and inform decision-making on local to international scales. Advanced modeling considers costs, benefits, and social impacts, enabling informed management that can be more cost-effective than inaction. This brief was built on the results of some research projects funded within the frame of the Belmont Forum and BiodivERsA joint call. It specifically uses results from the InvasibES, AlienScenarios, WildHealth, BioDiv-Support and LimnoScenEs research projects.

Key results

Integrating complex interactions between forest management practices, wildlife health and human well being in urban green space planning.

The effect of environmental biodiversity on wildlife health was considered through different scenarios in Northern Europe and in the US, including whether variation in forestry management impacts the diversity of microbial communities (both free-living and those associated with an animal host), variation in wildlife diet, and pathogen/parasite burden. The association of these aspects of biodiversity with wildlife health and fitness were also investigated.

With the putative health benefits to humans of utilising forest spaces, it is important that the health of key wildlife in addition to biodiversity, including microbial diversity and services provided, of urban green spaces be considered. Restoration of urban green spaces must be monitored to examine how these impact markers of wildlife health, linked with the EU's Biodiversity and Green Infrastructure strategies and urban development/planning.

Forecasting impacts of global biological invasions across regions and scales.

Biological invasions are a direct driver of biodiversity loss and have major impacts on supporting, provisioning, regulating and cultural services. Synthesis of knowledge across habitats and scales helps provide a comprehensive understanding of the impacts of biological invasions, including an evaluation of the costs and benefits of plausible intervention scenarios.

A developed framework for global 21st century scenarios and models of biological invasions at different spatial scales and for a range of taxonomic groups highlights the rapid actions needed to achieve goals of the Kunming-Montreal Global Biodiversity Framework. Even moderate increases in invasions may represent major impacts on biodiversity, and strong increases are projected for Europe, Temperate Asia, Northern America and Southern America. Such scenarios provide plausible future trajectories which can be used to undertake comprehensive assessments of changes for the decades to come, allowing for informed decision-making and the examination of future implications of different societal responses (Figure C).
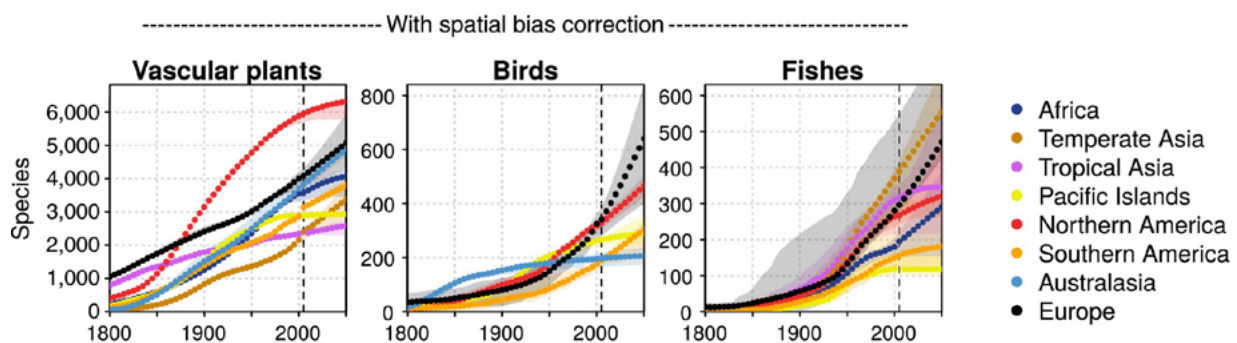

Figure C. Predicted developments of alien species numbers on different continents for seven taxonomic groups until 2050. The dots represent means of up to 100 model runs, while the full range of all predicted trajectories is indicated by shaded areas. To account for spatial variation in sampling intensity among continents, trajectories are corrected to have the same value of alien species numbers in 2000 as reported in recent publications for vascular plants, birds and fishes. This was not possible for mammals and invertebrates. Available in Global Change Biology, DOI: 10.1111/gcb.15333.

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Using future scenarios of biodiversity and ecosystem services in local freshwater management to identify key steps for governance in managing trade-offs and developing adaptive strategies.

The challenge for managing freshwater in the future is to develop adaptive strategies that account for ecological and social changes and visions, as well as their interaction. Using three lakes as case studies for transformative learning, the use of scenarios led to the creation of a model that by focusing on human-nature in-

teractions is able to aggregate hypothesized actions in a specific time frame (Figure A). It identified key steps for governance, the integration of which allows for the development of adaptive measures as well as the management of trade-offs.
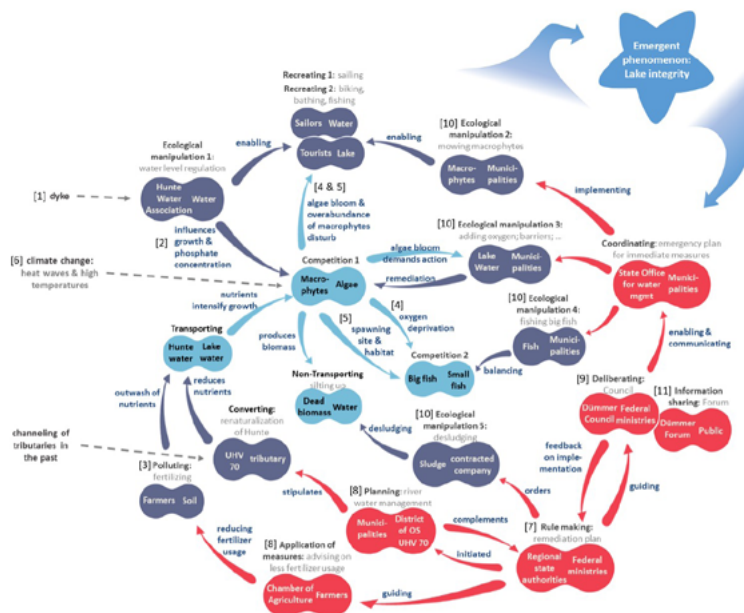
Figure A. Overview of the social-ecological system of Lake Dümmer, showing social (red), social-ecological (dark blue), and ecological (pale blue) action situations connected by external factors. Details of the full process are available at https://limnoscenes.org/dummer/.

A practical scenario tool for conservation planning to assess risks and impacts of climate change and air pollution in high-altitude ecosystems.

The IPCC highlights mountain areas as very sensitive to climate change and they encompass highly fragile ecosystems, essential for food security and other services. Scenarios informing on changes to vegetation and the impact on and of other indicators and services present pathways for end users to enable decision making for adaptation and policy. Protection of natural areas and cold refugia is essential in vegetation zones of high mountain areas that may form a haven for species at risk under the pressure of climate change. In particular, since many mountain species under threat of climate change are not well covered on the red lists of endangered species. Improved assessments of the frequency and intensity of climate change events and the estimation of changes in air pollution and the risk they represent to ecosystems were brought together in a web tool for policy planning (Figure B).
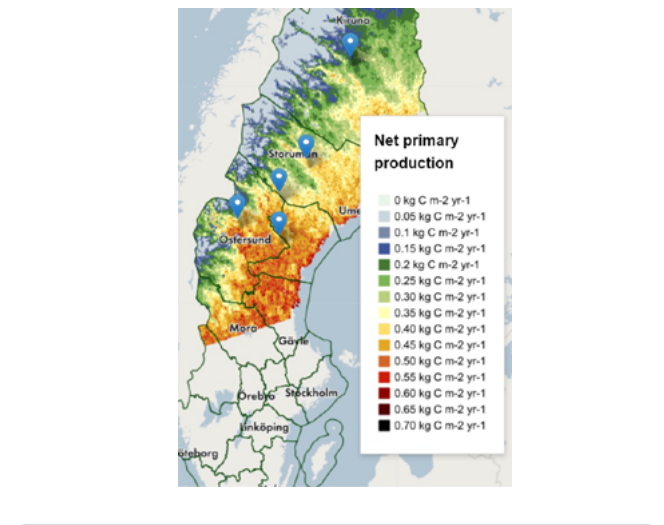

Figure B. Carbon fluxes and storage - net primary production in vegetation in Sweden and historical net primary production (mean 1987-1996). Modeled future changes until the mid-21st century are available in the online tool at https://biodivsupport-tst.smhi.se.

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Policy recommendations

Models and scenarios are practical tools that can help map potential pathways to ensure ecosystem resilience. The following are some of the recommendations arising from the application of different scenarios and models in various ecosystems.

○ Scenarios can enable the development of cross-sectoral measures through a participatory process in which each stakeholder group can share their needs, ideas, concerns and innovations towards a common vision. In addition, they help convey transparency regarding financing opportunities can ensure stakeholder empowerment and create a sense of ownership and opportunity for action.

○ Scenarios can help guide anticipatory surveilliance and protection in natural areas, including cold refugia in high mountain areas that may form biodiversity refugia for species at risk under the pressure of climate change and air pollution.

○ The health of wildlife should be considered in addition to biodiversity (including microbial diversity) green spaces. Monitoring the restoration of urban green spaces can link in with the EU's Biodiversity Strategy as well as future urban development and planning.

○ Scenarios and models are essential tools for assessing the future impacts of biological invasions under different trajectories of socio-economic development. It is critical to fully implement such models in integrated biodiversity management across regions and scales.

○ Scenarios can help account for both the negative and positive environmental impacts of biological invasions on native biodiversity can help inform conservation decisions. Evaluating future impacts of biological invasions is made possible by species distribution models calibrated using bioclimatic, environmental and human activity variables.

○ Tools and instruments are available to limit the introduction and impacts of biological invasions. However, consistency and proactiveness is required in the regulation of biological invasions across jurisdictional boundaries to prevent their introduction and spread.

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