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European Biodiversity Partnership

BELMONT FORUM

Charting the Future: collaborative Initiatives for Biodiversity Conservation and Restoration in Europe

PRESS KIT

Takeaways from 7 projects on Biodiversity Scenarios

Co-funded by
the European Union

EDITORIAL

The European biodiversity is currently at a critical crossroads. Recent scientific data indicate an alarming decline in the populations of farmland birds by 60% over the span of 40 years. Simultaneously, the abundance of European insects has seen a staggering drop of nearly 80% in the past three or four decades. The stakes go beyond ecological aspects, directly affecting the livelihoods of millions of people in the European Union, especially those dependent on a thriving environment.

The threats posed by climate change and biodiversity loss create a context where the need for significant and sustainable measures becomes imperative. In a proactive response to these challenges, Biodiversa+, the European Commission, and the Belmont Forum have joined forces to fund the development of prospective scenarios exploring possible futures for European ecosystems.

These scenarios cover a diverse range of crucial topics such as pollinators, migratory birds, marine and high-altitude biodiversity. They represent an innovative and crucial initiative for biodiversity preservation in Europe. This collaboration aims not only to address the knowledge gaps identified in the Methodological Assessment of Scenarios and Models by IPBES (2016) but also to make a significant contribution to future IPBES assessments. Often described as the 'IPCC for Biodiversity', IPBES is the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, which facilitates the analysis and synthesis of existing knowledge for policy and decision-making purposes.

The scenarios of the BiodivScen projects go beyond mere projection. They provide estimates of political and societal trajectories that present both desirable and concerning visions of the future. They emerge as central elements in the development of action plans, offering an essential roadmap for navigating the complex intersection of human activities and the environment.

At a time when the European countries have adopted the Kunming-Montreal Global Biodiversity Framework among 195 other states, dedicated to preserving the integrity of all ecosystems, including those impacted by human activities, and has committed to implementing the ambitious "EU Biodiversity Strategy for 2030," these scenarios are of crucial importance.

In support of the new EU nature restoration law, which is expected to compel European states to prepare and carry out national restoration plans to achieve the restoration targets for different types of ecosystems, including marine and agricultural ecosystems, and key species such as pollinators, these projections are called upon to play an essential role in guiding states in their collective effort to restore nature by 2050.

Magnus Tannerfeldt

Biodiversa+ Vice Chair

QUOTES & DIGEST

FutureWeb Project Accounting for food webs for understanding biodiversity patterns, threats, and implications for conservation

"Protecting an additional 5% of Europe's land could nearly double vertebrate protection and safeguard around 75% of threatened species, a vital step toward achieving conservation targets and sustainable development goals."

The FutureWeb project set out to address the neglect of trophic interactions in biodiversity scenarios and conservation efforts. Their research revealed the importance of these interactions in understanding biodiversity patterns. They also highlighted the impact of human activities on terrestrial vertebrate food webs in Europe, emphasising the need to consider species interactions when devising conservation strategies. FutureWeb also called for a more holistic approach to biodiversity conservation, recognizing the intricate relationships within ecosystems as pivotal for successful conservation efforts.

→ Project's details p.7

GloBAM Monitoring, understanding and forecasting global biomass flows of aerial migrants

"The integration of weather radar data into biodiversity monitoring has the potential to be a game-changer in conservation efforts."

Birds and insects play a vital role in connecting habitats and ecosystems, impacting ecological processes, and providing essential services like pollination. The GloBAM project leverages weather radar data to monitor their movements in the global airspace, shedding light on patterns and correlations with environmental factors. This integration of weather radar data into biodiversity monitoring not only holds significant potential for conservation efforts, but also has broader implications such as aviation, energy infrastructure, and legislation to safeguard migratory birds, as seen in New York City's recent laws to reduce light pollution during critical migration periods. The integration of weather radar data into biodiversity monitoring has the potential to be a game-changer in conservation efforts.

→ Project's details p.10

SOMBEE Future changes in marine fish biodiversity under climate change and fishing scenarios

"By the year 2100, there could be a 22% increase in biomass for top-level predator species in the Mediterranean, while the western Mediterranean encounters a 23% reduction in catch."

The SOMBEE project has studied marine fish biodiversity in the Mediterranean Sea and the North Sea. In the Mediterranean, high trophic species may experience a 22% biomass increase by 2100, but the western Mediterranean faces a 23% drop in catch. Meanwhile, in the North Sea, the study underscores the need for refining climate change impact predictions. SOMBEE highlights the intricacies of fish evolution under the dual pressures of fishing and natural selection. This complexity suggests a potential avenue for resilience in the face of climate change and overfishing, emphasizing the nuanced dynamics at play in these marine ecosystems.

→ Project's details p.12

OBServ Project Enhancing pollinator conservation through landscape heterogeneity

"Having 20% of semi-natural habitats is key for ensuring healthy pollinator populations in Europe."

The OBServ project has developed a predictive framework for policymakers by emphasizing the importance of landscape heterogeneity, suggesting that preserving and rejuvenating 20% of semi-natural habitats at various scales is crucial for pollinator conservation. The study found that smaller field sizes and diverse crops are essential for pollinator-dependent crop production and underscored the need to change agricultural practices to support diverse small-scale farming. This highlights the importance of maintaining various pollinator communities for the functioning of ecosystems.

→ Project's details p.15

BioDiv-Support Understanding future changes in biodiversity, climate and air pollution in high-altitude areas

"As vegetation adapts to new conditions, the tundra in the Scandes and diverse mountain vegetation in southern areas are at risk of being lost."

The BioDivSupport project highlights the changing dynamics of mountain ecosystems, revealing the profound impact of the combination of climate change and air quality on these fragile environments. Climate change affects water bodies, glaciers, wildfires and snow cover in mountains, causing shifts in vegetation belts, and risking the loss of tundra in the Scandes and diverse mountain flora in southern regions. This transformation not only threatens existing biodiversity, but also has implications for tourism and conservation efforts, impacting the aesthetics of mountain landscapes and increasing the vulnerability of ecosystems to droughts and pests. BioDivSupport also shows that efforts to reduce emissions can mitigate the negative impact of near-surface ozone on mountain vegetation, particularly if those efforts are consistently maintained.

→ Project's details p.17

SALBES project Scenarios for Agricultural Landscapes' Biodiversity and Ecosystem Services

"In certain regions of Europe, like Switzerland, agricultural policies can exert a more significant influence on the environment and ecosystems than climate change itself."

The SALBES project emphasises the importance of diverse land cover types and extensive management in preserving biodiversity and ecosystem services across different European regions. The project findings reveal that, while short-term economic trade-offs may be involved, achieving sustainable and resilient agriculture requires equal consideration of ecosystem services, biodiversity, and economic outcomes.

→ Project's details p.19

LimnoScenES Charting a path for freshwater resilience in the face of climate change and land use challenges

"Future freshwater will suffer from more frequent cyanobacterial blooms and more invading microorganisms."

The LimnoScenES project set out to support freshwater managers in making informed decisions about future freshwater management and resilience in the face of climate change and land use challenges. Their research found that climate change and land use are impacting lake biodiversity and causing eutrophication, resulting in more frequent cyanobacterial blooms and invading microorganisms. To address these threats, the project supports the adoption of biomanipulation as a restoration method and emphasises the importance of national and cross-national governance and social-ecological scenario planning for holistic lake management.

→ Project's details p.20

PRESS RELEASES

FutureWeb Project

Accounting for food webs for understanding biodiversity patterns, threats, and implications for conservation

"Protecting an additional 5% of Europe's land could nearly double vertebrate protection and safeguard around 75% of threatened species, a vital step toward achieving conservation targets and sustainable development goals."

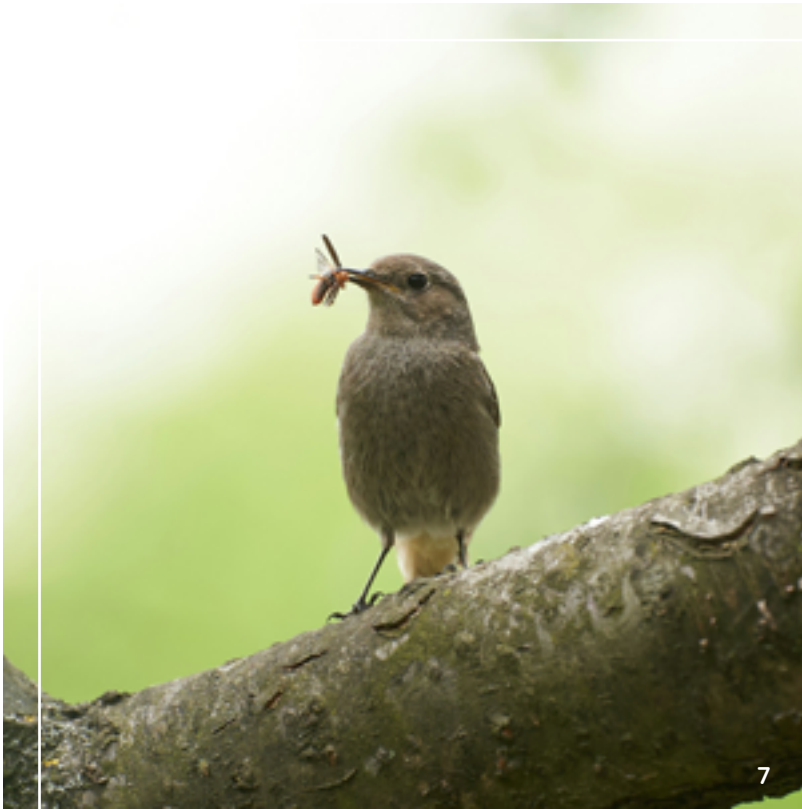
The intricate web of life on our planet relies on interactions between species, forming food webs that are the lifeblood of biodiversity and ecosystem services. However, these ecological relationships have often been neglected in biodiversity scenarios and conservation efforts, potentially leading to flawed predictions and suboptimal conservation strategies. The FutureWeb project set out to bridge these critical gaps using innovative data and a holistic approach.

Trophic interactions reveal biodiversity patterns

Trophic interactions, the relationships between species based on who eats whom, have emerged as a powerful lens through which to view biodiversity patterns on a continental scale. In Europe, the research revealed interaction-rich food webs in the European Boreal region and diverse ecological roles in the Mediterranean region. However, these regions, with their exceptional vertebrate diversity, face heightened vulnerability to climate change.

Human activities disrupt food webs

The findings from FutureWeb emphasised the important impact of human activities on terrestrial vertebrate food webs in Europe. Agricultural intensification and direct exploitation, such as hunting, pose significant threats to these ecosystems, affecting a majority of species interactions. Direct exploitation was the most impactful threat to both species and their interactions, with cascading impacts throughout the food web. Agricultural intensification, the second most impactful pressure, threatens a significant portion of species and interactions, especially targeting species that are essential prey resources to many predators.



Expanding protected areas safeguards biodiversity and nears conservation targets

FutureWeb also explored options for expanding protected areas in Europe, identifying priority areas for conserving biodiversity, cultural benefits, and regulating services. Focusing on species conservation helped maximise other indicators of protection simultaneously. Protecting an additional 5% of Europe's land could nearly double vertebrate protection and safeguard around 75% of threatened species, a vital step toward achieving conservation targets and sustainable development goals.

Trophic interactions need to guide conservation efforts

Preliminary results suggest that considering species interactions alongside distributions can reshape conservation priorities, benefiting predators, prey, and threatened species. This highlights the need for a more holistic paradigm in conservation, recognising biodiversity as an interconnected system.

Investigating the implications of land use intensity for biodiversity and Nature's contributions to people

FutureWeb also delved into the often-overlooked factor of management and land use intensity, showing its critical role in estimating species distribution and designing effective protected area networks. Innovative land use maps, incorporating varying levels of management intensity, provided valuable insights into food web structures across European regions, and associated ecosystem functions and services.

Looking to the Future

To effectively protect species, we must ensure they have suitable habitats within interaction networks, allowing them to adapt as habitats shift due to global change. **Integrating climate change, land use changes, ecological connectivity, and food web ecology into conservation strategies represents a novel approach**. It is a call to design protected area networks that can withstand future environmental changes while benefiting both nature and humanity.

Spatial coverage and ecological value of top 10% priorities in the optimal scenario.

(A) Map locating the top 10% priorities for all three nature's values considered. Top priorities for vertebrate species are shown in orange, cultural NCP are in yellow, and regulating NCP are in blue. Areas of overlap between top priorities for two different values are bright red (3.2% of entire study region); areas of overlap between top priorities for all three values are brown (0.29% of entire study region). https://www.science.org/doi/10.1126/science.abc4896

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GloBAM

Monitoring, understanding and forecasting global biomass flows of aerial migrants

"The integration of weather radar data into biodiversity monitoring has the potential to be a game-changer in conservation efforts"

Billions of birds and insects use the global airspace for key activities in their life cycles, such as food foraging, local or hemispheric movements, and daily and seasonal migrations. Their movements connect otherwise separated habitats, communities, and ecosystems, and influence many ecological processes. They also give rise to conflicts between humans and wildlife and provide services such as pollination, seed dispersal, pest control, and contributions to nature that are essential for human agriculture, economy, and health.

Many bird and insect populations have recently experienced alarming declines. Quantifying populations and their movements and understanding the drivers of their spatiotemporal distributions are essential for preserving aerial and terrestrial diversity. Although airspace is increasingly recognised as an essential habitat for much of global biodiversity, aerial habitats are poorly monitored and largely absent from legislation and policies, even though their fragmentation impacts biodiversity and ecosystem functioning similarly to other habitats.

Main results

The Global Biomass Monitoring (GloBAM) project has harnessed the power of weather radar data to quantify massive biomass fluxes across Europe and North America, representing a breakthrough in biodiversity monitoring. This pioneering effort has not only shed light on the spatial and temporal patterns of these flows but also uncovered their correlation with environmental factors and determinants.

Weather radar data policies for biodiversity monitoring

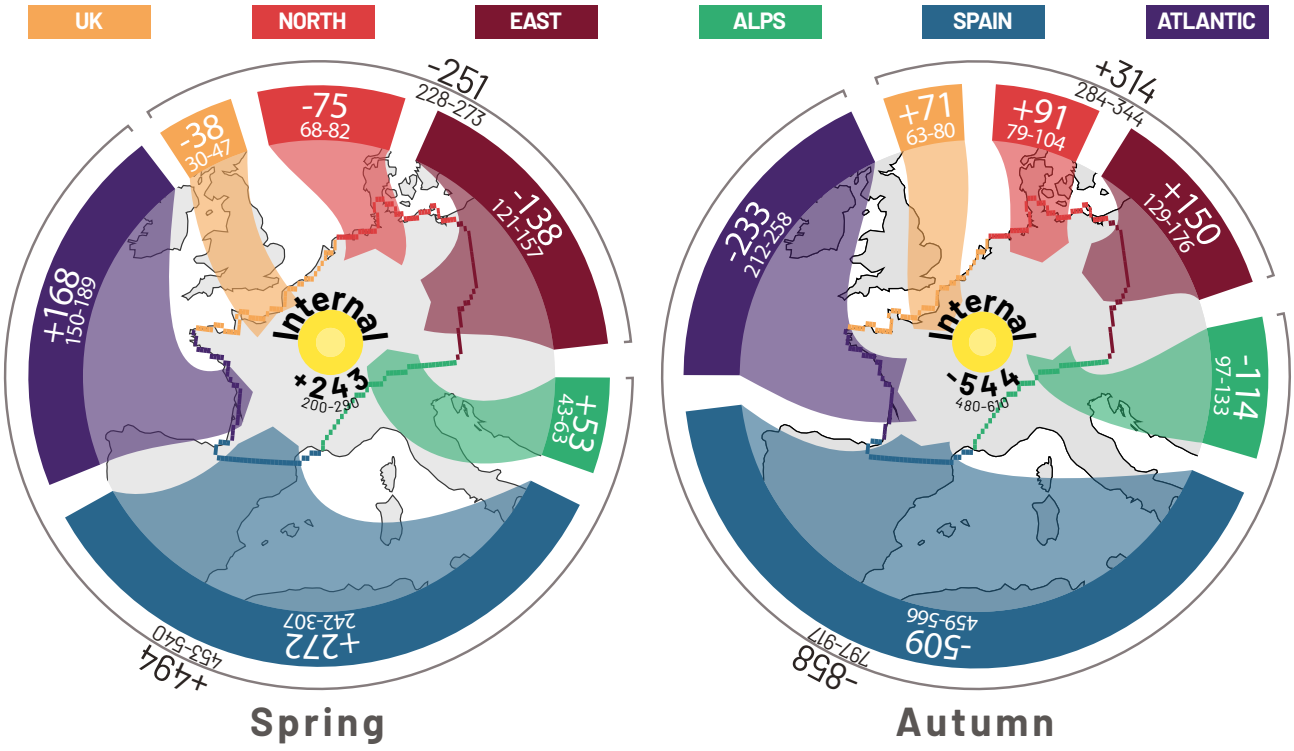
In response to the biodiversity crisis, there's a pressing need for standardised, widespread, long-term monitoring to assess populations, movements, and conservation effectiveness. Existing meteorological radars provide a cost-effective and innovative solution on this matter. GloBAM is formulating key changes to enable weather radar to monitor biodiversity. Recently, the World Meteorological Organization (WMO) adopted a unified data policy. This policy acknowledges the increasing demand for weather and climate data across sectors and represents a critical advancement in unlocking weather radar data's full potential for biodiversity conservation. The integration of weather radar data into biodiversity monitoring can become a game-changer in conservation efforts. However, it will require continued efforts to ensure the effective implementation of policies and initiatives, as well as the development of standardised protocols for utilising weather radar technology for this purpose.

Ecological forecasting for aviation, energy infrastructure and conservation

The scientific knowledge extracted from weather radar data on bird migration has opened a new frontier of ecological forecasting. Predicting when, where and to what extent bird migration will occur has far-reaching implications. It is influencing key aspects of energy infrastructure operation and site selection, such as wind power curtailment policies. It also plays an essential role in aviation planning, identifying the areas and periods of heightened risks or severity of impact. In addition, it guides conservation efforts, in particular initiatives aimed at safeguarding migratory birds facing precipitous decline due to the risks posed by light pollution.

Conservation legislation

In the United States, data derived from GloBAM's radar quantification of migratory birds has played a major role in new legislation, protecting nocturnal travellers. For example, in 2022, New York City passed two laws for the reduction of light pollution from buildings during critical migration periods. This legislation reflects a growing awareness of the need to mitigate man-made threats to bird populations and highlights the importance of innovative projects such as GloBAM in achieving positive conservation outcomes.



This is a summary of the analysis for Europe. It quantifies the numbers of birds migrating in spring and autumn along several transects (note that the arrows indicate the direction of movement, i.e. in or out of transect). Click here for a more dynamic visualisation: https://birdmigrationmap.vogelwarte.ch/2018/

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SOMBEE

Future changes in marine fish biodiversity under climate change and fishing scenarios

« By the year, 2100, there could be a 22% increase in biomass for top-level predator species in the Mediterranean, while the western Mediterranean encounters a 23% reduction in catch. »

Global changes, particularly climate change and the growing demand for seafood, are driving marine ecosystems into unprecedented states, demanding adaptation and mitigation strategies. Scenarios and models are valuable tools for guiding long-term strategic policies.

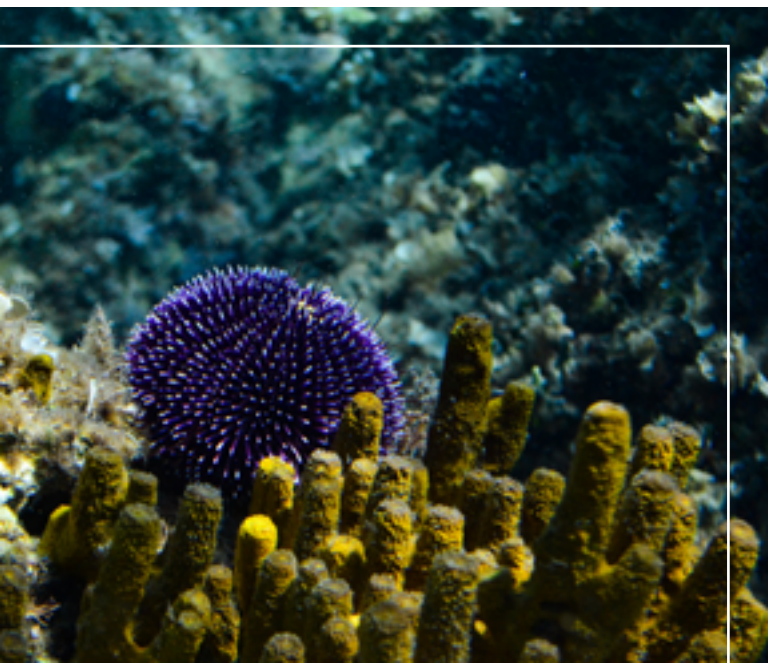
SOMBEE project set out to improve predictions in marine fish biodiversity in the Mediterranean Sea and the North Sea. It explored how future ecology and evolution are interconnected, shaping species traits and ecological communities, and their impact on the sustainable exploitation of fisheries resources using model simulations. The central question is whether exploited fish populations can adapt quickly enough in response to climate change and exploitation to ensure their persistence and sustainable use.

For the Mediterranean Sea results show that:

By 2100, biomass soars 22% for Mediterranean high trophic species, but western Mediterranean faces a 23% catch drop

In the Mediterranean Sea, projections indicate potential shifts in high trophic level species, which include both fish and macro-invertebrates, under a business-as-usual scenario of climate change and fishing. By the middle of this century (2021-2050), their combined biomass could increase by 5%. By the end of the century (2071-2100), this increase could be as high as 22%. In contrast, the total catch is projected to increase by only 0.3% by the middle of the century, followed by a more substantial 7% rise by the end of the century.

Behind these seemingly positive trends lies a more complex scenario. Beneath the surface, by the end of the century, marine species of the Mediterranean are likely to be engaged in a complex dance of winners and losers. The south-eastern part of the Mediterranean appears to be a possible hotspot of growth, where catches and biomass are expected to flourish. Conversely, in the western part, predictions point towards a potential drop in catches of up to 23%. This could have significant socio-economic consequences for the communities relying on fishing in this region.



The more commercially important species could lose out

The winners in this rapidly changing marine landscape would be the open water, thermophilic and/or exotic species. These are mainly the small fry at the bottom of the trophic scale, which could benefit from the warmth of the changing waters. But there is also a darker side. More commercially important species such as the sea bass or the octopus could lose out. They could face difficulties when their feeding grounds shift or shrink, resulting in a spatial mismatch with their potential prey.

Fisheries management can help tackle climate change challenges

Amid this uncertainty, there is a glimmer of hope. Fisheries management strategies could help mitigate some of the challenges posed by climate change. By reducing fishing mortality or improving size selectivity, we might reverse declining biomass and catches in the western Mediterranean. For instance, a 20% increase in the size of the smallest fish caught or lower fishing mortality would benefit all species. These regulations are expected to improve catches in the western Mediterranean and have the potential to revive struggling fish species and safeguard their populations.

For the North Sea results show that:

Predictions of climate change impacts need to be refined in the North Sea

In the North Sea, predictions of the impacts of climate change on fish need to be refined. The evolution and adaptation of fish populations are often neglected in projections, while they could mitigate their vulnerability to global change and prevent them from collapsing. But this could also push them into evolutionary traps, eroding their genetic diversity, thereby reducing their evolutionary potential and resilience in the face of new environmental challenges.

Survival strategies: fish evolution in response to pressures

The intricate puzzle of evolutionary changes in fish, driven by fishing pressure and natural selection, adds complexity. While some species adapt by speeding up their life cycles, as predicted by single-species models, predation introduces an unexpected twist to the projections when multiple species are considered.

Indeed, fishing poses a significant challenge to fish populations, increasing overall mortality and targeting larger individuals. This selective pressure encourages certain traits to emerge. For example, it promotes early reproduction, as fish that mature rapidly have a better chance of reproducing before being captured. Slow growth becomes advantageous as well, as it allows fish to remain below the size range commonly sought by fishermen, increasing their chances of survival.

In contrast, natural predators such as larger fish, birds, and marine mammals, focus on the smallest and youngest members of the fish population. This exerts a different set of selective pressures, encouraging rapid growth as a survival strategy. Fish that grow quickly to reach a size where they are less vulnerable to predation are favoured. Additionally, late reproduction and larger body sizes are advantageous, providing greater fecundity and better defences against natural predators and offering fish the upper hand on their own prey.

The anticipated adjustment of fish to climate change and fishing pressure provides a ray of hope

These shifts in how different species evolve alongside each other appear to enhance the resilience and abundance of marine ecosystems, even when subjected to heavy fishing pressures. But there's a catch. These changes could unpredictably alter the makeup of these ecosystems.

Overall, then, the projected adaptation of fish to climate change and fishing pressure offers a glimmer of hope. These evolutionary adjustments could potentially serve as a lifeline, helping to offset the imminent threats of reduced resilience and declining catches in exploited fish stocks in the face of climate change.

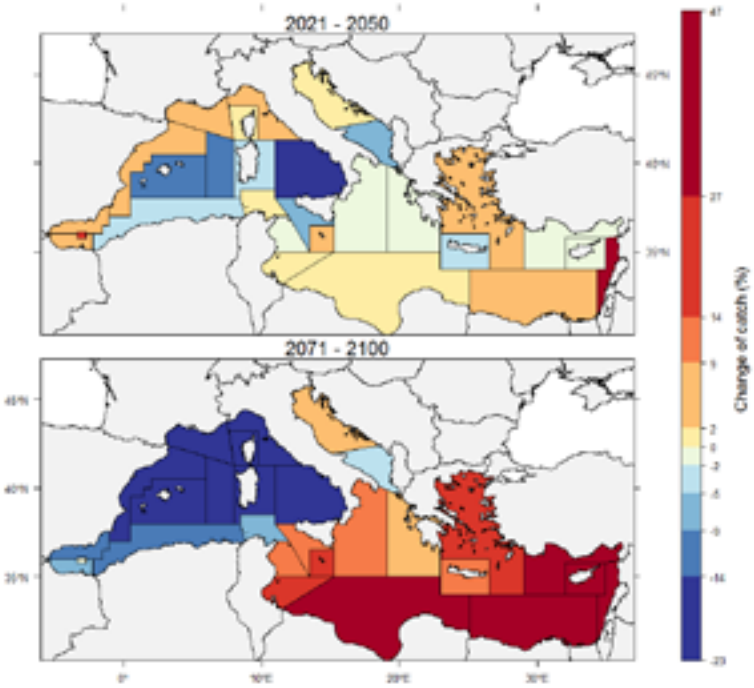


Figure shows changes in expected catches between now and the periods 2021-2050 and 2071-2100 for a status quo fishery under a RCP8.5 climate change scenario*. (https://doi.org/10.3389/fmars.2019.00345)

* RCP8.5 refers to “the worst possible scenario”, which corresponds to business as usual in terms of greenhouse gas emissions, with more than a 50% probability of resulting in a rise of more than 4°C by the end of the century.

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OBServ Project

Enhancing pollinator conservation through landscape heterogeneity

"Having 20% of semi-natural habitats are key for ensuring healthy pollinator populations in Europe"

Pollination is a critical ecosystem service that relies upon multiple species of pollinators, mainly insects. The total economic value of crop pollination worldwide is estimated to be over 153 billion USD annually, with over 75% of agricultural crops depending on pollinators. OBServ project aimed to leverage pollinators and the ecosystem services they provide as a key model system to develop a predictive framework to inform policymakers. Resolving the tension between pollinator conservation and pollination ecosystem service delivery requires increasing our ability to forecast which agricultural landscapes allow pollinator populations to thrive.

Diverse landscapes are crucial because pollinators have limited foraging areas

OBServ has calibrated different models using an unprecedented global database on crop pollinators. Beyond the known environmental climate variables influencing plant and pollinator development on a continental scale, landscape features such as the percentage of semi-natural habitats around crops are crucial for safeguarding pollinator populations. A sustainable future for pollinators relies on scenarios where 20% of semi-natural habitats are preserved and rejuvenated in a fractal fashion, encompassing all levels-be it 20% of an individual farm, 20% of a broader landscape, or 20% of an entire region. Semi-natural habitats - which could be meadows, forests, and shrublands - remain valuable even if they aren't pristine and have seen human management. Achieving this fine landscape heterogeneity is important because pollinators have limited foraging ranges. Consequently, measures such as planting flowers along field edges consistently benefit pollinators at those edges, but their positive impact only extending a few meters into adjacent fields.

Changed agricultural practices needed

Current agriculture favours larger fields and monocultures. However, without a change in agricultural practices, we may not meet EU targets to stop pollinator decline (European Green Deal) and risk losing pollinators, especially in intensively farmed areas. Therefore, the Common Agricultural Policy and other agricultural policies should support diverse small-scale farming. OBServ also showed that most crops lack sufficient pollination under current conditions, emphasising the need to change agricultural practices for conservation and ecosystem service delivery.

Composition of pollinators communities are key for their functioning

Although it is common to talk about "pollinators", they form a diverse group comprising different orders of insects, as well as birds and mammals in some latitudes. The composition and structure of this community are important for its functioning, and conservation actions targeting one group of pollinators may not benefit other groups. For example, OBServ has shown that changes in butterflies are not a good indicator of changes in other pollinators such as bees or syrphid flies. Consequently, monitoring the health of pollinators may require the use of more complex indicators, such as species dominance or flower abundance.

In summary, a bright future for pollinators integrates good quality semi-natural habitats within agricultural landscapes and strive to maintain diverse agricultural systems that can benefit from the pollination ecosystem services provided.

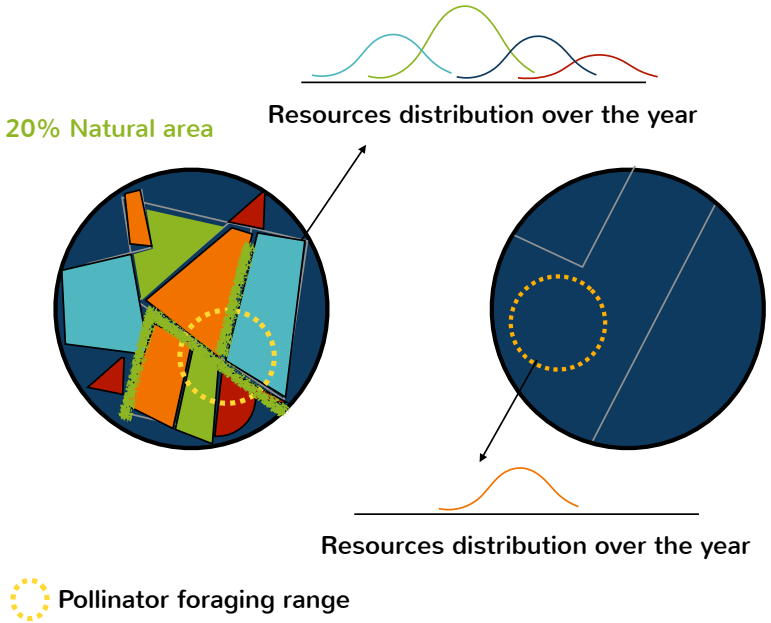

Illustration of two landscape maps, the one left with divers and small fields (colours), and with a 20% semi-natural area, including linear elements (green). The one on the right has one type of field cover (orange). Pollinators only forage in a certain distance (yellow dotted circle). On the left scenario, pollinators benefit from multiple resources along the year (multiple distribution plot), as each crop/natural area gives different resources. On the right, pollinators can only make use of a single pulse of resources (single distribution plot).

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BioDiv-Support

Understanding future changes in biodiversity, climate and air pollution in high-altitude areas

"As vegetation adapts to new conditions, the tundra in the Scandes and diverse mountain vegetation in southern areas are at risk of being lost."

High-altitude mountain regions include some of our most pristine environments, historically protected from considerable atmospheric pollution, but now at risk of being disproportionately affected by climate change. The BioDiv-Support project studied the impact of factors modifying biodiversity in Europe, such as climate change, management practices such as reindeer grazing, and atmospheric pollution. In particular, the changing dynamics of mountain ecosystems revealed the profound impact of the combination of climate change and air quality on these fragile environments.

Changing Vegetation Belts

Climate change is reshaping the very fabric of mountain landscapes. It's causing vegetation belts to ascend to higher altitudes and move northward in the case of the Scandes, the Scandinavian Mountains.

Loss of Tundra and Biodiversity

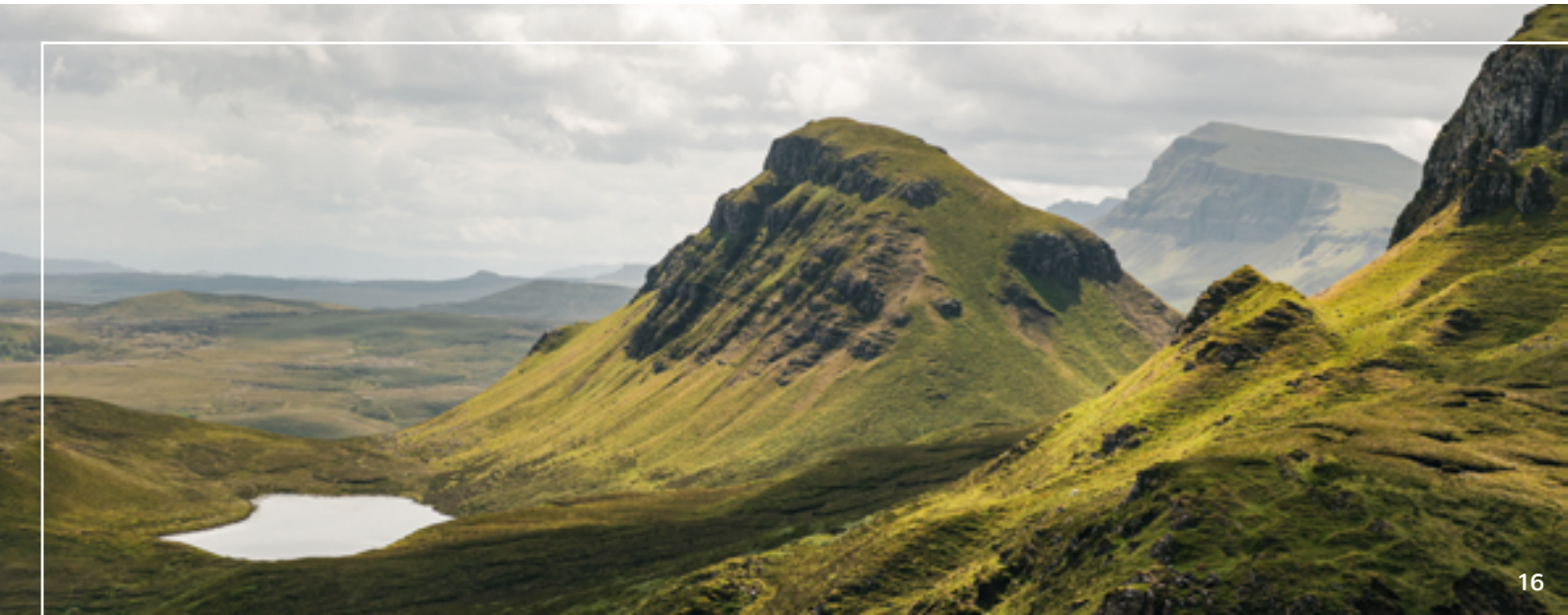
As vegetation adapts to these new conditions, the tundra in the Scandes and diverse mountain vegetation in southern areas are at risk of disappearing. The pace of this shift is a concern. Species struggle to adapt quickly enough, potentially facing local extinction or reduced vitality. Additionally, these changes affect the resilience of forests, making them more susceptible to threats like droughts and forest pests.

Tourism and Conservation

Beyond ecological concerns, these transformations hold significant implications for tourism and conservation efforts. Reduced snow cover and alterations in flora redefine the aesthetics and experiences of these mountain landscapes. Furthermore, the changes in vegetation cover and composition pose a substantial threat to endangered species, many of which are already at risk.

Climate Change Effects

Climate change doesn't just influence vegetation and terrestrial ecosystems. Increasing temperatures also leads to changes in rivers and lakes, retreating glaciers, increased frequency and extent of wildfires and less extensive snow cover. Also, precipitation patterns, even at high altitudes, are modified by climate change.



Nitrogen Deposition

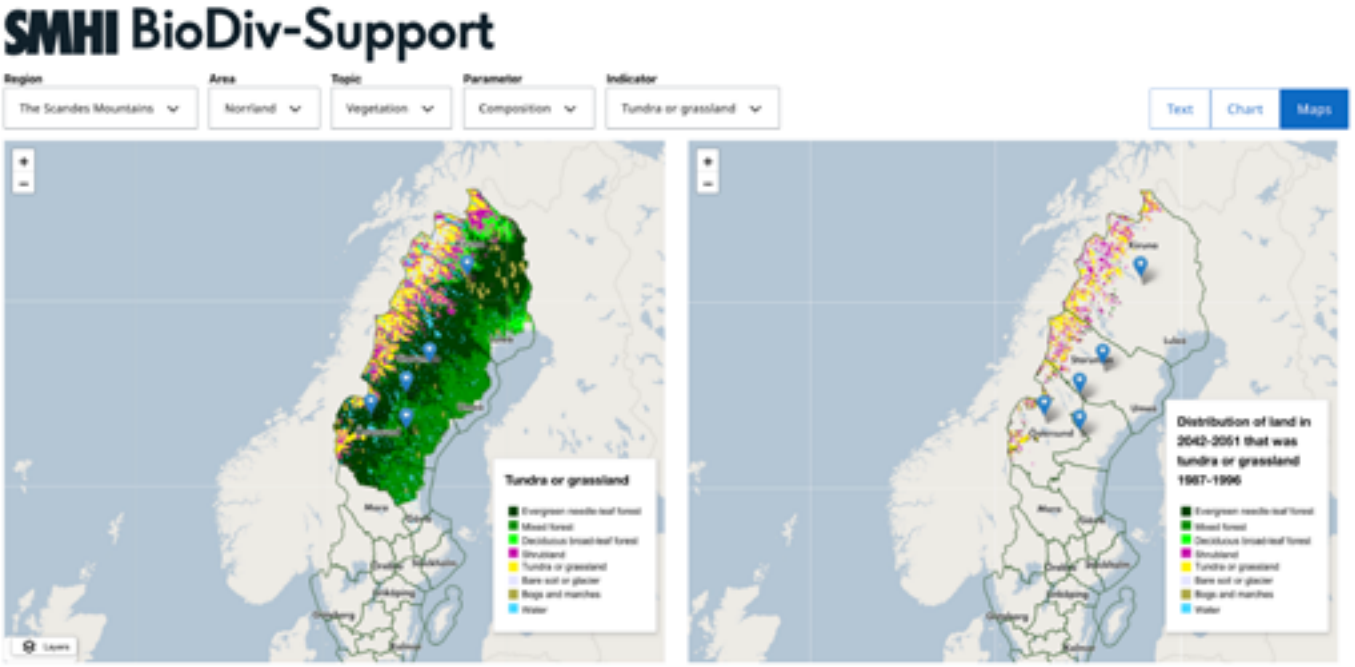
Total nitrogen deposition, caused by various human activities including agriculture, industrial processes and transport, and responsible for the eutrophication of water or damage to sensitive habitats, is expected to decrease in the Scandes, the Pyrenees and the Spanish mountain ranges of the central system by the middle of the 21st century. However, additional policy measures are needed, particularly for the agricultural sector, to reduce the adverse effects of nitrogen deposition.

Indeed, despite past policy interventions to reduce nitrogen deposition in Europe, levels will remain well above pre-industrial levels in most parts of Europe, even in remote high-altitude areas such as the Scandinavian mountains.

Near-Surface Ozone

Efforts to curb emissions should reduce the impact of near-surface ozone, a harmful air pollutant, on mountain vegetation by 2050, provided countries maintain their emission reduction initiatives. Central Spain, including the Central System, is expected to meet the short-term air quality objectives set in the current European legislation but may not meet the long-term objectives.

In Scandinavia, extreme weather events such as heat waves and forest fires can increase ozone levels near the surface, exacerbating the problem. In addition, the lengthening of the vegetation period due to climate change is contributing to earlier and more intense spring peaks in near-surface ozone levels, as shown by ecosystem simulations.



The productivity of the area that now has alpine tundra or grass vegetation will substantially increase in a warmer climate with higher carbon dioxide levels, and will experience competition from shrubs. The tundra will expand to land that has no vegetation in the current climate.

The map on the left-hand side shows mean vegetation composition over the period 1987-1996. The map on the right shows projected vegetation composition in 2042-2051.

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SALBES project

Scenarios for Agricultural Landscapes' Biodiversity and Ecosystem Services

"In certain regions of Europe, like Switzerland, agricultural policies can exert a more significant influence on the environment and ecosystems than climate change itself."

European agricultural landscapes are undergoing profound changes driven by global change phenomena. To safeguard biodiversity and the supply of ecosystem services, dedicated and adaptive management of both agricultural land use and ecological infrastructures is crucial. The SALBES project has developed a comprehensive scenario and modelling protocol, focusing on global change drivers, agricultural system functioning, and related policies. This protocol was tested across Europe (Switzerland, Austria, Germany, and Estonia) to evaluate conservation strategies.

Common Threads Across Regions

SALBES findings emphasise the importance of semi-natural habitats, diverse mosaic landscapes, and extensive management in preserving biodiversity and ecosystem services. These findings were consistent across all four regions explored in the scenarios.

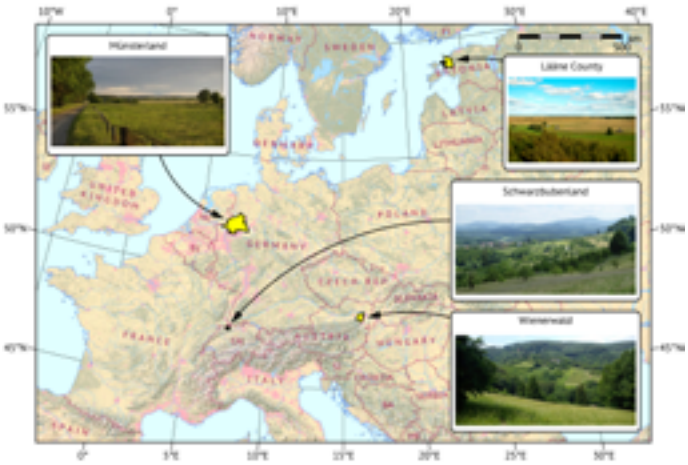
The underlying rationale is straightforward: the presence of diverse land cover types, encompassing different crops, grasslands, trees, hedges, and ponds, requires varied management approaches with distinct timing. This results in a range of ecological products, offering a wide array of habitats for flora and fauna, and reducing the prevalence of monocultures that solely exploit individual natural resources and ecosystem services.

This diversity in land uses encourages a harmonious utilization of natural resources. While it may involve short-term trade-offs in economic outcomes, the long-term perspective is clear. Achieving stable and resilient agriculture requires simultaneous and equal consideration of all ecosystem services, biodiversity, and economic outcomes, including product diversity, to create a sustainable and harmonious balance.

Swiss Insights: Global Land Use Drivers

The Swiss case study, known for its innovative cherry tree agroforestry system integrating fruit production and grasslands, sheds light on the significant influence of global factors on local agriculture. These factors include fluctuations in food prices, meat consumption, and labor availability. The study utilizes SALBES model projections for the year 2050, taking into account a broad range of socio-economic and biophysical factors that shape land use decisions.

Remarkably, the study reveals distinct consequences of these land use changes in various socio-economic and ecological aspects. Notably, it underscores that alterations in socio-economic conditions, especially those related to subsidies and agricultural structures, wield a more substantial impact on agricultural land use in Switzerland compared to the effects of climate change. This insight emphasizes the intricate interplay of global and local factors in shaping the future of agriculture in the region.



Estonia's Grassland Dilemma

Semi-natural grasslands in Estonia, invaluable ecosystems, are at risk of abandonment due to the limited opportunities for profit. SALBES results underscore the shortcomings of relying solely on Eco-scheme payments as incentives for their preservation. This issue arises from the limited market potential of products derived from these grasslands, such as hay or silage. Ensuring the conservation of these grasslands requires a multifaceted approach.

One potential avenue involves exploring marketing opportunities for grassland products. For example, exporting extensively produced hay to other countries has already proven to be a lucrative income source for many regional farmers. Additionally, utilising burning hay in local heating facilities to generate energy for nearby buildings presents another promising option for tackling grassland abandonment.

Furthermore, the successful expansion of extensive livestock production on these grasslands is contingent on a consistent demand for premium beef, a fiercely competitive niche within the agricultural market. Therefore, efforts to promote extensive livestock farming must align closely with market dynamics and consumer preferences.

Sustainable Future for Münsterländer Parklandschaft: Harnessing Tradition and Innovation in European Agriculture

The German "Münsterländer Parklandschaft" is a historically rich landscape with a park-like pattern, featuring small grassland patches, trees, hedgerows, and water bodies. It also hosts intensive agriculture, mainly in livestock and arable farming. Additionally, Münsterland is an "energy landscape," with sustainable energy sources like biogas plants and photovoltaic systems, catering to a regional market, including ecologically produced goods. These factors were crucial in scenario development. Of the 3 possible scenarios developed for the Münsterland region based on development paths for European agriculture up to 2050, the most sustainable scenario describes a future in which society is prepared to support sustainable regional agriculture by increasing product prices and implementing various agri-environmental programmes that protect biodiversity. In this scenario, new or expanded technologies (various forms of photovoltaics, expanded and flexible use of biogas plants) and a range of measures to improve biodiversity in arable crops, grassland and green infrastructure have a high potential for implementation. As an outcome of the modelling of "climate-like regions", new crops such as soya and chickpeas could diversify the agricultural landscape.

Wienerwald: A Natura 2000 biosphere reserve at the Crossroads of Urban Growth and Environmental Conservation

The Wienerwald region, situated near Vienna, is designated as a Natura 2000 area of high ecological significance due to its diverse landscape, including meadows, pastures, arable land, forests, and vineyards. This rich ecosystem provides a wide range of services that offer numerous advantages to a rapidly expanding urban area with over 2 million residents. The scenarios outlined in the SALBES project reveal that this proximity of high value plays a pivotal role in land use, particularly in addressing the need for outdoor recreation and controlling urban expansion. The geographical location of Wienerwald also presents opportunities for agricultural activities, such as direct sales. However, these opportunities do not guarantee the preservation of extensively managed and partially endangered marginal grasslands, nor do they contribute to efforts to combat climate change.

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LimnoScenES

Charting a path for freshwater resilience in the face of climate change and land use challenges

"Future freshwater will suffer from more frequent cyanobacterial blooms and more invading microorganisms."

Human life depends on the quality and quantity of freshwater. Many stakeholders work collaboratively on managing freshwater resources. However, successful collaboration is challenged by considerable uncertainty surrounding the impacts of climate change, the interaction between global and local disturbances affecting freshwater biodiversity, and multiple human activities like farming. A striking example is pollution, which disrupts the ecosystem and degrades water quality.

This has led to dangerous algae blooms and negative effects on biodiversity. The challenge for future freshwater management is to develop adaptive and anticipatory strategies that account for ecological and social changes and visions, as well as their interaction.

LimnoScenES set out to support freshwater managers in decision-making with future scenarios of biodiversity and ecosystem services for better freshwater management and resilience. The LimnoScenES case studies in Europe focused on Lake Ringsjön in southern Sweden and Lake Dümmer in Lower Saxony, Germany.

Main results

LimnoScenES explored how climate change and land use impact lake biodiversity and eutrophication, which leads to the harmful proliferation of algae and plants due to excess nutrients in water, causing to ecosystem disruption. **LimnoScenES found that during the past 23 years, green lakes became greener (experiencing more algae blooms) and blue lakes became more blue (fewer algae blooms)**. This trend is exacerbated by extended thermal stratification during the growing season because of warming and worsened by heat waves impacting different algal groups differently.

In the future, we expect:

- **Cyanobacteria to dominate in a warmer climate, particularly in lakes that are already nutrient-rich, impacting human and animal health**.
- Remote lakes will be more influenced by climate change, while others change more due to land use changes in the surrounding catchment.
- The biodiversity of algae will remain consistent under projected climate change, although cyanobacteria may become more dominant.
- Invasive species from warmer regions will be more successful in their establishment in a future climate.
- Future freshwater will suffer from more frequent cyanobacterial blooms and more invading microorganisms.
- Pressures on freshwater biodiversity from agriculture and urbanisation will accumulate, increasing conflicts of interests between agricultural production and biodiversity conservation at the landscape level.
- Institutions managing future freshwater systems will require legal and financial support across sectors and administrative levels to meet the anticipated challenges and mediate conflict effectively.

In response to these threats,

LimnoScenES supports **the adoption of biomanipulation as an effective restoration method** for eutrophicated lakes. It holds the potential to counteract the adverse effects of climate warming in cases where nutrients have been sufficiently reduced as a driving force.

However, local management measures, often characterised by delayed implementation and limited impact, may fall short. Instead, LimnoScenES emphasises the importance of national and cross-national governance. **It highlights the disparity between the substantial investments in intensified agriculture, driven by EU subsidies, and the comparatively meagre allocation for addressing biodiversity loss**.

Social-Ecological Scenario Planning

LimnoScenES activities reiterated that addressing these multifaceted challenges requires a holistic approach. Water governance decision-makers are encouraged to participate in collaborative scenario planning to discuss potential action paths and ongoing opportunities for learning. The project has advanced social-ecological scenario thinking, facilitating interdisciplinary collaboration to analyse human-lake interactions and their projected changes until 2050.

The collaborative approach adopted by LimnoScenES underscores the necessity of cross-border communication and collaboration at district and province levels for effective lake management. Rather than isolated, end-of-pipe measures, comprehensive strategies addressing environmental problems and their symptoms across various levels and landscapes are essential.

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The BiodivScen programme

The Belmont Forum and Biodiversa+ have joined forces to implement the joint programme "BiodivScen", for supporting international research efforts in the development of scenarios of biodiversity and ecosystem services. Under the BiodivScen call for research, 21 research projects were funded for a total budget of over 28 million euro.

The BiodivScen programme was co-funded by the European Commission under the Horizon 2020 programme as an ERA-NET COFUND.

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