

Managing Aquatic Biodiversity: The AQUACROSS Case Studies

Introducing eight practical applications of ecosystem-based management to protect biodiversity in Europe's lakes, rivers, coasts and oceans

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Case Study 1

Trade-offs in ecosystem-based management in the North Sea aimed at achieving Biodiversity Strategy targets



Biodiversity challenge

There is a need for a more integrated perspective for managing the many activities in the North Sea that impact biodiversity and hence compromise the achievement of societal goals. Management decisions are often taken without adequate knowledge of the associated risks. Our aim: to determine the requirements of the North Sea scientific knowledge base to guide decision-making toward the (balanced) achievement of societal goals, whilst involving important societal actors, including (national) government, fishing industry, the offshore wind energy sector, and Non-Governmental Organisations.

Context

The Faial-Pico Channel is a richly biodiverse Marine Protected The North Sea is one of the busiest seas with many (often growing or newly emerging) sectors laying claim to a limited amount of space. The main human activities include fishing, shipping, oil and gas extraction, and newly emerging activities such as the renewable energy sector. These combined human activities and their associated pressures on the environment have hindered the achievement of the ecological goals for the North Sea. Management of often multiple competing interests is complex and requires novel, more integrated approaches such as Maritime Spatial Planning or Ecosystem-based Management (EBM), which come with additional requirements for the scientific knowledge base.

What was done?

In collaboration with stakeholders:

- We assessed the current state of the North Sea ecosystem using a risk-based approach and the AQUACROSS linkage framework.
- We developed an integrated risk-based approach that linked the impacts on biodiversity to the supply of ecosystem services.

- we identified a number of likely ecosystem-based management measures for the North Sea.
- we evaluated the effectiveness of these EBM measures to contribute to the conservation of biodiversity, i.e. achievement of the “healthy marine ecosystem” societal goal, while also considering potential management initiatives toward achieving other societal goals, i.e. a “sustainable food supply” and “clean energy”.

Results

We show that integrated ecosystem-based scientific advice can provide a new perspective to the conventional science advice confined within institutional silos and, as such, should be considered complementary to this. The current knowledge base needs considerable development before it can fulfil this role. We show that risk-based approaches are promising for integrated assessments of cumulative effects and management of biodiversity.

Lessons learned for managing biodiversity

This work represents a first attempt to provide a more integrated, ecosystem-based approach that considers diverse societal goals, includes several sectors, and considers their impacts on the ecosystem and all relevant components. A risk assessment was applied to assess the effectiveness of a suite of management measures.

Applicability

Our findings provide direction for the (further) improvement of the North Sea knowledge base and the type of risk assessments it can support. It has provided input to policy makers in the Netherlands and Belgium on issues involving marine spatial planning and fisheries management.

Learn more about Case Study 1 at aquacross.eu or the AQUACROSS Information Platform

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Case Study 2

Analysis of transboundary water ecosystems, Green and Blue Infrastructures in the Intercontinental Biosphere Reserve of the Mediterranean (IBRM): Andalusia (Spain) – Morocco



Biodiversity challenge

The IBRM transboundary setting contains several remarkable protected sites, high biodiversity richness and an important cultural heritage. However, pressures from human activities in the area are threatening these distinct values. Our aim is to understand the social and ecological system of the Reserve to design a multifunctional Green and Blue Infrastructure network - with conservation, exploitation and restoration objectives - and implement Ecosystem-Based Management measures with a comprehensive focus on freshwater, coastal and marine realms.

Context

The study area encompasses the IBRM in Andalusia (Spain) – Morocco and its area of influence. The reserve spans over two continents, Europe and Africa, and the marine area of the Strait of Gibraltar, and includes river basins, coastal, and marine areas (UNESCO-MAB 2011). Economic activities in both the northern and southern sections of the case study area are based on agriculture, livestock, fisheries, and tourism, all of which are highly dependent on terrestrial and aquatic resources. The aquatic ecosystems provide a vital range of provisioning goods, and cultural, regulation and maintenance services for sustaining human well-being.

What was done?

In collaboration with regional and local governments of Andalusia (Spain) and Kingdom of Morocco, we applied the AQUACROSS Assessment Framework to develop and design a multi-purpose Green and Blue Infrastructure. This included:

- Analysing regional activities, pressures, ecosystem condition, biodiversity, and key aquatic ecosystem services.
- Identifying stakeholder objectives: synergies, conflicts, and opportunities for improvement.
- Green and Blue Infrastructure design based on spatial conservation prioritisation and modelling of biodiversity features and ecosystem services.

- Identifying the best spatial allocation for an ecosystem-based management plan for the restoration of degraded ecosystems.
- Co-creation with local stakeholders: two rounds of workshops held in Tarifa (Spain, northern section) and Tangier (Morocco, southern section).

Results

Our study identified the key areas that allow conserving biodiversity, maintaining ecosystem services capacity, and restoring degraded ecosystems, while minimising costs. The results suggest that implementing ecosystem-based management restoration measures when designing Green and Blue Infrastructure may result in greater coverage, while improving connectivity across its core and conservation zones.

Lessons learned for managing biodiversity

Green and Blue Infrastructure combines in one single solution an ecosystem-based management outcome that balances conservation, restoration and exploitation objectives. The Green and Blue Infrastructure multi-zoning approach offers co-benefits in terms of ecosystem and biodiversity conservation as well as human well-being, while minimising the potential conflicts between conservation and exploitation goals.

Applicability

The CS2 framework may be also useful in guiding Green and Blue Infrastructure investment at regional level. It also supports its integration in different policies at EU level and international/global level, among them, the Biodiversity Strategies, National Marine Strategies, Coastal Management Plans, and National Plans for Watershed Management in both Spain and Morocco.

Learn more about Case Study 2 at ibrm.aquacross.eu or the AQUACROSS Information Platform

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Case Study 3 Danube River Basin - Harmonising inland, coastal and marine ecosystem management to achieve aquatic biodiversity targets



Biodiversity challenge

Hydro-morphological alterations, such as disconnection of floodplains, threaten riverine ecosystems and their biodiversity, and are a particular challenge along the Danube. Multiple human activities, including the construction of hydropower plants, expansion of agriculture, and large-scale river regulation measures related to navigation and flood protection are resulting in an ongoing loss of habitat and biodiversity. Our aim: In this Case Study, we apply the AQUACROSS Assessment Framework to identify how management of river-floodplain systems along the Danube can be improved to jointly conserve and restore biodiversity and maximise provisioning of ecosystem services.

Context

Throughout the basin, hydro-morphological restoration of river-floodplain systems is important to conserve biodiversity (in line with EU Biodiversity Strategy to 2020, Target 2, and the EU Habitats and Birds Directive) and ensure that rivers stretches achieve "good status" according EU Water Framework Directive (WFD). Restoration also support other societal and policy objectives: flood protection, as called for by the EU Flood Risk Directive (FD), pollution reduction to improve the Black Sea marine environment under the EU Marine Strategy Framework Directive, and climate adaptation. However, the complexity and heterogeneity of the environmental problems, lack of data, strong differences in socio-economic conditions, as well as complexity and inconsistencies in legislation along the Danube significantly hampers planning of restoration sites. Only a few countries of the Danube region have already implemented or planned restoration activities, which are due by 2021.

What was done?

We conducted a prioritisation of the river-floodplain systems for restoration and conservation, using a novel integrative modelling approach that considered multiple targets related to biodiversity, ecosystem services and socio-economic benefits, in line with Ecosystem-based management. Unlike the current baseline, where each country selects their own restoration sites, our method selected optimal sites across the whole of the Danube.

Results

Our evaluation suggests that the ecosystem-based management approach is more cost-effective than the baseline scenario. Additionally, it represents a traceable and flexible approach that systematically balances the different objectives related to floodplain restoration.

Lessons learned for managing biodiversity

Systematically linking multidisciplinary data and knowledge within one analysis can foster integrated planning across multiple policies, and enable decision-makers to pursue different policy objectives simultaneously. Considering the Danube River at the ecosystem scale, independent from jurisdictional, administrative and political borders (e.g. country scale), supports transboundary coordination and cooperation and therefore has potential to foster consensus on a shared vision for the future.

Applicability

AQUACROSS results can promote successful implementation of river-floodplain restoration. The proposed EBM approach supports the joint selection of restoration sites including prioritisation of protected areas (HBD), and site selection for the next River Basin Management Plans (WFD) or Flood Management Plans (FD).



Learn more about Case Study 3 at aquacross.eu or the AQUACROSS Information Platform

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Case Study 4 Management and impact of Invasive Alien Species in Lough Erne in Ireland



Biodiversity challenge

The goal of this study was to examine the implications of the regulation on Invasive Alien Species (IAS) for practical management in Lough Erne, Northern Ireland, in the context of existing environmental commitments under EU legislation.

Context

Lough Erne sustains multiple competing activities, each with different demands from the system in terms of ecosystem services and physical resources. Lough Erne is a heavily modified water body, containing a range of non-native species following a long history of introducing new fish and other plants and animals. In recent times there has been an invasion and proliferation of the Nuttall's Pond Weed (*Elodea nuttalli*), which is listed as an Invasive Alien Species of Union Concern. This new arrival is able to colonise deeper areas of the Lough and has clogged many areas of the lake, interfering with popular recreational activities, in particular boating. Managing *Elodea* while meeting the needs of competing users requires consensus on ecosystem boundaries and effective cross border cooperation.

What was done?

The case study brought together a range of stakeholders from public service and NGOs, both north and south of the Northern Irish/Republic of Ireland border in a series of workshops. Mental models called "Fuzzy Cognitive Maps" of the Erne system were developed based on stakeholder inputs and were used to infer system behaviour. The models predict a likely decline in future water quality related to agricultural activities in the catchment. GIS models were used to map the impacts of altering lake levels on agricultural production in areas adjacent to the lake.

Results

Stakeholder views, combined with model outputs were used to identify a range of possible management options. One set of measures involved alteration of the lake levels to enable recreational boating, but also leading to a potential loss to agriculture in terms of inundated land, which we evaluated and costed. Agricultural nutrient management measures to reduce proliferation of the weed were also evaluated. The potential costs of conducting these measures were assessed and presented to stakeholders for feedback and comparison.

Lessons learned for managing biodiversity

The case study revealed the importance of considering the interconnections between policies. Potential solutions to the problem of Invasive Alien Species in Lough Erne will affect achievement of Water Framework Directive goals, as well as obligations under the regulation on IAS. At the same time, these goals cannot be considered in isolation from the overall driver of the Common Agricultural Policy.

Applicability

The case study provided a range of potential practical solutions to the problem of *Elodea* in Lough Erne, implementation of these solutions will require continued North South cooperation as well as consideration of trade-offs and development of consensus on the best approach for the area.



Learn more about Case Study 4 at aquacross.eu or the AQUACROSS Information Platform

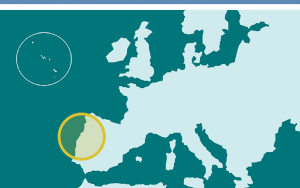
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Case Study 5 Improving integrated management of Natura 2000 sites in the Ria de Aveiro Natura 2000 site, from catchment to coast, Portugal



Biodiversity challenge

In 2018/2019, two management interventions will be implemented in the case study area that will have negative unintended impacts on biodiversity: 1) a dredging programme to enable hydrodynamic equilibrium and navigability in Ria de Aveiro coastal lagoon, and 2) the extension of a floodbank to disable surface saltwater intrusion into Baixo Vouga Lagunar agricultural area. The goal of this study is to apply adaptive management and address these foreseen but unintended management challenges in a Natura 2000 freshwater-marine continuum territory, in the context of EU water-related directives and EU Nature Directives.

Context

The geographic location of the case study combined with its natural capital enables a variety of economic, cultural and recreational activities. The region is subject to a complex variety of land and water uses and potential conflicts, and a number of anthropogenic pressures that impact the hydro-morphological conditions of the lagoon and the adjacent freshwater section of the Vouga River, the Baixo Vouga Lagunar. The region is also vulnerable to ocean storm surges and coastal erosion, and to torrential rain and flood events, meaning that it often requires human intervention for protection or to enable economic activities.

What was done?

We identify the overarching policy plans, programmes, and objectives relevant to managing biodiversity within the case study, as well as the key governance institutions. Stakeholders were engaged at different steps, contributing data, information, and perceptions to define the baseline and the management scenarios that were attained through: i) model-based scenarios built on causal links and habitat risk assessments; ii) stakeholders' perceptions regarding the present status and future trends; and iii) modelling the spatial multicriteria analysis results that were attained by stakeholder's valuation of ecosystem services.

Results

Two spatial scales, the entire Natura 2000 site and the Baixo Vouga Lagunar, were considered. The ecosystem-based management plan was co-created with input from local stakeholders and policy-makers. The plan proposes to restore saltmarshes and seagrasses, harmonise monitoring across EU Directives, and incorporate stakeholders and integrate territorial management instruments to mitigate the expected, unintended impacts of the floodbank and dredging in the Ria de Aveiro Natura 2000 site.

Lessons learned for managing biodiversity

The implementation of the proposed mitigation measures should be framed in the Sectoral Plan for Natura 2000 Network, which is the territorial management tool for the implementation of the national policy for the conservation of biological diversity; and should consider climate change projections and the National Strategic Plan for Climate Change adaptation. For the successful implementation of the identified water and nature policies at Ria de Aveiro Natura 2000 site, any actions need to ensure the involvement of users and landowners.

Applicability

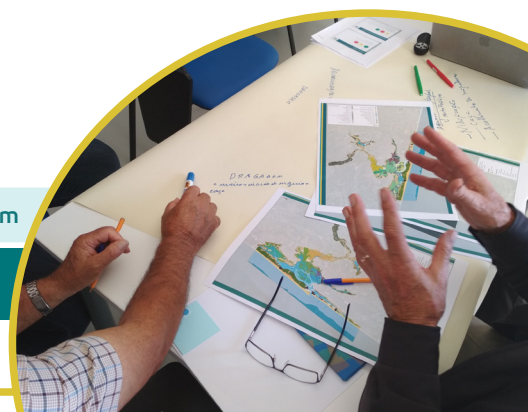
The EBM plan is foreseen to support the development of the Vouga estuary management plan, as well as actions for a more comprehensive understanding of the social-economic implications of ecosystem services provided by these aquatic habitats.

Learn more about Case Study 5 at ibrm.aquacross.eu or the AQUACROSS Information Platform

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Case Study 6 Understanding eutrophication processes and restoring good water quality in Lake Ringsjön – Rönne å Catchment in Kattegat, Sweden



Biodiversity challenge

Lake Ringsjön has experienced eutrophication, which has made it a target for restoration efforts by local municipalities. Situated in an agricultural landscape with a growing human population, the lakes provide multiple ecosystem services that are valued by different stakeholders. These ecosystem services increase – along with biodiversity – when the water is clear. We investigated the co-production of these ecosystem services and the interactions between the social and ecological aspects of the lake system together with stakeholders to suggest how water governance might be improved.

Context

The Rönne å catchment is located in Southern Sweden in a landscape that is witnessing a transition from an agricultural to a multi-functional landscape. The main pressures affecting freshwater quality are agricultural activities and insufficient sewage treatment. Swedish regulations are implemented from river basin to county to municipal levels. Water councils, a group of stakeholders including municipalities and water users, have developed bottom up solutions in the past, and are increasingly incorporated in the governance system through the Water Framework Directive.

What was done?

Our research and scenarios were co-designed with stakeholders, decision makers, civil servants and practitioners in three workshops and eight follow-up interviews, complemented by stylised social-ecological modelling. We operationalised the AQUACROSS Assessment Framework with insights from resilience thinking to focus on the social aspects of policymaking and implementation – particularly the governance-related resilience principles and

processes of change. In the scenarios, we explore two perspectives along which decision making in water governance could develop different from the baseline in the future: a) by the time horizon considered for expected effects taking place, and b) by the geographical space and institutions involved in collaborating on implementing measures.

Results

Scenarios were qualitatively evaluated using the resilience principles and a stylised social-ecological model which simulates social time lags and their effect on lake restoration and resulting ecosystem services. Our analysis shows: 1) consideration of the time lags between management actions and an improvement in the ecosystem can lead to stronger reinforcing feedbacks and larger improvements; and 2) an increase in the geographical and institutional scale of management allows more collaboration between water councils and across sectoral silos, though the final outcome would depend on which ecosystem service trade-offs are explicitly considered.

Lessons learned for managing biodiversity

Resilience thinking helps to identify feedback processes and social-ecological interactions that determine long term outcomes from restoration measures. There is a need to consider time lags and different dynamics within the system, as well as how the social aspects interact with the ecological aspects. Collaboration is necessary between different levels of water governance, and across different sectors and geographical regions in order to reach the full potential for managing eutrophication in the catchment.

Applicability

Our stakeholder process motivates an improved collaboration between practitioners and decision-makers in local freshwater management to take more ecosystem service interactions into account.

Learn more about Case Study 6 at aquacross.eu or the AQUACROSS Information Platform

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Case Study 7 Biodiversity management for rivers in the Swiss Plateau



Biodiversity challenge

Freshwater ecosystems in the Swiss plateau are threatened by multiple stressors that deteriorate water quality and hydromorphology. To restore these ecosystems and stop the biodiversity decline, multiple management measures will be implemented over the next decades. We propose methods for a spatial and temporal prioritisation to coordinate measures from different sectors and maximise their effectiveness, while considering other societal needs.

Context

Case Study 7 is based in the Swiss Plateau, a relatively flat and densely populated area that facilitates agricultural production and urban development (Fig. 1). Switzerland decided to fund the morphological restoration of one quarter of all morphologically degraded rivers over the next 80 years, to upgrade the 100 most important wastewater treatment plants to remove micropollutants, and to reduce pollution from agriculture. Cantonal authorities were asked to provide a strategic plan for the morphological restoration of rivers over the next two decades, which will be updated every 12 years and is intended to increase the effectiveness of restoration measures.

What was done?

Using the concepts underlying the AQUACROSS Assessment Framework, we developed a procedure to prioritise restoration measures by maximising the ecological state of a catchment under a given budget constraint, while considering other societal needs and other sources of impairment:

- In close collaboration with stakeholders from federal and cantonal authorities and environmental consulting companies, we integrated procedures for chemical, physical and biological assessment at the river reach scale and proposed a spatially explicit ecological assessment at the catchment scale.

- We applied the catchment scale assessment to search for management strategies that optimise the overall ecological state at the catchment scale, while increasing or not significantly decreasing services (e.g. recreation) demanded by society.

Results

We developed a methodology that supports environmental managers in the integrative assessment of restoration measures at the catchment scale. This methodology is based on ecological principles, such as maximising resilience and fish migration potential and minimising fragmentation. An optimisation procedure provides a set of near-optimal combinations of measures to reach the highest ecological state for a given budget. This list of potential measures can support the development of cantonal restoration plans and helps promote stakeholder involvement in decision making.

Lessons learned for managing biodiversity

Spatial assessment procedures that integrate over different aspects of the ecological state are essential for the prioritisation of restoration measures. The joint consideration of different types of impairments, such as hydromorphological degradation and chemical pollution, is important to increase overall effectiveness.

Applicability

The suggested procedure can support environmental managers in updating the strategic planning of restoration measures and coordinate with water quality management. The approach can be adapted and transferred to any catchment and applied to other management questions.

Learn more about Case Study 7 at aquacross.eu or the AQUACROSS Information Platform

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Case Study 8 Ecosystem-based solutions to solve sectoral conflicts on the path to sustainable development in the Faial-Pico Channel, Azores

Biodiversity challenge

Despite designation as a Marine Protected Area, biodiversity in the Faial-Pico Channel is declining. Our aim: to collaborate with local stakeholders and policy-makers and apply the AQUACROSS Assessment Framework to understand social and ecological aspects of the Channel, and identify actions to efficiently and equitably ensure the Channel's long-run sustainability, balancing the objectives of commercial and recreational fishers, tourism operators, and other local stakeholders.

Context

The Faial-Pico Channel is a richly biodiverse Marine Protected Area, covering 240km² of North Atlantic coast and ocean in the Azores, an EU Outermost Region. Recreational and commercial fishing place pressure on local biodiversity, while swiftly growing tourism fuels local economic growth but increases competition for use of the Channel, and also drives future pressures on biodiversity. While local stakeholders all value the Channel's biodiversity, they have different objectives and priorities. In 2016, local policymakers increased protection for some high biodiversity areas in the Channel, and have consulted with stakeholders on management. However, Channel management is complicated by multi-level and overlapping responsibilities, with policy development and implementation split across five institutions.

What was done?

In close collaboration with local stakeholders and policymakers, we applied the AQUACROSS Assessment Framework to develop and evaluate ways to more efficiently and equitably manage the Channel and protect biodiversity. This included:

- Analysing local biodiversity, tourism, and fishing policy and stakeholder objectives to identify synergies, conflicts, and opportunities for improvement.

- Characterising the Channel's social-ecological system to understand links between drivers, pressures, the ecosystem and its biodiversity, and ecosystem services.
- Identifying and evaluating an ecosystem-based management plan for the Channel.
- Co-creation with local stakeholders: throughout, we collaborated with local stakeholders, including at two day-long workshops with recreational and commercial fishers, diving operators, NGOs, scientists, and local policy representatives.

Results

We identified and evaluated a plan of five local policy solutions: (1) increased scientific monitoring, (2) increased stakeholder participation through a Stakeholder Advisory Group, (3) integrating and coordinating management of the Channel, (4) clearly communicating and enforcing fishing and biodiversity regulations, and (5) sharing costs through a sustainability tax or diving fee. We found that, as well as protecting biodiversity, this plan supports the sustainability of the Faial-Pico Channel – increasing stakeholder engagement, knowledge, and policy coordination enables adaptive management, reduces conflict, and can improve effectiveness and efficiency.

Lessons learned for managing biodiversity

Stakeholder engagement and participation support effective and equitable management of Marine Protected Areas. Stakeholders can clearly identify challenges and priorities, co-create innovative solutions, provide low-cost knowledge and expertise, and support ongoing monitoring, enforcement, and evaluation.

Applicability

AQUACROSS work is supporting the Azores Regional Directorate for Marine Affairs as they establish Management Plans for Marine Protected Areas (including the Faial-Pico Channel) and develop Marine Spatial Planning in the Macaronesian region.

Learn more about Case Study 8 at aquacross.eu or the AQUACROSS Information Platform

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