Safeguarding life in our waters

Policy measures to protect biodiversity must be scientifically sound in order to deal with the complexity of nature and the human pressures on nature. This thematic issue reports on research which can help policy makers understand biodiversity in water and different ways in which human activity can be managed to ensure both wildlife and humans benefit from healthy aquatic and marine ecosystems.

In Europe, the Black Sea represents a significant case of how an intricate array of human pressures has cumulatively damaged a complex ecosystem with a huge catchment area. Intense fishing pressure has eradicated a number of important species, including tuna and swordfish. Introduced jellyfish species have outcompeted and preyed upon small fish. Agricultural pollution has led to intense algal blooms, depleting oxygen levels in the water and resulting in the collapse of seabed habitats. Economic collapse of the surrounding socialist republics in the early 1990s actually provided an opportunity for the Black Sea ecosystem to begin to recover, as agricultural activity slowed. Now the challenge is to balance growing economic needs with ecosystem recovery.

Rebuilding an ecosystem, such as the Black Sea’s, is a huge challenge and understanding the role that social and political factors play in ecosystem health could help underpin recovery. In a recent study, researchers suggest that social and environmental needs must be prioritised alongside or above immediate, local, economic needs if the Black Sea is to recover, as detailed in the article ‘The socioeconomics behind ecosystem collapse: the case of the Black Sea’. This cross-disciplinary, integrated approach to understanding and managing biodiversity is essential.

Fisheries constitute, at present, the most important single pressure exerted on marine biodiversity. New ways of protecting marine ecosystems, while ensuring food security and the survival of jobs in fisheries, are needed and the EU’s Common Fisheries Policy is currently undergoing drastic reform in order to achieve this delicate balance. Marine Protected Areas (MPAs) are widely touted as a tool for marine ecosystem protection and in 2002, the World Summit of Sustainable Development called for a worldwide commitment to establish networks of well managed MPAs by 2012. However, their role is still under discussion. Can MPAs sufficiently protect biodiversity and promote sustainable fishing?

US researchers suggest that MPAs can provide greater benefits for biodiversity and fisheries if they are organised into a network. Citing evidence from MPA networks in the USA and Australia, they provide clear recommendations (Continued on page 2)
for networking MPAs. For example, they suggest that around one-third of a region should be placed in an MPA network to receive simultaneous multiple benefits. More details are in ‘Marine reserve networks could benefit fishing and conservation’.

What happens outside MPA borders can enhance or reduce the effectiveness of the MPAs themselves – there are no obstacles for fish and other life in the seas as they move between different parts of the interconnected marine system. Research conducted in the North-East Atlantic suggests that proposals for future deep water MPAs may not be effective in protecting deep sea biodiversity unless commercial fishing is also controlled in the surrounding area. The study, described in ‘Impacts of commercial fishing may reach deep sea waters’ documented a decline in deep sea species in recent decades, probably caused by fishing in shallower waters.

Eutrophication is a widespread problem for both marine and aquatic ecosystems, caused by excess levels of nutrients. With increasingly intensified agriculture, high levels of phosphorus and nitrogen from fertilisers and manure are reaching water bodies, and shallow, small lakes are especially at risk. Danish policies for tackling this problem are analysed in the article ‘Eutrophication: small-scale, targeted approach the way forward’, which suggests that measures should be tailored to individual sites in order to ensure further improvements to water quality. Undertaking a site-oriented approach involves exploring the specific history of a water body, such as a lake, either by looking at sediment records or long-term changes in water quality.

The economic value of biodiversity is an increasing consideration for policy makers, and understanding the public’s willingness to pay (WTP) for biodiversity may reflect its social value. In a recent UK survey, 27 per cent of those questioned were willing to pay towards improved river biodiversity, via higher energy prices from the resulting drop in hydro-electricity power output. 43 per cent were not willing to pay at all. Among those willing to pay, beliefs and motives should be distinguished and considered in management decisions, such as ethical and social norms. For more details, see: ‘Bringing social values into the economic value of water biodiversity’.

The final article in this thematic issue, ‘Assessing the status of riparian zones through satellite images’, describes a new indicator based on vegetation cover to assess the status of river and lake banks. Under the Water Framework Directive all EU surface waters must reach a good status by 2015 and this status includes the condition of banks with ecotones (transition areas) important to biodiversity as they provide breeding grounds and act as corridors for species. They are also areas where considerable leaching of pollution or erosion might occur. Using this indicator, the researchers demonstrated that agri-environmental measures, such as leaving undergrowth in olive groves, can improve the status of banks.

To further improve the policies that protect water and biodiversity, such as the EU’s Marine Strategy Framework Directive, the Water Framework Directive and the Biodiversity Strategy, we must continue to ensure that they draw upon research that accounts for the complexity of nature. The research should consider an ecosystem as a whole and account for different levels of the food chain, as well as non-biological drivers and human processes. It must also understand how aquatic or terrestrial ecosystems are connected to their surroundings. We also need research, which considers long-term (historical) data or makes broad comparisons between different types of ecosystems.

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The socioeconomics behind ecosystem collapse: the case of the Black Sea

Marine ecosystem recovery is directly linked to socioeconomic choices, according to a recent study. The study focused on the Black Sea, where economic collapse and recovery in the surrounding regions has had a large impact on ecosystem collapse and recovery in recent years.

The Black Sea drains a catchment containing large proportions of 16 different countries; seven of these countries are EU Member States. The Sea's ecology is thus influenced by the widely differing politics and socioeconomic conditions of these countries, including environmental and economic policy.

During the 1970s and 1980s, intense fishing pressure, excess nutrients brought by riverine waters and the introduction of alien species all profoundly changed the structure of the marine ecosystem, sending it into decline. Economic collapse in surrounding regions during the 1990s resulted in decreased nutrient loading which provided an opportunity for ecological recovery to begin. The question now is whether that trend can continue in spite of increasing pressure from economic growth.

The study, conducted under the EU ELME project, used models to better understand the relationship between European lifestyles and marine ecosystems. It suggested that recovery might be possible through cooperation between Black Sea countries, for example, by implementing international agreements that limit how fish stocks are exploited.

The researchers constructed four alternative future socioeconomic scenarios, which each incorporated different political values:

- **‘National Enterprise’**: an individualistic, consumption-oriented scenario, with strong commitment to national culture and interests.
- **‘Local Responsibility’**: with a ‘think local, act local’ ethos. Economic growth is slow, social equity and environmental protection are prioritised.
- **‘World Markets’**: libertarian and consumerist, with economic growth taking precedence over social equity.
- **‘Global Community’**: with internationalist values, where economic, social and environmental welfare are balanced.

Through modelling, the consequences of these on the marine ecosystem were compared to a baseline scenario where continued economic development in Black Sea catchment countries leads to environmental degradation. Of the scenarios, ‘Local Responsibility’ and ‘Global Community’ resulted in an improvement compared to the baseline.

‘National Enterprise’ was the most environmentally damaging, due to the intense pressure it places on natural resources. ‘World Markets’ saw an increase in eutrophication resulting from increased agricultural activity but a decrease in fishing, due to increased imports. In all cases, ecological outcomes were strongly linked to socioeconomic factors.

1. ELME (European Lifestyles and Marine Ecosystems) was supported by the European Commission under the Sixth Framework Programme. See: www.elme-eu.org
Marine reserve networks could benefit fishing and conservation

Marine protected areas (MPAs) usually entail a trade-off between conservation goals and the goals of commercial and recreational fishing. A new study indicates that connecting MPAs into networks could reduce this trade-off. It suggests design guidelines for these networks in terms of size, spacing, location and configuration.

The conservation benefits provided by individual MPAs tend to be minor, mainly due to their small size compared with the geographic ranges of the species they are designed to protect. Although larger MPAs could increase conservation, they could also incur large economic and social costs. Nations such as Australia and the USA have pursued an alternative approach by creating networks of marine reserves. Using previous research the study provided guidelines on the design of MPA networks.

Size and Spacing. Evidence suggests that fisheries can benefit from a reserve area that is divided into a network of small closures spaced closely together to maximise the dispersal of adults and larvae to fished areas between the reserves. From a conservation perspective, larger reserves are preferred because they increase the protection of adults and the likelihood that larvae will settle in a protected area. Research has indicated the middle path between these two positions could be moderately sized reserves of several to tens of kilometres along the length of the shore, with distances of tens to one hundred kilometres between them.

Locating Reserves in a Network. Some sites are “connected” by ocean currents that carry eggs and larvae to suitable sites where they can grow to be adults. These “connected sites” should be protected by reserves. Other sites may produce many young but ocean currents take them out to sea or to places with poor adult habitat. These sites are better targeted for fishing.

Proportion of Protection in a Region. Very approximately, one-third of a region should be placed in reserves to produce simultaneous benefits for conservation and fisheries. For example, under California’s Marine Life Protection Act the guidelines for reserve size is 20km and maximum spacing is 50km, which yields a fractional area of 29 per cent of the total region covered by the legislation.

Although there have been advances in MPA network design, several challenges remain. For example, MPA network designs do not currently consider the interaction with future climate change. In addition, the effectiveness of MPA networks has yet to be tested in real ecosystems, but this will soon change since networks are now established.

Impacts of commercial fishing may reach deep sea waters

New research indicates that there has been a decline in the abundance of deep sea fish in recent decades. If this is caused by commercial fishing, then the impacts of commercial fishing could be occurring in deep offshore areas that were previously thought to be unaffected. These areas are not routinely monitored or included in fishing management strategies.

The spatial distribution of deep water fish has been widely studied but their distribution over time is under-researched. The study, supported by the EU's HERMES programme\(^1\), analysed a unique dataset of scientific trawls made from 1977 to 1989 and from 1997 to 2002 at depths from 800 to 4800m in an area in the northeast Atlantic Ocean. The ‘early’ period (1977-1989) is before and during the development of modern commercial fishing, whilst the late period (1997-2002) is considered to be after the onset of modern commercial fishing.

Overall fish abundance fell significantly at all depths from 800 to 2500m between the two time periods. This is considerably deeper than the level at which commercial fishing generally occurs (1600 m). Large declines were observed in nine of the 15 most common species and were greater in species whose ranges fell at least partly within depths where commercial fishing occurred. For example, numbers of the commercially fished roundnose grenadier declined by 41 per cent and species that are not the target of commercial fishing also declined, such as the smallmouth spiny eel, whose numbers fell by 77 per cent.

The study also considered possible natural explanations for the decline in fish. Changes in food availability could be a possible explanation, but the amount of food available appears to have been stable or even increased between the two periods.

Having discounted natural explanations, the results indicated that the impacts of fishing extend deeper than the reach of fishing gear. It is possible that the impacts are primarily on those fish whose ranges include the shallower areas where fishing occurs. These losses reduce the amount of fish that can spread out into the deeper water and therefore deprive these deeper areas of part of their normal fish community. The ecological consequences are not known.

If fisheries impacts spread beyond the area directly affected by fishing gear, then proposals for future deep water marine protected areas are likely to be limited in their effectiveness unless commercial fishing is controlled in the surrounding area.


\(^1\) HERMES (Hotspot Ecosystems Research on the Margins of the European Seas) was supported by the European Commission under the Sixth Framework Programme. See www.eu-hermes.net
Eutrophication: small-scale, targeted approach the way forward

A series of national Action Plans has dramatically reduced water pollution from the agricultural sector in Denmark, although significant improvements in aquatic ecosystems are yet to be seen. A shift towards small-scale environmental management in sensitive areas is now needed to ensure further improvements to water quality, according to researchers.

The agricultural sector is a major part of the Danish economy and farming practices have intensified over time. In the 1970s and 1980s the increased discharge of nutrients from farm fertilisers and manure contributed to eutrophication. Eutrophication occurs when high nutrient loads cause excessive plant growth and decay, reducing water quality and damaging ecosystems.

Concern over this pollution led to the introduction of a series of national Action Plans in 1985 and 2004. Together with EU Directives and international obligations, these have targeted agricultural practices that contribute to eutrophication.

By 2003, changes in agricultural practices, such as regulating the density of farm animals and stricter storage rules for manure, reduced the nitrogen load from agriculture that reached aquatic ecosystems by 48 per cent. In addition, improved treatment of wastewater cut phosphorus loads by 80 per cent. Other measures included: reducing the surplus of nitrogen from excessive fertiliser application, more efficient use of animal manure, and reducing the use of artificial fertilisers.

However, only small improvements have occurred at ecosystem level despite clear reductions in nitrogen and phosphorus concentrations in water bodies. This could be due to the time difference between implementing remedial measures and recovery in habitats, as well as far-reaching physical, biological or chemical changes occurring in ecosystems.

The future management of aquatic habitats will be strongly influenced by the Water Framework Directive. The researchers suggest there is now the opportunity to replace the old regime, of regulating all areas equally regardless of the individual impact on the environment, with a new approach of evaluating environmental impacts on a small geographical scale.

Some important changes include: taking a holistic view, focusing on a wider range of detailed measures which are tailored for specific sites and where there is great potential for reducing nutrient loads; extensive cost-benefit and cost-effectiveness analysis at the local scale; taking time lags into account when evaluating measures; recognising that baseline conditions change over time; and ensuring active participation by the agricultural sector early in the planning process to create win-win situations.


Bringing social values into the economic value of water biodiversity

New research has integrated individual motivations and beliefs into the economic valuation of biodiversity. The study surveyed members of the public about a river biodiversity improvement project in the UK, and indicated that willingness to pay for this initiative depended on attitudes and ethical beliefs, as well as consequences of the measure.

There is a growing trend in legislation to consider the economic value of biodiversity and a popular method to assess this is using people's willingness to pay (WTP) for an initiative that improves biodiversity. These economic models tend to focus on the consequences or the impacts of the projects, neglecting the social context and the motivations of respondents.

The study, funded by the EU ADVISOR project, introduced factors from ethics and social psychology into an economic model of human behaviour. It identified key elements in the human valuation of the environment that are missing from economic explanations:

• Ethical beliefs about the need to protect biodiversity or nature
• Attitudes towards paying to improve biodiversity and its effectiveness
• Subjective norms or the perceived social pressure to pay
• The degree of perceived behavioural control over payment and over the improvement of biodiversity through payment

The research applied the model of environmental valuation to a proposed initiative in the River Tay in Scotland that aims to protect endangered species by changing the river flow. This would reduce the amount of electricity derived from hydro-electric power, which would increase the price of electricity for consumers. The researchers conducted over 1000 face-to-face interviews to investigate the public's willingness to pay higher electricity prices.

The results suggest that multiple values, beliefs and motives are influential in people’s valuation of biodiversity and these should be considered in management decisions in order to ensure projects and initiatives are successful.

27 per cent of those surveyed indicated a positive willingness to pay whilst 43 per cent were not willing to pay at all. The rest refused to answer or did not know. The results indicated that over 40 per cent of those who were willing to pay did so on the basis of ethical beliefs that biodiversity has a ‘right’ to be protected, rather than just the positive impacts of the project.

Social norms were influential on people’s WTP in terms of beliefs about expectations from family, colleagues and environmental groups. People’s perception of control over payment, in terms of affordability and choice of electricity supplier, was also related to their WTP. However, perceived control over the impact of the payment on biodiversity did not influence their WTP.

Assessing the status of riparian zones through satellite images

Riparian zones (river banks and lake shores) have an important ecological role. Researchers have developed a new indicator to assess the status of riparian zones based on their vegetation cover and used it to demonstrate the beneficial effects of extending agri-environmental measures to these zones.

The European Commission’s Water Framework Directive\(^1\) states that all EU surface waters must reach a good status by 2015. A rating of “good status” includes the condition of the riparian zones, which protects against erosion, provide breeding grounds and act as corridors for dispersal of species. Undisturbed or nearly undisturbed riparian zones are considered to have high ecological status and are important elements of Green Infrastructure\(^2\).

The study evaluated an indicator of the status of riparian zones that measures the amount of permanent vegetation. Vegetation reduces leaching and erosion and provides cover for wildlife. The suitability of this indicator was assessed along the river network of Andalusia in southern Spain. The researchers derived the permanent vegetation fraction (PVF), i.e. the amount of vegetation that is permanently on the area, using high-resolution satellite images of the area over 16 years (1989-2004).

On the basis of the PVF they classified the riparian zones into ‘favourable’ and ‘unfavourable’. This was compared with a classification based on field observations that designated riparian zones as ‘natural’ and ‘very bad’. The comparison indicated that the PVF classification was 89 per cent accurate. The most intensively used agricultural areas of the river basin and mountainous areas were classified as unfavourable whilst lowland valleys and plains tended to be favourable.

The researchers applied this indicator to assess the impact of extending agri-environmental measures (AEM) to riparian zones. In Andalusia the most common AEM is to leave undergrowth and maintain high vegetation cover to control erosion in olive areas. The results indicated that riparian zones with an unfavourable status reached a higher PVF value if they were subject to AEMs. Furthermore, there was no difference in PVF between a favourable riparian zone without AEMs and an unfavourable riparian zone with AEMs, suggesting that implementing AEMs improves the status of unfavourable riparian zones to that of favourable riparian zones.

The study suggested that the indicator of PVF could be used in EU River Basin Management Plans and to assess the effectiveness of AEMs on erosion control in olive areas in Southern Spain.

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LIFE, water and biodiversity

The LIFE programme has played an important role in addressing some of the key issues with regards to water and biodiversity within the EU and neighbouring states. Issues such as the efficacy of Marine Protected Areas, setting up Green (Blue) Infrastructures, deep sea biodiversity, the impact of eutrophication on biodiversity in coastal waters, oligotrophic and acid lakes, and ecosystem services resulting from marine and freshwater biodiversity.

Biodiversity in rivers and alluvial floodplains

Achieving ‘favourable conservation status’ for Europe’s rivers and alluvial floodplains is one of the aims of the EU Habitats Directive. LIFE has provided support for many projects that have helped restore biodiversity in these important riverine habitats.

The LIFE INNOWA project in Finland (LIFE00 ENV/FIN/000668) created a network of 27 partners and five co-financiers to develop novel and effective methods of water management and protection. Tasks included ecological restoration of running waters, improvements to the functional value of Lake Lohjanjärvi, pollution control methods for farmers and forestry to prevent mis-use or overuse of fertilisers, a management plan for the Karjaanjoki river basin, and development of river basin monitoring systems.

In Austria, the LIFE LiRiLi project (LIFE02 ENV/A/000282) focused on a stretch of the River Liesing that was converted from a canal-like concrete channel into a semi-natural river meeting relevant flood protection requirements. Restoration of the river bed was achieved with a gravel substrate, while the steep banks were flattened and partly enlarged. A new sewer system was constructed and actions taken to restore the natural flora and fauna of the riverbank. As a result of the project, species diversity in the river increased from 2.0 to 3.2 (Shannon-Wiener-Index).

The LIFE SUMAR project in Hungary (LIFE03 ENV/H/000280) implemented a range of habitat restoration activities on the Vezseny Bend floodplain of the Middle-Tisza river, including the creation of an ecological corridor, turf and forest restoration, the cutting back of invasive alien species and the enlargement of the habitats of native species, as well as extensive agricultural practices and animal husbandry.

As well as reducing flood risks, project actions resulted in a diverse landscape consisting of wetland habitats and spawning ponds for a variety of fish, amphibian and bird populations.

LIFE Nature projects have also demonstrated the positive impact of strategic restoration and management of rivers and floodplains, including LIFE05 NAT/UK/000143 and LIFE02 NAT/F/008482. The latter succeeded in reconnecting five channels that benefitted least from fluvial dynamics to the Rivière d’Ain in France, helping a range of species, including the otter.

Within two years of restoration, 20 new flora species had reappeared around the Sous-Bresse channel including floating water plantain. The nightjar and woodlark have also returned to the project site.

(Continued on page 10)
Supporting green infrastructure

LIFE projects have also restored river dynamics and reconnected floodplains, thus improving the ecology of the river and its ecosystem functions, while maintaining the river's navigability. For example, the Austrian LIFE02 NAT/A/008518 set out to remove all artificial elements strengthening the bank from a 2.8 km pilot section along the left bank of the Danube near the town of Hainburg, so that erosion and accretion processes can again lead to the formation of natural river bank structures. In this way, the project helped recreate breeding habitats for fish and birds, such as kingfishers and sand martins, and provided the optimum conditions for plants to flourish, thus slowing down erosion. In this way, they have supported the green infrastructure associated with the river by restoring areas containing valuable ecosystems, thus increasing the ecological value of the river and maximising the ecosystem services provided by the Danube.

Combatting eutrophication, oligotrophic and acid lakes

LIFE has co-funded a number of projects designed to tackle the detrimental impact of eutrophication on habitats such as coastal lagoons. The Danish project LIFE02 NAT/DK/008588 took steps to obtain a favourable conservation status of the Tryggelev Nor coastal lagoon and to improve the conditions for Annex I Birds Directive species, such as the bittern. A salt water inlet to the lagoon was created to flush out accumulated nutrients and the water level of the adjoining Norrebolle Nor lagoon was raised to create a freshwater lake with surrounding reed beds and wet meadows. The project actions have helped reduce nitrogen input to Tryggelev Nor by 60 per cent and increased or maintained numbers of targeted bird species.

In Germany, LIFE support tackled the issue of oligotrophic and acid lakes, enabling the project LIFE00 NAT/D/007057 to improve the hydrological balance and ecological status of the Stechlinsee, a large water-mire forest complex. As well as restoration measures such as blocking ditches to re-humidify the bogs, management plans were drawn up to enable sustainable forestry and fish-farming to take place and to encourage sustainable tourism.

LIFE is the EU’s financial instrument supporting environmental and nature conservation projects throughout the EU, as well as in some candidate, acceding and neighbouring countries. Since 1992, LIFE has co-financed some 3115 projects, contributing approximately €2 billion to the protection of the environment. http://ec.europa.eu/environment/life/
A selection of articles on water and biodiversity from the Science for Environment Policy news alert.

Selective fishing could damage marine ecosystems (1/7/10)
Selective fishing aims to prevent the overexploitation of target fish species and to protect by-catch species, but recent research has indicated that it could be having the opposite effect by damaging biodiversity and sustainability. An alternative approach called ‘balanced exploitation’ works at the level of the ecosystem instead of selectively removing specific components from the ecosystem.

Using ‘best professional judgement’ to rate the benthic zone (27/5/10)
Assessing the environmental condition of sediments and bottom waters of coastal and marine ecosystems over wide geographic areas can be a problem when indicators used to evaluate specific ecological conditions cannot be easily compared. A recent study suggests that a common scale of assessment can be established by experts from different regions using ‘best professional judgement’.

Coastal structures change marine ecosystems (15/4/10)
The urbanisation of coastal areas and introduction of man-made structures, such as jetties and seawalls, are changing marine environments. A new analysis highlights the impacts of these changes on marine plants and animals and suggests options to manage the detrimental effects.

Impact of one-off dredging deposits important for licensing (25/2/10)
Aquatic organisms are exposed to many stressors, including a variety of pollutants from human activities. New research suggests that commonly used models in toxicological studies can fail to adequately predict the range of effects of complex mixtures of chemicals in aquatic environments.

What are the impacts of fish-farming on marine ecosystems? (11/2/10)
New EU-supported research in the Mediterranean Sea has assessed the impact of fish-farming on seafloor ecosystems. Results indicate that impacts are only apparent in habitats with no vegetation, but the researchers suggest that habitats with vegetation seagrass could be masking the effects.

Less agricultural phosphorus could be key to cleaner Baltic Sea (5/2/10)
Reducing the amount of phosphorus used in agriculture could go a long way in meeting the Baltic Sea Action Plan (BSAP) targets. A Swedish evaluation of measures for reducing agricultural phosphorus suggest phosphorus inputs to the sea could be cut by 180 tonnes per year, or about two-thirds of Sweden’s target.

To view any of these articles in full, please visit: http://ec.europa.eu/environment/integration/research/newsalert/index_en.htm, and search according to article publication date.
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