# 10 messages for 2010
# Freshwater ecosystems

European Environment Agency

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This document is the 3rd in a series of assessments under the title '10 messages for 2010'. Each message provides a short assessment focusing on a specific ecosystem or issue related to biodiversity in Europe. The remaining messages will be published at various intervals throughout 2010. More detailed information on the published and forthcoming messages can be found at www.eea.europa.eu/publications/10-messages-for-2010.

European Environment Agency

# Freshwater ecosystems

**Key messages**

- Freshwater ecosystems in Europe are rich in biodiversity but at risk. They provide essential ecosystem services to humans, such as cleaning water, preventing floods, producing food, providing energy and regulating freshwater resources.
- Numerous pressures affect European freshwater ecosystems. Biodiversity has suffered from pollution and degraded water quality. In addition many inland waters endure too little water (water scarcity and drought), too much water (floods), and modification by artificial structures. As a result, freshwater biodiversity is at risk.
- Restoring and preserving natural freshwater ecosystems has multiple benefits and should be encouraged. It requires close coordination between nature protection, water uses, energy production and spatial planning.
- Europe has taken action to improve freshwater ecosystem quality but achieving good ecological status by 2015 will require that synergies are found between nature conservation policies and sectoral policies, with special focus on restoring many water regimes.

## 1 Freshwater ecosystems in Europe are rich in biodiversity and provide essential ecosystem services to humans

Europe's freshwater ecosystems range from rivers, flood plains, lakes and ponds, marshes and peatlands, to man-made water bodies such as canals and reservoirs (EC, 2007a; EC, 2007b). They encompass a broad variety of wetlands. These different systems also interact with groundwater.

Around 250 species of macrophytes and 250 species of fish inhabit European inland surface waters and a significant number of birds, fish and mammals depend on wetlands for breeding or feeding (EC, 2007a).

Freshwater ecosystems deliver many important goods and services, including providing food, clean water, transporting wastewater, and controlling floods and erosion (IUCN, 2008).

## 2 Numerous pressures affect European freshwater ecosystems

During the last century, the biodiversity of Europe's freshwaters has suffered due to pollution and degraded water quality. Climate change represents a new and increasing threat.

In addition to water quality problems, many inland waters suffer from:

- dramatic changes in their water regime, resulting in too little or too much water (water scarcity, drought, hydropeaking and floods);
- heavy modifications (dams, weirs, sluices, interrupted connectivity, straightening and canalisation, and disconnection from floodplains) and related changes in the discharge regime (low flows, surge-low flow dynamics);
- invasive alien species.

While there has been progress in mitigating or reducing some of these pressures in recent decades, impacts on freshwater ecosystems still persist. As such, many EU river basins may not achieve good ecological status by 2015, as required by the Water Framework Directive (EC, 2000).

### *Modification of freshwater ecosystems*

Many European river basins and waters have been altered by human activities. These activities include land drainage, dredging, flood protection, water abstraction and inter-basin water transfer, building dams to create reservoirs and digging new canals for navigation. These actions have significantly affected many freshwater habitats. The frequency of such activities was intense during the last 150 years but has started to level off due to increased awareness of factors such as the importance of riverine habitats as flood buffers and the conservation value of those river systems that have been little impacted.

The extent of man-made modifications is apparent, for example in Switzerland, where the water network encompasses 65 300 km of rivers and streams. Of these, 10 600 km have been considerably altered by construction work and around 5 200 km are culverted. Furthermore, about 88 000 artificial barriers with a height difference of more than 50 cm hinder the migration of fish. Since the late 1980s, more and more sections have been restored, resulting in a slight increase in natural rivers and streams (BAFU, 2009; FOEN, 2009b).

Reservoir construction leads to a number of environmental issues, both during building and following completion. Dams interrupt the natural flow of a river and reservoirs change the hydrological cycle. This has ecological impacts, for example impoverishing freshwater habitats or inducing 'malfunctions' in river ecosystems, the most visible being the loss of most migratory fish in European rivers, since fragmentation of habitats jeopardises or prevents access to spawning sites.

Large dams and weirs also have an effect on the natural sediment transportation, resulting in the retention of sediment upstream of dams and the loss of sediment downstream and nutrients storage leading to eutrophication. This results in more uniform and structurally impoverished habitats with declining biodiversity. The beds of waters are sealed, particularly near weirs at run-of-river hydropower facilities, impairing drainage and diminishing groundwater recharge.To stabilise the river bed and prevent incision in the downstream areas, additional material must be artificially imported.

### *Fragmentation*

Dams, weirs and other obstacles may seriously affect all fish species: migratory fish which need to move between their freshwater habitats and the sea in order to reproduce and non-amphibiotic fish which need circulating along the river system. River bypasses, fish ladders or other types of passes may maintain or improve passing at one point; they however do not address the degradation of habitat because of the still water mass created just upstream of the obstacle.

In addition to its ecological effects, fragmentation of rivers and other freshwater ecosystems has increased the risk of flooding.

### *Alien and invasive alien species*

For centuries, alien (non-indigenous) species have been settling in European inland waters. According to a recent inventory, 296 invertebrate and fish species found in Europe's freshwater environment are alien to Europe and 136 are alien to at least one country but native to others. An increase in the numbers of alien animal species in European inland waters has been particularly evident in the period since the Second World War (DAISIE, 2009). Globalisation and climate change are projected to increase these aquatic 'bioinvasions' and reduce environmental resistance to organism groups that are adapted to higher temperatures (Galil *et al.*, 2007).

According to DAISIE (2009), the primary pathways for introducing animal alien species to European inland waters are stocking of water bodies to support extensive fish culture and sport fishing (30 %), intensive aquaculture (27 %) and passive transportation by ships (25 %).

It is important to understand whether these species just fill up an unoccupied ecological niche or that of a native species without causing its extinction (Brown and Sax, 2005; Sagoff, 2005; Warren, 2007). This needs to be considered especially in view of the fact that human-induced climate change is altering freshwater habitats, allowing alien species to colonise such ecosystems and impacting their ecological status.

### *Water abstraction and water scarcity*

Large areas of Europe are affected by water scarcity in relation with structural low water availability, high demand and the occurrence of droughts. Pressures on European water resources have increased in recent decades. Since this increase occurs in areas naturally poor in water resources,

## The rise and fall of migration barriers in France's Loire River Basin

Europe's rivers have about 6 000 large dams, whose height exceeds 10 m, and tens of thousands of smaller ones. With most lacking equipment to facilitate the passage of fish, their threat to migratory species has long been recognised but, until now, seldom quantified.

To address this issue, EEA has developed a methodology to analyse the impact of dams on major migratory fish species, and is currently applying it to three species (European sturgeon, Atlantic salmon and Allis shad). The results are expected for late spring 2010.

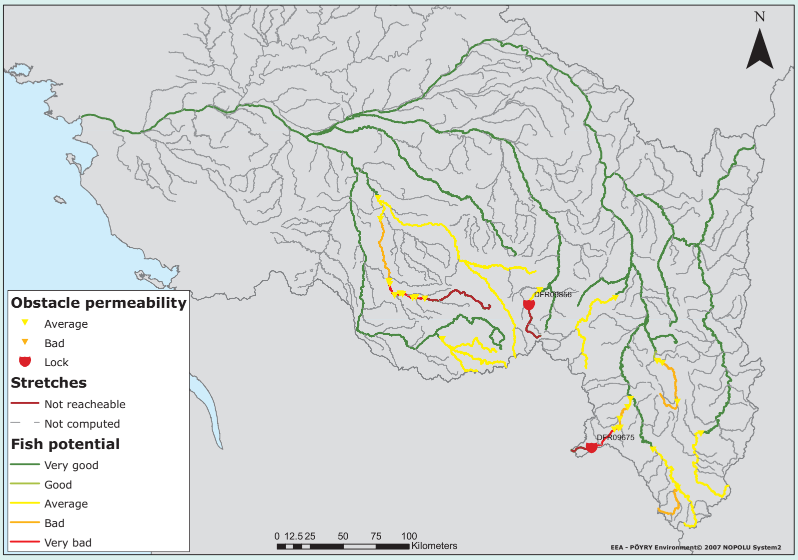
During its pilot phase, the methodology was applied in the Loire catchment. In accordance with other analyses, the study found that:

- The use of mechanical power or navigation devices (in the Vienne River and the Cher River, for example) brought about major transformations in Loire river systems as early as 1750–1820. Such changes limited salmon migration possibilities and the stock accordingly declined in affected watercourses.
- With industrialisation in the 19th century, more and more large dams became operational and the positions of migration locks for salmons spread downstream.
- The situation worsened further in the 20th century as dams were commissioned on the main stretches of the Loire River for cooling of nuclear power plants and recreation facilities.
- From the 1990s onwards, various measures facilitated or reopened migration routes. Salmon have had the opportunity to recolonise some rivers again and, assuming no other interventions occur, stocks should be able to stabilise or partially recover.

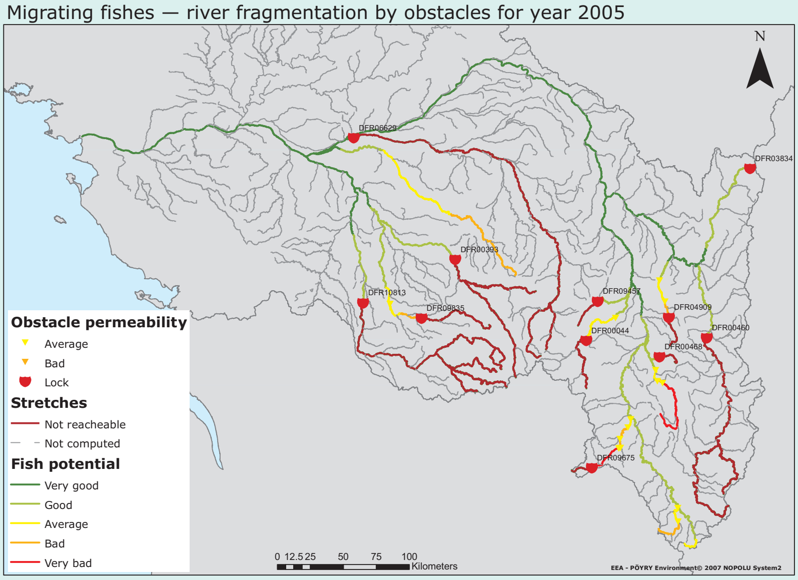
**Source:** Crouzet, 2007.

**Map 1 Migrating fishes — river fragmentation by obstacles for year 1700 and 2005, salmon adult, downstream to upstream**

Migrating fishes — river fragmentation by obstacles for year 1700




Migrating fishes — river fragmentation by obstacles for year 2005




**Source:** EEA, 2007.

**Multiple stressors producing a combined impact on the European eel**

Overfishing has led to population declines in some species, for example some sturgeons, salmonids and coregonids. Over-exploitation is often followed by stocking of non-native species or captive-bred individuals (Kottelat and Freyhof, 2007).

The European eel (*Anguilla anguilla*) is an example of a critically endangered species. It is facing many threats including overfishing, dams, introduced parasites and pollution. Eels reproduce in the Atlantic Ocean. The number of juvenile eels reaching European coasts has crashed since 1980.

because agriculture or tourism development, conflicts between human requirements and ecological needs are likely to increase. In many locations, agriculture, public water supply and tourism pose a threat to Europe's water resources and demand often exceeds availability. The increase in artificial storage volumes in turns reduces the share of water allocated to natural sytems and increases their fragmentation because of damming.

Over-abstraction and prolonged periods of low rainfall or drought have frequently reduced river flows, lowered lake and groundwater levels, and dried up wetlands. Diminished water resources may have detrimental impacts on freshwater ecosystems and worsen water quality because there is less water to dilute pollutants. In addition, salt water increasingly intrudes into 'over-pumped' aquifers throughout Europe.

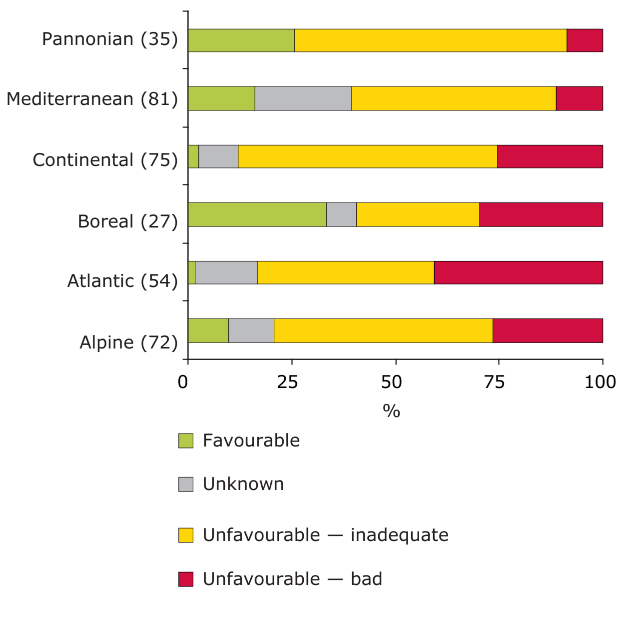
### *Despite some progress, water pollution remains considerable*

During the last two decades, pollution has been reduced significantly in numerous European rivers. Key measures include improved wastewater treatment, cutting volumes of industrial effluents, less use of fertilisers, reducing or banning phosphate content in detergents, and lower atmospheric emissions of pollutants (EEA, 2009b). The improved quality of freshwater ecosystems benefits fish and aquatic invertebrates, and facilitates human water uses.

With decreasing nutrient pollution of freshwater ecosystems, micropollutant contamination has become an issue of concern. Micropollutants are the residues of everyday substances, such as body care products, pharmaceuticals, cleaning agents, pesticides, veterinary medicines and industrial chemicals. These substances can have adverse effects on aquatic ecosystems even at very low concentrations, thus threatening biodiversity and human health (FOEN, 2009b).

On the average, the quality status of waters (with respect to organic pollution, nutrients, etc.) tends to improve. However, this general improvement hides contrasted situations. Statistical analysis first carries out for methodological developments in France (EEA, 2007) suggests a strong improvement in relation with the implementation of the Urban Waste Water Directive (91/271/EEC) and lesser changes in areas under the Nitrates Directive (91/676/EEC). The general improvement is however very depending on the good operation and maintenance of waste water treatment plants. The development of cities and the growth in soil sealing (and the resulting impact of storm overflows) is another concern.

**Figure 1 Percentage of assessed freshwater animal species in each conservation class in the EU-25 per biogeographic region**




**Note:** The number of assessed species present in each region is given in brackets.

**Source:** ETC/BD, 2008.

**Photo:** © Pavel St'astny

*Climate change*

In the context of climate change, species and habitat dynamics are complex and multifaceted. Increased temperatures and $CO_2$ concentrations will affect processes such as photosynthesis, respiration and decomposition, generally accelerating them. Climate-induced changes in ice cover periods, river discharge regimes, thermal stratification, nutrient availability and the duration of growing seasons affect species composition and food web structures.

Water temperature is one of the parameters that determine the overall health of aquatic ecosystems. Most aquatic organisms (e.g. salmonid fish) have a specific range of temperatures that they can tolerate, which determines their spatial distribution along a river or across a region. Climate change could lead to the extinction of some aquatic species or at least could modify their distribution in a river system or move their distribution northwards.

Several indications of climate change's impact on the functioning and biodiversity of freshwater ecosystems have already been observed, such as phenology changes and invasive alien species. There are European examples of aquatic species (dragonflies, brown trout) that have shifted their ranges to higher latitudes (northward) and altitudes in response to climate warming. Thermophilic fish and invertebrate taxa will to a certain extent replace cold-water taxa.

Enhanced harmful algal blooms in lakes resulting from climate change may counteract nutrient load reduction measures and also require a revision of classification systems for ecological status assessment. The inclusion of additional nutrient load reduction measures in river basin management plans may be needed to obtain good ecological status, as required by the Water Framework Directive. Public health may be threatened and the use of lakes for drinking water and recreation may be reduced.

According to reports submitted by 25 EU member states under Article 17 of the EU Habitats Directive, climate change is having a negative impact on the conservation status of 42 habitat types (19 %) and 144 species (12 %) included in the annexes. Wetland habitats, such as bogs, mires and fens, are among the most affected by climate change, with dune habitats also affected negatively. Six of the twelve bog, mire and fen habitat types protected by the EU Habitats Directive are reported by the Member States to be affected by climate change (ETC/BD, 2009a).

Of the major groups of species, amphibians react most strongly to climate change. This may be because they are strongly associated with wetland habitat types affected by climate change. It is also possible that the shifts in climate may have an impact on the success of breeding (ETC/BD, 2009a).

### The Eurasian Otter (*Lutra lutra*): an emblematic freshwater species

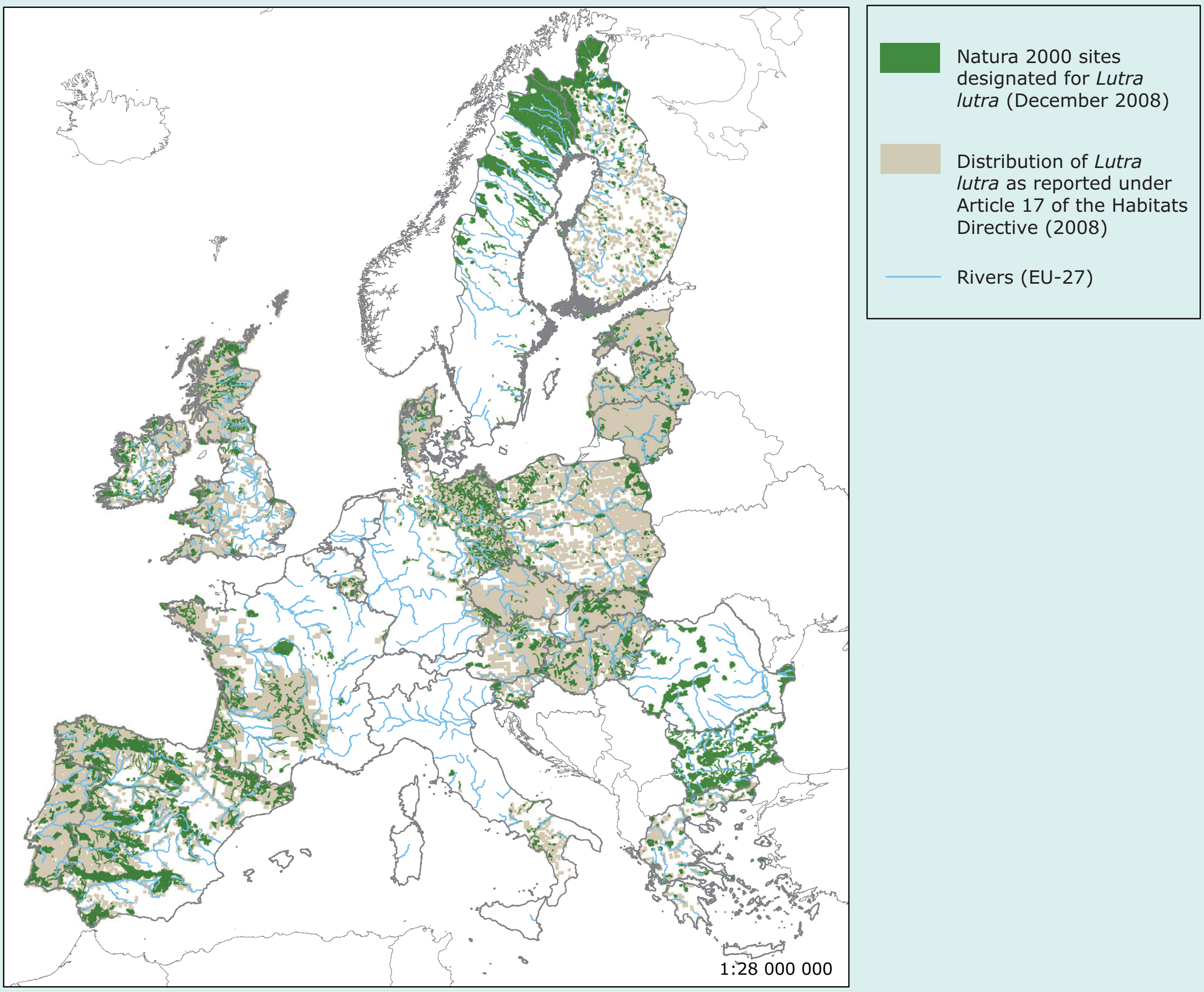
The major threats to freshwater mammals are modification or destruction of their habitat, pollution, trapping and hunting (Veron *et al.*, 2008).

The presence of the Eurasian Otter (*Lutra lutra*) serves as a relatively good indicator of unpolluted natural freshwater ecosystems in a good ecological status (Bedford, 2009). The Eurasian Otter is found in European rivers, lakes and marshes as well as coastal waters. Once widespread, inland water populations in particular decreased dramatically during the last century in countries such as France (EEA, 2005a).

There are now signs of recovery in several countries, including Denmark, Sweden and the United Kingdom. Nevertheless, otters are still absent or sparse in many countries (EEA, 2005a; ETC/BD, 2009b).

Many sites where the otter occurs are included in the EU Natura 2000 network of protected areas across 27 EU countries. However, as shown in Map 1, the otter is still absent from large areas of Europe, suggesting that conditions for the species are still inadequate. The area of freshwater habitats protected by the Natura 2000 network has increased almost twofold over the past decade in these countries and this will hopefully have a positive effect on otter distribution and abundance in the future (ETC/BD, 2009b).

**Map 2 Sites of Community Importance (SCI) designated for the Eurasian Otter (*Lutra lutra*) in the EU-27 and its current distribution in EU-25 Member States according to the Article 17 EU Habitats Directive Reporting in 2008**




**Source:** ETC/BD, 2009b.

## 3 As a result, freshwater biodiversity is at risk

As reported by EU countries under article 17 of the Habitats Directive, the conservation status of freshwater species of European Community interest is generally unfavourable, although there are some variations across biogeographical regions (ETC/BD, 2009a) (Figure 1).

The assessments of the 51 amphibian species, 16 dragonflies, 54 freshwater fish, 12 freshwater molluscs and 5 freshwater mammals listed in the Habitats Directive show that the situation is worst in the Alpine, Atlantic, and Continental biogeographic regions. The situation is a little better, though still critical, in the Pannonian and Boreal regions (Figure 2).

## 4 Europe is taking action to safeguard the water quality and ecological status of freshwater ecosystems

As described above, freshwater ecosystems are vulnerable to pressures caused by human activities. Many countries have recognised this fact and several pieces of EU and national legislation have been adopted to protect our waters. Synergies need to be found between nature conservation policies and sectoral policies if freshwater ecosystems are to be maintained or restored.

Under the 1979 Birds Directive (EC, 2009b) and the 1992 Habitats Directive (EC, 1992), several types of freshwater habitats and species of European concern are protected. EU LIFE funding has contributed to a large number of projects conserving freshwater ecosystems. Most focus on restoring and managing wetlands, although a number also target key wetland species. While the main targets are nature conservation, there are often indirect benefits to human well-being, for example through creating pleasant landscapes for recreation and tourism or reducing flood risk (EC, 2009c).

The most important legislation in Europe for the protection of our waters is the Water Framework Directive or WFD (EC, 2000). It sets up a new legislative approach, establishing very ambitious objectives for water quality and protection, and relies on a river basin approach for water management. The WFD has an ambitious objective that all water bodies meet good ecological status by 2015. 'Good ecological status' is defined in terms of a set of biological elements (often common indicator species) that are to be expected in the different habitat types of a (geographical) region under clean and natural conditions. The WFD is thus the key tool to protect and restore rich biodiversity in terms of creating appropriate chemical and hydromorphological conditions. Its also requires groundwater bodies to achieve good quantitative status. Although the WFD defines which biological elements must be taken into account when assessing ecological status, it gives the EU Member States a lot of flexibility in defining the details of their own assessment system (EC, 2009d).

The main tool for the implementation of the WFD and the achievement of good ecological status by 2015 is the establishment of river basin management plans and related programmes of measures. The first round of river basin management plans must be reported to the Commission by March 2010 and thereafter every six years. The precise measures to be taken within a given river basin may vary widely according to what is most appropriate. A 'programme of measures' must be fully operational by 2012, however, with a progress report submitted to the European Commission.

Article 6 of the WFD in particular is linked to nature protection, addressing areas designated for the protection of habitats or species where the maintenance or improvement of the status of waters is an important factor in their protection, including relevant Natura 2000 sites designated under the Habitats and Birds Directive. Annex 5 of the directive further specifies monitoring requirements for habitat and species protection areas.

Finally, the WFD is innovative in that it includes provisions (Article 9) on the full cost recovery of water services and on water-pricing policies, thus taking into account environmental-economic aspects in EU environmental policy.

In addition to the WFD, the Directive on the assessment and management of flood risks (EC, 2007c) requires that EU Member States assess risk of flooding for all water courses and coast lines, map the extent of floods and assets and humans at risk in these areas, and establish Flood Risk Management Plans by 2015. The reestablishment of floodplains is supposed to be a central element in future flood risk management and in many Member States has been taken up already in the first round of River Basin Management Planning under the WFD.

Further EU regulations have been introduced with a view to reducing water pollution by agriculture, industry and urban waste water (EC, 2009e).

In non-EU European countries, comparable policies and targets exist regarding water protection and management. One example from outside the EU-27 is Switzerland. In contrast to the WFD, which is based on planning periods with specified targets, the Swiss legislation formulates binding requirements including a set of national limits that must be met at all times. Notably, as a result of the current amendment of the Swiss Water Protection Act and Ordinance, new regulations, which include concrete financial solutions for river restoration and hydromorphological measures, are now anchored in the national legislation. With these recent developments the legislative system is sufficient to ensure protection and restoration of freshwater ecosystems and to thus safeguard the respective ecosystem services ((FOEN, 2009a; FOEN, 2009c; OFEV, 2009; BAFU 2010).

Restoring natural river ecosystems in Europe enhances their natural capacity to clean themselves of pollutants, to reduce risks of flooding in natural river beds due to climate change and to reopen the natural variety of habitats for the settlement of typical species. Restoring these ecosystems is a complex issue that needs to integrate interests of different land uses that may affect freshwater ecosystems, such as agriculture, industry, wastewater discharge, inland waterways and hydropower. It needs close coordination between nature protection and spatial planning (agricultural, urban and coastal) to ensure the most effective protection of ecosystems, habitats and their connectivity.

# Further reading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