

Rivers and lochs

Despite good and improving water quality, nutrient enrichment, water use, habitat change, invasive species and climate change still threaten freshwater wildlife.



Summary

Scotland has a considerable freshwater resource; 125,000 km of rivers, 27,000 lochs, 198,000 ponds and 220 km of canals. Freshwater wildlife is largely in good condition, reflecting long-term quality improvements. Some habitats and species are influenced by a range of impacts, including physical modifications and water abstraction, although the overall ecological condition of Scottish rivers and lochs is considered to be in a (generally) favourable state. Despite improvements over several decades, some problems persist. For example, water voles and freshwater pearl mussels continue to decline, and nutrient enrichment threatens vulnerable populations of plants such as river jelly lichen and slender naiad. Climate change and invasive species have introduced new challenges to be addressed.

Introduction

Rivers, lochs, canals and ponds

Scotland has a considerable freshwater resource. There are approximately 125,000 km of running waters (rivers and burns), over 27,000 lochs and lochans, an estimated 198,000 ponds and 220 km of canal habitat. Covering about 2% of Scotland's land area, rivers and lochs represent around 70% of the total surface area and 90% of the volume of surface freshwater in the UK.

When in good condition, rivers, lochs, canals and ponds can support a wide range of plants and animals, many of which are listed in the [UK Biodiversity Action Plan](#). Freshwater habitats also provide a valuable economic and recreational resource for people. The combined effects of weather, altitude, geology, soil type, landform and land use have produced a range of freshwater habitats, natural and artificial, each with its associated wildlife. Important freshwater features for wildlife in Scotland include:

- a considerable number of relatively unmodified and unpolluted river systems with natural physical, chemical and biological variety resulting from changes in altitude and rock and soil types along catchments;
- many deep, unpolluted lochs formed by glacial activity, with wildlife characteristic of nutrient-poor waters;
- extensive systems of globally rare blanket bog pools and lochans;
- a typical freshwater plant assemblages where North American and European species distributions overlap;
- several internationally rare invertebrate species, including some of the world's largest surviving populations of freshwater pearl mussel.

Ponds, the smallest standing water bodies, can greatly increase the range of wildlife found in a landscape. [Scotland has an estimated 198,000 ponds](#). Canals are artificial water channels, originally built for navigation or water transport. [Scotland's canal resource](#) is relatively small, at 220 km in length, with five main canals.

The importance of Scotland's freshwater environment is described in the topics on [water](#). Freshwater wildlife makes its own distinctive contribution to the [benefits from nature](#) provided by Scotland's natural resources. These were valued at between £21.5 and £23 billion per year in 2009¹. Lochs alone were estimated to contribute between around £1.4 and £1.5 billion per year.

References

1 Williams, E. (2009). Preliminary exploration of the use of ecosystem services values in a regulatory context. *Environmental and Resource Economics Project Report for the Scottish Environment Protection Agency (SEPA)*.

Description of river and loch wildlife



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Rivers

Much of our knowledge of the state of biodiversity or wildlife in Scotland's freshwaters comes from two sources: water environment monitoring carried out by SEPA and protected species and habitat monitoring undertaken by SNH.

State of habitats

Just over 50% of our rivers are at good or better status, as assessed by SEPA's monitoring of ecological status under the Water Framework Directive, with many being less disturbed by human activity when compared to the majority of rivers elsewhere in the UK and Europe. Many of the rivers which are currently at less than good status (despite being in good chemical and biological condition) have been affected by changes to physical habitat, such as straightening, deepening and loss of natural vegetation. SNH monitors 12 designated areas specifically for river and stream habitat features provided with special conservation protection (although many other rivers are monitored by SNH for their protected species). In 2011, only 50% of the habitat features of these river and stream habitats were in ['favourable or recovering condition'](#).

State of species

Most monitoring information is available for larger, more 'iconic' freshwater animals, like mammals and birds, with less available for other groups of species. In Scotland, [otters](#) are widespread on rivers, lochs, coasts and estuaries. As otters require good-quality water environments with plenty of food, they are good indicators of well-functioning freshwater habitats. SNH's 2011 assessment of sites protected for otters reported that 100% of sites were in favourable condition. SNH also publishes [a biodiversity indicator for otters in Scotland](#), which shows that otter distribution has increased dramatically in Scotland since 1979.

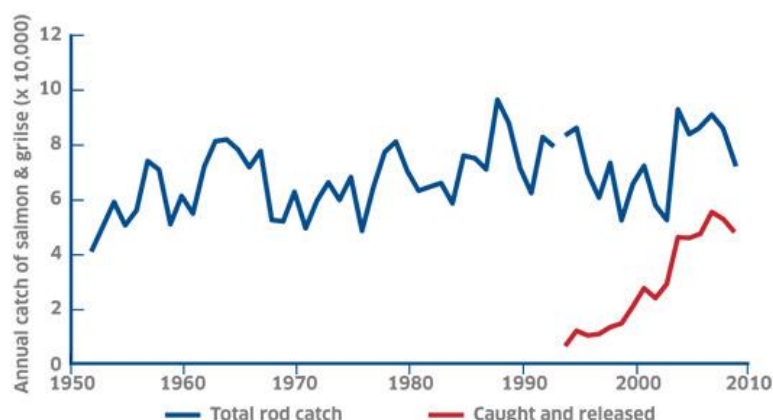
Otters are now near-ubiquitous in Scotland, even occupying sites in urban and highly disturbed waterways. [Water voles](#) live in burrows near freshwater. They are one of Scotland's most threatened mammal species, having declined dramatically during the second half of the 20th century. Due to pressures such as habitat loss and predation by American mink, water voles in Scotland are now mainly restricted to smaller upland watercourses. There are also some large urban areas, notably Glasgow, supporting viable populations in patches of undeveloped land.

Scotland's rivers support a diverse range of birds, including waterfowl, waders and songbirds. Fluctuations have been recorded in a number of populations; for example, the [reed bunting population in Scotland](#) increasing by 58% between 1995 and 2008. The [dipper](#), by contrast, although widespread on Scottish rivers and expected to be making a recovery as acid rain problems are resolving, [continues to decline in](#) parts of Scotland.

As only a few [fish species](#) were able to reach Scottish freshwaters and survive here soon after the last ice age, Scotland's rivers naturally support a lower diversity of native fish species compared with southern Britain.

Annual government statistics on the catches of Atlantic salmon and sea trout provide the only long-term consistent national reporting of freshwater fish populations in Scotland. For Atlantic salmon, [the most recent report \(2009\)](#) highlights the annual rod catch as showing a slight increase over the long term (Figure 1), despite a continuing decline in the catch of salmon entering rivers to spawn in spring. The practice of catch-and-release has continued to grow in popularity and is likely to assist with ensuring that populations are maintained with a sufficient number of spawning adults.

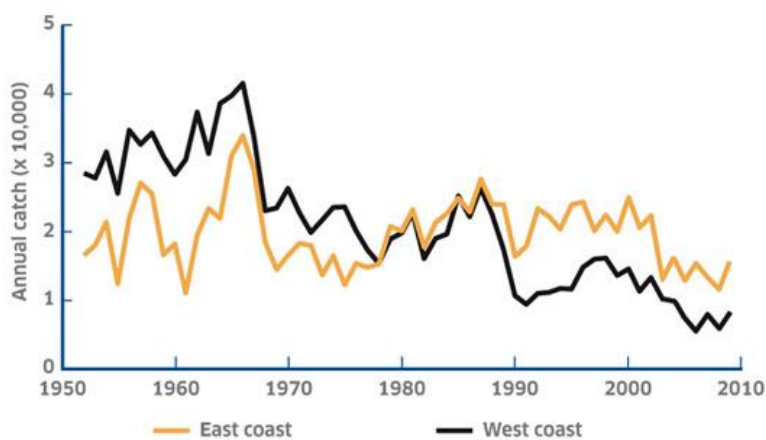
Figure 1: Trends in rod and line caught salmon



The [2009 report on sea trout](#) shows that total rod catches had declined over much of the period since 1952 (Figure 2). Catches in 2009, however, showed a 12% increase compared with the previous 5-year average.

Over the period 1952–2009, broad-scale geographical differences are apparent in the sea trout fisheries. Catches from the west coast have declined, whereas those on the east show no clear trend. Catches from the west coast are currently at the lowest levels recorded since 1952.

Figure 2: Trends in rod and line caught sea trout in east and west coast fisheries



Nearly 200 long-term river monitoring sites have been sampled by SEPA at least twice annually (spring and autumn) for the [invertebrates](#) living in them (e.g. [river flies – mayfly, caddis and stonefly larvae](#), water beetles, worms, flatworms, snails, freshwater mussels, shrimps), to assess their quality. The average number of species and higher level groups varies between years but increased between 1981 and 2008. Care must be taken in drawing too strong a conclusion from this upward trend as there were changes in the nature of the sampling programme over the period, as well as improvements in the quality of river waters.

Many Scottish rivers and burns are designated for conservation protection for populations of rare and declining species. In 2010, SNH [reported](#) mixed fortunes for designated river species (Table 1), the most widespread concerns being water quality and water management.

Table 1: SNH condition assessment summary for selected protected river species

Species	Number of features assessed	Features assessed in favourable or recovering condition, 2005 (%)	Features assessed in favourable or recovering condition, 2005 (%)
European otter	27	100	100
Atlantic salmon	19	95	100
Lampreys (brook, river and sea)	16	67	68
Freshwater pearl mussel	24	33	33

Scotland is a global stronghold for the freshwater pearl mussel, and has many of the world's remaining populations of this rare mollusc. In 2006, only 62 of 106 Scottish populations [were assessed as viable](#). In 2005 and 2011, freshwater pearl mussel populations on designated sites were causing the most concern, being in unfavourable condition due to a low density of adult mussels and poor populations of juveniles. Historic and recent, illegal, pearl fishing [were assessed as a negative influence](#) on [21 of the 24 sites designated for freshwater pearl mussel](#).

State of plants

Scotland's rivers support a range of [submerged and emergent plants](#): flowering plants and simpler algae, mosses and lichens. Some species have been accorded protected status, like the threatened [river jelly lichen](#). Nutrient levels in Scotland's rivers usually increase with increasing distance downstream, and the more sluggish-flowing lower reaches support a higher abundance of aquatic plants, such as water-crowfoots, water-starworts and alternate water-milfoil. These provide seasonal cover for fish and habitats to support aquatic insects such as [damselflies](#).

Riverbank (or riparian) plants, from waterside trees and wet woodlands to flowering plants, grasses, ferns and mosses play an important role in the ecology of rivers, as an important habitat and as a source of shade, cover and nutrients for the river. [Species richness of stream-side plants was 12% lower in 2007 than in 1998](#). Since 1990, the composition of riverside vegetation has changed to include more tall species, with more competitive and more woody species present. This may be the result of more widespread fencing-off of watercourses, which reduces the impacts in rivers and lochs from diffuse pollution.

The overall ecological condition of Scottish rivers is generally good, with healthy populations of many mammal, bird, fish, invertebrate and plant species, and has improved over the last few decades, but some problems remain. For example, populations of water voles and freshwater pearl mussels continue to decline or do not improve, and rising nutrient levels in some rivers put at risk vulnerable populations of lower plants such as river jelly lichen.

Lochs

State of habitats

[The water quality of a loch affects the wildlife that it supports](#), for instance, lochs with naturally low nutrient levels support a different range of wildlife to those with naturally high nutrient levels. The importance of Scotland's freshwater lochs, and the wildlife they support, is reflected in [the high number of designated sites for lochs](#).

In [March 2010](#), SNH reported that, of 203 loch features monitored, 164 (or 80.8%) were either in a favourable condition or were regarded as recovering (representing an improvement from 75%, as recorded in 2005).

The 2009 Water Framework Directive classification found that [65% of the area of 334 lochs assessed](#) (all those over 0.5 ha in size) was in high or good condition.

State of animals

Scotland's lochs support a wide range of breeding and wintering birds. Some, such as the black-throated diver, common scoter and Slavonian grebe, are relatively rare. Many lochs are designated to protect bird habitats. SNH has assessed (March 2011) that, of 86 freshwater breeding bird features, 70 (81%) are currently in favourable or recovering condition. Of the 19% of designated sites in unfavourable condition, the majority were for the black-throated diver and Slavonian grebe.

Scottish lochs are home to [a number of fish species](#), some of which are rare or threatened (e.g. [Arctic charr](#), powan and vendace). [Many species of coarse fish, such as pike and perch](#) have been introduced to a number of Scottish lochs over time, a practice which is now illegal without a licence. Designated features for protected loch fish species were reported generally to be in favourable condition [by SNH in March 2010](#) – only one Arctic charr population was reported as unfavourable.

A small trial reintroduction of the [European beaver](#), formerly extinct in Scotland, is under way in lochs in Knapdale in mid-Argyll to assess the feasibility and effects of reintroduction.

Several rare invertebrate species are recorded in Scottish lochs, including the [medicinal leech](#), known only from a few shallow, weedy, nutrient-rich lochs.

State of plants

Scotland's lochs support a wide range of [flowering plants](#), [mosses](#), [algae](#) and [lichens](#). An extensive database of loch plant records has been collected by SNH but no overall assessment of the state of loch plants has yet been undertaken.

The slender naiad is the only loch plant species for which Special Areas of Conservation require to be designated under the [EC Habitats Directive](#). SNH found that only three of six sites for slender naiad were in favourable condition in March 2011.

Based on the water quality of lochs and the reported condition of designated site features, the state of animals and plants in Scottish lochs is generally good and, in many remote lochs, is likely to be relatively undisturbed. Where loch water quality is degraded by nutrient enrichment, there are likely to be changes in the expected plant assemblage.

Ponds

Whether natural or artificial, ponds are often [important wildlife habitats](#). Although very small, they may support a surprising diversity of wildlife, and are particularly good habitats for [amphibians \(frogs, toads and newts\)](#), and invertebrates, such as [dragonflies](#), snails and water beetles. They are also known to support rare species such as the [aquatic fern pillwort](#).

State of habitats

The number of ponds in Scotland declined by an estimated 7% between the 1950s and the 1980s ([National Amphibian Survey](#)). According to the Countryside Survey, however, the number of ponds increased again by 6% in Scotland between 1998 and 2007. The estimated numbers of ponds in these two surveys cannot be directly compared as the sampling methods were very different, but a comparison of the trends in numbers over the time periods is valid. There is not enough information yet to allow an assessment of the trend in their quality over time.

State of animals

Ponds are the preferred habitat for some animal species. Some of these, such as the great crested newt and natterjack toad, are given legal protection wherever they occur in Scotland in accordance with the requirements of the [EC Habitats Directive](#), and a number of sites are also designated for these species. In March 2011, [SNH judged that, of 11 features for amphibians in Scottish designated sites](#), ten (90.9%) were either favourable or recovering from unfavourable condition.

Invertebrates are an important component of Scottish ponds. Not enough is known, however, to allow an assessment to be made of their state or the trend in their condition

State of plants

[In 2007, ponds in Scotland](#) supported an average of about 10 wetland plant species per pond. In total, one in 10 of the ponds surveyed were of high enough quality to meet the UK Biodiversity Action Plan's 'Priority Habitat' status, based on the number of plant species. Across all 81 ponds surveyed (by the 2007 Countryside Survey) in Scotland, 137 different plant species were recorded.

Canals

Scotland's canals are made up of a broad range of habitats and so support a variety of wildlife. The diverse canal wildlife resource in Scotland has been recognised, with 22 Sites of Special Scientific Interest on or within 500 m of Scotland's canals. Along the Forth and Clyde Canal, more than 310 species of plants have been recorded. Canals are biologically productive and support a variety and abundance of invertebrate fauna, plants, many birds and fish (including several coarse fish species), and a range of amphibian and mammal species, including bats ([e.g. Daubenton's bat](#)).

Pressures affecting rivers and loch wildlife



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The main pressures on Scotland's freshwater wildlife are:

- nutrient enrichment;
- acidification;
- water use;
- physical modification of freshwater habitats;
- invasive non-native species;
- climate change.

Nutrient enrichment

Excessive inputs of plant nutrients (nitrogen and phosphorus) into freshwater in run-off from land use, and in effluents from sewage treatment works, fish farms and industrial sources, can lead to ecological changes in the water body. These can include dense and sometimes toxic algal blooms, shading out and loss of higher (flowering) water plants, and the decline or loss of fish species. For example, the rare fish, [vendace](#), is thought to have died out in Castle Loch near Dumfries in the 1960s as a result of over-enrichment of the loch with nutrients, principally from sewage pollution. [Extensive studies have been undertaken](#) over several decades into the effects of, and more recent recovery from, nutrient enrichment in Loch Leven in Perth and Kinross.

Acidification

Acid rain had major effects on Scottish freshwater food chains in the 1970s and 1980s. There were reductions in invertebrates on acidified streams and rivers, leading to declines of the river bird, the dipper.¹ The systematic survey of loch water quality by the UK Acid Waters Monitoring Network (UKAWMN) has led to numerous scientific investigations of causes and changes, and the [annual reports from the UKAWMN](#) show evidence of biological recovery at many, but not all, surveyed freshwater sites, and some chemical recovery.

Water use and physical modification of freshwater habitats

Abstraction of too much water can be a problem for river and loch wildlife. Changing water levels too rapidly or too often through abstraction can lead to loss of shallow water habitats for plants and animals. In extreme cases, river beds can dry up. This can prevent the passage of migrating fish. Dams or weirs, which modify or regulate flow regimes, often built to support water abstraction, can cause problems to waters downstream. In addition, fish migration over dams may be restricted. [Aquatic habitats are often modified physically](#) to allow people to make use of waters or land. These modifications, often associated with engineering works (such as flood defence engineering and agricultural drainage schemes), can directly remove or destroy habitat or indirectly change the natural flow or sediments of freshwaters.

Invasive non-native species (INNS)

Non-native species are those that have been introduced, deliberately or accidentally, by humans. There are many non-native species in Scotland, but only a small number of these have spread, causing damage to the environment, the economy, our health and the way we live – these are called INNS. The threat from INNS is growing, assisted by increased global movement of people and goods; the Millennium Ecosystem Assessment identifies INNS as one of the most important direct drivers of biodiversity loss. [It has been estimated](#) that INNS cost the Scottish economy almost £245 million each year. Examples of INNS affecting Scottish freshwaters include [Rhododendron](#), [American Mink](#) and [New Zealand pygmyweed](#).

Climate change

By the 2080s, Scotland is likely to be warmer by several degrees, especially in summer ([UK Climate Projections 2009](#)), and with less snow, wetter winters and drier summers. Seasonal weather patterns [already appear to be becoming disrupted](#). These changes, along with increased flooding, will affect the wildlife of freshwaters, with some long-term changes in rivers and lochs already being observed. The winter flow in the River Teith [increased by 91% over the last 40 years](#), and the mean spring temperature in Loch Leven [increased by 1.5°C between 1970 and 2000](#). Life in rivers can be adversely affected by rising temperature, low water levels and flows in summer, and flash floods in winter, making conditions less hospitable to, for example, fish and freshwater pearl mussels. The timing of some seasonal events has already been shown to have changed significantly: since the 1970s [dippers have been laying eggs 3 days earlier each decade](#) on average (or 4 days earlier per 1°C warmer).

References

1 Vickery, J (1992) The Reproductive Success of the Dipper *Cinclus cinclus* in Relation to the Acidity of Streams in South-West Scotland. *Freshwater Biology*, **28**: 195–205.

Consequences of a change in river and loch wildlife



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Functionally intact and biologically complex aquatic ecosystems provide many economically valuable services and long-term benefits to society (source: [UK National Ecosystem Assessment](#)). In Scotland, society receives many benefits from freshwater ecosystems, habitats and wildlife. Freshwater is used for drinking, irrigation and navigation, and contributes to food supply. Freshwater habitats can assist flood control, the treatment and disposal of human and industrial wastes, and support plant and animal life.

In the longer term, freshwater systems provide part of Scotland's capacity to respond to future environmental pressures, such as climate change. This range of benefits from freshwaters may be put at risk if the quality of those waters, or the availability of water, is impacted by the above pressures. The loss of these services would have significant economic and social costs in Scotland, affecting the revenue from tourism and those industries that depend on the delivery of clean water and other resources from functioning freshwater [ecosystems](#). Some of Scotland's most popular wildlife is associated with freshwaters, from otters returning to urban rivers to salmon leaping up waterfalls. These make an important contribution, not just economically (e.g. angling and tourism), but also to the cultural story of Scotland.

Response by society



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Pollution

In general, pollution levels in Scottish freshwaters have been declining over time, with conditions improving for wildlife following significant investment in better treatment of effluents and strengthened [regulation](#). Sometimes, however, specific action is required to protect biodiversity from pollution. For example, during the 1960s and 1970s, when acidification of Loch Doon in south-west Scotland threatened the loch's unique population of [Arctic charr](#), Loch Doon Arctic charr were relocated to two reservoirs elsewhere in the Scottish Borders, where acidification was not a problem.

Sometimes, action must be taken at a catchment level when wildlife interests are threatened by diffuse [pollution](#). In response to a threat from nutrient enrichment to rare loch plants in Tayside, SEPA initiated a lochs partnership, with funding from the Tayside Biodiversity Fund for remediation measures. The project included a diffuse pollution audit of farms in the catchment, soil nutrient budgets, provision of advice to land managers and funding to create buffer strips around lochs to trap nutrients.

Physical modification and water use

The main development control mechanism, Town and Country Planning legislation, was not designed to provide the specialised protection required for freshwaters. Consequently, for example, many barriers to fish migration have been installed (bridges, weirs, etc.) as part of developments. Conservation legislation controls some impacts through licensing of operations likely to damage designated conservation sites. A more targeted policy response came through the development of the [Water Framework Directive](#) and its implementation in Scotland through the [Water Environment and Water Services \(Scotland\) Act 2003](#) and its [Controlled Activity Regulations \(CAR\) regime](#). This legislation regulates both physical modification of, and water abstraction from, rivers, canals and lochs. SEPA also manage a programme of restoration work, which aims to restore water bodies to good ecological status, in line with the aims of the WFD River Basin Management plans.

As one of the requirements of the WFD, SEPA published river basin management plans (RBMPs) for the Scotland and the Solway Tweed River Basin Districts in 2009. These plans, to be reviewed in 2015, will ensure that public sector bodies, businesses and individuals work together to protect the water environment and address significant impacts, through water management co-ordination. The plans will also ensure a balance is struck between the protection of our water environment and wildlife, and the interests of other water users. The RBMPs are available at http://www.sepa.org.uk/water/river_basin_planning.aspx.

Invasive non-native species (INNS)

The [Scottish Government](#) is working with a range of partners to minimise the risk of invasion and the negative impacts caused by INNS in Scotland, following the principles set out in the [INNS framework strategy for Great Britain](#), of prevention, early detection and rapid response, and control, eradication or mitigation.

[The Wildlife and Natural Environment \(Scotland\) Act 2011](#) has introduced more consistent and preventative legislation on INNS. SNH is co-ordinating work on several riparian and aquatic INNS through a Species Action Framework, including [North American Signal Crayfish](#), [American Mink](#), [New Zealand Pygmyweed](#) and [Rhododendron](#).

There are two popular campaigns that give good practice advice on biosecurity – [for plants](#) – and [for water sports](#). The Rivers and Fisheries Trusts of Scotland are leading on [biosecurity in many Scottish river catchments](#), eradicating species such as Japanese Knotweed, Giant Hogweed, Himalayan Balsam and Rhododendron. The [Scottish Mink Initiative](#) aims to protect nationally significant populations of water voles, salmonids, ground-nesting birds and other native riparian wildlife from mink predation.

Climate change

As part of its policy response to [climate change](#), the Scottish Government has developed a Climate Change Adaptation Framework to build Scotland's resilience to the unavoidable consequences of a changing climate. Scotland's first [Climate Change Adaptation Framework](#) is designed to help manage the risks and safeguard communities from the impacts of a changing climate.

A key element of the framework is the preparation of Sector Action Plans, of which one identifies the potential impacts of the changing climate on the [Biodiversity and Ecosystem Resilience](#) sector and [sets out the action being taken](#) in Scotland to adapt to those impacts. It also begins to consider what this sector can do to help other sectors and wider society adapt. The changing climate will have both positive and negative impacts and the Action Plan has been developed to minimise the negative consequences and take advantage of opportunities.

Further information on climate change in Scotland can be found in the [Climate change topic](#) on this site. A useful resource for information on climate change adaptation in Scotland is also provided by [Adaptation Scotland](#).