Freshwater lochs

Scotland's lochs are an important part of our landscape and provide water for drinking and power generation as well as space for recreation. They are generally in good condition.

Summary

Key messages

- Scotland's lochs are renowned for their beauty and form a dramatic part of our landscape.
- There are over 25,500 lochs in Scotland, with the Western Isles and Sutherland having the highest concentration of lochs.
- Almost two-thirds of lochs surveyed are of good or high quality.
- Some lochs are still recovering from historic damage; for example, from acid rain.
- There are unlikely to be dramatic improvements in lochs affected by abstractions (removing water) or impoundments (dams) in the short or medium term.
- Lochs provide a range of benefits, including supplying much of our drinking water and renewable energy from hydropower.
- Lochs also support tourism and provide important recreational space for boating, fishing, kayaking and nature-watching.
- Integrated catchment management is necessary to improve the lochs that are of a poorer quality.

State and trend

State: Good - high agreement, high evidence

Trend: Stable/improving - medium agreement, high evidence

There is an explanation of the diagram and further information on how we carried out the assessments on the summary pages.

- These assessments are of the current "average condition"; some lochs are in a worse condition, and others are in a better one. Equally, the condition of some lochs is worsening, while it is improving in others.
- Making any overall assessment of the condition of our lochs is a simplification.
- We have taken account of the scale of any damage to the environment in these assessments; local damage may have little effect on a national scale.
- We have stated how confident we are in the assessments based on the level of agreement between the specialists involved, and the quality and quantity of the supporting evidence.

Overview

There are over 25,500 lochs in Scotland, varying greatly in size and volume (Figure 1). Many of the smallest lochs and lochans are concentrated around the northern and western Highlands and are found on peatlands (Figure 2). Larger lochs are often found in U-shaped valleys that were formed during the last ice age. Loch Lomond has the largest surface area (71 km^2), while Loch Morar is the deepest at 310 m. Loch Ness holds the most water with 7.4 million m^3; more than all the English and Welsh lakes combined.

Area category (km^2)	Area: > 20	Area: 10 - 20	Area: 5 - 10	Area: 2 - 5	Area: 1 - 2	Area: 0.5 - 1	Area: 0.25 - 0.5	Area: 0.10 - 0.25	Area: 0.01 - 0.1	Area: < 0.01
Number of lochs	8	11	23	56	73	168	365	840	6,434	17,637
Total area (km^2)	301	159	170	168	1,021	15	128	130	201	64

Figure 1: Number and area of Scottish lochs

Figure 1 shows that together, the eight largest lochs cover an area of 301 km^2 – almost five times the area of the 17,637 smallest lochs combined.

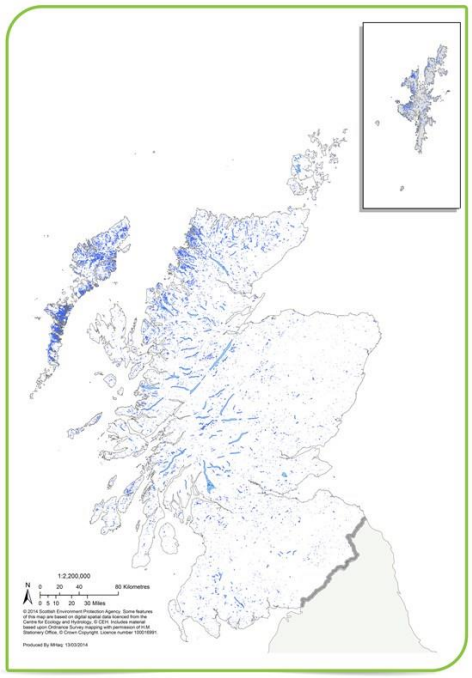

Figure 2: Location of Scottish lochs

Scotland's lochs provide many benefits and services, and they are important as an economic resource. The most obvious examples are for water supply and generating electricity.

Hydropower generation is found mainly in the uplands of the central Highlands and northern areas of Scotland. Lochs for water supply are mainly found near to larger towns and cities in the south of Scotland, but there are some notable exceptions, such as Loch Katrine in the Trossachs and Megget Water in Upper Tweedale.

Lochs in Scotland also make a significant contribution to the cultural and social wellbeing of the nation. Lochs are valued recreational resources, used for boating, fishing, kayaking and nature-watching. The dramatic setting of many lochs, and the myths and folklore associated with some lochs – such as Loch Ness – make them popular tourist attractions.

State

The quality of nearly 63% of assessed lochs has been assessed as 'good' or 'high'. Many lochs are relatively unaffected by human activity, compared with the majority of lakes elsewhere in the UK and Europe.

The Water Framework Directive (WFD) assessment applies to the 334 lochs whose areas is greater than 0.5 km^2 in size. These make up two-thirds of the total area of Scottish lochs. The assessment system used by the WFD divides lochs into five classes depending on levels of human impact on the environment. Lochs with high status show very little human alteration from undisturbed conditions, and those with good status have only low levels of human alteration. Those with moderate, poor or bad status show progressively greater impact.

Some lochs are man-made or have been significantly altered by human activity to provide an important socio-economic benefit; for example, damming a loch for hydropower generation. In these cases, the loch cannot meet good status, so it is assessed according to its potential. A modified or artificial loch is considered to have good ecological potential if it is free from pollution and managed in the best possible way to protect the environment and maintain the wider socio-economic benefits.

The detailed classification results for each individual loch can be found on the Discover data pages.

Table 1 shows the water-assessment results for Scottish lochs for 2012, and Figure 3 shows the overall status of the lochs. The overall status of 63% of the 334 assessed lochs was classified as good or high in 2012.

Figure 3 shows that the majority of the lochs in the Highlands have a high or good status, although many of these are affected by hydropower schemes.

Lochs in the more intensively farmed areas are often polluted by nutrients through run-off from fields, and are affected by changes to their habitats.

Table 1: Classification of Scotland's lochs, 2012

Indicator	Status									
	High		Good		Moderate		Poor		Bad	
	Number of lochs	Area (km^2)	Number of lochs	Area (km^2)	Number of lochs	Area (km^2)	Number of lochs	Area (km^2)	Number of lochs	Area (km^2)
Overall status/ potential	69	87	141	538	78	258	35	56	11	53
Water quality	102	150	133	520	88	301	10	20	1	2
Water levels	230	586	19	59	13	27	15	92	57	229
Beds and shores	217	478	22	59	52	251	42	205	1	1

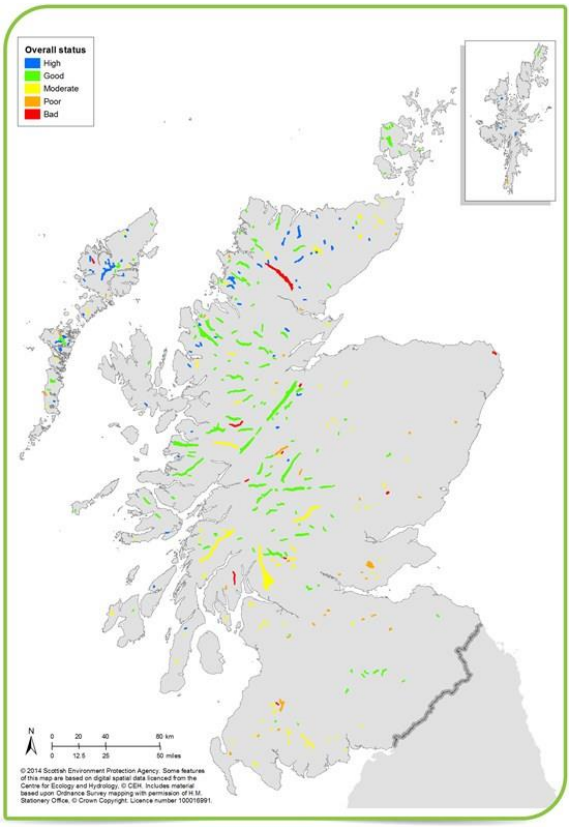

Figure 3: Overall status of lochs, 2012 data

Water quality

Many of the lochs at less than good status are affected by land-management practices or acidification.

Water quality is measured using a combination of chemical and biological pollution indicators. The plants and animals that live in our lochs are affected by a range of pollutants, including excessive nutrients, chemicals and sediment. Excessive inputs of nutrients can boost the growth of algae and other water plants, causing oxygen depletion and major changes in the balance between the plants and animals living in the loch. Although rarely a problem, other pollutants can be directly toxic, causing death of organisms, reducing their growth or interfering with reproduction. Some of these pollutants break down very slowly and can accumulate over time in sediments and plants, and sometimes within the bodies of animals. A total of 235 of the 334 assessed lochs (70%) were at good or high status for water quality in the 2012 assessment (Table 1).

Although water quality in Scotland's lochs is generally high, we have to maintain this standard and improve other lochs where water quality is not as good.

Excessive nutrients

When nutrients, such as nitrogen and phosphorus, are present in excessive concentrations they may accelerate the growth of algae and other water plants in the loch, reducing oxygen levels and making it impossible for some plants and animals to survive.

Many of Scotland's lochs have naturally low levels of nutrients, so even quite small increases can significantly alter their sensitive ecosystems. In Scotland, the addition of phosphorus to lochs has the greatest impact on water quality. Phosphorus can enter lochs through run-off or drainage from land, or directly from fish farming and sewage inputs.

Algal blooms

Blooms of cyanobacteria (blue-green algae) are a particular concern for human health, as they can produce toxins. Algal blooms in reservoirs mean that water companies have to apply extra treatment before the water can be supplied for drinking. It may also be necessary to restrict the use of lochs for water sports to protect human health.

Acidification

Water quality in some lochs, particularly those in upland locations, has been affected by atmospheric pollution since the industrial revolution. Industrial and vehicle emissions containing compounds of nitrogen and sulphur are very acidic and when deposited in lochs they can cause the water to become acidic as well. In general, acidified lochs contain fewer plant and animal species.

Several populations of Arctic charr and brown trout have become extinct in lochs in Galloway as a result.

The problem is especially acute in the south-west of Scotland where soils surrounding the lochs are unable to neutralise the acidity. Conifer trees are also extremely good at collecting acidic water droplets from the air, which can make things worse.

Strict controls on industrial emissions and reduced acid deposition mean that some lochs are showing signs of recovery from acidification. However, other lochs will recover more slowly and their full recovery may be prevented by the effects of nitrogen emissions from vehicles and the impacts of climate change.

Invasive non-native species

Invasive non-native species (INNS) can be introduced unintentionally in many ways; for example, discarded exotic plants from garden centres. If they become established in the wild, they tend to thrive at the expense of native water plants and animals.

The WFD classification includes an assessment of the impact of the INNS that pose the greatest risk to lochs; currently, information on where invasive NNS are causing problems is limited, but in 2012, three lochs (Loch Ken, Strathclyde Loch and Lochrutton Loch), an area of 8 km^2 in total, were at moderate status because of invasive NNS, with 33 lochs (covering a total of 125 km^2) being downgraded to good status. Invasive NNS are recognised as a risk to Scotland's lochs; the "Current condition and challenges for the future" report estimated that 2% of lochs are at risk of failing to meeting environmental objectives because of them.

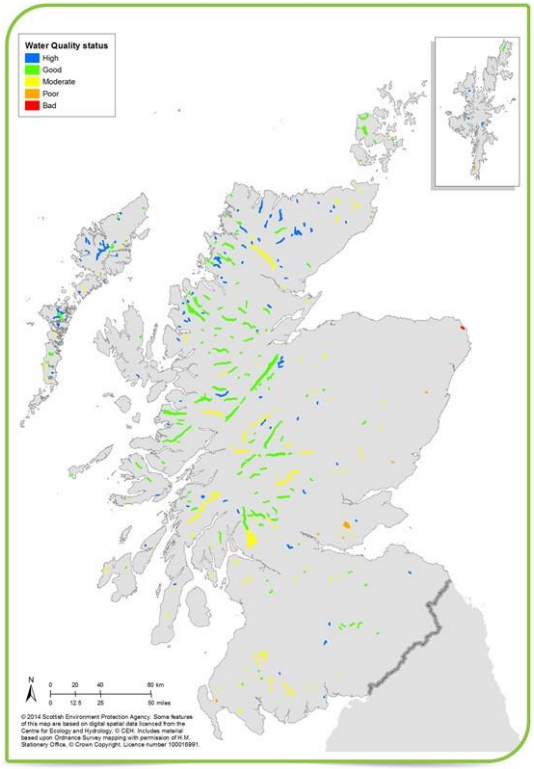

Figure 4: Water quality of lochs in 2012

Water levels

Loch ecosystems are affected by changes in their water levels. Lochs need to hold enough water to maintain the habitats of animals and plants, and to limit their vulnerability to pollution and high summer temperatures. Natural changes in water levels occur in most lochs throughout the year; however, fluctuations that are too rapid or large can damage habitats and reduce species numbers.

Figure 5 shows the condition of water levels in lochs. A total of 249 of the 334 assessed lochs (75%) were at good or high status for water levels in the 2012 assessment (Table 1). Many of the lochs affected by alterations to water level are used for electricity generation or drinking-water supply.

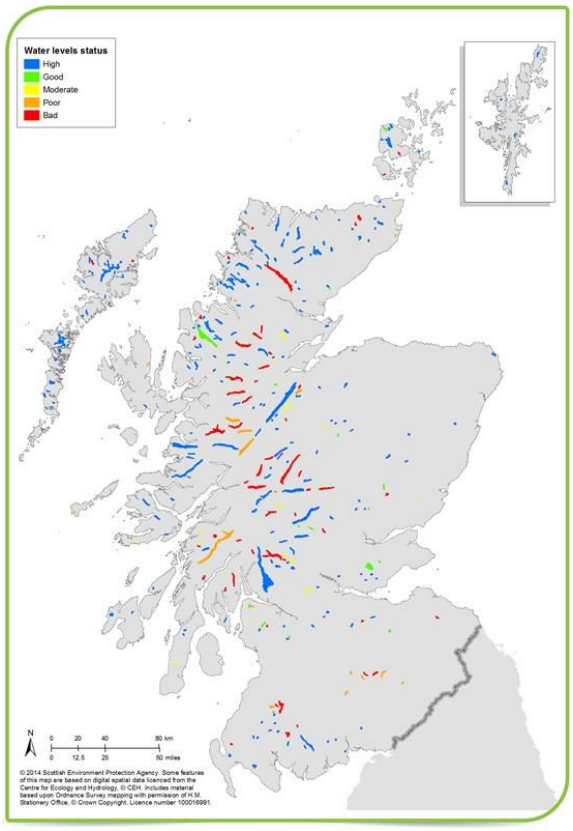

Figure 5: Condition of water levels in lochs in 2012

Beds, banks, and shores

The beds and banks of lochs provide habitats on which many plants and animals depend. Some species are mobile and some, such as rooted plants, live attached to the bed. A total of 239 of the 334 assessed lochs (72%) were at good or high status for beds and banks in the 2012 assessment.

Alterations to loch beds and banks caused by engineering activities such as road-building or preventing wave damage can reduce the area, diversity and quality of available habitats. Loss of vegetation on banks and shores can also make the loch more vulnerable to pollution and erosion, and reduce the food available for wildlife in the loch. Man-made obstacles, such as weirs and dams, can block access to the loch for fish. The impact of weirs and dams on migratory fish is included in the WFD assessment of loch beds and banks (Figure 6).

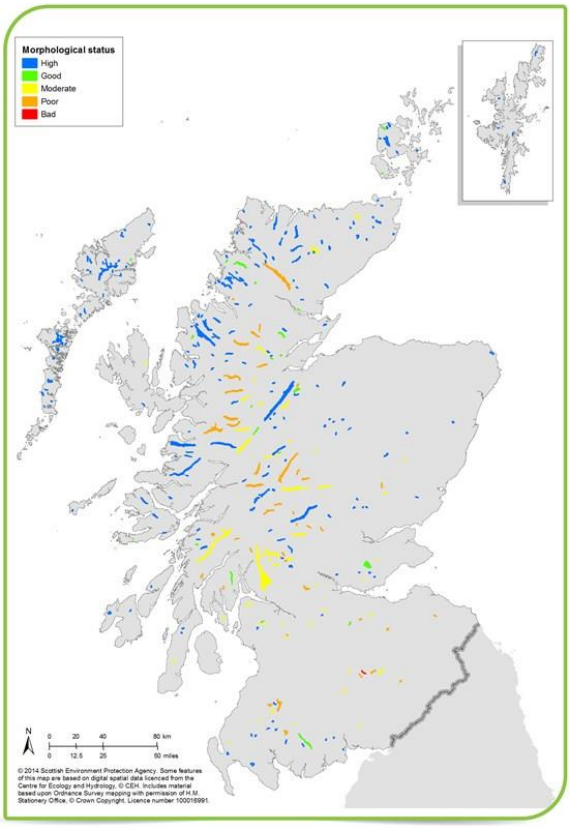

Figure 6: Condition of the beds and banks and impact of fish barriers in lochs in 2012

Pressures affecting freshwater lochs

The pressures on Scotland's lochs reflect firstly the variety and intensity of the activities undertaken on and around them, and secondly the wider environmental trends that are being experienced on a global scale.

The main pressures affecting Scotland's lochs are:

- changes to water levels from hydropower generation and water-supply industries;
- nutrients from land-management activities, including agriculture and forestry, and from sewage inputs;
- obstacles to fish migration, such as weirs and dams;
- pollutants deposited from the atmosphere, leading to acidification.

Changes to water levels

Artificial lochs built for hydropower and drinking-water supply usually involve a dam to raise the water level of an existing river or loch. Water-supply reservoirs tend to fill up over the winter, and are then gradually drawn down through the summer as the demand for drinking water is greater than the amount of water flowing in.

Hydropower reservoirs are filled and allowed to draw down regularly, and there are relatively rapid fluctuations in the water level. These rapid fluctuations can lead to draw-down scars on the banks, similar in appearance to the rings around a dirty bath. This scarred area provides an unstable and poor-quality habitat for plants and animals, and has a negative effect on the appearance of the loch.

Dams can also affect loch ecosystems by preventing or making it difficult for migratory fish, such as salmon, to move upstream and spawn in headwater tributaries. When gravel and coarser sediments get trapped behind dams, this can lead to the erosion of gravel habitats downstream, by interrupting the supply of new gravel.

Nutrients

Increased levels of nutrients can lead to the growth of unwanted and harmful algal blooms that reduce oxygen levels in the loch. This is a process known as eutrophication and can result in the deaths of other plants and animals in the loch.

Increased levels of nutrients, such as nitrogen and phosphorus, enter lochs mainly as a result of land-management practices such as agriculture and forestry and from the aquaculture industry. These pollutants are known as ‘diffuse pollutants’ because they cannot be traced to a single source. Instead, they arise from many individually minor inputs that, when combined, can result in a major problem. Well-managed farm and forest land presents minimal risk to lochs, but poor land-management and land use change can lead to diffuse pollution, as shown in Figure 4.

Although it is rare for sewage to be directly discharged into lochs, there are some local problems caused by septic-tank discharges that are high in phosphorus, or through rivers that sewage has been discharged into.

Sediment and disease-causing microorganisms are also commonly associated with diffuse pollution from rural land management and from sewage discharges. For more details on the interactions between land use and watercourses, read the soils topic.

Atmospheric deposition

When pollution – mainly compounds of nitrogen and sulphur from burning fossil fuels – is washed out of the air it can produce *acid rain*. This rainwater can cause the acidification of lochs in areas where the soils and underlying rocks are not able to neutralise the acidity in the groundwater.

Obstacles to fish migration

There are many small weirs and dams in lochs across Scotland, many of which were erected more than 50 years ago. They were initially used to control the water level for activities such as fishing, boating, local water supply and electricity generation. Although small, these obstacles can prevent migratory fish travelling to breeding areas and prevent or reduce successful spawning upstream.

Climate change and invasive non-native species

The condition of lochs can also be affected by climate change, which can increase the other pressures described above.

For waters that are already under pressure from nutrient inputs, the higher temperatures predicted as a result of climate change may further stimulate excessive and damaging growth of water plants. The potential increase in extreme rainfall events may result in more of the soil and nutrients from agricultural land being washed into surface waters.

INNS already pose a significant threat to the ecosystems of our lochs. Our current relatively cool climate prevents many species from other parts of the world from establishing themselves and posing a threat to native plants and animals. However, a warming climate may favour some of these currently benign species, which could decrease the ecological quality of our lochs.

Urban pollution

Run-off from roads and urban developments also contains pollutants that can affect water quality in lochs. Additionally, road-building, housing, commercial and recreational developments have all played a part in the loss of shoreline and inshore shallow-water areas of Scottish lochs. This loss may affect the wide range of plant and animal species dependent on these shallow, well-lit areas of lochs.

What is being done

Scotland has a long track record of protecting and improving the quality of Scotland's waters through action to prevent and reduce pollution. There are ambitious targets to achieve further improvements over the coming years, and these are set out in Table 2.

The ultimate aim is for 98% of our lochs to be at good or high status/potential for habitats, water quality, invasive NNS and levels by 2027.

Policies and legislation

The European Water Framework Directive provides a framework for protecting and improving the condition of the water environment across Europe, through the development of River Basin Management Plans (RBMPs). In Scotland we are implementing the WFD through the Water Environment and Water Services (Scotland) Act 2003, which makes SEPA responsible for coordinating the development of the RBMPs, working in partnership with many sectors, public bodies and non-governmental organisations, These same sectors and organisations are responsible for the successful implementation of the plans, by developing partnership initiatives, and delivering public investment programmes and responsibilities.

Any new activities likely to have an adverse impact on the water environment are controlled under the Water Environment (Controlled Activities) (Scotland) Regulations 2011, known as 'CAR'. These include discharges of wastewater or industrial effluent, and abstractions for irrigation, hydropower or drinking water, as well as engineering activities in or near lochs.

The scope of WFD improvements is far greater than that of any previous initiatives, and includes:

1. ongoing work with farmers and other land managers to reduce diffuse pollution from a range of land-management activities (e.g. concerted work in priority catchments);
2. working with operators to reduce the impact of water regulation (dams and reservoirs) on wildlife;
3. controlling invasive non-native species;
4. projects to remove blockages to fish migration, where appropriate, or reduce their impact.

Scotland's Land Use Strategy sets out the key principles for balancing the conflicting demands on the use of Scotland's land. These principles are embedded in the river basin management plan and will be emphasised even more in future river-basin management delivery programmes.

The drive to increase the proportion of Scotland's energy generated by renewable power (such as hydropower) must be balanced with the damage that these schemes can cause to the aquatic environment.

The RBMPs offer opportunities for developing approaches to managing and improving our water environment at a catchment scale through more effective co-ordination between partners.

This collaborative approach to managing and improving the environment, offers opportunities for more effective co-ordination between partners. It is being carried out through river-basin planning, in which a detailed classification of the condition of Scotland's lochs has led to a river basin management plan setting out Scotland's objectives for further improving our lochs.

Table 2 shows the target for achieving this: by 2027, the objective is for 98% of our lochs to be at good or high status for habitats, water quality, invasive NNS and flows.

Table 2: Targets for improvements to the status of lochs to be achieved through the Water Framework Directive

Overall status/potential	Target area (km^2) by year		
	2015	**2021**	**2027**
High	147	147	148
Good	542	563	820
Moderate	139	218	24
Poor	153	53	1
Bad	11	11	0
Total	**992**	**992**	**992**
Proportion of total at good or better status (%)	**69**	**72**	**98**

A catchments-scale approach is being used to tackle diffuse pollution to benefit the rural economy as well as improving the health of lochs. SEPA has created a Diffuse Pollution Management Advisory Group to ensure that actions to reduce diffuse pollution are managed effectively and that there is input from rural, environmental and biodiversity groups.

Part of the work of the group has been to set up a project based on partnerships between SEPA and farmers to work towards reducing diffuse pollution in 12 catchment areas where it was a particular problem. The project uses a combination of approaches, including monitoring water quality and carrying out 1,270 farm visits, with a further 2,500 planned before the end of 2015. SEPA estimates that around 75% of the farms visited have taken steps to reduce diffuse pollution, and believes that working with land managers and other stakeholders to identify pollution risks and agree on the best way to reduce them is the best way to ensure that effective action is taken.