Red List of Ecosystem assessment series

Produced by JNCC and NatureScot, supported by Natural Resources Wales, Natural England, and Northern Ireland Environment Agency.

This resource is one in a series/number of Ecosystem Red List assessments developed to accompany the UK Biodiversity Indicator 'Red List of Ecosystems'. The assessments are available at: https://jncc.gov.uk/resources/7b922dfc-708b-4c8c-9e6a-e2040447fb39.

Resilient ecosystems are crucial for preventing biodiversity loss and species extinction. Maintaining healthy ecosystems safeguards the essential services they provide, which are fundamental to human well-being and a thriving economy. However, pressures and threats such as deforestation, overfishing, or climate change, can disturb the balance of ecosystems and threaten their health and functioning. Assessing the level of threat facing ecosystems is important in helping us understand the current status of the environment, and on a practical level, assessments can be used to help prioritise conservation funding decisions and where to take conservation management action on the ground.

The 'Red List of Ecosystems' (RLE) is a global assessment approach set out by the International Union on Conservation of Nature (IUCN). The approach includes consideration of a series of criteria, including change in geographic distribution through time; whether the ecosystem distribution is geographically restricted; evidence for any environmental degradation; and disruption to biotic processes or interactions. We have not carried out the quantitative analyses of the probability of ecosystem collapse necessary to assess criterion E as we do not have the data needed to carry out such analyses consistently. The IUCN methodology is widely used as a robust approach to assessing the status of ecosystems. Further details of the criteria used in these assessments are available on the IUCN portal.

This assessment series sets out the RLE assessment conclusions for ecosystems found in the UK, alongside the details of how the assessment was made, including for each IUCN component criterion. The assessments have been peer-reviewed, and source data is referenced. Once complete, the series will cover the full range of natural and seminatural habitats that occur in the UK, throughout marine, terrestrial and freshwater environments.

Assessments are conducted according to the Global Ecosystem Typology Level 3 (Ecosystem Functional Groups). This enables the assessments to feed into the Kunming-Montreal Global Biodiversity Framework (GBF) headline indicator A.1 Red List of Ecosystems. This indicator, which has been incorporated into the UK Biodiversity Indicator suite, is designed to measure progress against Goal A ('Protect and restore') and Target 1 ('Plan and manage all areas to reduce biodiversity loss') of the GBF.

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F2.2 Small permanent freshwater lakes

1. Key facts

Ecosystem description: With a surface area of up to 100 km^2, the diversity of small permanent lakes, ponds and pools depends on their size, depth and connectivity. Littoral vegetation and benthic energy pathways are critical to productivity and food web complexity. Deep lakes have plankton, supporting fish, birds and amphibians, in different habitats of the lake. Shallow lakes are often more productive, providing breeding habitat for birds, amphibians and invertebrates, but limited buffering against nutrient inputs may result in regime shifts between alternative stable states dominated either by large aquatic plants or phytoplankton.

Image credit: Fallonside Loch, Scottish Borders © Henry Lima NatureScot

Overall assessment conclusion: Endangered (EN) based on criteria C1, C2b, D1 and D2b

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Corresponding habitat classifications: The following habitats were considered in the production of this assessment.
EUNIS codes: C1.1 Permanent oligotrophic lakes, ponds and pools, C1.2 Permanent mesotrophic lakes, ponds and pools, C1.3 Permanent eutrophic lakes, ponds and pools, C1.4 Permanent dystrophic lakes, ponds and pools
UK BAP Priority Habitats: Eutrophic standing waters, Mesotrophic lakes, Oligotrophic and dystrophic lakes, Ponds
Habitats Directive Annex I habitats: H3110 Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*), H3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*, H3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp., H3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation, H3160 Natural dystrophic lakes and ponds

2. Assessment against IUCN criteria

Criterion A: Reduction in geographic distribution

Criterian A considers reduction in geographic distribution over ANY of the defined time periods for criteria A1, A2a, A2b or A3. For details of time periods and criteria see IUCN Red List of Ecosystems Criteria Summary Sheet_2.2_EN.pdf

Freshwater lakes are widely distributed across the UK although the type and extent varies regionally. In modern times, it is unusual for lakes to be physically lost. The last published round of Article 17 Reporting found the trend in surface area between 2007-2018 was stable for all five corresponding Habitats Directive Annex I habitat types JNCC (2019). In contrast, the number of small waterbodies has risen substantially across in Britain over the past few decades, from an estimate of 425,000 ponds in 1998 to 478,000 ponds in 2007, though includes considerable turnover with around 18,000 ponds being lost and 70,600 ponds being created during the period (Williams et al., 2010).

However, historical losses, especially of small waterbodies, have been substantial. Wood et al. (2003) report on various estimates of pond loss in different parts of the UK between c.1900 to c.1990, which range from 6-90% at a regional scale to 57.5% for England and Wales and 75% for Great Britain; Swan and Oldham (1993) estimated that overall pond loss in Britain since c.1945 was of the order of 38%; and analysis of Countryside Survey results suggested losses of around 1% per annum for the period 1984 to 1990 (although interpretation of these data was hampered by difficulties in distinguishing seasonal ponds from ponds which were permanently lost) (Barr et al., 1994). Larger lakes are likely to have been more resilient. However, the agricultural improvement period of the 18th and 19th centuries was remarkable for the lengths and expense which land managers used to drain lakes, particularly in lower lying more productive areas and near to settlements (Stratigos, 2016). It is also likely that peat-stained (dystrophic) lakes, which are associated with peatland bog habitats, have been lost historically due to peat extraction or agricultural improvement.

Assessment: Vulnerable (VU) A1, A3

Criterion B: Restricted geographic distribution

Criterian B considers restricted geographic distribution indicated by ANY of the time periods for criteria B1, B2 or B3. For details of time periods and criteria see IUCN Red List of Ecosystems Criteria Summary Sheet_2.2_EN.pdf.

Almost all UK freshwater lakes, lochs, pools and ponds fit under this ecosystem type, with the exception of reservoirs, seasonal lakes, a small number of freeze-thaw lakes and one large lake (Lough Neagh, Northern Ireland). Small permanent freshwater lakes cover 2,205 km^2 in the UK (Mountford et al., 2025). The north-west of Scotland and parts of Northern Ireland have the greatest land cover (Maberly et al., 2024). Northern Ireland is 4.42% (though this figure is skewed by Lough Neagh, which is 381km^2 in area and is classified as F2.1 Large permanent freshwater lakes ecosystem) as compared to Scotland 2.05%, Wales 0.41%, and England 0.38%. Lakes are widespread within the UK, with different lake types having different ranges reflecting geology physical and climatic conditions. The range surface area is at least 170,000 km^2 (JNCC, 2019). As with extent, the geographic distribution of UK lakes has largely remained stable in recent times, with the trend in range surface area between 2007-2018 reported as stable for all five corresponding Habitats Directive Annex I habitat types (JNCC, 2019). Although historical loss of ponds has been

substantial (see Criterion A), this has had limited impacts on the range of the ecosystem type at a national scale.

Assessment: Least Concern (LC) Despite substantial historical losses of ponds, this has had limited impacts on the range of this ecosystem type at a national scale.

Criterion C: Environmental degradation

Criterion C considers environmental degradation over ANY of the time periods for criteria C1, C2a, C2b or C3. For details of time periods and criteria see IUCN Red List of Ecosystems Criteria Summary Sheet_2.2_EN.pdf.

The relevant UK environment agencies monitor the ecological status of lakes as a requirement of the Water Framework Directive (WFD). The most recent online figures for this (downloaded 2025) report on the status of 944 lakes using a variety of physical, chemical and biological parameters. The overall classification for each lake is based on the worst parameter. At an aggregate UK level, only 33% of monitored lakes achieved the target of good or better classifications (Scotland 70%, England and Wales 14 and Northern Ireland nil). Habitats Directive Annex I reporting also showed high levels to be in unfavourable condition in 2019 (JNCC 2019), ranging from 25% for H3110 Oligotrophic lakes on sandy plains to 97% for H3150 Natural Eutrophic lakes.

Monitoring focuses on larger lakes and there is little systematic information on the condition of ponds. Combining information gathered at a country level is also complex. However, based on the information available it is likely that there has been >50% environmental degradation over the last 50 years

Nutrient enrichment is an important pressure on UK lakes both from development and agriculture (JNCC, 2019, Maberly et al., 2020), particularly in lowland areas. Phosphorus concentrations in many lakes increased significantly between 1950 and the 1980s due the introduction of phosphorus-based detergents, population growth and increasing use of artificial phosphorus fertilisers. These pass into lakes through sewage effluent (primarily from water industry sewage treatment works) and losses from agricultural land. Septic tanks and package sewage treatment plants are small sources nationally but can be important locally, particularly in rural areas (Environment Agency, 2022). Excessive phosphorus often binds with lake sediments making restoration a time consuming and expensive process.

Historically the pH of acid sensitive lakes has been lowered by atmospheric deposition, which resulted in chronic acidification of runoff into drainage waters and thence lakes (UK Air Pollution Information System, 2025). Deposited compounds of sulphur and nitrogen, in addition to hydrochloric acid, derived predominantly from the burning of fossil fuels, contributed to a progressive loss in buffering capacity of catchment soils and consequent reductions in pH and increases in inorganic aluminium in these waters from around the onset of the industrial revolution until the 1970s-80s. However, over the last decade action to improve emissions means that an increasing number of lakes are now demonstrating changes consistent with strong ecological recovery (Monteith et al., 2022).

Water temperature rises in many Scottish lochs have already been recorded and temperatures are projected to increase further and reach all parts of Scotland by 2040 (May et al. 2022). Climate change will increase the risk of algal blooms developing. Under a future characterised by high intensity farming practices and failure to achieve low greenhouse gas emissions, less than half of Scottish lochs are expected to achieve to Good Ecological Status or higher by 2080 (May et al., 2024). The UK Climate Change Adaptation Manual (Natural England and RSPB, 2019) reports that lakes and ponds are highly sensitive to the

projected effects of climate change, including shifts in temperature and hydrological regimes bringing about changes in the sediment and nutrients delivered to and retained by lakes and ponds. Changes in water temperature associated with climate change are also likely to promote algal blooms.

Assessment: Endangered (EN) C1, C2a Monitoring indicates that a large part of this ecosystem type has been impacted by eutrophication and acid deposition, with only 33% achieving good or better status under the WFD and Habitats Directive. This largely reflects abiotic degradation that has taken place in the last 50 years Modelling suggests further deterioration is likely.

Criterion D. Disruption of biotic processes or interactions

Criterion D considers Disruption of biotic processes or interactions over ANY of the time periods for criteria D1, D2a, D2b or D3. For details of time periods and criteria see IUCN Red List of Ecosystems Criteria Summary Sheet_2.2_EN.pdf

Many lakes in the UK, especially in the lowlands, have been impacted by nutrient enrichment both from development and agriculture (JNCC, 2019; Maberly et al., 2020). Artificial increases to the nutrient status of lakes will affect the organisms living in the lake favouring those more able to utilise the nutrients and competitively disadvantaging others. Nutrient enrichment is likely to promote algal growth, which may result in reduced light penetration shading out other species such as larger plants. In some cases, this may result in a complete change to an algal based system. An increase in the total biomass may affect oxygen concentrations as it is taken up by respiration; either directly or as the material rots down. Changes to oxygen levels in turn may affect nutrient cycling between the water and sediments. Some organisms, which may produce toxic substances, such as cyanobacteria, can also be promoted.

Historic impacts on the pH of acid sensitive lakes from atmospheric deposition (see Criterion C) influenced aquatic biota at all levels of the food chain, from primary producers, such as aquatic algae and macrophytes, to macroinvertebrates, fish and water birds. This led to an overall reduction in species biodiversity as well as functional diversity; caused major declines in yields of salmonid fisheries in some areas; and recued the abundance of several molluscs, amphipod and mayfly taxa (UK Air Pollution Information System, 2025).

Invasive non-native species (INNS) are an increasing problem for UK lakes (JNCC, 2019). The introduction of INNS may lead to a number of adverse impacts, such as the formation of dense stands shading out other plant species and changing the flow of water, effects on oxygen concentrations and the flow of nutrients within lakes. Some species may predate others, such as mussels feeding on algae significantly changing the food web within the lake. Examples of problematic aquatic INNS in the UK include Canadian pondweeds, swamp stonecrop and North American signal crayfish; once established they can cause dramatic impacts and are very expensive and often almost impossible to eradicate (UKTAG, 2013).

Abstraction during dry periods is likely to increase as is water use to support a renewable economy in the shape of pumped storage, hydrogen and heat pumps. The UK Climate Change Adaptation Manual (Natural England and RSPB, 2019) report that lakes and ponds are highly sensitive to the projected effects of climate change. Shifts in temperature and hydrological regimes could affect both aquatic biotic and biological processes. Species reliant on well oxygenated water will potentially have their habitat reduced by increased temperatures; wetter winters and an increase in the frequency of storm events could increase run-off of silt and nutrients, potentially resulting in physical impacts of sediment covering substrates and macrophytes. Predicted increased duration and frequency of

summer drought (Kirkpatrick Baird et al. ,2023) could cause some sites to dry out with consequent effects on the biota, as would saline intrusion at the coast resulting from rising sea levels.

Assessment: Endangered (EN) D1, D2b
A large part of this ecosystem type has been impacted by eutrophication, non-native species and other factors, with only 33% of monitored lakes achieving good or better status (WFD, 2025) and many being in unfavourable favourable condition (JNCC, 2025), reflecting degradation that has taken place in the last 50 years. This ecosystem is also highly vulnerable to current and likely future effects of climate change.

Conservation measures in place

A variety of funding and regulatory measures are in place. All of the UK is covered by River Basin Management Plans (Environment Agency, 2022). They set the legally binding locally specific environmental objectives that underpin water regulation for lakes and planning activities. These are reviewed and updated every 6 years. Land use within catchments is key to conservation and the various UK countries have agri-environmental schemes which set minimum environmental standards and support positive action. Regulations to reduce the impact of nutrient enrichment from development have been introduced including Nutrient Neutrality (Wood 2022). Each UK country also has strategies to promote biodiversity and tackle the climate crisis. The best examples of each lake types are notified for their national or international interest and appropriate protection is in place through the relevant legislation (https://jncc.gov.uk/our-work/uk-protected-areas/). Work is underway to identify alternative funding mechanisms to support conservation or restoration. Engagement is key to tackling in-direct drivers of biodiversity loss and there are a number of initiatives aimed at addressing this. There is a wide variety of guidance on lake management and restoration available online (Ottwell, 2018).

Overall assessment conclusion

Small permanent freshwater lakes in the UK are assessed as being Endangered (EN) based on criteria C1, C2b, D1 and D2b

3. Literature references

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