Arctic charr
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Whitefish *Coregonus lavaretus*, Vendace *Coregonus albula*, and Arctic charr *Salvelinus alpinus* (Linnaeus)

Climate Change Sensitivity:	HIGH	Ability to Manage:	LOW
Non climatic threats:	HIGH	Vulnerability:	HIGH

Summary

Climate change is a threat to whitefish, vendace and Arctic charr in England, and this is exacerbated by other environmental pressures such as increased colonisation of non-native species and nutrient enrichment. Nutrient enrichment can result in deoxygenated conditions in deep water, where the water is coolest, resulting in a contraction of suitable habitat for these species. Climate change is predicted to increase lake water temperatures, and increase sediment loads and nutrient concentrations due to more storms and wetter winters, resulting in increases in run-off from the catchment bringing sediment and nutrients with it, with a resulting loss of spawning habitat.

Restoring naturally functioning lake habitat by limiting inputs of nutrients and sediments and restoring natural hydrological regimes will benefit whitefish, vendace and Arctic charr populations. However, the long-term future of some standing waters as habitat capable of supporting these species is confounded by climate change. Climate change is predicted to exacerbate eutrophication and sediment loads, and increase water temperatures.

In response, every effort should be made to restore natural function to the habitat, but alternative populations may need to be established to ensure the survival of the species within their natural English range. If translocations of these fish species to new water bodies are planned, the indigenous fish populations of the receiving water body must be considered. Whitefish, vendace or Arctic charr should not be translocated to water bodies containing other rare fish species which may suffer either competition or genetic pressures.

The threats posed by non-native species are difficult to control once colonisation has occurred. It is possible that new eradication methods may become available in the future but the prospect of this seems limited. Therefore, it is imperative that biosecurity measures are maintained to reduce the risk of initial colonisation by both non-native and locally non-native species.

Description

These three species of fish are treated together in this account as they are all species restricted to cool, deep lakes in northern Britain, with many of the same threats.

The whitefish *Coregonus lavaretus* is the most widely distributed coregonid in the UK. This geographical distribution is reflected in the species having three long-standing common names in the UK, schelly (or skelly) in England, powan in Scotland and gwyniad in Wales. It is a streamlined but heavily built fish with a typical maximum length of 30-35 cm and weighing up to 400 g. British populations are resident in lakes throughout their lifecycles and require cool water with relatively high dissolved oxygen levels. They typically spend daylight hours in deep water (>20 m) and move into marginal areas at night to feed. Spawning takes place from late December to early February and requires clean gravels around inshore areas at depth <4 m. The fry emerge after 90-100 days, depending on water temperature. Whitefish shoal throughout their lifecycle, with juveniles feeding on zoo-plankton and adults selecting benthic macroinvertebrates.

Whitefish. © Colin W. Bean

Vendace. © Ian J. Winfield

The vendace *Coregonus albula* has an extremely limited distribution in the UK and is considered the UK's rarest fish. It is a streamlined and slender fish with a distinctive leading lower jaw, typically up to 25 cm in length and weighing up to 150 g. British populations are found in oligotrophic or mesotrophic lakes and maintain a shoaling habit throughout their lifecycles. They are considered a glacial relict and require cool water with high oxygen concentrations. During daylight hours, vendace remain close to the lake bed at depths >10 m before rising through the water column at night to feed on zooplankton. Spawning occurs on clean, inshore gravels from late November to mid-December, with fry emerging during the following March and April.

The Arctic charr *Salvelinus alpinus* is thought to be another glacial relict species and in England and Wales is only found in large, deep, cold lakes. However, it has the ability to survive in much more productive systems at other locations. In the UK, even where access to the marine environment is possible, it does not attempt to revert to the anadromous habit seen in other countries. Arctic charr are streamlined and resemble a slender trout, typically reaching 20-25cm in length and weighing up to 170g; however, larger specimens up to 35cm/600g may occur. They tend to occupy offshore habitats as a result of inter-specific competition with other fish species, and come inshore to spawn. Spawning usually takes place from October to December, however 'spring' spawnings between February and March have also been recorded. Clean gravels are required and may be located around lake margins, inlet streams/rivers and occasionally deeper water areas within the lake.

Ecology and Distribution

The whitefish is widespread in northern Europe; however, in the U.K. it is restricted to a number of sites in the Lake District (Brothers Water, Haweswater, Red Tarn, and Ullswater), Loch Eck and Loch Lomond in Scotland, and Llyn Tegid in Wales. The species shows considerable genetic and morphological variation between sites. Attempts have been made to establish refuge populations of whitefish in Small Water and Blea Water in the Lake District. Egg incubation was very successful at both sites and in late 1997 surveys recorded young whitefish at Small Water, but not at Blea Water. In subsequent years, surveys at Small Water have recorded an established whitefish population, and anglers fly fishing for brown trout have occasionally reported catching adult whitefish at both locations. Similar reintroductions of whitefish have been undertaken at Carron Reservoir and Sloy Pond in Scotland and to Llyn Arenig Fawr in Wales.

Vendace occurs in lakes across north-west Europe (northern Scandinavia and north-west Russia to the north, north Bavaria to the south, English Lake District to the west and western Russia to the east). In England, vendace is found in mesotrophic Bassenthwaite Lake and oligotrophic Derwent Water. These lakes are connected by the River Derwent. As well as the natural difference in trophic status, Derwent Water is slightly deeper and has a much smaller catchment than Bassenthwaite Lake. While Derwent Water has consistently supported vendace, none were found in Bassenthwaite Lake from 2001-2013 despite specific searches. Since 2013 a limited number of individuals have been found in Bassenthwaite Lake, suggesting the range may not have declined as previously suspected, and may be recovering, although it is premature to be confident about this.

A very high variability is reported for all morphological characters between the many populations referred to as *C. albula*. The Derwent Water and Bassenthwaite Lake populations are distinct from *C. albula* populations from the eastern Baltic basin, but it is similar to some populations from the western Baltic.

Due to concerns for the conservation of this species, attempts have been made to establish refuge populations using fish from both Derwent Water and Bassenthwaite Lake. This has included attempts to establish populations at Sprinkling Tarn in the Lake District. There have been no reports of success from the site, but this may be due to a lack of sampling effort. However, progeny from fish collected from Bassenthwaite Lake have successfully been established in Loch Skeen, Scotland. Although it is still too early to state with confidence, 2016 surveys of the Loch Skeen vendace population appeared to indicate a strong population.

Arctic charr *Salvelinus alpinus*, **male swimming over the gravels, Ennerdale Water, Cumbria, November.**

The Arctic charr is a cold-loving, salmonid fish which is distributed throughout the temperate and subarctic regions of the northern hemisphere. It is an anadromous species in the northern part of its distribution, but in the southern part, including Britain and Ireland, it is non-migratory and confined to fresh waters. Natural populations in the south of its distribution are believed to have been derived from anadromous stocks which dispersed at the end of the last ice age but were then isolated in a variety of lakes as the climate warmed. All stocks in Britain and Ireland are found in lakes, even though many are located with Atlantic salmon *Salmo salar* and sea trout *Salmo trutta*, indicating that migration to and from the sea is physically possible in many cases. In Britain and Ireland, most populations of Arctic charr have been isolated from each other for thousands of years and have developed a variety of genetic and morphological variations. The differences between some populations are so great that many were originally described as distinct species. This species is now suffering a recent and widespread decline in the UK.

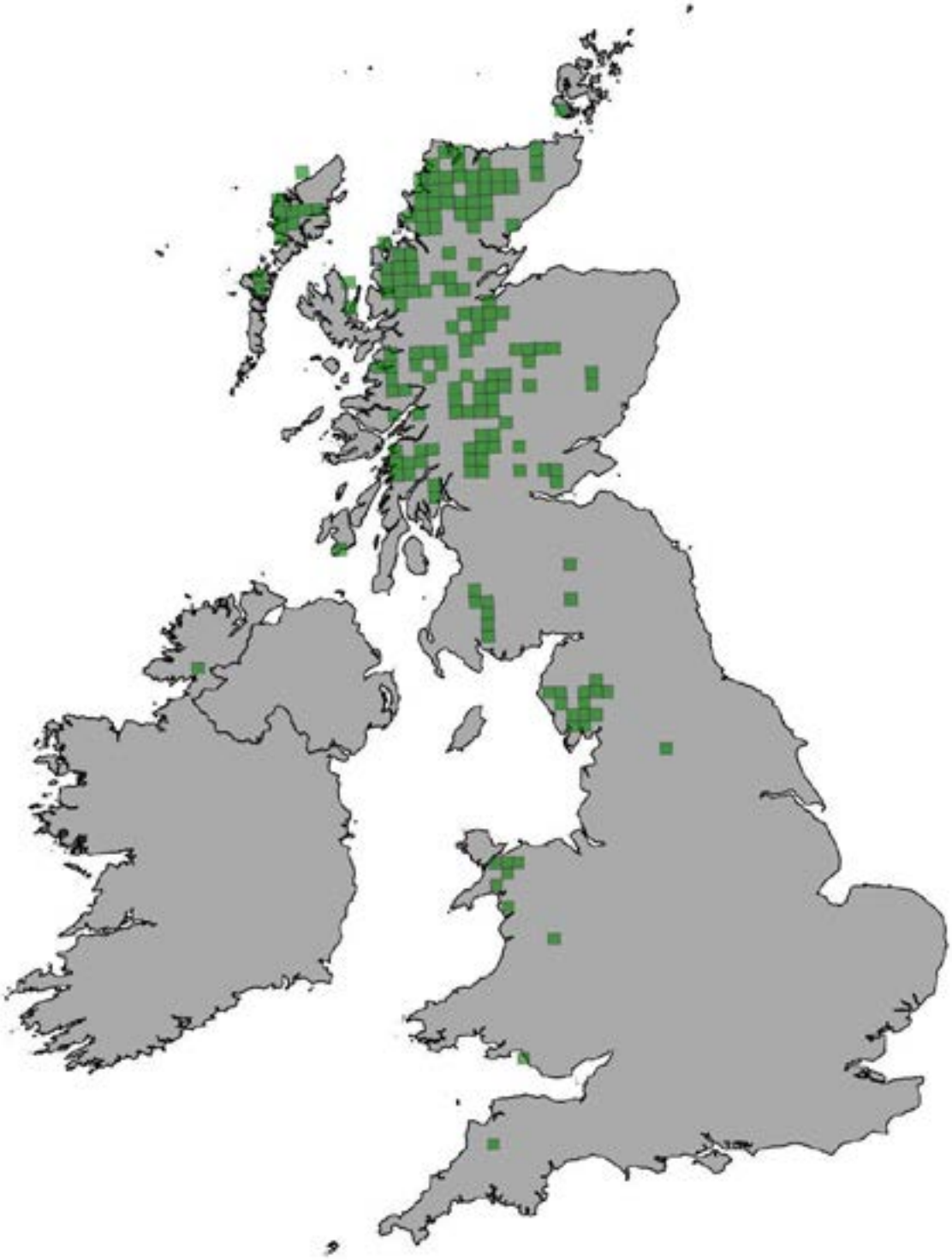
Presence of whitefish records, 10km², NBN Atlas

The National Biodiversity Network presence records for whitefish are shown on the map above (10km grid scale). (See **terms and conditions**, see Appendix 1 for the list of datasets included)

Presence of vendace records, 10km², NBN Atlas

The National Biodiversity Network presence records for vendace are shown on the map above (10km grid scale). (See **terms and conditions**, see Appendix 1 for the list of datasets included)

Presence of Arctic charr records, 10km², NBN Atlas



The National Biodiversity Network presence records for Arctic charr are shown on the map above (10km grid scale). (See **terms and conditions**, see Appendix 1 for the list of datasets included)

Climate Change Impacts

Climate change is considered to be a threat to all three species in England, and this is exacerbated by other environmental pressures such as increased colonisation of non-native species and nutrient enrichment. Nutrient enrichment can result in deoxygenated conditions in deep water, where the water is coolest, resulting in a contraction of suitable habitat for these species. Climate change is predicted to increase lake water temperatures, and increased sediment loads and nutrient concentrations are expected due to more storms and wetter winters, resulting in increasing sediment and nutrient run-off from the surrounding catchment. This could also result in a loss of spawning habitat.

The results of modelling to assess the long-term suitability of Bassenthwaite Lake as a habitat for vendace suggest that its probability of long-term viability is extremely low (Elliott & Bell 2011). Derwent Water is more likely to support vendace as it is expected to be more resilient to the impacts of climate change than Bassenthwaite Lake. This is because being naturally oligotrophic, Derwent Water is further from the nutrient concentration limits that vendace can tolerate, has a smaller catchment (despite a similar lake size) to deliver nutrients, and is slightly deeper.

A similar investigation found that 10 of the 11 Arctic charr populations studied along the latitudinal distribution gradient of this species in the UK showed significant recent declines in abundance, with only the most northerly population surveyed (Loch of Girlsta in the extreme north of Scotland) exhibiting a significant increase. Declines observed in the Arctic charr populations of Scotland, England and Wales are likely to have resulted from a number of environmental factors, some of which may be unrelated to climate change. However, the hypothesis that the observed widespread decline of Arctic charr in the UK can be attributed at least in part to climate change is supported.

Please read this case study alongside the relevant habitat sheets.

Adaptation Options

Restoring naturally functioning lake habitat by limiting inputs of nutrients and sediments and restoring natural hydrological regimes will benefit whitefish, vendace and Arctic charr populations. However, the long-term future of some standing waters as habitat capable of supporting these species is threatened by climate change. As a consequence, alternative populations may need to be established to ensure the survival of these species within their natural English range.

This is particularly relevant to the vendace, whose current range is thought to be limited to two lakes in the Lake District, and where assisted migration, perhaps to a higher altitude, may be possible. However, even if areas of suitable habitat capable of supporting a sustainable vendace population could be identified there is no guarantee of success. Of the four sites where attempts have been made to establish a new vendace population in the UK, only one is known to be successful.

The threats posed by non-native species are difficult to control once colonisation has occurred. Removing introduced fish species is not currently considered technically feasible, as any methods which could control the invasive species would also impact other fish species, including whitefish, vendace and Arctic charr. It is possible that new eradication methods may become available in the future but the options for this seem limited. Therefore, it is imperative that biosecurity measures are maintained to reduce the risk of initial colonisation by both non-native and locally non-native species.

Although charr will feed on zooplankton, they will also feed on many other sources of food such as macroinvertebrates and therefore may not compete directly and aggressively with vendace. Whitefish may feed exclusively on zooplankton or more generally on macroinvertebrates, indicating that competition with vendace may be either intense or more limited. The feeding preference of whitefish may determine the intensity of the competition with vendace. This was demonstrated in a Norwegian study by Bøhn, & Amundsen (2001). They found damage to an indigenous zooplankton feeding whitefish population due to an introduction of vendace into a water body where vendace were not previously resident. However, in a similar water body containing a macroinvertebrate feeding whitefish population, the whitefish population remained largely unaffected by the vendace introduction.

Due to the genetic closeness and plasticity of the coregonids, hybridisation may be technically possible. However, under field conditions spawning triggers such as water temperature are likely to separate the different species.

When these factors are taken into consideration, the precautionary principle dictates that whitefish, vendace or Arctic charr should not be translocated to water bodies containing other rare fish species which may suffer either competition or genetic pressures.

Relevant Countryside Stewardship options

To address the in-lake and wider catchment issues impacting negatively on coregonid and Arctic charr populations in England, Countryside Stewardship may be used to fund measures to restore the naturally functioning habitat required for sustainable fish populations. Countryside Stewardship includes a number of options intended to reduce run-off and siltation of spawning habitat, improve water quality, and reduce water temperatures within tributaries. Relevant options to consider include:

SW1 ***4 - 6 m buffer strip on cultivated land***

SW2 ***4 - 6 m buffer strip on intensive grassland***

SW4 ***12 - 24m watercourse buffer strip on cultivated land***

SW5 ***Enhanced management of maize crops***

SW6 ***Winter cover crops***

SW7 ***Arable reversion to grassland with low fertiliser input***

SW8 ***Management of intensive grassland adjacent to a watercourse***

SW9 ***Seasonal livestock removal on intensive grassland***

SW10 ***Seasonal livestock removal on grassland in SDAs next to streams, rivers and lakes***

SW11 ***Riparian management strip***

SW12 ***Making space for water***

UP3 ***Management of moorland***

UP5 ***Moorland re-wetting supplement***

Case Study

Due to the rapidly declining vendace population at Bassenthwaite Lake during the early 1990's, efforts were made to establish new vendace refuge populations in both Scotland and England. Care was taken to avoid the creation of new conservation problems at the recipient site and to maintain the genetic integrity of the refuge populations. The former requirement required extensive searches for, and assessments of, potential sites against a wide range of criteria, including the characteristics of the receiving fish community. The latter requirement meant avoiding the use of hatcheries completely or limiting their use to eyed-egg or swim-up larvae stages, to guard against any inadvertent but significant genetic selection.

Derwent Water. © Dave Ottewell

Progeny from the Bassenthwaite Lake and Derwent Water populations were kept separate and egg collections were made a number of times over the course of the spawning season and in more than one calendar year. Following the above approach, a total of 35 female vendace were stripped for eggs at Bassenthwaite Lake in 1997 and 1999 and a total of approximately 65,000 eggs and larvae were introduced during the following springs to Loch Skeen in Dumfries and Galloway, south-west Scotland. Following the introduction, anglers fishing for brown trout at Loch Skeen reported unintentionally catching vendace at this locality. An initial survey in 2003, demonstrated that a reproducing vendace population had become established in the loch. A more comprehensive survey was carried out in 2007 by a combination of survey gill netting and hydroacoustics. The survey identified a vendace population density estimated at 231.7 fish per hectare, with individuals ranging in age from one to six years. A follow up survey in 2016 again found a healthy vendace population, clearly indicating that a viable refuge population had become successfully established.

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