



Definition of Favourable Conservation Status for Vendace *Coregonus albula*

Defining Favourable Conservation Status Project

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About the DFCS project

Natural England's Defining Favourable Conservation Status (DFCS) project is defining the minimum threshold at which habitats and species in England can be considered to be thriving. Our FCS definitions are based on ecological evidence and the expertise of specialists.

We are doing this so we can say what good looks like and to set our aspiration for species and habitats in England, which will inform decision making and actions to achieve and sustain thriving wildlife.

We are publishing FCS definitions so that you, our partners and decision-makers can do your bit for nature, better.

As we publish more of our work, the format of our definitions may evolve, however the content will remain largely the same.

This definition has been prepared using current data and evidence. It represents Natural England's view of FCS based on the best available information at the time of production.

The document *Defining Favourable Conservation Status in England* describes the methodology used by Natural England to define FCS.

1. Introduction

1.1 Favourable Conservation Status Definition for Vendace in England

This document sets out Natural England's view on Favourable Conservation Status (FCS) for **vendace** in England. Favourable conservation status is defined in terms of three parameters: natural range and distribution; population; extent and quality of habitat necessary for long-term maintenance of populations.

Section 2 provides the summary definition of favourable conservation status in England. Section 3 covers contextual information, Section 4 the units used and Section 5 describes the evidence considered when defining favourable conservation status for each of the three parameters. Section 6 sets out the conclusions on favourable values for each of the three parameters. Annex 1 lists the references.

This document does not include any action planning, or describe actions, to achieve or maintain favourable conservation status. These will be presented separately, for example within strategy documents.

2. Summary Favourable Conservation Status Definition

2.1 Favourable Conservation Status in England

Vendace (*Coregonus albula*) is a rare and declining species naturally found in only two lakes in England. It requires lakes with silt-free gravelly littoral habitat, high water quality, cold temperatures and relatively high oxygen concentrations throughout the water column. It is considered a glacial relict species and is threatened by deteriorating habitat and climate change.

Vendace range, population size and habitat distribution would be considered favourable if:

1. Their range comprises Bassenthwaite Lake and Derwent Water within the Lake District.
2. Two sustainable populations are located within Bassenthwaite Lake and Derwent Water. The number of vendace per population should have an abundance of greater than 7,000 post-juvenile fish within Bassenthwaite Lake and 5,000 post-juvenile fish within Derwent Water in three out of four years. Numbers within each lake must not fall below 1,000 post-juvenile individuals.
3. The two water bodies (lakes) within the Lake District should be naturally functioning, conducive to the completion of the vendace life cycle and the production of naturally spawned future year classes. The minimum area of the functional aquatic habitat is 1,053 ha.

2.2 Confidence

FCS parameter	Favourable status	Confidence
Range and distribution	Bassenthwaite Lake and Derwent Water	High
Population	Greater than 7,000 post-juvenile fish within Bassenthwaite Lake and 5,000 post-juvenile fish within Derwent Water in the previous 3 out of 4 years. Numbers within each lake must not fall below 1,000 post-juvenile individuals.	Low
Habitat	Functional aquatic habitat across the whole of Bassenthwaite Lake and Derwent Water – 1,053 ha.	High

3. Species definition and ecosystem context

3.1 Species definition

S2492 Vendace (*Coregonus albula*)

The species of vendace found in England and Scotland has historically been considered to be *Coregonus albula*. However, Kottelat & Freyhof (2007) split this species and classified vendace from England and Scotland as *Coregonus vandesius*; a species endemic to the UK. There is very little statistical support for the morphological separation of British and European coregonids into separate species. The general consensus amongst UK fisheries scientists is that the trait variation observed within the *C. albula* group is more likely to be a result of one highly variable species, with variability resulting from plasticity, founder effects and adaption (Etheridge and others 2012), therefore vendace should continue to be classified as *C. albula*. The current management in the UK effectively treats each native coregonid population as a separate 'evolutionarily significant unit' (ESU). This enables populations to be conserved and resources allocated depending on phenotypic, ecological and genetic distinctiveness allowing the conservation of UK coregonids to reflect site specific variability independently of current taxonomic treatment.

Sources: Davies and others 2004; Etheridge and others 2012; Kottelat & Freyhof 2007; Maitland & Campbell 1992.

3.2 Species status

Red list status for vendace (*Coregonus albula*):

An assessment of the risk of extinction.

- Global: Least Concern. Source: Freyhof 2011
- European: Least Concern. Source: Freyhof & Brooks 2011
- GB: Endangered. Source: Freyhof & Kottelat 2008.

Conservation status for vendace (*Coregonus albula*):

- Protected under Schedule 5 of the Wildlife and Countryside Act 1981.
- Listed under Annex 5 of the Habitats Directive
- Species of Principal Importance under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006
- Listed under Annex III of the Bern Convention
- Reported as 'Unfavourable – bad' in the fourth report by the United Kingdom under Article 17 of the Habitats Directive

3.3 Life cycle

Vendace is considered to be an opportunistic species with high fecundity, high mortality rates and a relatively short generation time. Vendace has a life span of approximately 5-6 years and matures at 2-3 years of age.

The species spawns in the late autumn (Nov-Dec), producing many small eggs.

The eggs hatch in the spring and in the first month or two after hatching the larvae and juveniles are found close to the lake shore. They feed entirely on zooplankton and recruitment success may be dependent on good timing between hatching and the spring plankton bloom.

Later in its lifecycle the vendace moves to deeper water feeding extensively on zooplankton; the availability of this prey may determine population size in the absence of other habitat stresses.

During daytime vendace forms shoals and move to the deeper parts of the lake, probably to avoid predation.

3.4 Supporting habitat

In England vendace occur in one oligotrophic and one mesotrophic lake, Derwent Water and Bassenthwaite Lake respectively. The species is considered a glacial relict species requiring cold temperatures and relatively high oxygen concentrations.

Vendace spawn on coarse substrates lacking overlying fine sediments, usually in water less than 5 m deep. For the rest of its lifecycle vendace inhabits deeper water during the day, which can be significantly cooler than surface waters when the lake is stratified, coming to the surface at night. The general habitat requirements are given in the "2015 common standards protocol for population monitoring of charr, whitefish and vendace" and defined by the "2015 common standards protocol for lake habitats".

These can be summarised as follows:

- Presence of a natural shoreline.
- Presence of natural and characteristic substrate to the lake.
- Stable nutrient levels - Site specific targets are promoted, but in their absence type based targets should be used (Annual mean Total Phosphate target for Derwent Water is $<8 \mu\text{g l}^{-1}$ and for Bassenthwaite Lake is $<10 \mu\text{g l}^{-1}$). Type based targets are $< 10 \mu\text{g l}^{-1}$ in deep oligotrophic lakes and $<15\mu\text{g l}^{-1}$ in deep mesotrophic lakes. Annual mean Total Nitrogen concentration $<1.5\text{mg/l}$.
- pH 5.5 - 7.0 for oligotrophic lakes and 6.5 - 8.0 for mesotrophic lakes.
- Acid neutralizing capacity $> 40\mu\text{eq L}^{-1}$
- Water quality at good chemical status (as defined by WFD).
- In summer dissolved oxygen levels must remain $>9.0\text{mg/l}$ as a mean throughout the water column when unstratified or as a mean below the thermocline if stratified.
- Clarity of water sufficient to allow plant colonisation at or to at least a depth of 2.5 metres or the maximum depth of the waterbody if this is less than 2.5m.
- Chlorophyll concentrations to levels which comply with 'high' ecological status (as defined by WFD).
- Natural hydrological regime and sediment load.

No non-native, or locally non-native, species likely to cause impairment of coregonid populations should be present, for example ruffe (*Gymnocephalus cernua*) and New Zealand pygmyweed (*Crassula helmsii*).

Sources: Common standards protocol for lake habitats 2015; Common standards protocol for population monitoring of charr, whitefish and vendace 2015; Maitland & Campbell 1992; Davies and others 2004; Winfield and others 2011; Winfield, Fletcher & James 2004; Winfield, Fletcher & James 2016.

3.5 Ecosystem context

Vendace (*C. albula*) occur in lakes across north-west Europe from northern Scandinavia and north-west Russia to north Bavaria in the south and from the English Lake District in the west to western Russia in the east.

Vendace can be found across a range of trophic states and their abundance will potentially be greater where lake productivity is higher. Their requirement for relatively high oxygen concentrations will restrict them from the most productive lakes of sufficient depth as these will have lower oxygen concentrations at depth. Vendace are not part of a recognised species assemblage but may coexist within a salmonid-percid-esocid assemblage typical of northern oligotrophic or mesotrophic lakes.

Whilst the species is mostly a lake species some populations occur in the Baltic Sea and migrate to freshwater to spawn. Vendace in England do not migrate to the sea and generally undertake their lifecycle within a single lake.

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 similar to some populations from the western Baltic. There are also significant genetic differences between the two English populations. However, the high level of connectivity between these sites, particularly during flood events, makes it probable that some gene flow between the two populations will have once occurred and may do so again.

Only the two English ESUs are now found within Great Britain, the two Scottish populations having become extinct. There have been attempts to establish conservation refuge populations of the two English ESUs, mostly in Scotland, through translocation of eggs, fry and adults. There is an established population at Loch Skeen in Scotland originating from Bassenthwaite Lake and a further small population at Loch Earn. There is also a small population originating from Derwent Water at Daer Reservoir but there is currently no evidence that two further translocations from Derwent Water, to Loch Valley in Scotland and Sprinkling Tarn in Cumbria, have been successful.

Sources: Davies and others 2004; Elliot and Bell 2010; Maitland & Campbell 1992; Winfield and others 2011; Winfield, Fletcher & James 2004; Winfield, Fletcher & James 2016.

4. Units

4.1 Natural range and distribution
Water bodies in the Lake District.
4.2 Population
The metric to be used is the total number of vendace individuals per waterbody, including a range of age classes present (to reflect geographic origin of the population and conserve the genetic diversity).
4.3 Habitat for the species
The metric to be used is ha of waterbody surface area.

5. Evidence

5.1 Current situation

Natural range and distribution

In England vendace is found in Bassenthwaite Lake and Derwent Water, these lakes being connected by the River Derwent.

Derwent Water has consistently supported vendace. No vendace were found in Bassenthwaite Lake from 2001-2012 despite targeted searches. Since 2013, a small number of individuals have been found suggesting the species' gross range has been maintained.

Population

Surveys for vendace do not give precise estimates of population size, although they provide an indication of trends over time and, combined with assessments of age classes, provide an indication of the long-term viability of the populations. However, the large inter-annual fluctuations in vendace population size also have to be considered when assessing population size and viability. To accommodate these fluctuations, surveys must be carried out annually as a minimum level of effort.

Hydroacoustic surveys are used to provide fish numbers for the lakes. Gill netting is then used to determine the fish assemblage and percentage composition of species within the lakes. These are single events because they lead to death of the fish caught. Vendace densities are then extrapolated from this data. The population sizes of post-juvenile vendace are calculated by multiplying post-juvenile vendace population densities by the surface area of the parts of Bassenthwaite Lake and Derwent Water where water depth exceeds approximately 10 m, that is 85.2 ha (Ramsbottom, 1976) and 65.0 ha (CEH unpublished data), respectively.

2017 survey data gave the following approximate population assessments for total post-juvenile vendace numbers:

Bassenthwaite Lake

1 vendace caught by gill netting. In conjunction with hydroacoustic survey data fish density was estimated at 37.1 post-juvenile fish/ha.

Estimated vendace population size of 3,160 post-juvenile fish

Lower 95% confidence limit of 1,812 fish

Upper 95% confidence limit of 5,512 fish

The mean percentage contribution by small (assumed to be 0+/1+ age class) individuals to the total vendace population was 89%, with lower and upper 95% confidence limits of 78% and 99%, respectively.

Derwent Water

12 vendace caught by gill netting. In conjunction with hydroacoustic survey data fish density was estimated at 69.5 post-juvenile fish/ha.

Estimated vendace population size of 4,517 post-juvenile fish

Lower 95% confidence limit of 1,550 fish

Upper 95% confidence limit of 13,162 fish

The mean percentage contribution by small (assumed to be 0+/1+ age class) individuals to the total vendace population was 87%, with lower and upper 95% confidence limits of 75% and 98%, respectively.

The current population density of vendace in Derwent Water is low in a European context but is within the range reported for non-eutrophic lakes elsewhere (Winfield 2011). Despite the failure to record vendace in Bassenthwaite Lake between 2001 and 2012 (resulting in the species being considered locally extinct), a single under-yearling vendace was recorded in 2013, followed by two adult vendace in 2014 and a single adult in 2015. It is possible that vendace have survived in Bassenthwaite Lake since 2000 at a very low abundance (below the limit of detection), though the fish may have arrived in Bassenthwaite Lake by moving down the River Derwent from Derwent Water. It may be that this 're-colonisation' happened some years ago and the observed individuals are the locally spawned offspring of the original colonists. Such immigration may have occurred during the extensive flooding experienced at both lakes and the connecting River Derwent in November 2009 (Winfield and others 2010), though at least one of the two adults recorded in 2014 was too old to have colonised at this time. DNA analysis of the single under-yearling vendace of 2013 was undertaken. The results were inconclusive but suggestive of a Derwent Water origin.

Habitat for the species

In England vendace is found in mesotrophic Bassenthwaite Lake and oligotrophic Derwent Water. As well as the natural difference in trophic status, Derwent Water is slightly deeper and has a much smaller catchment than Bassenthwaite Lake.

Vendace exploit both marginal and deep water areas of standing waters, therefore, when assessing the current habitat area utilised by vendace in both Bassenthwaite Lake and Derwent Water it is vital to include the whole lake surface area as this provides the functional habitat for all life stages of the fish.

Bassenthwaite Lake = 524 ha

Derwent Water = 529 ha

Sources: Davies and others 2004; Maitland & Campbell 1992; Rosch & Schmid 1996; UK Lakes Portal <https://eip.ceh.ac.uk/apps/lakes/>; Winfield *pers comm* 2016; Winfield and others 2011; Winfield, Fletcher & James 2004; Winfield, Fletcher & James 2016a; Winfield, Fletcher & James 2016b.

Confidence: High

5.2 Historical variation in the above parameters

Vendace populations have historically been recorded from only four UK lakes. Two of these populations, in Castle Loch and Mill Loch in Dumfriesshire in Scotland, have been extinct since the 1910s and 1970s respectively, leaving two remaining natural populations in Bassenthwaite Lake and Derwent Water.

Functional aquatic habitat in Derwent Water and Bassenthwaite Lake has been reduced by increasing eutrophication, sedimentation, climate change and the introduction of invasive species. This has had a detrimental impact on populations.

Invasive species include the fish species roach (*Rutilus rutilus*), ruffe (*Gymnocephalus cernuus*) and dace (*Leuciscus leuciscus*) which have been introduced to Bassenthwaite Lake with roach first recorded as present in 1986, ruffe in 1991 and dace in 1996. All of these fish species have more recently been introduced to Derwent Water (first recorded roach 1991, dace 1999 and ruffe 2001), giving cause for considerable concern over possible food competition and egg predation in that lake.

Natural range and distribution

Vendace populations in England have only ever been known from Bassenthwaite Lake and Derwent Water. Furthermore, there is no palaeo or other evidence to suggest that English *C. albula* once occurred in other lakes. The present-day distribution is considered as an example of a glacial relict population, persisting where there is a suitable combination of shallow water gravels in a sufficiently deep waterbody.

Population

Prior to the 1990s no quantitative studies of vendace populations were undertaken in either Derwent Water or Bassenthwaite Lake, though qualitative assessments were made using gill nets. From 1995 onwards a more detailed survey regime has been followed using a combination of gill nets, hydroacoustics and, latterly, photographic evidence via underwater, remotely-operated vehicles, allowing more quantitative data to be obtained. The limitations of deploying these methods across large areas of deep lakes, to locate a fast-moving fish, which may be either dispersed or shoaled dependent on season, must be considered when interpreting population estimates. The use of standardised techniques and gear allows a small level of confidence when determining whether the population is increasing or decreasing, however, extreme caution should be applied to data used to estimate total numbers of individuals or biomass.

Derwent Water supported a sustainable vendace population from the 1960s to the early 2000s. Vendace have been consistently recorded from 1998 onwards and have continued to be the most numerous fish in deep water (>20m) within the lake.

Bassenthwaite Lake has historically supported a sustainable vendace population, but the population deteriorated from a stable, viable condition in the 1960s and early 1970s to a potentially unsustainably low population density by the late 1980s. There was further decline during the 1990s and the species was not recorded in the lake between 2001 and 2012. 1-2 individuals were recorded in 2013, 2014 and 2015.

Studies indicated that vendace growth rates in Bassenthwaite Lake had not decreased, suggesting that feeding or food availability was not limiting the population. The population reduction is therefore likely to be related to recruitment failure resulting from sedimentation and the growth of *Crassula helmsii* damaging vendace spawning habitat.

If the original Bassenthwaite population is extinct in the lake, and the Bassenthwaite population contained genotypes not shared with the Derwent Water population, the only potential location

of these genotypes is now Loch Skeen, where there is now a substantial vendace population at the site derived from Bassenthwaite.

Habitat for the species

Vendace use the entire waterbody during different phases of their lifecycle, so it is impossible to define the effects of in-lake habitat losses quantitatively. Functional aquatic habitat must therefore encompass the attributes of the waterbody as a whole. These include shallow/marginal gravel zones for spawning and an oxygenated deep water or hypolimnion for refuge.

Sources: *Maitland & Campbell 1992; Davies and others 2004; Winfield and others 2011; Winfield, Fletcher & James 2004; Winfield, Fletcher & James 2016a; Rosch & Schmid 1996; Winfield, Fletcher & James 2016b; Winfield, l. pers. comm. 2017*

5.3 Future maintenance of biological diversity and variation of the species

There are several pressures currently affecting vendace populations or which have the potential to impact on populations in the future.

Spawning grounds are vulnerable to being smothered by silt, when sediment loads are high, or the growth of invasive plants such as New Zealand pygmyweed (*Crassula helmsii*). Drawdown associated with water abstraction can lead to spawning grounds being inaccessible to fish or being exposed when in use, resulting in the desiccation of eggs. Therefore, natural sediment loads, a lack of non-native species such as New Zealand pygmyweed and a natural hydrological regime are necessary for successful recruitment.

Nutrient enrichment can result in decreased oxygen concentrations, particularly in the deep water of lakes when they stratify, resulting in a contraction of suitable habitat. Nutrient enrichment is thought to have caused the extinction of this species at the two Scottish sites. Acidification is also thought to impact vendace and is believed to explain why the establishment of one of the refuge sites (in Scotland) for this species failed (Winfield 2011). However, acidification is not considered to be a current stress on either of the English populations.

Climate change is considered to be a threat to vendace in England especially in combination with other threats such as nutrient enrichment. 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 increased run-off from the catchment bringing sediment and nutrients with it. The long-term suitability of Bassenthwaite Lake as a habitat for vendace has been assessed using two models (Elliot & Bell 2010). A phytoplankton model that provided temperature and phytoplankton biomass outputs has been used to drive a second model of changes in lake oxygen concentrations. Both temperature and oxygen concentrations were used to define the available habitat for adult vendace, using 18 °C as an upper temperature limit and 2 mg/l as a lower dissolved oxygen threshold. The outputs of a regional climate model suggest the future climate will cause a mean increase of 2°C, or more, in water temperature, little change in overall phytoplankton biomass and a 10% decline in oxygen concentration. The available habitat volume is thus predicted to decline greatly under the future climate scenarios, with all of the 20 years simulated having periods of zero habitat volume for 7, or more, consecutive days, primarily caused by high temperature. These results suggest that the long-term viability of Bassenthwaite as a habitat for vendace is extremely low.

Derwent Water is naturally more likely to be resilient to the impacts of climate change than Bassenthwaite Lake. This is because, being naturally oligotrophic, its waters are further from the nutrient concentration limits that vendace can tolerate: it has a smaller catchment (despite being of a similar lake size) to deliver nutrients and is slightly deeper.

Natural range and distribution

The species natural range in England is Bassenthwaite Lake and Derwent Water which must be maintained for favourable status.

Population

There is no information available to indicate what a favourable population of vendace should be within Bassenthwaite Lake and Derwent Water. In order to conserve the genetic diversity of the species in England (and hence achieve favourable conservation status), the number of vendace per population should be increased.

Derwent Water has supported a vendace population from the 1960s but the population density is low in a European context. To provide greater resilience to potential threats, an arbitrary increase of 10% in the population density for Derwent Water is proposed for favourable status. This would give a favourable fish density of 76.5 post-juvenile fish/ha and a favourable population size of 4,972 post-juvenile fish.

Applying the same favourable fish density to Bassenthwaite Lake gives a proposed favourable population size of 6,518 post-juvenile fish.

The above figures are rounded to 5,000 and 7,000 post-juvenile fish to reflect the large potential errors in the data. To accommodate natural fluctuations in population sizes, the favourable population levels should be reached in three out of four years. Numbers within both lakes must not fall below a minimum of 1,000 post-juvenile individuals. This represents the lower range of numbers estimated for Derwent Water which has remained self-sustaining.

Habitat for the species

For the long-term survival of the species, Bassenthwaite Lake and Derwent Water, covering an area of at least 1,053 ha, must contain functional aquatic habitat to sustain healthy vendace populations. As vendace require both deep and shallow areas of standing waters to complete their lifecycle, the whole of the lake habitat must be maintained or restored to maintain healthy vendace populations.

Sources: *Maitland & Campbell 1992; Davies and others 2004; Winfield and others 2011; Winfield, Fletcher & James 2004; Winfield, Fletcher & James 2016a; Rosch & Schmid 1996; Winfield, Fletcher & James 2016b, Winfield, Fletcher & James 2018.*

Confidence: High

5.4 Potential for restoration

Vendace populations could be restored via a combination of habitat restoration measures, particularly within Bassenthwaite Lake, and in the surrounding catchment.

Restoring Bassenthwaite Lake's abiotic conditions to a naturally functioning state is technically feasible, by dealing with activities in the catchment that result in higher sediment loads and nutrient enrichment. Whether this will be sufficient to enable vendace to persist in the light of warmer waters and increased nutrient and sediment loads due to climate change is unclear.

Removing non-native fish recently introduced to the lake is not currently considered technically feasible as any methods which could control the invasive species would also impact other fish species, including vendace. Removal would risk deleterious effects on the habitat as a whole by physical damage and destabilisation of food webs. It is possible that new eradication methods may become available in the future but the options for this seem limited.

There are currently no methods available to remove or control New Zealand pygmyweed, although biocontrol options are currently being investigated.

The re-introduction of fish from Loch Skeen (of Bassenthwaite origin) is an option following habitat restoration. However, out of the 5 sites where attempts have been made to establish a new vendace population in the UK only one is known to be successful. The success of any such attempt is therefore not guaranteed.

Derwent Water is thought to provide sufficient habitat of a suitable quality to support vendace. The habitat may be improved by catchment-based measures to limit nutrient and sediment inputs to the lake. The benefits of reduced siltation and smothering of spawning areas may assist recruitment success and mitigate for climate change and invasive species pressures.

If a habitat led approach was used to restore vendace populations in both Derwent Water and Bassenthwaite Lake, an increase in the population to favourable levels would not be expected to have a negative impact on other habitats or species.

Sources: *Bøhn & Amundsen 2001; Maitland & Campbell 1992; Davies and others 2004; Winfield and others 2011; Winfield, Fletcher & James 2004; Winfield, Fletcher & James 2016a; Rosch & Schmid 1996; Winfield, Fletcher & James 2016b*

Confidence: High

6. Conclusions

6.1 Favourable range and distribution
Present within Derwent Water and Bassenthwaite Lake in Cumbria.
6.2 Favourable population
<p>For the species population to be at favourable conservation status, two sustainable populations located within Bassenthwaite Lake and Derwent Water are required. The number of vendace per population should have an abundance of greater than 7,000 post-juvenile fish within Bassenthwaite Lake and 5,000 post-juvenile fish within Derwent Water in three out of four years.</p> <p>Numbers within both lakes must not fall below 1,000 post-juvenile individuals as this has been demonstrated to allow a continued, viable population. This figure is derived from data for vendace numbers collected between 1995 and 2017 and may represent the lowest levels possible for the continuation of the species at these locations.</p> <p>The populations should be confirmed to be present and spawning successfully. Juvenile fish (0+ & 1+) should comprise at least 70% of the total vendace population. Age classes should not be missing and post-juveniles would normally be dominated by 3+ & 4+ individuals. >4+ fish should be present within the population.</p> <p>Populations can be monitored by a combination of netting and hydroacoustic studies. Both methods are required as hydroacoustic methods cannot accurately define the species composition or age class in a waterbody and netting will not accurately define fish biomass in a large water body such as Bassenthwaite Lake or Derwent Water. It is likely that gill netting would be required to survey vendace populations. Sampling effort must be carefully controlled as gill netting will result in the mortality of any fish captured. An annual survey frequency would be sufficient to detect long-term changes in vendace populations in the two water bodies. These methods are defined in the common standards protocol for population monitoring of Arctic charr, whitefish and vendace, contained within the CSM guidance for Freshwater Fauna. Environmental DNA techniques have the potential to play an increasing role in vendace monitoring in the future.</p>
6.3 Favourable supporting habitat
For the habitat area to be at FCS, fully sustainable vendace populations must be present in both Bassenthwaite Lake and Derwent Water covering an area of at least 1,053 ha.

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Further information

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Vendace
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