Atlantic salmon
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Atlantic salmon *Salmo salar* (Linnaeus)

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

Summary

The Atlantic salmon *Salmo salar* is native to the UK. It has an anadromous[15] lifecycle, and requires good water quality and river morphology, together with an unimpeded migration route to and from the sea. Although the Atlantic salmon occupies a large range, populations have been greatly impacted by poor water quality, engineered barriers to migration and exploitation. Climate change now represents an increasing threat to Atlantic salmon populations, potentially resulting in a northerly shift of the population and the loss of salmon from rivers in the south of England. Habitat restoration is required to both reduce increases in water temperature and re-open areas of catchment previously lost to engineered barriers to mitigate for any losses of habitat in the southern areas of the salmon range.

15 Anadromous fish migrate from the sea to fresh water to spawn

Description

The Atlantic salmon *Salmo salar* is the only native salmon to the UK. It is an anadromous species, with the freshwater phase requiring cool, swift-flowing streams and rivers (although it can also occur in lakes), with good water quality, clean gravels, physical habitat complexity that provides shallow water and flow refuges for juveniles, deeper water for adults, and an unimpeded river corridor for adult and smolt migrations.

Spawning takes place in shallow, gravelly areas where the water flows swiftly. The juvenile 'parr' spread out into other parts of the river. After a period of 1-6 years, the young salmon migrate downstream to the sea as 'smolts'. If they survive at sea, most salmon return to spawn in the river of their birth after 1-3 years. A small percentage of individuals do not return to their natal river and instead choose a different river in which to spawn.

Adults returning to freshwater vary greatly in size. Atlantic salmon are normally found in the range of 40 – 70cm in length and 1 – 5kg in weight, however, they can achieve much larger sizes with the current UK rod caught record standing at 29kg.

Ecology and Distribution

Historically, the species was widely distributed in all countries whose rivers enter the North Atlantic. In the UK, Atlantic salmon are widely distributed in suitable river systems not affected by poor water quality or barriers to upstream migration throughout Scotland, Wales, northern and southwestern England, together with a number of southern English chalk streams. The main distribution gap in England is from rivers entering the sea between the Yorkshire Esk and the River Itchen in Hampshire. Recent improvements in water quality have allowed the species to return to some rivers from which they have been absent for most of the last century, including several previously grossly polluted waterways, such as the River Mersey and River Trent catchments.

Salmon rivers vary considerably in their ecological and hydrological characteristics and in the life-cycle strategies adopted by the salmon within them. There are particularly strong contrasts between southern and northern rivers. The UK's varied climate, geology and terrain means that high diversity can be found within many large rivers. The cool and wet climate in the north, often with harder, more resistant rocks and steeper gradients, result in rivers that are sparsely vegetated, nutrient-poor and prone to spate flows in response to heavy rain or snow-melt. As a result, salmon may take up to three years to reach the smolt stage and migrate to sea. In the south, rivers flow across lower gradient terrain and softer rocks, in a warmer, drier climate. Here, salmon often grow sufficiently quickly to smolt as yearlings.

The Atlantic salmon is a keystone species in freshwater ecosystems, allowing the transport of nutrients from the marine environment to often nutrient poor upland rivers. This transfer of allochthonous[16] nutrients may help sustain the complex food webs and other species present in these headwater areas.

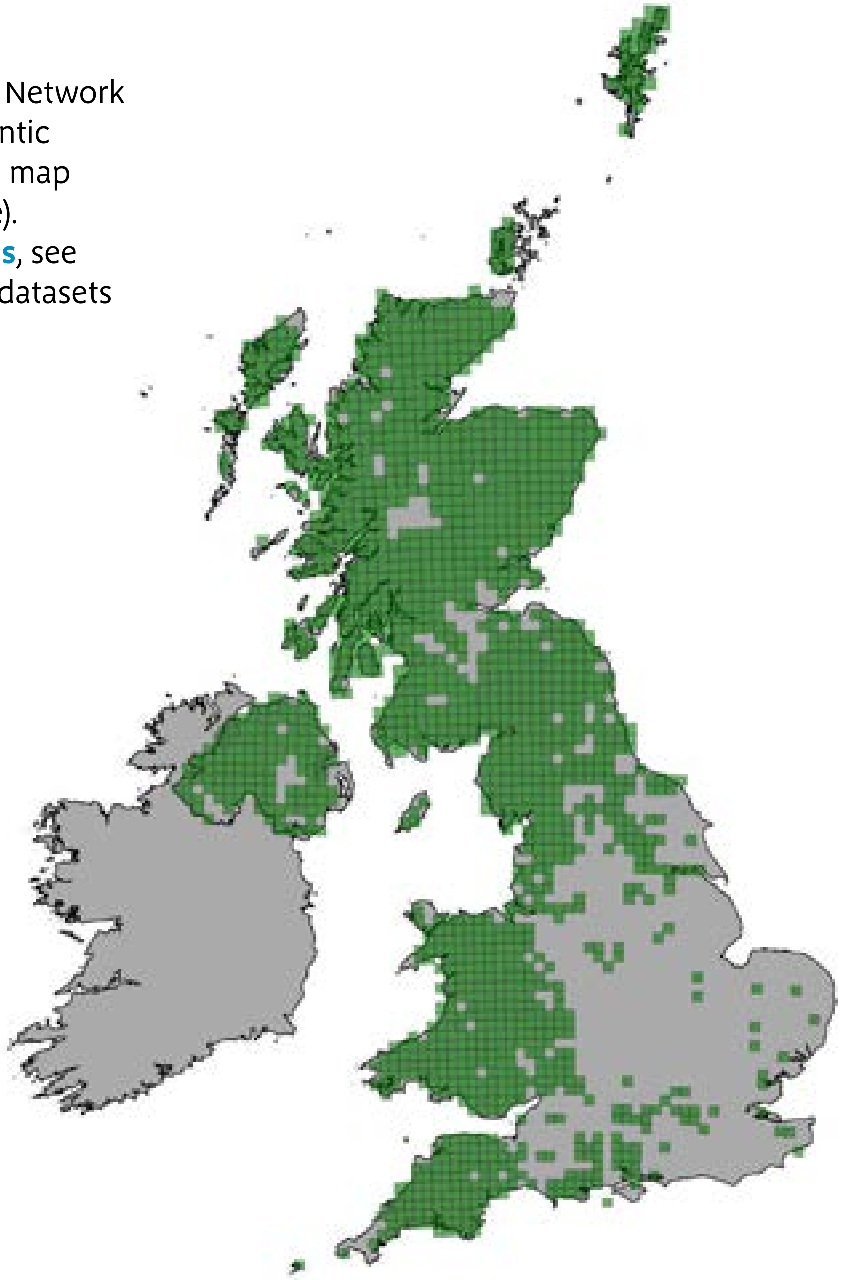
16 not formed in the region where found

Together with brown or sea trout, the Atlantic salmon forms a vital role in the life history of the freshwater pearl mussel *Margaritifera margaritifera*. The larvae, glochidia, are inhaled by juvenile Atlantic salmon and brown or sea trout. Glochidia then attach to the gills of the juvenile fish, encyst, live and grow in the hyper-oxygenated environment until the following spring when they drop off. Once widespread and abundant in areas of England and Wales, most former populations are virtually extinct or with very little active recruitment. Without healthy, sustainable populations of Atlantic salmon and trout to act as hosts for the glochidia, the remaining pearl mussel populations will continue to decline.

The UK's central location within the Atlantic salmon range, the diverse range of habitat offered by the rivers around the extensive island coastline and its proximity to known marine feeding grounds highlights the ecological importance of English rivers for the survival of the Atlantic salmon and other associated freshwater species.

Presence of Atlar

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



Climate Change Impacts

The recent distribution of Atlantic salmon has been restricted by anthropogenic effects, particularly engineered barriers to migration, deterioration in water quality, and the combined impacts of climate change. Consequently, the Atlantic salmon has declined or become locally extinct in many of the larger rivers.

Climate projections suggest that precipitation will tend to increase in the winter and decrease in summer. Wetter winters may result in more frequent and more extreme spring floods, and milder winters could lead to higher winter water temperatures. Hatching of eggs will be accelerated in the southern portion of the salmon's range, and juveniles will need to start feeding earlier in spring. It is likely that food organisms will be available, as they will also develop more rapidly at higher water temperatures. However, altered flood regimes may present a harsher environment for juvenile salmon.

Growth conditions in northern rivers are likely to improve, and so will the production of salmon smolts. In contrast, rivers in the southern part of the distribution range are likely to present salmon juveniles with warmer water at a lower run-off, which may reduce productivity. Altered flow regimes are likely to influence the timing of smolt migration and adult return. Warming of the freshwater and coastal marine environment is highly synchronous, and amplification of climatic process such as the North Atlantic Oscillation may combine to affect both the survival and growth of Atlantic salmon, leading to a northern shift in range.

Increased water temperatures associated with climate change may be particularly pronounced on the southern edge of the English Atlantic salmon range. If the expected northward movement of the thermal niche of anadromous salmonids occurs, decreased production and population extinction in the southern part of the range may result in a loss of salmon from southern chalk streams draining to the south coast.

Please read this case study alongside the relevant habitat sheets.

Adaptation Options

Improvements in water quality due to reductions in both diffuse and point source pollution, combined with the removal of engineered barriers to migration will continue to open up new areas of river catchments in England. Functional freshwater habitat is vital to maximise juvenile production. When considering options for improving fish passage, the best solution generally is total removal of the obstruction, as the geomorphological benefits gained by removal may enhance spawning gravel quality, increase habitat heterogeneity and increase food production for fry and parr.

Tree planting alongside headwater streams and rivers may provide a sufficient cooling effect (Woodland Trust, 2016) to stop water temperatures causing direct physiological stress for adults and/or juveniles, or secondary effects such as food shortages or initiating migratory avoidance responses. In certain areas, water blending from impoundments may also be regulated in such a manner as to provide both sufficient flow and suitable water temperatures for salmon migration. Exploitation controls such as net limitation orders, fishery buyouts and catch and release schemes may further reduce fish mortality.

These factors will assist in the maintenance of Atlantic salmon populations in England, however, they may not fully compensate for marine mortality and the effects of climate change on both the marine and freshwater environment. It appears likely that, although the available functional freshwater habitat suitable for salmon may increase in England, the overall population numbers may continue to fall in many areas, particularly in southern England. Although it may ultimately not be technically feasible to prevent a decline in salmon stock from southern areas, all feasible climate change adaptation methods should be implemented on southern salmon rivers to delay the loss of the species from these areas, while restoration of northern rivers should continue to open up historic habitat from which salmon have been excluded by human activity.

One potential mitigation option which should be discouraged is the removal of natural barriers, which would allow access to new areas of a catchment from which migratory species have been excluded for a long time. Under these circumstances, the integrity of the existing upstream species community should be maintained.

Relevant Countryside Stewardship options

To address the in-river and wider catchment issues impacting negatively on Atlantic salmon populations in England, Countryside Stewardship may be used to fund measures to restore the naturally functioning freshwater habitat required for sustainable salmon 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 rivers. 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

In 2012, Eden Rivers Trust, and project partners the Environment Agency and Natural England, began planning a river restoration project on the River Lyvennet, a tributary of the River Eden, at Barnskew in Cumbria. A 2km section of the River Lyvennet and the Howe Beck, an associated tributary, had been historically straightened and dredged for land management purposes. Bed material was predominantly boulder and cobble, with riparian land use a mixture of rough pasture, silage and commercial non-native forestry.

Prior to restoration, the River Lyvennet was known to contain Atlantic salmon, brown trout, bullhead, and native crayfish. However, habitat was often suboptimal for these species. The straightened section offered a poor range of habitats and flow types, with limited floodplain connectivity due to engineered boulder bank revetment. Riparian habitat was also poor with heavily grazed rough pasture and conifer plantation.

The project focused on re-meandering the river by reconnecting it to a pre-selected and excavated paleo channel. Channel selection was undertaken using LIDAR imaging. The restoration process benefited from using the remnant channel as stream bed material was readily available, which increased the speed of recovery and reduced project costs. The process increased stream length by more than 20% and re-established the natural meander pattern, slope and cross section.

The project has resulted in the restoration of natural stream processes and increased habitat heterogeneity, in both the channel and riparian areas. Although erosion has been exacerbated in some areas due to a lack of bankside vegetation and the active nature of the channel, it is expected to stabilise rapidly as deeper-rooted tree and other plant species become established. Following completion of the re-meandering, Atlantic salmon have been seen spawning in the restored river section. This demonstrates the importance of high quality gravels and spawning habitat being made available, and the willingness of salmon to exploit these new resources.

References and further reading

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