AQUACULTURE

05 PRODUCTIVE

What, why and where?

Aquaculture produces Scotland’s most valuable food export. It involves the farming or culturing of fish, molluscs, crustaceans or algae. The industry in Scotland is dominated by farming of Atlantic salmon but also has significant rainbow trout and mussel production. It is also important because of its capacity to produce food rich in omega-3 oils that help to promote health. Although much of the production is exported, aquaculture also makes an important contribution to food security.

Scotland is one of the three largest producers of farmed Atlantic salmon in the world along with Norway and Chile, and the largest in the EU. 144,000 tonnes were produced in 2009. Rainbow trout (2,620t), brown trout (157t), halibut (69t) and some Arctic charr are also produced. Cod production in 2009 was negligible compared with 2008 when 2,620t was produced. This change was because of the closure of the major production company.

Shellfish production was dominated by blue mussels in 2009 (7,180t). This was an increase of about 36% since 2006. Pacific oysters (2,911,000 shells) and Native oysters (490,000 shells), King Pacific oysters (2,911,000 shells) and Queen (168,000 shells) scallops have also been cultured. All statistics are from the Scottish Fish Farms and Shellfish Farms, Annual Production Surveys 2009(1)(2).

Aquaculture has been the fastest-growing food production sector in the world, with an average worldwide growth rate of 6-8% per year since the millennium. Global aquaculture has increased by a third since 2000, and currently provides around half of the world’s seafood for human consumption(3).

Atlantic salmon production and turnover (2005-2009)

Source: Marine Scotland(1)

Other fin-fish species production and turnover (2005-2009)

Source: Marine Scotland(3)

Mussel and other shellfish – production and turnover (2005-2009)

Source: Marine Scotland(3)

Other shellfish, by species, production and turnover (2005-2009)

Source: Marine Scotland(3)

Contribution to the economy

Aquaculture is a growing and increasingly important industry, helping to underpin sustainable economic growth in rural and coastal communities in the Highlands & Islands. It has a production value (turnover) worth around £427M per year to the Scottish economy, at farm gate prices in 2009. This was composed of about £412M Atlantic salmon, £6M rainbow and brown trout and £0.5M halibut, with £7M mussels, £1.4M other shellfish. Farmed salmon exports are valued at £285M annually. Exports from fish and aquaculture are Scotland’s largest food export.

Key export markets for Scottish salmon include major European countries such as France, Belgium, Netherlands and Luxembourg. The USA became the number one export market for Scottish farmed salmon in 2009.

The provision of jobs in remote and rural areas is a key benefit. Salmon production supports about 874 full-time and 963 part-time jobs. Trout and other finfish production and processing support about 134 full-time and 183 part-time jobs with shellfish supporting about 169 full-time and 345 part-time jobs.(1)(2)

A survey of the Scottish Salmon Producers’ Organisation members indicates that employees stayed an average of eight years against a UK average for length of service of 5.6 years. 13% of staff were migrant workers.

Production growth in value terms has averaged 4.6% per annum over the period 2000-2009. The salmon sector in particular is now expanding again after several years of contraction, partly in response to the production gap left by the recent collapse in Chilean salmon production, and partly in response to the opening up of new, and strong growth in existing, markets.

Pressures and impacts on Scotland’s socio-economics

Positive

- Salmon provides significant food exports
- Employment in remote and rural communities
- Knowledge transfer from university to industry
- Providing healthy food and food security

Negative

- Potentially restricting sea bed use by other users
- Infrastructure may have a visual impact on coastal locations

Source: Based on OP2 PESC Feeder Report section 3.1.6(4) and UK Marine Policy Statement(5)

Source: Based on CP2 PSEG Feeder Report section 3.1.6(4) and UK Marine Policy Statement(5)
Aquaculture produces Scotland’s most valuable farmed product, Atlantic salmon, worth around £427M per year to the Scottish islands. It has a production value (turnover) of £285M annually. Other farmed fish include rainbow trout and mussels, which contribute around £183M and £50M, respectively. The production and turnover of shellfish is not available, but it is estimated that they contribute about £134M to the Scottish economy.

The growth in aquaculture production has been substantial. Since the millennium, global production has increased by a third, with an average worldwide growth rate of 6-8% per year. Scotland is one of the three largest producers of farmed Atlantic salmon in the world along with Norway and Chile, and is the largest producer of farmed rainbow trout in the UK. Aquaculture is a growing and increasingly sustainable economic growth in rural and coastal communities.

However, the expansion of the aquaculture sector has also raised concerns about potential environmental impacts. For example, infrastructure may have a visual impact on coastal locations and other users, and there are concerns about the impact of fish farm waste on local ecosystems and water quality. Additionally, there is a perception that fish farm closures could lead to job losses, although this has not been supported by data indicating the number of jobs that have been affected.

The Scottish Government has highlighted the importance of supporting and promoting sustainable aquaculture development, including through investment in research and development and the provision of support for the aquaculture industry. The Scottish Government has also developed a range of policies and initiatives to support the growth of the aquaculture sector, including through the provision of funding for research and development, the development of new markets, and the provision of support for the growth of the aquaculture sector in rural and coastal areas.

In conclusion, the growth of the aquaculture sector in Scotland has been substantial, with a focus on producing Atlantic salmon, rainbow trout, and mussels. However, there are concerns about the potential environmental impacts of aquaculture, and the Scottish Government is working to support sustainable aquaculture development through investment and policy initiatives.
Unimpacted seabed in the vicinity of a well managed fish farm: brittle stars, common sea urchin, kelp and shell debris present

Pressures and impacts on the environment

Pressure theme: Climate change and physical pressures
Pressure: Local water flow rate and wave exposure changes
Impact: Site infrastructure (e.g. pens and floats) has the potential to alter tidal currents and wave conditions.

Pressure theme: Pollution and other chemical pressures
Pressure: Synthetic compound contamination
Impact: The dispersion of chemicals (from treatments, spills, food and faecal matter) has the potential to be toxic to benthic species.

Pressure theme: Organic enrichment
Impact: Deposition of particulate waste (faecal material and uneaten food) beneath cages can result in de-oxygenation of sediments. Discharges of chemicals can be toxic to benthic species.

Pressure theme: Other physical pressures
Pressure: Litter
Impact: Litter, such as broken nets, plastic pipes and metals, impact on marine species through ingestion, entanglement and smothering.

Pressure theme: Habitat changes
Pressure: Excretory products and decaying food release ammonia and salts of nitrate and phosphate. This can contribute to eutrophication and possibly to Harmful Algae Blooms.

Pressure theme: Biological pressures
Pressure: Sustainability of fish feed
Impact: Feeding using wild-caught fish from a lower trophic level may deplete wild stocks. UK industry accounts for 4% of total world-wide fish-oil consumption.

Pressure: Introduction or spread of non-indigenous species and interaction with wild species.
Impact: Escapes interbreeding with wild populations resulting in losses of genetic variability, including loss of naturally selected adaptations. Some mariculture species can cause habitat modification and trophic competition with indigenous species. Cages provide potential substrate for non-native species such as caprellid shrimps and colonial sea-squirts (e.g. Didemnum).

Pressure: Reduction in plankton levels
Impact: Overstocking of shellfish could lead to reduction in the standing stock of phytoplankton.

Pressure: Increased numbers of sea lice
Impact: Infection of wild salmonids by sea lice from farmed fish.

Pressure: Introduction of microbial pathogens (disease)
Impact: Parasites and diseases are part of the natural biology and functioning of ecosystems. Disease can move in both directions between farmed and wild fish.

Pressure: Settlement of cultivated species outside sites
Impact: Shellfish larvae can overspill into the surrounding environment, creating new habitat and biomass for others e.g. waterbirds.

Pressure: Management of other species that impact on aquaculture
Impact: For example, taking or killing of seals to protect salmon stocks and prevent damage of aquaculture cages.

Source: Based on CP2 PSEG Feeder Report Table 3.8(4) and UK Marine Policy Statement(5)

Forward Look

The immediate prospects for Scottish aquaculture are good. The salmon industry is thriving due to the worldwide effect on demand of the collapse in Chilean production and the opening up of new markets. A recent Institute of Aquaculture report(6) suggests that the prospects for mussel farming are good, in some part due to a decline in Dutch mussel production. Scotland is well positioned to contribute to continued growth in the EU, in line with the EU Aquaculture Strategy.

The global demand for seafood, driven by such factors as the need for protein for an expanding population and the need to replace land-based sources suffering from climate change, is likely to increase demand for Scottish production. The salmon industry has identified a significant opportunity for growth in the next five years. In the 2009 European Fisheries Fund awards, grants to the mussel sector were made which could alone lead to a further increase of more than 2,000 tonnes of production.

The stated desire of one company to move to off-shore or exposed salmon farms may remove the main spatial constraint on the industry, and could herald the next stage of aquaculture development. Potential sites could be over twice as large as existing sites and each would therefore represent a significant increase in the value of the Scottish industry.

Given the interest in macro-algae as a basis for biofuel production and other non-food uses over the last five years, and the established Scottish history of macro-algal harvesting, research is underway to assess international progress in this field to inform possible development of this sector.

The proportion of fish meal and fish oil from capture fisheries in farmed fish diets is starting to decline as alternative ingredients are substituted. Most, but not all, of this comes from capture fisheries from stocks primarily from the NE Atlantic and SW Pacific which are considered to be fished at sustainable levels, although there are uncertainties over the sustainability of some. Scottish aquaculture uses about 4% of this global resource.
What, why, where?
Fishing provides a source of fresh, nutritious food and supports remote rural communities around Scotland’s coast. There are also strong export markets for Scottish fish.

Most of the fish stocks of interest to the Scottish sea fisheries industry span international boundaries and are often caught in mixed fisheries. This can lead to complicated interactions between regulations applied by different countries to individual species.

Managing stocks
For stocks which occur exclusively in the waters of European Union (EU) Member States, the amount of fish caught is regulated by the EU through the Common Fisheries Policy (CFP). For stocks that move between EU and third country waters, the Commission negotiates fishing opportunities with the relevant country or countries. The key third country agreements for Scotland are with Norway (for the North Sea) and Iceland and the Faroes (for pelagic stocks).

In international waters to the west of Scotland, beyond British Fisheries Limits, management of stocks is agreed through the North East Atlantic Fisheries Commission (NEAFC). Between EU Member States Total Allowable Catches (TACs) are allocated according to historic fishing patterns. For joint stocks shared between EU and non-EU countries, allocations are shared between the signatories to the agreement according to the principles laid down by the United Nations Convention on the Law of the Sea (UNCLOS).

Decisions are based on scientific advice from the International Council for the Exploration of the Sea (ICES).

Fishing activity changes to reflect scientific advice, the location of fish and the need for possible closure of areas. Up-to-date information on temporary closures can be found on the Scottish Government website.[]

Data collection
All landings are reported according to the regions in which fish were caught (known as ICES squares). This catch information, together with independent fish surveys, form the basis of the data used to assess the amount of fish that can be caught each year. Larger fishing vessels (15m and over) are fitted with a Vessel Monitoring System (VMS), which allows for more detailed information about the location of fishing activity. Smaller vessels are currently not covered by VMS. Landings data from Scottish vessels are published annually in the Scottish Sea Fisheries Statistics.

Scottish fishing fleet
The Scottish fishing fleet can be split into four broad sectors:

- The pelagic fleet which mainly targets herring and mackerel. It is comprised of a relatively small number of large, profitable vessels.

- The demersal or whitefish fleet targets bottom-dwelling fish in two types of fishery: the roundfish fishery in the North Sea and west of Scotland (which comprises cod, haddock, whiting and saithe) and the species found in the deeper water to the north and west of Scotland.

- The mixed demersal and shellfish fleet are the boats from the whitefish fleet which move between whitefish and Nephrops fisheries (prawn, or langoustine, fisheries).

- The shellfish fleet is those vessels that specialise in shellfish such as scallops and Nephrops. They tend to operate within the inshore waters of the west coast, east coast, Borders, Fife, and south west of Scotland. A high proportion of these vessels are under 10m.

The following species make up the bulk of Scottish catches: mackerel and herring (pelagic); haddock, cod and monkfish (whitefish); Scottish langoustine (Nephrops); crabs and scallops (other shellfish).

Fishing ports
The largest part of the commercial fishing industry operates from ports located in the north-east of Scotland, especially around Peterhead and Fraserburgh. This region has both the greatest volume and value of landings, as well as a greater concentration of local fish processors and an important level of local economic dependence on fishing activity (see Economic Analysis Section). Shetland has a fishing sector on a similar scale to that of the north-east and provides important landing facilities for many of Europe’s pelagic fleets. The north coast and Orkney support a small local industry and also have some busy fishing ports, notably Scrabster and Wick.

In the north-west, Lochinver and Kinlochbervie are important ports for access to the fishing ground to the north-west of Scotland and often receive landings from fishing vessels from other EU countries that operate to the west of Scotland. The western coast still supports numerous small ports and harbours, the largest of which are Ullapool, Oban, Portree and Mallaig. Elsewhere, in the south-east and south-west, numerous small ports continue to support a small local industry based on small vessels fishing inshore grounds, mostly for shellfish. Most of the fishing industry on the west coast is now dependent upon shellfish.

Fishing effort has decreased significantly since 2000 due to continuing restrictions on fishing activity in order to promote stock recovery.

To obtain a fishing licence for the first time, an entitlement has to be secured from a current licence holder. An entitlement becomes available when a licence is no longer attached to an active fishing vessel or it may be transferred alongside the purchase of a fishing vessel.

Contribution to the economy
In 2009 366,569 tonnes of fish with a first sale value of £416 million were landed from Scottish waters. This figure includes all fish caught by UK vessels in Scottish waters and fish caught by non-UK vessels in Scottish waters and landed into the UK. Catches by non-UK vessels landing outside the UK are not available below the level of ICES sub-divisions so cannot be attributed to the ICES squares (as shown in the maps) or totalled into Scottish sea areas, as shown on the map opposite.

Pressure and impacts on Scotland’s socio-economics
Positive
- Long and significant fishing history has large impact on the culture, due to Scotland’s proximity to productive fishing grounds
- Employment (full and part time), often in remote communities, for catching and processing sectors
- High quality locally sourced, nutritious source of protein
- Role in achieving food security
- Exports contribute to international trade

Negative
- Fishing often competes for sea space with other marine economic activities
- Most fish caught in Scottish waters is exported while most fish eaten within Scotland is imported

Source: Based on CP2 PPEG Feeder Report section 3.5.6 and UK Marine Policy Statement.

Scottish Sea Fishes Statistics. 2009
Sustainability of fish feed

Feeding using wild-caught fish from a sustainable source can be a viable option to reduce the impact of aquaculture on the environment.

Excretory products and decaying food can be toxic to benthic species.

Impact:

Pressure:

- Introduction of microbial pathogens
- Colonization of cultivated species
- Increased numbers of sea lice
- Reduction in plankton levels

Local water flow rate and wave conditions can be affected by mariculture practices.

Site infrastructure (e.g., pens and floats)

Potential sites identified for Scottish production. The salmon industry has identified a significant opportunity for expansion in the next five years. In the 2009 European Fisheries Fund awards, grants to develop marine aquaculture are good. The salmon industry started to decline as alternative ingredients became available.

Nephrops fisheries (prawn, or Norway lobsters) and the species found in the North Sea and west of Scotland (which comprises cod, haddock, whiting and saithe) and the species found in the Celtic Sea and Moray Firth.

Tonnage (live weight tonnes) and value of catches 2005-2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Value (£ millions)</th>
<th>Live weight ('000 tonnes)</th>
<th>Value and weight of catches 2005-2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>78,000</td>
<td>£27,889,000</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>73,289</td>
<td>£24,500</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>60,000</td>
<td>£15,000</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>50,000</td>
<td>£10,000</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>40,000</td>
<td>£5,000</td>
<td></td>
</tr>
</tbody>
</table>

Sources:
- CP2 PSEG Feeder Report section 3.5.6
- Scottish Sea Fisheries Statistics, 2009
- Government website
- Law of the Sea (UNCLOS)
Effort of selected regulated gears (in KwDays) in West of Scotland, Scottish vessels over 10m

Source: Scottish Sea Fisheries Statistics, 2009(2)

Note: these two gears are the main mobile gears used by the Scottish fleet

Whitefish
Nephrops

% catch by value for all Scottish waters

Source: Marine Scotland

Under 10m fishing vessel

Prawn tails

© SNH

© SNH
Average effort (kw Days) in Scotland’s seas by all UK vessels (all lengths) 2005-2009

Source: Marine Scotland
Note: no kw Days effort data for non-UK vessels. Rectangles where no effort by UK vessels was recorded are not coloured.

Average value of landings from Scotland’s seas 2005-2009

Source: Marine Scotland
Note: excludes landings data for non-UK vessels landing outside the UK. Rectangles where no catch was recorded are not coloured.
Forward look

The fisheries sector is currently, and is likely to remain, important to many rural areas in Scotland. Fisheries management will continue to focus on bringing down rates of exploitation to Maximum Sustainable Yield (MSY) targets. There is increasing downward pressure on the levels of exploitation. Past over-exploitation of some stocks means that current stocks are depleted and require time to become re-established. It is likely that pressure to reduce discarding will increase, though without allowing overall catch to rise. Management measures will need to reduce bycatch and discards, and be more responsive to changing patterns of fish migration and movement.

Currently, Scottish Ministers will not license any expansion in Scotland’s existing fishing capacity. So no new fishing licences (which are needed to fish commercially for sea fish and land a catch for profit; and also stipulate authorised seas area, species and gear) are issued.

Reform of the CFP in 2012 may result in significant changes to the aims and objectives of the policy with a consequent effect on management. The outcome of this reform process cannot be predicted with any certainty but one possibility is that EU fisheries may be managed on a regional basis and fishermen may be more directly involved in the management of the fish stocks.
**SALMON AND SEA TROUT FISHING**

### What, why and where?

Scotland is a stronghold of wild salmon *Salmo salar* and sea trout (the anadromous form of brown trout) *Salmo trutta*. These fish spend several years in rivers, migrate to sea then return as adults to spawn. Marine migrations in salmon are generally more extensive than those of sea trout. Salmon usually spawn once whereas sea trout may spawn several times.

All salmon fishing and sea trout fishing rights in Scotland, including in the sea, are private, heritable titles, which may be held separately from any land. They fall into one of three broad categories.

**Fixed engine fisheries** are restricted to the coast and must be set outside estuary limits. Bag-nets, stake nets and jumper nets are different forms of fishing gear used across Scottish fisheries, with pole nets and haaf nets restricted to the Solway Firth area.

**Net and cobe fisheries** generally operate in estuaries and the lower reaches of rivers.

**Rod and line fisheries** comprise angling activities which generally take place within rivers and above tidal limits. This method currently accounts for the majority of salmon and sea trout catches.

Catch data are combined geographically into 109 Districts and further aggregated into 11 Regions. Some Regions are not fully covered by the data survey at present. Districts correspond either to a single river catchment together with the adjacent coast or to groups of neighbouring river catchments and their associated coastline. Catch statistics have been collected since 1952 and are published annually as topic sheets by Marine Scotland(1). Neither the Districts nor the Regions correspond with the sea areas being used in this Atlas.

**Net fisheries**

Reported annual catches of wild salmon and grilse by fixed engine and net and coble both illustrate the decline of the Scottish net fishing industry over the last 50 years. This decline in catches has been mirrored in annual catches of sea trout. Reporting schemes and pollution.

Employment tends to be seasonal and varies particularly in the net fisheries. The numbers fluctuate with July having the most employment in the net fisheries.

### Contribution to the economy

The overall value of these fisheries is difficult to calculate and has many dimensions. Figures for GVA and numbers employed cannot be obtained from the ABI, as it does not separately assess this activity. Rod fishermen cannot sell their catch but contribute to the general tourist economy (spending on accommodation and associated expenditure) and pay tax. Rod and line fisheries continue to operate on many of Scotland’s rivers. In contrast to the net fisheries, rod catches of salmon have increased slightly over the past 50 years. This is likely, at least in part, to be due to the decline in the netting industry.

Since 1994, the proportion of the total rod and line catch accounted for by catch and release of both salmon and sea trout have shown a general increase.

### Reported annual catches, number of salmon (2005 – 2009)

<table>
<thead>
<tr>
<th>Year</th>
<th>Fixed engine catch</th>
<th>Net and coble catch</th>
<th>Rod and line (caught and retained)</th>
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### Reported annual catches, number of sea trout (2005 – 2009)

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**Source:** Marine Scotland(2)

### Pressures and impacts on the environment

**Pressure theme:** Biological pressures

**Pressure:** Removal of marine fauna and flora

**Impact:** Potential for reduction in fish stock species through fishing.

### Jobs (in July) associated with salmon and sea trout fishing

- Net and coble 117 (2005) and 75 (2009)
- Fixed engine 180 (2005) and 150 (2009)

Data for the whole of Scotland not routinely collected for rod and line.

**Source:** Marine Scotland

### Pressures and impacts on Scotland’s socio-economics

**Positive**
- Tourism (for rod fisheries)
- Local employment
- Iconic food product of Scotland (net fisheries only, rods not permitted to sell fish)

**Negative**
- Possible competition with other amenity users

**Source:** Based on CP2 PSEG Feeder Report section 3.6.6(3) and UK Marine Policy Statement(4)

### Forward look

The sector’s future very much depends on the status of stocks together with the general economic situation. New coastal salmon nets are rarely opened and the main trend has been for declining catch and fishing effort in the net fisheries. Marine Scotland Science will continue to monitor the status of both stocks and fisheries.

© Marine Scotland

### Contribution to the economy

The overall value of these fisheries is difficult to calculate and has many dimensions. Figures for GVA and numbers employed cannot be obtained from the ABI, as it does not separately assess this activity. Rod fishermen cannot sell their catch but contribute to the general tourist economy (spending on accommodation and associated expenditure) and pay for the fishing experience. It has been estimated that anglers fishing in Scotland for salmon and sea trout spend some £73M annually(2). Net and coble and fixed engine fisheries can sell their catch.

Employment tends to be seasonal particularly in the net fisheries. The numbers fluctuate with July having the most employment in the net fisheries.

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**Source:** Marine Scotland(1)
Scottish salmon rivers and salmon and sea trout net fisheries reporting catches in 2009

- Net and coble 2009
- Fixed engine 2009
- Main salmon rivers
- Regions

Reported annual catches of wild salmon and grilse (by fixed engine and net and coble) (1952-2009)

Reported annual catches of sea trout (by fixed engine and net and coble) (1952-2009)

Reported annual catches of wild salmon and grilse by rod and line (1952-2009)

Reported annual catches of sea trout by rod and line (1952-2009)

Source: Marine Scotland(1)