

## Information

### Farmed Fish

Fish can be farmed in numerous different ways - here are some of the main methods that are used to farm around 50% your seafood. Farmed seafood can be split into three different sections:

- Finfish (fish that swim)
- Shellfish (crabs that pinch, squid that ink and clams that pearl)
- Seaweed

### Finfish

Below are some of the methods and issues around them that are used to produce finfish.

#### Open systems

Open system farming is the term used to describe the process of farming fish (including shellfish and seaweeds) in cages or pens that are open to the sea. These comprise nets suspended from either a floating metal framework or from round plastic floating structures, both of which are anchored to the seabed. It is important that the nets are kept free from debris and accumulation of marine life to allow seawater to flow through to maintain water quality within the cage. All waste generated by fish in the cage falls through the bottom of the net to be deposited on the seabed underneath or around the cage. This waste can build up in areas with poor or low water flushing. Being open to the surrounding water means that the fish can potentially be infected with and/or transmit water borne disease and sea lice infestations to/from wild stocks.

Open sea cage farming happens almost exclusively in the west coast of Scotland and the Scottish Islands due to their good water quality and coastline topography, which provides numerous sheltered sea-lochs and voes.

#### Closed systems

Closed system farming is the term used to describe farming finfish, shellfish or seaweed in enclosed systems not open to any water body. There are a number of methods that can be used: enclosed ponds, tanks or raceways. Within these closed systems water can be obtained and treated in either of two ways: 1. Pumped from a nearby water source such as a river or the sea, filtered, used in the system, filtered and treated to remove any waste or contaminants and then pumped back or 2. As above but where the water is not pumped

back to the source but remains in the system using re-circulation technology. The latter (2) relies on the water within the system being constantly passed through filters to remove waste matter and the water being continually reoxygenated.

Fully enclosed or recirculating system farming has the advantage of being land based and not having to be in close proximity to the sea. The waste from the farm is totally contained and there is no risk of predation or fish and parasites escaping into the wild.

## Sea ranching

Sea ranching is the process of releasing artificially raised juvenile fish or shellfish into the sea, allowing them to mature to market size and then recapturing them. This is not a common practice in the UK because other EU countries have historical fishing rights in our waters from 6nm out, however lobster restocking programmes have taken place within 6nm. Further information on a manmade lobster hatchery programme at Loch Linnhe in Scotland can be seen at <http://www.sams.ac.uk/schools/artreef.pdf>

## Tuna ranching

Tuna ranching involves catching juvenile tuna from the wild and growing them on in cages. This is particularly aimed at the commercially valuable but severely depleted bluefin tuna, which is highly prized for the sushi market. Predominantly juvenile fish, that have not had a chance to reproduce, are caught in nets and towed slowly through the sea to nearshore waters where they are transferred to netpens or cages for on-growing. Here they are fed on large amounts of small pelagic fish such as sardines and anchovies, taking as much as 20 kg of wild fish to produce 1kg of tuna. After several months, when the tuna have reached optimal market size, they are harvested and sold primarily for the sushi and sashimi markets. Tuna ranching is based primarily in Australia, Spain and Croatia.

## Salmon

Commercial salmon farming began in the 1970s although the ability to raise juvenile salmon in hatcheries was achieved in the 1800s. The salmon farming industry rapidly expanded during the 1980s and 1990s and today Atlantic salmon is the most commonly farmed species in the UK, with approximately 70 companies producing over 140,000 tonnes of farmed salmon each year, 90% of which is in Scotland.

Juvenile salmon are grown in hatcheries from eggs produced by broodstock, when the eggs hatch the young fish are called alevins until they discard their yolk sac when they are termed fry. Fry are grown in freshwater tanks, where they undergo a series of size sortings called gradings, a process to ensure that fish of a similar size are kept together. They remain in these tanks until they undergo a process called smoltification, a physiological process that enables the fish to live in seawater, which normally occurs when they are 12-18

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months old. After smoltification the fish are termed smolts. Once transferred to sea cages the salmon take between 18 months and 2 years to reach harvestable size of 3-4kg.

## Other farmed species

Other finfish species currently farmed in the UK are rainbow trout, sea trout, Atlantic halibut, Atlantic cod and turbot. The trout species are farmed in closed systems such as raceways, whilst the halibut and turbot are raised in enclosed tanks containing seawater. Cod is a new species for cultivation, currently farmed in Scotland and Norway in a manner similar to salmon using open sea cages. Unlike salmon, cod do not go through a smoltification process.

## Future farmed species

There are a number of alternative species that can possibly be farmed in the UK, some of which are being trialed at present. These include: Arctic Charr; haddock; Senegal, Dover and lemon sole; turbot; spotted wolffish (prized not only for their flesh but also for their skin which is made into leather); sea bass and gilthead sea bream both of which are currently farmed extensively in the Mediterranean) and three freshwater species: barramundi; pangasius and Tilapia.

## Fish feed

Different species of farmed finfish require different diets. Some species such as Tilapia can be fed on an entirely vegetarian diet, whilst the majority of UK farmed species are fed a carnivorous diet. The feed for carnivorous fish comprises fishmeal and fish oil derived from wild caught species of small pelagic fish predominantly anchovy, jack mackerel, blue whiting, capelin, sandeel and Medhaden. These pelagic fish are processed into fishmeal and fish oil, with the final product being a pelleted (for larger fish) or flaked (for juveniles) feed. The other components of the feed pellet are vegetable protein, vitamins, minerals and pigment as required.

It takes on average 3kg of wild caught feed grade fish to produce 1kg of salmon, and 12kg of fish to produce 1kg of fish oil. Although these figures represent a significant improvement in feeding technology over recent years, the fact remains that farming carnivorous fish relies on wild capture fisheries, and removing a large number of smaller species of fish from the food chain can have adverse ecosystem affects.

Organic requirements for feed composition differ in that it currently uses offal and trimmings from the fish filleting industry as the main ingredient. Ultimately, organic feed will be sourced from offal and trimmings from certified sustainable fisheries, but as yet no such feed-grade fisheries have been certified as sustainable. Using offal addresses one of the key sustainability issues of farming carnivorous fish by using the waste product of another fishery, which would otherwise be discarded, rather than relying on large quantities of wild caught fish.

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## Environmental impacts

In addition to the dependence on wild capture fisheries to supply fish feed there are a number of other environmental impacts associated with fish farming such as:

Benthic impacts affecting the seabed beneath the cages in open systems. As the cages are open to the sea all faeces and uneaten food falls through the cage bottom to be deposited on the sea floor. In some areas, such as those with poor water flushing, low water exchange or shallow depth this organic build-up can prevent oxygen from reaching the underlying sediments and eventually lead to the formation of bacterial mats. Benthic impacts can be minimised by siting the farm in highly flushed areas and limiting the biomass and stocking density of the fish to avoid excessive waste.

## Disease

Diseases can occur amongst farmed fish which are kept in much higher stocking densities than would naturally occur in the wild. Disease and parasites can be easily transferred between individuals due to their close proximity. Many diseases are now largely (but not entirely) prevented by the use of effective vaccines and strict regulations. Controls and Codes of Practice are in place to prevent spread of any disease outbreaks.

Sea lice is a term used to describe many species of ectoparasitic copepods. These are small parasites, naturally occurring in the sea, that attach themselves to salmon and trout and feed on their host's mucus, skin and blood. If excessive infestation occurs then death can result. Choosing the best site for fish farms can play a significant part in determining the sea lice burden and spread of these parasites. When infested, however, the fish need to be treated either by direct (bath) or indirect (in-feed) application of sea lice treatments.

Unfortunately, a number of sea lice treatments are either toxic for some marine life such as crustaceans or their effect on many other marine organisms is unknown. The use of sea lice treatments is regulated by the Scottish Environment Protection Agency.

## Escapes

Escapes from open sea cages cause problems for wild fish populations, in particular salmon. Farmed fish can escape for a number of reasons: pens can be torn open or damaged by storms; accidents and poor management can lead to escapes and predators can also damage nets allowing fish to escape. The main concern regarding escaped farmed fish is their interaction with the threatened wild populations of Atlantic salmon.

Farmed species of Atlantic salmon are genetically different from their wild counterparts: they are genetically selected to have farm-adapted suitability and as a consequence only come from a limited genetic stock. Wild salmon by comparison have a much larger gene pool. Each wild population is genetically adapted to its specific environment and has an inherent homing instinct, which allows them to return to their natal river to spawn.

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Escaped farmed salmon can inter-breed with their wild counterparts leading to genetic dilution of the wild stock, leading in turn to the probability of the hybrid fish not having the genetic adaptations to survive in the wild, resulting in the decline of future population resilience, numbers and further loss of genetic variation.

## Best environmental practice

Best environmental practice, is what MCS would like to see adopted by all fish farmers, regardless of species farmed or the size of company. MCS guidelines for best environmental practice can be summarised as follows:

### Siting of fish farms

Most of the adverse environmental impacts of fish farms can be addressed by siting the farms in the most appropriate areas. Sites should be in areas of high flushing, deep water, away from any wild salmon runs or predator hot spots such as seal haul out sites, away from any areas containing vulnerable or protected marine species and habitats (e.g. maerl), in areas with historically no/low sea lice levels and sited in such a way as to minimise visual impacts.

### Feed

All feed should ideally be manufactured sourced from offal and trimmings from certified sustainable, effectively managed fisheries that have full traceability back to source. Until such feed is available, feed should be manufactured from filleting waste (offal and trimmings) from sustainable human consumption fisheries, supplemented by certified sustainable feed fisheries ensuring a supply where impact on the wider marine ecosystem is minimised; increased substitution of marine proteins with vegetable alternatives; and best practice in terms of feed wastage minimisation.

### Pollution effects

Farms should keep chemical use to a minimum by not using any treatments (such as antifoulants which are mainly copper based and toxic to marine life) where there is a tested non-chemical alternative (such as non-chemical net cleaning), recognising that the environmental effects of many treatments are unknown. Sea lice treatments are also a source of localised marine pollution and are toxic to some other marine organisms such as crustacea. However, as sea lice infestation is a welfare issue for the farmed salmon and can be transmitted to wild salmon stocks the need to use such treatments exists. MCS position on the use such treatments is that they should only be used if welfare is compromised or as part of a strategic management plan in conjunction with other farms. Some farms, due to their location, never have a sea lice infestation and MCS would like to see further research into why this is the case as well as supporting the research and development of an effective sea lice vaccine. Effective feeding systems that monitor and reduce uneaten feed should be used and litter should be recycled wherever possible

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Escapes – all cages should be suitable for the environment they are used in (such as in high energy areas), they should be inspected regularly and repaired as soon as damage is noted. All staff on the farms should be trained to handle the fish in the most efficient and effective way to prevent escapes. All escapes should be promptly reported and a contingency plan implemented as soon as possible after the escape event to recapture fish and thus minimise the effects on wild populations.

## Welfare

High welfare standards should be maintained, such as those set out by the RSPCA Freedom Food scheme. Fish farms should have effective, humane predator control measures in place not only to reduce stress to the fish but to ensure the nets do not become damaged by predators, leading to fish escapes.

Effective management – fish farms should be effectively managed including environmental aspects and monitoring as part of the process. Farms should monitor and work to improve their environmental performance.

## Organic farmed fish

Organic farmed fish –where farming practices meet high environmental standards, including limits and restrictions on the use of medicines, chemicals and sea lice treatments. Feed is sourced sustainably and stocking densities are limited.

## Freedom Food Certification

Freedom Food Certification- is the RSPCA scheme to ensure high welfare standards are implemented and maintained for farmed animals. A set of standards have been developed for farmed salmon that are based around the scheme's five principles, namely, freedom to express normal behaviour and freedom from: fear and distress; hunger and thirst; discomfort and; pain, injury and disease.

## Offshore aquaculture (open ocean aquaculture)

Offshore aquaculture is the farming of any species in the sea away from the coast. It has been defined in the US as occurring “from the three mile territorial limit of the coast to two hundred miles offshore”; in Europe it is generally accepted to mean sites that are subject to ocean waves. The fish farming industry is looking to move further offshore in the future as competition for coastal space increases. Although moving into deeper water has a number of environmental benefits such as increased dilution and little or no seabed effects, it also has a unique set of challenges such as ensuring cages are sufficiently robust to withstand the high energy environment.

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## Shellfish

Below are some of the major species of seafood commonly farmed today.

### Shrimp/prawn farming

The names shrimp and prawn are sometimes used interchangeably, however there are differences between the two. Shrimp are generally smaller with a narrow pointed rostrum (tail end of the body) and a sculptured or spiny carapace (shell). Farmed prawns represent a third of the global harvest, with developing countries accounting for 99% of production. However, prawn farming has a high environmental cost, with loss of wetland and mangroves, degradation of habitats, pollution and depletion of wild fish stocks.

Prawns are raised in ponds or enclosures until they reach harvestable size. There are three categories of farm: extensive/traditional; semi-intensive and intensive. The Environmental Justice Foundation advises consumers to only buy shrimp/prawns with recognised, credible, environmental, Fair Trade and organic labels. For more information see: <http://www.ejfoundation.org/>

### Oysters

There are two species of oyster farmed in the UK: the European Flat or native oyster, *Ostrea edulis* and the Pacific cupped oyster, *Crassostrea gigas*. Native oysters are virtually all dredged from wild stocks and some of these may be re-laid to grow on more sheltered inshore beds until they reach marketable size. The Pacific oyster was introduced in the 1970s. They are bred in hatcheries and then grown to market size by: 1. Placing them in plastic mesh bags fastened onto steel or timber trestles with rubber bands and submerged; 2. Placing them in elongated cages suspended between a series of poles submerged in seawater during high tide or 3. By re-laying larger oysters loose onto the seabed where there is firm gravel ground. The best farming areas are sheltered sites where some mixing of marine and fresh water occurs.

### Mussels

Mussels are the most common species of shellfish farmed in the UK. In England and Wales, the mussel spat are collected from naturally occurring ephemeral beds and re-laid in sites in more sheltered inshore waters for them to grow to marketable size. In Scotland, mussels are predominantly rope grown which entails suspending ropes from floating buoys in areas that have naturally occurring mussels in the water. The rope provides a substrate for spat attachment, where they continue to grow until reaching harvestable size, when they are collected by hand from the ropes.

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## Other farmed shellfish

There are other species of shellfish farmed within the UK and Ireland, though not in the same numbers as mussels and oysters. These include scallops, abalone, carpet shells, sea urchins and cockles. Scallops are farmed by collecting spat from the wild and growing them to marketable size either in special bags or by relaying them on the seabed. Harvesting is normally carried out by divers using hand gathering, this method of collection ensures no damage to the seabed or other marine organisms occurs.

## Water quality

Water quality is very important for the production of shellfish and is regulated by two directives. The EC Shellfish Waters Directive (79/923/EEC) seeks to protect or improve shellfish waters in order to support shellfish life and growth and thus contribute to the high quality of shellfish products directly edible by man.

The EC Shellfish Hygiene Directive (91/492/EEC) monitors the suitability of all shellfish for human consumption. Harvesting sites are monitored and classified in terms of concentrations of coliform bacteria and salmonella. Sites are graded from A to C depending on how much purification (depuration) the shellfish require before consumption.

## Environmental impacts

As shellfish require no feed inputs and no chemical treatments the environmental impacts of farming mussels, oysters and other shellfish in the UK are minimal, as long as the shellfish are harvested in such a way as to not damage the seabed, i.e. avoiding the use of dredges especially in sensitive marine areas. The only output from shellfish is pseudofaeces, a waste product generated by filter feeders; this can accumulate on the seabed in areas of low water flushing or high densities of wild or farmed stocks.

## Seaweed

The Lowdown on your favourite macro algae:

## Types of seaweed

Globally there are over 9,000 species of seaweed divided into three major types: green, brown and red. Red is the most species-rich group (6,000) followed by brown (2,000) and green (1,200). Around 600 species are found on UK shores. Like land plants, all seaweeds depend on light for growth, so they only occupy the intertidal area or relatively shallow photic (light penetrating) zone. Green seaweeds tend to be found towards the top of the shore, browns from the top to deeper waters, and, since they are adapted to photosynthesise at lower light levels, red seaweeds tend to dominate the deeper, darker waters and also beneath kelp canopies and in shady rockpools.

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## Seaweed farming

In 2002, world aquaculture production of seaweeds reached over 11.5 million tonnes with a value of over \$6 billion, with China accounting for almost 9 million tonnes of that total. In Europe, seaweed cultivation occurs only on a small scale, with France being the only commercial producer in 2002, growing 35 tonnes (Source FAO 2002).

## Uses of seaweed

Seaweed is not only used as a food source (particularly in Japanese cooking), it has a range of other uses. It can be used in agriculture and horticulture as an organic fertiliser and soil dressing; in beauty treatments, not only as an ingredient in products such as moisturisers but also in seaweed baths; as a health supplement and also as a source of agar and alginates for a range of products including ice cream, yoghurt and pet food.

## Polyculture

Polyculture or integrated aquaculture is the term used to describe the farming of one or more species simultaneously in the same area. Within the aquaculture industry, trials are currently taking place to see if growing seaweed and/or mussels adjacent to fish farms can reduce the amount of organic nutrients being dispersed from the fish pens. The cultured seaweed/mussels utilises the nutrients in the waters surrounding the sea pens, and also provides the fish farmer with an additional cash crop. Trials are also being undertaken to farm sea urchins adjacent to salmon farms, it is thought these grazers will “clean up” the seabed whilst providing an additional commercial species for the farmer.

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