



Bitter Harvest

*A call for reform in Scottish
aquaculture*

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Executive Summary

Marine aquaculture has grown to become a significant industry in Scotland over the last 30 years. Commercial salmon production has grown almost exponentially since the 1980s, and today stands at more than 125,000 tonnes a year. But while salmon dominates Scottish finfish farming, interest in the commercial production of other species such as cod, haddock and halibut is also increasing, and this sector is likely to grow in the future.

By contrast, shellfish farming amounts to just over 1 per cent of Scotland's total aquaculture production. This sector remains relatively small, producing around 1,770 tonnes of mussels, scallops and oysters in 1999. Although operating on a smaller scale than finfish farming, shellfish farming is nonetheless economically important. And in contrast to the finfish industry, it is more likely to be locally owned, providing local people with more of a direct stake in aquaculture and its benefits.

However, this growth of the aquaculture industry in Scotland has attracted a raft of concerns largely to do with environmental impacts. Stemming predominantly from salmon production, these concerns include:

- **Nutrient enrichment:** this is caused by the release of uneaten food and faeces of farmed salmon into the water column and onto the seabed. This can produce changes in the physical and biological characteristics of the seabed, and has been cited as a contributing factor in the production of toxic algal blooms in the water column.
- **Chemical pollution:** this has been brought about by releasing “therapeutic” chemicals which are used to treat diseases and parasites in farmed fish.
- **Impact on wild fish populations:** some farmed salmon escape and then breed with wild salmon stocks, which alters the gene pool. Escaped salmon can also transmit disease and parasites to wild fish.
- **Impacts upon the wider environment:** large numbers of small fish species low in the food chain are harvested to provide feed for farmed fish. The logic of removing huge amounts of these fish from the global marine ecosystem raises questions about the future expansion of the salmon industry if it continues to rely on this resource.

Although efforts have been made to reduce the industry's “environmental footprint” – the impact of the industry on the global environment – the ever-expanding scale of aquaculture operations may have largely offset any beneficial effects of these counter-measures.

For years, much criticism has been levelled at the way in which Scotland's aquaculture industry has been planned, regulated and managed. Recently, however, positive changes have either been proposed or are being implemented. WWF welcomes these moves, which are a start in the process of redressing the permissive attitude towards environmental impacts – an attitude that has developed because of the industry's economic importance.

Even so, WWF strongly believes that further fundamental review and reform of the industry – and in particular its planning and regulation – are required if it is to have a more

environmentally and socially sustainable future. Such change should encompass areas including:

- SEPA's powers being expanded so that it can act as the competent authority with respect to Environmental Impact Assessments (EIAs) on fish farm developments;
- SEPA's powers being extended to include stipulations relating to husbandry process and best practice management procedure as part of licence and discharge consents;
- SEPA's ability to introduce an annual quota system limiting the maximum amount of feed to be used at fish farms where appropriate;
- guidance and improved resources for local authorities to allow them to analyse EIAs on aquaculture projects;
- the development and implementation of national and management area pest control strategies to control lice and reduce emissions of toxic therapeutic chemicals;
- stricter requirement for accurate monitoring of environmental impacts resulting from aquaculture operations;
- the development of a national aquaculture strategy that sets out a suite of principles, objectives and common standards for sustainability, carrying capacity, environmental footprint, inclusion and social justice – this strategy to be implemented through area management framework plans and advisory committees; and
- the closer involvement of the industry and wider marine stakeholders in the process of reform. A real commitment to greater transparency and to continual improvement of environmental and social performance is required on the part of the industry.

WWF's vision for aquaculture in Scotland is one of sustainability, with an industry driven and shaped by the needs and aspirations of coastal communities and the carrying capacity of our fragile marine environment. It must also be concerned with meeting the longer term economic and expansionary desires of a maturing industrial sector. WWF believes that there are two processes, above and beyond the measures outlined above, which are key to achieving a sustainable aquaculture industry:

- the setting up of a Strategic Environmental Assessment (SEA) to establish the carrying capacity of Scotland's marine environment in relation to aquaculture activity, and the sustainability of current policy and legislation relating to aquaculture in Scotland; and
- the development of a comprehensive Aquaculture Strategy for Scotland, which would be informed by the SEA process, and would seek to balance the development and financial aspirations of an expanding industry (taking into account social and economic factors) with the requirement for sustainability and continued good stewardship of Scotland's marine environment.

Having carefully reviewed the industry, its environmental impacts and how it is planned and regulated, WWF welcomes the commitment by Scottish Executive ministers to develop a Scottish Aquaculture Strategy which will map out a sustainable future for the industry. However, in the interim it is almost impossible for the current regulatory system to ensure that further major finfish farming developments would be sustainable, or that they would be within the carrying capacity of the marine environment for which they are proposed. Therefore, until the strategy is developed and implemented, WWF believes it prudent and precautionary to call for a pause in the licensing of all further major fish farming developments.

Introduction

Aquaculture – the farming of fish and shellfish – has grown to become a significant industry in Scotland over the last 30 years. Scotland is now a major international player in the farming of species such as salmon, and levels of production appear set to increase. Furthermore, research into the commercial production of other species is progressing apace.

However, while Scottish aquaculture has grown rapidly, so have concerns regarding the environmental and social impacts caused by the industry. Possibly now more than at any time in its relatively short history, Scottish aquaculture finds itself at the centre of a storm of controversy as to its present form and its future development. Debate about the industry has resulted in repeated calls for public inquiries and has raised the interest of several Parliamentary committees. At a European level, calls for the reform of the Common Fisheries Policy and moves towards greater environmental integration also have implications for Scottish aquaculture.

WWF's vision for aquaculture in Scotland is one of sustainability, with an industry driven and shaped by the needs and aspirations of coastal communities and the carrying capacity of our fragile marine environment. We believe it must also be concerned with the sustainable, economic and expansionary desires of a maturing industrial sector.

WWF has produced this report to inform the debate on the future of aquaculture in Scotland. Consideration is given to the developing status and potential future directions of the aquaculture industry, recognising both the economic importance of the sector and concerns over the environmental impacts for which it is responsible. Analysis is made of the regime regulating the industry, and the report suggests areas where improvement and amendment are required. Finally, it reveals WWF's vision for the future of the industry: it identifies the need for a more strategic course of control and development, and suggests action that will guide the sector towards an environmentally sustainable future.

Section 1: The status of the marine aquaculture industry in Scotland

Over the last 20 years, Scotland's marine aquaculture industry has undergone considerable development and change. It has transformed itself from its small-scale beginnings in the 1970s, when it was perceived and promoted as "crofting of the sea" – locally-owned, low-intensity and small-scale – to a well-established major industrial sector. While it has grown in both scale and economic importance, its expansion has also been responsible for (or implicated in) significant environmental problems and the degradation of areas of Scotland's inshore marine environment.

The marine aquaculture industry is based almost exclusively along the western and northern seaboard of Scotland, stretching from Argyll and Bute as far north as Shetland. But while it might be considered to be a single industrial sector, the reality is that it can be divided into two discrete areas – one involving the production of finfish, currently dominated by salmon, and the other concerned with the production of shellfish, at present comprising a range of molluscan species. These two areas differ considerably in the intensity and scale of production involved, and in their socio-economic structure.

Unless stated otherwise, all figures quoted are derived from the Fisheries Research Service Scottish Fish Farms and Scottish Shellfish Farms Annual Production surveys 1994-2000.

FINFISH AQUACULTURE

As the industry matures, there is a growing realisation that finfish aquaculture in Scotland is limited in the number of suitable production sites available for large-scale finfish farming. The race to produce bulk quantities of cheap fish to compete with the Norwegian and Latin American mass producers is increasingly seen to be commercially imprudent. It would therefore seem necessary for the industry to realign itself and move towards the production of a higher quality product that will cater to the requirements of an increasingly discerning consumer. WWF believes that the industry's environmental and social responsibility will be of increasing relevance to the commercial viability of this sector.

Salmon

The commercial production of salmon currently dominates Scotland's aquaculture industry. As figure 1.1 illustrates, since the mid-1980s there has been an almost exponential increase in commercial salmon production, from a comparatively modest 10,500 tonnes in 1986 to an estimated 130,000 tonnes in 2000 (FRS 2000a). Salmon production in 2000 equated to an estimated farm gate value of approximately £300 million (IntraFish, 2001).

Figure 1.1 The increase in farmed salmon production in Scotland



As salmon farming in Scotland has grown rapidly, a number of changes in the structure of the industry have also occurred. These include:

- **Farm size:** The production demographic of salmon farming has changed considerably in the last decade, moving towards an ever-increasing reliance upon large-scale production facilities, with farm sites producing in excess of 1,000 tonnes annually growing rapidly. Whereas in 1994 only some 19 per cent of salmon production sites were producing more than 1,000 tonnes per annum, by 1999 this figure had risen to some 59 per cent.
- **Salmon farming companies:** There has been a consistent downward trend in the number of salmon farming companies operating in Scotland between 1993 and 1999, with a total reduction during this period of some 29 per cent. However, production was not equitably distributed among the 94 salmon producing companies operating in 1999. Research into the structure of the salmon producing industry in 1996 indicated that:
 - 15 companies accounted for 70 per cent of salmon production, and of these, the six largest were responsible for 53 per cent of total production;
 - of the 106 producing companies operating in 1996, 45 contributed only 4 per cent of total production;
 - foreign-owned companies produced over 47 per cent of total Scottish salmon output in 1996 (Highlands & Islands Council, 1999).

These statistics indicate that there is an increasing trend towards conglomeration in the salmon production sector in Scotland, with the industry being increasingly dominated by a small number of large companies. Furthermore, a substantial proportion of the industry is not Scottish-owned, but is controlled by foreign multinational companies. These trends have been recognised by the industry itself: in 2000, William Crowe, general secretary of the Scottish Salmon Producers Organisation (SSPO) – a trade organisation for Scottish Salmon growers – commented: “The fundamental economics of this industry mean that one can envisage that there would [eventually] be five or six large global companies. This seems to be the way the industry is going” (IntraFish 14/03/2000).

- **Employment:** Employment in the salmon production sector increased from 1,224 employees in 1993 to a peak of 1,391 in 1996, but declined to 1,304 by 1999. While employment levels fluctuated by some 12 per cent between 1993 and 1999 (and were in overall terms only some 6 per cent greater in 1999 than they were in 1993) salmon production has increased markedly during this period.
- **Productivity:** Technical advances or alterations in husbandry techniques – such as the move to intensification at existing sites and large-scale farming – have brought about a substantial increase in production. Technical advances in husbandry, increasing automation and economies of scale have been the result and have negated the need to increase the size of the workforce proportionately. Productivity has risen from an average 39.8 tonnes per person in 1993 to 97.2 tonnes per person in 1999 – an increase of some 169 per cent.

Other finfish

While salmon is the major finfish aquaculture species in Scotland, there has latterly been considerable interest the commercial production of other species, including:

- anadromous salmonid species, including the Arctic char, the brook trout and sea trout; and
- marine species including halibut, cod, turbot, lemon sole, lump sucker and haddock

At present, production of some species listed above is at a research stage, although comparatively small-scale commercial production has begun for other species. Table 1.1 identifies those species now being commercially produced in Scotland and the level of production to date (at 1999, the date for which the latest statistics are available), and shows estimated production levels for 2000.

Table 1.1 Farmed production of marine finfish species other than salmon

Species	No. of Companies	No. of Sites	1999 Production (Tonnes)	2000 Production (Tonnes)*
Arctic Char	7	10	2.8	6
Brook Trout	3	3	0.5	1.5
Brown Trout/Sea Trout	19	26	92	182.5
Cod	6	7	0.1	26
Halibut	7	12	3.6+	57.5+

* Farmers' estimates based on stock currently being grown (FRS 2000a)

It is anticipated that diversification into production of commercial species other than salmon will allow some of the smaller fish farming companies to continue to operate, and larger companies to broaden their product base (FRS 2000a).

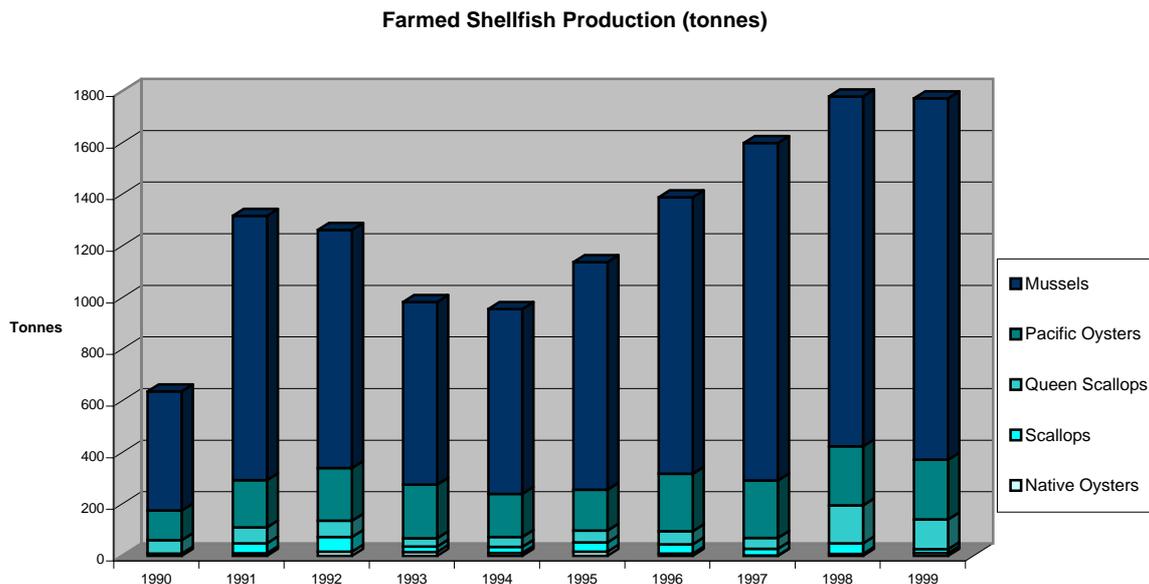
In 1999 commercial producers of the finfish species listed above employed some 72 people.

Concerns have been raised about potential environmental problems resulting from the production of finfish species other than salmon in Scotland's marine waters.

SHELLFISH AQUACULTURE

In terms of production, the shellfish aquaculture sector in Scotland is considerably smaller than the finfish aquaculture sector. Trends in production are also more variable. Figure 1.2 illustrates the trends in production levels for Pacific and native oysters, scallops, queen scallops and mussels that are commercially farmed. Total production levels during the 1990s have shown a general upward trend, though with some variation caused by a fall in production during the middle of the decade. In 1999, total farmed shellfish production in Scotland stood at 1,772 tonnes – a 178 per cent increase on production levels in 1990.

Figure 1.2 Farmed shellfish production in Scotland



The economic importance of the shellfish sector is shown in table 1.2, which illustrates the value of each crop in 1999, according to farm gate prices. The values are banded as the market price of each shellfish species fluctuated throughout the year.

Table 1.2 Economic importance of the shellfish sector

Species	Market Value of Production
Mussel	£1.12 – 1.82 million
Pacific oyster	£0.43 – 0.72 million
Native oyster	£0.07 million
Scallop	£0.06 – 0.08 million
Queen	£0.14 million
Total	£1.82 – 2.83 million

Shellfish farming in Scotland has undergone a number of changes during the last 10 years. These include:

- **Farm size:** The number of active shellfish sites in Scotland has fallen from 324 in 1994 to 237 in 1999 – a decline of some 27 per cent. Yet during the same period, the overall production by weight in the shellfish-farming sector increased, suggesting rising production levels at those sites still in operation.
- **Shellfish farming companies:** The number of active shellfish farming companies declined from 132 in 1993 to 94 in 1999. Detailed analysis of the size and structure of companies operating in this sector does not appear to have been undertaken, but anecdotal evidence suggests that there is a greater prevalence of locally-based owners operating single or a small number of farms. However, in some instances a number of individual shellfish producers appear to work together to facilitate the more efficient processing and marketing of their crops.
- **Productivity:** Despite this decline (see above), overall production by weight in the shellfish-farming sector increased, suggesting rising production levels at those sites still in operation.
- **Employment:** The number of staff directly employed in shellfish farming in Scotland fluctuated during the 1990s, rising from 337 in 1994 to a peak of 345 in 1996 before declining to 232 in 1999. It is not clear what has caused such a significant decline in staff levels towards the end of the 1990s, but it may well be related to the overall decline in the number of active sites and companies during the same period.

Comparison between marine finfish and shellfish aquaculture

The two main sectors of aquaculture in Scotland appear to be substantially different. Shellfish farming seems to be based on small-scale operations, and anecdotal evidence suggests many farms are locally owned and operated. There is a general trend towards increasing shellfish production, although levels fluctuated during the 1990s, and expansion may be limited because salmon farms already occupy sheltered inshore sites suitable for shellfish farming.

By contrast, salmon farming still dominates the finfish farming sector and is large-scale. It relies on increasingly large, intensive production facilities and has shown an almost exponential growth in production since the 1980s. While a number of farms remain locally owned, an increasing majority of the industry appears to be controlled by foreign-owned multinational companies. While these companies provide much-needed employment in many coastal rural areas, the locally-created jobs tend to be relatively low-skilled and low-paid. The bulk of the profit from the farms tends to be exported.

In recent years, the number of jobs on fish farms has remained steady while fish output has increased dramatically. This is due to efficiencies in the scale of intensified operations and automation. Locally-owned farms tend to be more closely rooted in the community, with profits remaining in the area. If the future direction of aquaculture is to be more sustainable, it will have to take into account a number of important matters, such as providing benefit to local communities, and better integration and cooperation between itself and other marine users. The social responsibility required of all sectors of the now maturing aquaculture industry is becoming an important commercial factor. It is likely that in order to operate effectively in a more strategic regulatory regime – and to supply a market that is increasingly driven by quality – a demonstrable commitment to long-term environmental, economic and social sustainability on the part of aquaculture businesses will be a commercial necessity.

Section 2: Environmental impacts associated with marine aquaculture in Scotland

It is clear that aquaculture in Scotland is now a highly developed industry. In common with other industrial sectors, it causes a range of environmental impacts. Environmental problems associated with salmon farming were identified more than 10 years ago by the House of Lords inquiry (1989) and the Friends of the Earth report, *The Salmon Myth* (1987). The impacts associated with salmon farming remain much the same today, while production levels have increased substantially since the 1980s. Environmental impacts resulting from salmon aquaculture are widespread throughout the northern and western seaboard of Scotland and are of significant concern to WWF and other environmental NGOs.

While efforts have been made by the industry and Scottish Quality Salmon to address some of the environmental problems associated with fish farming, its continued expansion (which is considerable in the case of salmon farming) and changes in production processes are causing aquaculture to have a detrimental impact upon the marine environment. In the last 20 years, considerable research has been undertaken into these impacts, and this has been reviewed in a number of publications (NCC 1989, Ross 1997, Black 2001, FoE 2001, Milewski in print). Presented below is a brief synopsis of key environmental issues drawn from these publications, together with additional supplementary information that is identified where appropriate.

ENVIRONMENTAL IMPACTS RESULTING FROM SALMON FARMING

At present, the overwhelming majority of farmed salmon in Scotland is grown in cages or pens, which are usually located in relatively sheltered sea areas such as bays or sea lochs. These cages are open to the wider marine environment, and while they are designed to contain the fish, they also allow seawater – and anything else that may be added to the cage system – to flow through.

In their natural state, salmon are active predators, but when reared in captivity they have to be supplied with artificial feed. Because farmed salmon are kept at far higher densities than they would naturally occur (which may in itself cause stress), they are susceptible to disease and parasites that can readily spread from one fish to another in such conditions. Because the systems in which they are reared are open to the wider marine environment, leftover food, their waste products and the therapeutic chemicals used to treat diseases and parasites may easily reach the wider marine environment. Farmed salmon may also interact with natural populations of salmon. Consequently, environmental impacts arise from salmon farming as a result of:

Nutrient enrichment: This occurs through the release of uneaten food and waste from the fish. It can smother the seabed immediately below the cages, potentially depriving it of oxygen and altering the ecology and range of organisms found on or in the benthic (seabed) habitat. Impacts of nutrient enrichment can also be more widespread, which is perhaps unsurprising given the amount of waste released by the salmon industry. Using guidelines laid down by OSPAR – the international organisation responsible for combating marine pollution in the north-east Atlantic – it has been estimated that in 2000 Scottish salmon farms produced:

- 7,500 tonnes of nitrogen, comparable to the annual sewage inputs of 3.2 million people; and

- 1,240 tonnes of phosphorous, comparable to that from 9.4 million people (McGarvin, 2000)
- The release of such large quantities of nutrients causes serious pollution, the impact of which poses a risk to the wider marine environment by increasing levels of phytoplankton in the water column. This in turn will increase the cloudiness of the water, thereby reducing the depth to which habitats such as seaweed forests and eelgrass beds can grow (McGarvin 2000). Not only are the quantities of nutrients released of concern in themselves, but they are also likely to alter the natural balance between nitrogen and phosphorus in the marine environment, which can alter the characteristics and abundance of phytoplankton communities. Such changes can make phytoplankton less valuable as food for filter-feeding animals (Asche et al. 1999), and may be implicated in the formation of toxic algal blooms (Pearson & Black 2001, McGarvin 2000). As well as having implications for the wider marine environment, as was observed in the case of the bloom resulting in amnesic shellfish poisoning (ASP) that affected large areas of Scotland's inshore waters in 1999, toxic algal blooms may also impact upon the salmon farming industry directly. For example, toxic algal blooms in Norway have resulted in the deaths of hundreds of tonnes of farmed salmon and salmon trout (Asche 1999).

Chemical pollution: Therapeutic chemicals such as antibiotics are used to treat a range of diseases and parasites – chiefly sea lice – in farmed salmon. Applied as a bath treatment or incorporated in feed, quantities of these therapeutics eventually find their way into the wider marine environment. Once outside the confines of the salmon cage, they may impact on a range of organisms. For example, antibiotics that are either excreted or not consumed by the fish may accumulate in the sediment under farms, where they may persist for a considerable time, depending on the drug used. This is of concern because:

- wild fish and invertebrates can accumulate antibiotics in their tissues to levels that would be considered unacceptable for human consumption;
- the widespread use of antibiotics can lead to resistance in both target pathogens and other microbial species such as those found in seabed sediments; and
- the wider ecological impacts resulting from the use of antibiotics in fish farming remain virtually unexamined.

It should be noted that the development of vaccines for a number of salmon diseases has led to a significant reduction in the use of antibiotics, compared with levels of use in the early 1990s. However, in 1999 (the most recent year for which statistics are freely available) some four tonnes of antibiotics were sold for use by the salmon and trout farming industry in the UK. This compares with 11 tonnes used in cattle farming and less than one tonne in rearing sheep (Veterinary Medicines Directorate, 2000).

The use of chemicals to treat sea lice is also an issue, as the vast majority have been developed for use in terrestrial agriculture and are internationally classified as being toxic or extremely toxic to aquatic organisms. The use of such treatments is of concern because:

- there is only a relatively small body of research and data on the lethal and sub-lethal effects of such treatments on non-target marine organisms;
- the ecological implications of the impacts of such chemicals in the broader marine environment remain little examined in the field;
- there is a lack of toxicity data relating to “inert” ingredients such as solvents or carriers that may be used in treatments. Such “inert” chemicals may be toxic or possess endocrine

(hormone) disrupting properties, and in some instances may be of greater environmental concern than a treatment's "active" ingredient (Milewski, in print).

Although toxicity testing is carried out on chemicals used to treat sea lice, aspects of this are considered inadequate by a number of organisations. This is because the broader ecological consequences of the release of such chemicals to the wider marine environment, as well as cumulative and synergistic effects resulting from the range of chemicals used, has not been sufficiently investigated. Although the Scottish Environmental Protection Agency (SEPA) with other partners is now undertaking a "post-authorisation assessment programme" to assess the ecological effects of the residues of sea louse treatments, many salmon farm sites will already have a long history of using various chemical treatments, which may influence such assessment. The Scottish salmon farming industry heavily relies on the use of therapeutic chemicals, as was indicated in a recent report by FoE, which stated that the number of salmon farm chemical licences issued by SEPA rose from 49 in 1998 to 474 in 2000 (FOE, 2001).

Impacts upon wild salmon populations

Considerable concern has been voiced over the effect salmon farming may be having upon wild populations of salmon in Scotland. This is focused in two areas:

- **The impact that salmon escaping from farms may have on the genetics of wild populations:** Given that the number of fish escaping can be considerable – half a million are estimated to have escaped from Scottish farms during 2000, for example (IntraFish, 10.04.2001) – and that farmed salmon are usually derived from non-local stocks and are selectively bred to enhance traits favourable for aquaculture production, it is feared that the interbreeding of farmed fish with wild fish could alter the genetic make-up of wild stocks and have an adverse impact on their capacity for survival.
- **The transmission of sea lice to wild salmon:** The continuing drastic declines in native salmon populations in the UK and elsewhere in Europe has led to speculation as to whether salmon farms may act as a "reservoir of infection" for wild salmonids – salmon and sea trout – that come into contact or proximity with them. Research in this area is difficult because diseased or highly parasitised fish in the wild are quickly predated upon. However, recent unpublished research using new sampling techniques indicates that sea lice infestation may have a considerable impact upon the survival of young salmonids migrating to the sea from the rivers in which they were spawned. Results from research into wild migrating post-smolts (juvenile salmon) in two Norwegian fjords indicate that up to 86 per cent of these fish were killed as a direct result of sea lice infestation in 1999. It is possible that smolts from other fjords experience the same problem (Pearson and Black, 2001).

Impacts upon the wider environment

The broader environmental impacts associated with the exploitation of "industrial" fish to provide food for the salmon industry is also causing considerable worry. Fish meal and fish oil constitute important components in salmon feed and other agricultural foodstuffs, and are mostly derived from the worldwide exploitation of small fish species low in the food chain. The logic of removing such large amounts of fish from the global marine ecosystem – beyond what might be considered a sustainable level – has been questioned in a number of quarters, and the fact that industrial fish resources are now being exploited at or beyond a maximum sustainable level raises questions about the future expansion of the salmon industry if it continues to rely on this resource. It has been calculated that to keep up with the demand for fish meal and oil by the European salmon farming sector, the industry will need a 'marine support area' of between

40,000 and 50,000 times the surface area of cultivation. This is equivalent to around 90 per cent of the primary production area of the North Sea (Naylor et al, 1998).

Research is being undertaken into whether oils and other materials utilised in fish feed can be replaced with vegetable products such as soya and soya oil. However, fears have been expressed that these may be genetically modified, and that feeds already being used may contain genetically modified ingredients (Intrafish 18/12/2000).

ENVIRONMENTAL EFFECTS OF SHELLFISH FARMING

Compared with salmon farming, shellfish farming seems to cause considerably less environmental impact. This is not least because, unlike fish species, the bivalve molluscs produced by the Scottish sector are grown in the natural environment without need for therapeutic chemicals or supplementary food (Kaiser 2001). Even so, shellfish farming does exert a number of influences upon the marine environment, and these have been reviewed in general terms by Kaiser (2001) and – in specific relation to Scotland – by NCC (1989). Impacts derived from shellfish aquaculture include:

Changes to the water column

As shellfish feed on phytoplankton, they are not considered to be net contributors to nutrients in the water column: rather, they remove nutrients by way of their feeding process. The quantity of nutrients removed will vary seasonally and will depend upon the species being farmed, the size of the farming operation, the siting of the farm and the prevalent physical and biological conditions. It has been suggested that for each tonne of mussels produced, approximately 0.5kg of phosphorus, 6.6kg of nitrogen and 32.5kg of carbon are removed from the water column.

Changes to the seabed

Despite the lack of supplementary food, shellfish farming will produce solid wastes comprising organic faeces, pseudo-faeces (particles rejected during filtering which are often bound in mucus) shells and other detritus. Estimates of solid waste production from shellfish cultivation vary considerably, and the differing culturing and analytical techniques used make it difficult to interpret the data. It should be noted, however, that in shellfish aquaculture, a significant proportion of solid waste is intercepted and consumed by animals on the farm. As a result, sedimentation reported in shellfish farms is usually considerably less than that for finfish farms.

Landscape and visual impacts

Both shellfish and finfish aquaculture can impact upon the landscape, due to the location of structures such as cages and buoys in the water, and the construction of support facilities on land adjacent to farms.

New species

There is a rapidly growing interest in the culturing of non-salmonid marine fish species. In particular, the economic climate for the commercial farming of cod and haddock is the subject of much debate and the commercial production of these species seems poised to become a reality. The culture of such species brings with it the risk of unforeseen problems. Experience from salmon farming shows how many unexpected impacts, such as diseases and negative interactions with natural populations, can arise. It is noticeable that in reviewing the published literature concerning the commercial farming of these “new” marine fish species, much is known about the husbandry, economic and marketing aspects of their culture – but limited

consideration seems to have been given to the relative sustainability and likely environmental footprint of these developments. Detailed environmental assessments should be regarded as absolutely vital before commercial production units are licensed.

Other potential marine species for culture are non-native. While the introduction of non-breeding species such as the Pacific oyster (*Crassostrea gigas*) has been relatively benign – at least directly – there is a risk of introducing other associated alien species. The culture of the Pacific oyster, for example, has resulted in the introduction of the invasive *Sargassum muticum* seaweed into many parts of Europe and America. Although quarantine requirements are now much improved, further introductions of alien species for culture may present a risk of other invasive species being released into UK waters.

Section 3: The Regulation of Aquaculture in Scotland – Current Status and Proposed Directions

As has been illustrated, the scale of potential impacts from some sectors of Scotland's aquaculture industry seriously threatens the sustainability of the industry itself and the environment on which it relies. Some critics claim that unsustainable development of certain sectors of the industry has been caused in no small part by the inadequacy of legislation intended to control and guide it. Part of the reason is because some legislation predates the rapid development of aquaculture, so by definition it fails to address present issues and concerns. These problems have been compounded by an apparent unwillingness on the part of successive administrations to address the poor regulation of aquaculture in Scotland.

WWF believes that the climate is at last right for change. The Scottish Parliament and Executive have an opportunity to develop the future vision and form for Scottish aquaculture, which takes account of the needs and aspirations of rural coastal communities, the carrying capacity of our valuable inshore marine environment as well as the developmental and financial desires of an industry increasingly dominated by multinationals. Specifically, WWF believes that the following deficiencies need to be addressed:

- the lack of an overarching, strategic vision for the development of the industry;
- the absence of coordinated forward planning;
- the poor coordination and communication between regulators with regard to a strategy for development of the industry;
- the continuing culture of permissiveness with regard to environmental impacts, originating from the early political desire to encourage the development of the industry;
- the poor matching of existing legislation with the need to regulate aquaculture adequately; and
- the failure of licensing and permit systems associated with aquaculture – such as the licensing of therapeutic chemicals – to consider environmental impacts fully.

WWF recognises that it is essential for the industry itself to engage and participate in any fundamental review of aquaculture regulation if successful and meaningful reform is to be achieved.

In addition, it is increasingly apparent that in order to remain commercially successful, Scottish aquaculture needs to progress and move away from intensive bulk production to the cultivation of a higher quality product. The industry's willingness to participate in transparent self-regulation initiatives, and its commitment to continually improve environmental and social performance, is essential if it is to achieve greater sustainability and reduce its environmental footprint.

Recently, moves have been under way to address a number of inadequacies in the regulation of aquaculture. These have resulted in actual and proposed changes to legislation and policy, and an alteration in the responsibilities of various bodies (the roles of which are outlined in Box 1: *Key Regulatory Bodies in Scottish Aquaculture*). Such moves should generally be welcomed.

Box 1 – Key Regulatory Bodies of Scottish Aquaculture

The Crown Estate was charged with both regulating the aquaculture industry, through the issuing of seabed leases, and generating income as landlord. This was seen by many as a fundamental conflict of interests (Ross, 1997)

Scottish Environmental Protection Agency (SEPA) is the government agency charged with ensuring the cleanliness of Scotland's tidal waters and the conservation of flora and fauna that depends on the aquatic environment. Under the Control of Pollution Act 1974, consent is required from SEPA to discharge trade effluent including waste food, faecal material and therapeutic chemicals from marine fish farms to coastal waters (Scottish Executive, undated).

Scottish Natural Heritage (SNH) is responsible for securing the conservation and enhancement of Scotland's natural heritage. It is consulted on aquaculture applications in order to assess the proximity to and potential impact upon wildlife, habitats and landscape.

Local Authorities, although previously having no jurisdiction below the low water mark (and therefore having no direct influence on the marine components of fish farms), they are responsible for permitting and controlling land-based structures associated with aquaculture developments. Shetland and Orkney Councils possess greater legislative powers entitling them to license works in coastal waters, including those relating to the development and regulation of fish farms.

Scottish Executive Environment and Rural Affairs Department (SERAD) requires all fish and shellfish farms to register with it for the control of fish diseases. It also has wider responsibilities in relation to the protection of fish, fisheries and the marine environment (Scottish Executive, undated).

However, it is apparent that deficiencies still exist in both the current and proposed systems of regulation, so these must also be addressed if the industry is to be guided towards a more environmentally sustainable operation.

Since 1998, significant changes have been enacted or proposed concerning the role of certain organisations and the legal framework governing environmental aspects of the industry. These were brought about by the introduction of revised EU legislation increasing environmental protection in member states; concerns regarding the apparent conflict of interest in the role of the Crown Estate as both regulator and landlord of aquaculture developments; and the lack of transparency and accountability in arrangements to authorise aquaculture developments (Scottish Executive, 2000).

The changes outlined below are generally to be welcomed, as they go some way to addressing this lack of environmental assessment by the Crown Estate.

The changes include:

- 1 The introduction of the Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations 1999:** These were introduced in order to enact an amended version of the EC Directive on Environmental Assessment. They require a formal Environmental Assessment (EA) to be undertaken for any proposed new aquaculture development or modifications to an existing development where:
 - any part of the proposed development is to be carried out in a sensitive area; or
 - the proposed development is designed to hold a biomass of 100 tonnes or greater; or

- the proposed development will extend to 0.1 hectare or more of the surface area of the marine water, including any proposed structures or excavations.

In addition to these thresholds, Scottish Ministers take the view that “there is a need, based on current knowledge and understanding, to highlight constraints within particular areas due to existing levels of [aquaculture] development and to set more prescriptive procedures for EIA”. They have therefore produced a policy guidance note that lays down further indicative criteria beyond those defined in the above regulations, that will determine the need for EIA for aquaculture projects (Scottish Executive, 1999).

The introduction of these regulations and additional criteria has resulted in increased numbers of aquaculture developments being subjected to formal EIA although it should be considered that the level of EIA being undertaken prior to the introduction of the changes was extremely low.

- 2 **Proposals to extend planning controls to marine fish farming:** These will effectively relieve the Crown Estate of its responsibility as regulator of aquaculture in Scotland and transfer this role to local authorities. It is proposed that:
 - shellfish and fish farming developments below the low water mark will require planning permission;
 - planning authorities will be empowered to consider the environmental impact of those developments and determine planning applications for them;
 - the existing works licence regime in Orkney and Shetland relating to fish and shellfish developments will be replaced by the new Scotland-wide system;
 - those seeking to develop fish and shellfish farms will continue to obtain a lease from the Crown Estate Commissioners, as changes will not affect their estate management functions (Scottish Executive, 2000).
- 3 **Locational guidelines produced for guidance on the environmental factors to be taken into account when considering new fish farm development:** In effect, these place certain restrictions on the fish farming industry by establishing a framework to guide the location of new fish farm developments.

Specifically, the guidelines aim to safeguard sensitive areas including sites designated for their national or international nature conservation interest. They establish “a presumption against further...marine fish farm developments on the east and north coasts”, with the main purpose of protecting wild salmonid stocks. The rest of the coastline is divided into three categories, based on a combination of criteria including:

- natural heritage interests;
- existing levels of development; and
- physical and hydrographic characteristics.

The Category 1 areas are deemed to be the most environmentally sensitive. Within these areas new developments, or expansion of existing developments, will only be allowed in exceptional circumstances. Category 2 identifies coastal areas where the potential for new development is limited by environmental constraints, although expansion of existing sites

may be appropriate where there will be an overall environmental benefit. Category 3, covering the rest of the coast, is deemed to be more environmentally robust and is therefore seen as more appropriate for new development.

While the changes in legislation, policy and responsibility progressed by the Scottish Executive are welcome, further action is required to address the considerable environmental impacts resulting from Scotland's marine aquaculture industry, and to ensure any future development and expansion is sustainable and is undertaken with due regard to the finite availability of resources and capacity. This is in keeping with the principles of environmental stewardship, sustainability and the precautionary approach recognised by other industrial sectors operating in the marine environment. WWF therefore believes that further action should be undertaken in the following areas:

ENVIRONMENTAL IMPACT ASSESSMENT

a) Resources and capacity for EIA in local authorities: The assumption of responsibility by local authorities for the control and assessment of impacts of aquaculture developments is welcomed by WWF. However, this new role is considerably different from that which local authorities have traditionally undertaken to control developments in the terrestrial environment. Assessing potential aquaculture-related impacts in the marine environment is likely to demand a considerably different knowledge and skill base to those already existing, so some authorities will need to appoint specialist staff, with obvious resource implications. Funding to enable specialist staff to be appointed should be a matter of high priority – and given that local authorities are effectively assuming a managerial role previously undertaken by the Crown Estate, one possible source of funding might be a portion of the lease fee levied by the Crown Estate for all aquaculture development occurring in the marine area it controls.

WWF recommends that:

an assessment be undertaken to determine the additional resource requirements of each local authority assuming responsibility for the regulation of aquaculture, and that adequate resources be made available to allow them to take on their new role successfully.

b) Procedural guidance for assessing aquaculture EIAs: The Scottish Executive's recent document, *Locational Guidance for the Authorisation of Marine Fish Farms in Scottish Waters* (1999), provides only limited guidance as to how local authorities should review the adequacy of environmental assessments for proposed aquaculture developments. WWF believes it essential that more detailed guidance be given, in order to ensure uniformity and a common standard in assessment procedures. A useful model might be the *Procedures Manual for the Regulation and Monitoring of Marine Cage Fish Farming in Scotland*, produced by SEPA for its staff working in this area.

WWF recommends that:

- SEPA becomes the competent authority to consider EIAs for fish farms, under the Environmental Assessment (Marine fish farms) Regulation 1999;
- the Scottish Executive, in cooperation with SEPA and SNH, develops comprehensive guidelines and common standards for setting and reviewing the terms, suitability and adequacy of environmental statements (ES) resulting from the EIA process. Such guidance would help guarantee uniformity in the decision-making process in relation to the environmental regulation of aquaculture developments. It could usefully incorporate a suite of quality standards, drawing (for example) on the work of the Institute of Environmental Management and Assessment.

c) Application for planning permission and consent to discharge: Under the current and proposed systems, separate applications are likely to be required for permission to undertake an aquaculture development (to be submitted to the local authority) and for consent to discharge waste effluent (submitted to SEPA). As almost identical information will be required, it is suggested that applicants should submit only one application, which will be forwarded to both bodies.

WWF recommends that:

a comprehensive single application, or at least a parallel application procedure, be developed for both planning permission and discharge consent, as this will result in the best use being made of available environmental data, and is likely to improve the efficiency and cohesiveness of the regulatory process.

The new process would be able to consider and assess the full environmental impact of the proposed development, incorporating site-based and discharge assessments. It should also ensure adequate and comprehensive consultation.

d) A proactive approach to reducing emissions: It is generally recognised that the main environmental impacts resulting from aquaculture stem from the emission of waste or chemicals used to treat diseases or parasites. To reduce the environmental impact of these emissions (and in keeping with EIA procedures), SEPA and the industry should seek to develop an integrated disease control strategy for aquaculture that prioritises non-toxic alternatives over toxic, persistent and potentially bio-accumulative chemicals.

The environmental impacts of chemical treatments should be given fuller consideration, and in keeping with the precautionary approach, SEPA should adopt a more restrictive stance to their release. Greater emphasis should be placed on the prevention rather than treatment of sea lice infestation and disease by introducing stringent requirements for good husbandry and site management practices such as the re-siting of farms away from sites vulnerable to emissions, and the lowering of stocking densities to reduce vulnerability to sea lice infestations. Although a Code of Practice for site management to control fish disease is being developed, a legislative rather than voluntary approach to disease control may be more appropriate – something that has been recognised by the joint government/industry working group on infectious salmon anaemia.

Increasingly, Area Management Agreements (AMAs) are being used to coordinate aspects of fish farming activity in certain sea loch systems. AMAs are agreements that bring together salmon growers and freshwater interests, and largely consider the timing and intensity of the use

of fish medicines and other management techniques to control sea lice burdens in a loch. AMAs are a small step in the right direction, but any environmental benefits are largely ancillary. A coordinated approach to disease management is a good idea, but it is far better to address the causes of disease and to take site management actions to minimise it.

WWF recommends that:

- the development of a mandatory integrated pest control strategy, implemented on a management area basis and coordinated through a national pest control strategy. This should focus on coordinated pest control and aim to reduce emissions of chemical therapeutants through prioritising good husbandry techniques and utilising non- or low toxic therapies. Greater emphasis should be placed on prevention rather than treatment as a means of addressing disease;
- that in view of SEPA's difficulties in monitoring and regulating fish farm discharges, its powers be extended to allow stipulations concerning processes and best practice in farm management to be included as licence and consent stipulations; and
- the introduction of a "single year feed quota" to farms that places a maximum limitation on the feed usage at a particular farm in any given year. This would go some way to addressing nutrient pollution concerns and would promote responsible and efficient husbandry and farm management.

e) Monitoring environmental impacts: Monitoring the environmental impacts of an aquaculture development – even after an environmental assessment has been undertaken and permission for development is granted – should be an essential requirement of any regulatory process. This is not least because EIA should be a dynamic process, with data being collected in order to verify on site the assumptions and predictions presented in the original Environmental Statement (ES) resulting from the EIA. Information and data obtained through monitoring should then be used to fine-tune the EIA, taking into account any adjustments that might be required as a result of environmental mitigation or consent measures. The Scottish Executive's *Guidelines for the Authorisation of Marine Fish Farms in Scottish Waters* (1999) suggest that the developers themselves should monitor aquaculture developments, with the data being relayed to the regulatory authority for analysis and assessment. This system is already used by SEPA to assess discharge consents, following "the large number of marine cage fish farms in Scotland and SEPA's resource limitations" (SEPA, 1998).

For a number of reasons, self-monitoring could be considered inconsistent with satisfactory environmental regulation of the aquaculture industry, not least because even with an auditing system in place, data quality may vary. However, any increase in the frequency or scale of monitoring would demand considerably increased financial and human resources. Even so, it is highly desirable for minimum standards to be set for both the nature and frequency of site visits by SEPA in order to assess comprehensively the environmental and fish health performance of aquaculture developments. In addition to regular assessment visits, unannounced spot checks should also take place to assess compliance and adherence to environmental standards. Data obtained from such a monitoring programme would be independently verifiable, and could therefore be used to inform decisions relating to carrying capacity and overall aquaculture policy. The additional cost of this extended monitoring programme could be met by a levy upon production.

WWF recommends that:

- a greater degree of environmental monitoring be directed towards the aquaculture industry in order to verify regulatory compliance and to act as a continuing scheme to survey environmental impacts;
- increased monitoring requirements in areas considered to be especially environmentally sensitive or where nature conservation designations apply;
- minimum standards of routine monitoring be set, and that they be augmented by a system of random site visits;
- a transparent self-monitoring regime implemented by the industry (this may be adapted from the existing Environmental Management System scheme operated by Scottish Quality Salmon);
- sufficient resources be made available for existing regulatory bodies to undertake comprehensive environmental monitoring;
- that consideration be given to appointing one accredited independent organisation to monitor and inspect a number of compliance aspects concerning aquaculture legislation. Consideration should be given to delegating responsibility for a number of inspection roles such as health and safety, fish health and environmental inspection and monitoring;
- full account be taken of the EC Water Framework Directive when considering future monitoring requirements and regimes.

f) Environmental assessment of previously permitted aquaculture developments: During the time that the Crown Estate has been responsible for regulating aquaculture, only a small number of formal EIAs have been undertaken for marine aquaculture developments. Consequently, there is likely to be a limited amount of information – if it exists at all – relating to what the predicted and actual environmental impacts are for such developments. So that regulatory bodies can effectively manage the impacts of existing aquaculture operations, and to establish the carrying capacity of marine areas in relation to aquaculture, it would be advantageous for a retrospective EIA or environmental audit to be undertaken. Obviously, given the large number of fish farm sites already in existence, it would be unreasonable to expect the authorities and operators themselves to complete this process for all sites simultaneously. But a degree of screening could be applied, whereby established operations equalling or exceeding the thresholds for EIA requirement laid down by the Scottish Executive for new developments (see above) should be expected to undertake a full EIA in the following circumstances:

- upon expiration of their lease or discharge consent (four years in the case of a discharge consent);
- upon application for an increase in capacity (the required EIA would be for the whole operation, not just any proposed expansion);
- where the development exists within a designated nature conservation site. Here an EIA would be immediate; there is already a requirement for all regulators to review existing licences and consents in designated European marine sites, and such a review would best be achieved by initiating a formal EIA process.

Priority should also be given to an audit or retrospective EIA for aquaculture operations in particularly sensitive locations such as enclosed sea lochs or other water bodies that have low rates of flushing, and those adjacent to designated conservation areas such as European Marine Sites (identified under the EC Habitats Directive or EC Birds Directive). It should be incumbent upon the regulating authorities to ensure that action is taken to restore degraded environments,

and to ensure that any further industrial aquaculture activity is in line with the carrying capacity of the site and the wider marine area.

Where the assessment of established aquaculture operations indicates that the degree of impact – either individually or collectively – is unacceptable (i.e. the carrying capacity has been exceeded), remedial action should be taken. In some circumstances, it should be accepted that remedial action would be insufficient to alleviate the environmental impact, and in such cases the revoking of planning permission and consents for the operation should be considered.

WWF recommends that:

retrospective environmental assessments or environmental audits to be carried out on aquaculture operations that have not previously been subjected to EIA and that meet or exceed the criteria governing new aquaculture developments. Priority should be given to aquaculture operations located in particularly sensitive areas. Such EIAs would be instrumental in establishing the overall carrying capacity of a marine area with regard to aquaculture operations.

Strategic environmental assessment and regulation

a) The need for strategic environmental assessment: It is hoped that the legislative and regulatory changes proposed by the Scottish Executive will increase the use of the EIA in assessing the environmental impact of individual marine aquaculture projects in Scotland. Beneficial though EIA is, however, it has a shortcoming in that it is only able to examine the potential impacts of a single project or development in isolation. Individual project EIAs will not in themselves be able to quantify the long-term, cumulative, interactive and synergistic effects resulting from the location of a number of aquaculture developments in a particular sea loch or body of coastal water (Thompson et al., 1994). What is required is a strategic environmental assessment (SEA).

By undertaking a comprehensive audit of the physical and environmental characteristics of discrete marine areas such as sea lochs or coastal cells, assessing the current level of aquaculture activity to which they are exposed, and the nature and level of other uses and resources, it should be possible to calculate the carrying capacity for aquaculture within a particular marine area. Indeed, SEPA has already identified this necessity in respect of sea lochs and coastal waters (SEPA 1998). Information regarding the wider nature of the impacts resulting from aquaculture appears to be essential for informing the forthcoming development of an aquaculture strategy for Scotland (see below). A similar process for offshore marine areas in the UK will inform the future direction of offshore oil and gas projects there. Accordingly, an SEA of Scottish aquaculture should be the responsibility of SERAD and undertaken by both government and academic experts.

WWF recommends that:

a more cohesive and integrated legislative and regulatory regime should be developed to manage the aquaculture sector. Legislation not specifically designed to control the industry – but that is applied to it – should be replaced with regulations that are more directly applicable.

Obviously a comprehensive SEA could not be undertaken simultaneously for all sea lochs and coastal waters subjected to aquaculture activity. Therefore priority should be given to areas considered to be most sensitive because of their conservation importance or because they have

low rates of water exchange – for example certain sea lochs with low levels of flushing as identified by Turrell & Gillibrand (1992)

It should be noted that the ability to undertake a successful SEA depends on the availability of sufficient relevant physical and environmental background information. Where this is inadequate or not available, a moratorium on future large-scale aquaculture developments should be seriously considered until the information is available.

WWF recommends that:

a Strategic Environmental Assessment to be undertaken to establish the sustainability of current policy and legislation relating to the aquaculture sector. The SEA process should also be utilised to establish the carrying capacity of the inshore environment including sensitive areas such as sea lochs. The results of the SEA should be used to develop an Aquaculture Strategy for Scotland and to implement area-specific action plans. Such action plans should then determine the future management and development of aquaculture on a regional or area basis.

Priority should be given to the assessment of particularly sensitive areas. Any deficiencies in data or information should be addressed through the initiation of a relevant programme of survey work, which is adequately resourced.

b) The need for a more strategic approach to regulation: The complexity of the legislation and bodies regulating marine aquaculture in Scotland has been criticised for impacting upon the effectiveness and efficiency of the regulatory process. It may therefore be beneficial to rationalise this legislative control into a single act. As well as unifying linked aspects relating to pollution, nature conservation and impact assessment, the development of new primary legislation would also allow the revision of outdated or inappropriate statutes. Of particular concern are legislative tools that pre-date or are not specifically designed to address aquaculture, and therefore do not sit well with issues generated by the sector. For example, the Control of Pollution Act 1974 controls the discharge of pollutants from fish farms, even though the legislation came into force significantly before the advent of the aquaculture industry as we know it today. By incorporating pollution control functions into an aquaculture-specific bill, it would be possible to make the legislation more directly relevant to specific issues and demands within the sector.

c) The need for a more strategic and locally responsive management mechanism: The regulation of aquaculture would almost certainly benefit from a decision-making process that was balanced against economic, social and environmental factors so that it delivered sustainable development. The move towards making local authorities responsible for the control and assessment of impacts may provide an opportunity to set up a more integrated communication structure for those involved in regulating aquaculture. This could be done by establishing regional aquaculture management committees (RAMCs) facilitated by local authorities. Indeed, the need to develop contact between local authorities, the industry and other bodies has already been recognised, leading the Highlands and Islands Convention to establish an Aquaculture Forum. This will consider how the aquaculture sector can be sustainably developed. The Forum was set up very recently, so WWF will assess its effectiveness in due course.

Loosely based on the Sea Fisheries Committees which regulate inshore fisheries in England and Wales, each RAMC would comprise local or regional representatives of those bodies directly involved in regulating aquaculture, such as local authorities, SEPA and SNH. It may also wish to draw membership or seek input from other organisations including industry, environmental NGOs and salmon boards, thereby increasing transparency and the degree of stakeholder consultation. Meeting regularly, the committee would consider applications for new or additional aquaculture developments. The transfer of a comprehensive regulatory function to local authorities has the potential to greatly expand democratic involvement in aquaculture. RAMCs could provide an immediate and direct means of integrating local communities' views and long-term objectives into the aquaculture regulatory process.

Although locally based, the work of the RAMCs would be coordinated under an overarching strategy for Scottish aquaculture, and would be informed by SERAD's guidance and regulation. In WWF's view, the RAMCs could develop forward-looking aquaculture area framework plans that would implement future strategy regionally and locally, and deliver the long-term sustainability of aquaculture within a particular area. The plans should integrate with the requirements and aspirations of other sea users and aim to match the nature and scale of aquaculture to the available carrying capacity and environmental sensitivity of a particular marine area.

WWF strongly argues that there are significant benefits in using the planning system to develop area framework plans. This would allow decision-making to be more transparent and relatively familiar, and would lead to the increased integration of other aquaculture-related licence and consent mechanisms.

WWF recommends that:

a more strategic and integrated approach to the decision-making process relating to aquaculture should be developed through the establishment of Regional Aquaculture Management Committees (RAMCs). These would bring together representatives of organisations regularly involved with aquaculture regulation, and would allow the democratic participation and representation of local stakeholders in decision-making. Working within a framework laid down by SERAD, RAMCs would seek to produce aquaculture area framework plans which would deliver locally the sustainable development targets set out in the Scottish Aquaculture Strategy.

d) Working towards a sustainable future: the need for a National Aquaculture Strategy in Scotland

To date, the Scottish aquaculture sector has been developed without any overall strategy. As a result, development has been driven primarily by the desires of industry while wider environmental and socio-economic issues have not been addressed.

Aquaculture can no longer be considered as new, young, small-scale or environmentally insignificant. WWF believes that a National Aquaculture Strategy is required so that the Scottish Executive can draw together the issues and aspirations of all stakeholders with vested interests, and to develop an accountable, transparent framework that will shape the future of the industry and its place in the marine environment. We therefore welcome the Executive's recent announcement to hold consultations with a view to developing such a strategy.

WWF also believes that the development of this strategy should bring together the economic, social and environmental aspirations of all stakeholders. The strategy should comprise a suite of operating principles to guide the sector's future development, regulation and monitoring regime. This is long overdue and there is now an excellent opportunity for the Executive to consider the widely held environmental concerns in the broadest context.

WWF believes it essential that the National Aquaculture Strategy is truly comprehensive and is developed with a simultaneous reassessment of the aquaculture management system in Scotland. The strategy should set principles, targets and actions at a national level, and common standards concerning sustainability and environmental carrying capacity. It should require the establishment of regional aquaculture fora (see section above) that would formulate and implement area aquaculture framework plans. During the SEA and strategy development process, it is very likely that a comprehensive picture of legislative deficiencies will emerge. These too, will need to be addressed.

WWF considers that this national strategy should be undertaken by an appointed group of independent experts, so that a more integrated view of relevant issues can be developed. The Strategy Group would be seen to be neutral when engaging with stakeholders and interested parties, yet equally receptive to their respective representations. In this way, the process of developing a strategy can achieve much of the benefit of a full public enquiry without incurring either the time or costs.

WWF believes that the Scottish Aquaculture Strategy Group could function along the lines of the Agricultural and Environmental Biotechnology Commission. Further details can be found at www.aebc.gov.uk. Once the group has been convened, its formulation of strategy should encompass a number of key stages, including:

- the production of background briefing papers to provide an overview of relevant issues (these should be made available on a website);
- informal and formal briefings to be taken from experts and stakeholders;
- group members to visit appropriate sites;
- written submissions to be invited from a variety of sources including scientists, NGOs, policy makers, industry and the public;
- oral evidence to be gathered, to enable group members to question people on the basis of their written submissions;
- consultative meetings to be held so that members of the public can question key players and present their own views;
- focus groups or workshops to be convened so that the views of the public and key stakeholders, including coastal communities, can be established;
- deliberations to be made by the Scottish Executive – either in private or public – on the draft reports by the Aquaculture Strategy Group; and
- the group's findings to be made available to interested parties through press launches and events involving stakeholders and the public, providing an opportunity for further comment.

WWF recommends that:

a comprehensive Scottish Aquaculture Strategy should be developed by the Executive for approval by the Scottish Parliament. This strategy should be informed by a strategic environmental assessment under EC guidelines, and should balance the development and financial aspirations of an expanding industry with social and economic factors and the requirement for continued good stewardship and sustainability in Scotland's marine environment.

In the light of the environmental and sustainability shortcomings of the present regulatory system and the urgent need for a strategic approach to be taken to the future development of the industry, WWF strongly believes that there is merit in seeking a pause or temporary moratorium on further large-scale aquaculture development until the promised strategy is implemented.

This moratorium would avoid any temptation to rush applications through the existing system when the Scottish Aquaculture Strategy is being devised and implemented.

e) The need for the Scottish aquaculture industry to play a leading role in self-regulation and reform WWF recognises that engagement with, and comprehensive cooperation from, the aquaculture industry – and in particular the fin fish sector – is central to ensuring a more strategic and sustainable future for the inshore marine environment and the industry itself.

The salmon growing industry has taken action to bring about proactive environmental improvements. For example, Scottish Quality Salmon's environmental management system and production standards have been established to ISO 14001 standards. These initiatives aim to implement self-regulatory quality standards and to ensure continuing improvement in the environmental performance of participating farms. However, unresolved issues remain concerning the transparency and effectiveness of the system, even though its implementation is recognised as a potentially significant step forward.

Recent developments allow fish feeding systems on farms to become more efficient, with less fish-feed pellet wastage. The technology is not widely used, however, and may reduce the number of staff required in the operation of finfish farm. These and other technical improvements discussed earlier, such as fish vaccinations and coordinated pest control in Area Management Agreements, have helped reduce some aspects of the environmental footprint resulting from fish farming in sea cages. But there is much to be done and the industry itself is increasingly recognising the need for change and reform. As it matures, a more long-term commitment to sustainability and environmental objectives is being sought from all sectors of the aquaculture industry.

WWF recognises the need for the aquaculture industry – in particular the fish farming sector – to embrace the need for change and to put a strong commitment to long-term sustainability at the heart of its management. Taking the long-term view, it is apparent that all forms of Scottish aquaculture must rely on a healthy marine ecosystem to culture and market high-quality Scottish farmed seafood.

The Scottish aquaculture industry has a vital role to play in self-regulation and continual improvement. WWF believes that the industry should seize the opportunity to demonstrate a firm commitment to sustainability, environmental responsibility and stewardship.

Section 4: An Agenda for the Future of Aquaculture in Scotland – Progress Towards Sustainability, Innovation and Inclusion

Scotland's aquaculture industry is facing a watershed. Now, more than any other time since its beginnings in the 1970s, Scottish fish farming is being confronted with forces for change that will determine the way in which it will continue and develop. Such forces present themselves not from one source, but from many.

Regulation of the industry is undergoing considerable restructuring. Interest in the exploitation of new species is growing – species that may in time threaten the overwhelming dominance of salmon. The trend towards greater consolidation in finfish farming appears to continue (IntraFish 20.11.2000), despite the recent refusal of permission for the merger two of the UK's largest aquaculture production companies.

Increasingly, however, calls for change in the Scottish aquaculture industry result from disquiet over the way in which it is presently structured, controlled and operated. These calls come not only from environmental organisations such as WWF, but also from government and from within the industry itself (IntraFish 10.05.2001, 05.04.2001).

As we have illustrated, the marine aquaculture industry is diverse and, in some respects, potentially split between organisations producing finfish (primarily salmon) and shellfish. These sectors differ greatly in terms of environmental performance – one being relatively low in environmental impact and the other highly intensive – and they differ significantly in their socio-economic structure, which is relevant to the industry's sustainability. WWF considers the local ownership and management of an environmentally sustainable aquaculture business to be an important contribution to rural development in coastal communities. While it is recognised that intensive salmon farming provides much needed employment, the numbers employed have fallen since the mid-1990s, even though production continues to increase. Furthermore, a number of jobs generated may be part-time and not particularly well-paid, and profits generated by the multinational companies dominating the sector are unlikely to stay in the local area.

It is clear that certain aspects of the aquaculture industry can be considered as being either undesirable and/or unacceptable. Presented below is an agenda to promote change. The proposals attempt to identify and address many of the industry's negative aspects, and to stimulate debate on how it might progress towards sustainability, innovation and inclusion.

FORCES FOR ENVIRONMENTAL CHANGE

It is clear that aquaculture has changed significantly during the last two decades, transforming itself into a multi-million pound industrial sector occupying several hundred producing companies with sites throughout the west and north coasts of Scotland. Yet its expansion – especially in finfish production – has not been without environmental consequences, some of them considerable.

It would be wrong to say that the industry has not responded to the environmental impacts resulting from its operations: indeed, some progress has been made by the industry as it attempts to reduce its environmental footprint. However, these efforts might be considered as insufficient, while at the same time being offset by the rapid expansion and increasing intensification of some sectors of the industry in the last decade.

The environmental problems associated with fish farming may also stem in no small part from the manner in which the industry and its expansion has, until recently, been controlled. It could be argued that the socio-economic importance of the industry has brought about a culture of permissiveness relating to acceptance of environmental impacts resulting from aquaculture. This in turn has influenced the industry's regulation, resulting in either a political unwillingness or logistical inability on the part of those controlling it to properly consider its environmental effects.

The present and proposed regulations governing the industry have been assessed in the previous section of this report, and analysis and recommendations as to how they might be improved have been made, including:

- the review and reinforcing of EIA procedures to quality and consistency; and
- a more strategic approach to the development of aquaculture.

Key among these is the call for a Strategic Environmental Assessment and review to be undertaken into the industry's environmental status and performance. As is detailed below, it is also suggested that such a review/assessment should seek to integrate socio-economic factors, taking into account the issues relevant to all stakeholders with vested interests in the Scottish aquaculture sector.

The lack of strategic guidance and environmental assessments during the industry's development over the last 20 years has left us in the situation of not knowing whether present-day aquaculture in Scotland is sustainable. A strategic review and assessment is essential to the overall strategy.

Considering the scale and range of environmental impacts associated with the industry – especially the finfish sector – the conclusion might be drawn that the industry is not sustainable, as a result of:

- production levels (of individual sites or a number of farms in an area) having exceeded the carrying capacity of the environment in which they are located;
- sites being inappropriately located, resulting in significant conflict with other users, interests and resources;
- unacceptable levels of environmental impact resulting from waste production, and chemical therapeutics from the industry; and
- the industry consuming large quantities of resources such as fish products used to produce feedstuffs.

A strategic review of the industry, coupled with a national strategy and local framework plans, would enable its operations to be audited, and allow remedial action to address unacceptable aspects of its operations. Until this review is concluded, it is almost impossible for the industry to develop sustainably. This is a key issue, as exploitation of species other than those so far farmed is progressing at a considerable pace. Even though the industry may be unsustainable at the moment, its development is being allowed to continue rapidly. It is essential that past

mistakes and mis-assumptions associated with the development of salmon farming are not repeated. That is why WWF is calling for a pause or temporary moratorium on further large-scale aquaculture expansion in Scotland until a strategy is developed and implemented. This pause would also serve to avoid a repeat of the “gold rush” of applications seen just before the most recent locational guidelines were implemented in 1999.

The necessity of a strategic approach to aquaculture development has long been recognised in Norway, our main aquaculture competitor in Europe. There, the Nationwide Assessment of Sustainability of the Norwegian Coastal Zone and Rivers for Aquaculture – known as LENKA – was established during the late 1980s. It has been suggested that in many respects, the aquaculture industry itself has been a considerable force in reducing its own environmental impacts in Norway (Asche et al 1999). It is also interesting to consider the importance given to aquaculture research and development in Norway, with Asche et al (1999) again noting that:

“With respect to research and development, [it] has been seen that when the industry has failed to internalise environmental externalities [i.e. impacts], or other types of market failures have been present, the government has intervened to ensure that research and development has been supplied at (or closer) to a socially desirable level”.

This support for research and development, including aspects relating to the environment and sustainability, has led to Norway being considered as the technology leader in salmon farming, supporting six government and industry research institutes working in this area (University of Stirling Institute of Aquaculture, 1998).

In contrast, it appears that Scotland’s aquaculture sector has, for the most part, failed to respond to environmental issues in a similar way. But it should be noted that Scottish Quality Salmon – the industry quality scheme – has developed an environmental management systems guidance manual to help its members formalise and extend their environmental control measures in order to meet the requirements of the ISO 14001, the international standard for environmental management systems (Scottish Quality Salmon, Undated). This is a step in the right direction and is presented as a commitment by Scottish Quality Salmon to seeking improvement in the environmental performance of their members. However, it must be borne in mind that ISO 14001 has been criticised by a number of environmental management professionals who say it is “not particularly meaningful” and that it “says nothing about the environmental performance of a firm” (ENDS, 1998). Indeed, in their detailed analysis of the ISO 14001 standard, Krut & Gleckman (1998) go so far as to conclude that “on its own, ISO 14001 cannot achieve sustainable industrial development or even environmental performance improvement” and that “ISO 14001 may become, like many ISO standards, a market instrument – in this case with no connection to its original environmental moorings”.

So despite a welcome commitment of Scottish Quality Salmon to promote the environmental conditions under which its members produce salmon, the standards and environmental management system to which they adhere must be alive to these criticisms. For an industry-sponsored scheme to address the environmental concerns of its stakeholders and the public, it must demonstrably deliver continual environmental improvements, and the criteria for judging sustainability and environmental performance must be open to public scrutiny. At present, the scheme’s lack of transparency makes it difficult to assess its effectiveness in reducing the

environmental impacts of participating farms. WWF have highlighted these concerns to Scottish Quality Salmon who have given their commitment to addressing them (J Lindsay pers comm).

A number of institutes are conducting research and development in the UK aquaculture sector, including the University of Stirling Institute of Aquaculture, and the Seafish research laboratory at Ardtoe. Collaborative research is also being done by industry, academic institutions and government (Link Aquaculture, 2001). However, criticism has implied that UK research is not being matched by appropriate investment (IntraFish, 27.01.2000 & 07.08.2000).

FORCES FOR SOCIO-ECONOMIC CHANGE

Analysis of the socio-economic structure of Scotland's aquaculture industry suggests that it comprises a range of participants. Now, in the salmon sector at least, a small number of foreign-owned, multinational companies dominate production. The fact that the industry is so heavily dominated by a handful of companies is very distant from the original perception, held during the 1970s, of aquaculture being more akin to "crofting of the sea" – locally-owned, small-scale and non-intensive. The domination of the salmon sector by a small number of companies, which are predominantly multinational, might also be viewed as undesirable for a number of reasons – for example:

- By their very nature, large companies – especially multinationals – have management structures which often result in strategic and management decisions being taken at levels remote from local operations, potentially making consideration of environmental and social issues difficult and of low priority. This is of considerable significance in the case of aquaculture, an industry that is intrinsically associated with the natural environment and local communities.
- Multinational companies have operations centred at other global locations, so their interests are not solely concerned with the socio-economic welfare of communities in Scotland. Competitive aquaculture is developing rapidly outside Scotland: for example, it is reported that Chile is set to overtake Norway as the world market leader in farmed salmon production within three years (IntraFish, 01.03.2001). Despite the fact that international companies have committed themselves to the aquaculture sector in Scotland, the reality is that they operate within a global commercial structure, and are responsive to international economic and market conditions. They may therefore have to consider the status of part or all of their operations in Scotland in response to global market conditions.

In contrast with the salmon sector, shellfish aquaculture in Scotland appears to be composed of smaller, locally-based producers, although they may work collectively in the processing and marketing of their products. While the shellfish sector does not appear to be dominated by multinational companies, and is seen to be considerably less environmentally damaging than the finfish sector in Scotland, levels of production lag considerably behind salmon farming. A key reason, identified by the Shellfish Association of Great Britain, is the lack of government and EU funding and a "coherent" strategy, which hinders the development of shellfish farming in the UK (IntraFish 07.08.2000).

WWF believes that environmentally sustainable aquaculture that responds to the needs and aspirations of local communities should be encouraged, and that this might be effectively

achieved through more locally-owned production facilities. While locally-owned aquaculture may be seen as the ideal, in the present commercial climate it looks set to remain the exception rather than the rule. However, there is increasing pressure from consumers, politicians, regulators and local communities on all aquaculture producers to consider the social aspects of their employment and environmental policies and their dealing with other sea users. This pressure should be a force for good, and recent experience has shown that community consultation, liaison and investment is increasingly important to many rural industries. However, irrespective of the nature of the aquaculture – whether it involves shellfish or finfish – development must not exceed the carrying capacity of the marine environment in which it is established.

FORCES FOR CHANGE FROM THE MARKET

The domestic and overseas markets for Scottish aquaculture produce are well established. Produce is marketed as being high-quality, healthy, nutritious and natural, and produced in what is often portrayed as a clean and pristine environment. However, recent scares over issues such as ISA, and reported elevated levels of dioxins in farmed salmon, have influenced purchasing patterns – at least temporarily (IntraFish 12.10.1998, 09.01.2001).

It is evident that these concerns over the quality of food, including potential health risks whether real or perceived, and the environmental implications of intensive food production, have led to a trend towards “responsible consumption”: witness, for example, the growth in demand for organic produce in recent years. There is no reason to believe that UK aquaculture would be immune to this trend.

In their analysis of the environmental attributes in marketing aquaculture products, Young et al (1999) identified negative aspects. They note:

- pollution from fish farms is the most widely perceived impact. Features such as sedimentation, chemical dispersion into water bodies and interactions with wild fish stocks, birds, benthic populations and marine mammals, may be less directly obvious to the public eye, but are none the less gaining attention and may generate doubt and uncertainty;
- the vulnerability of many forms of commercial aquaculture in respect of their dependency upon “industrial” fisheries to supply feed, leading people to question the merits of catching one fish species simply to feed to another;
- concerns generated through the perceived inadequacy of legislation for aquaculture developments;
- adverse responses and activist targeting relating to issues associated with “factory production” such as stocking densities and the confinement of fish in cages – not dissimilar to those experienced by the livestock farming sector; and
- health and safety concerns linked to production practices such as the chemical and microbiological cleanliness of the production environment and the use of chemicals at various stages of intensive aquaculture.

Growing public concern may increasingly impact upon the future market for Scottish aquaculture produce. This concern may also arise from seemingly indirect factors, such as the presence of genetically modified products in the foodstuffs fed to salmon. Any reduction in

demand for farmed salmon, for example, could have serious consequences for the market price, and would impact upon producers, given that global production levels are rising and prices for salmon are low (IntraFish 04.04.2001).

If consumers are concerned about the perceived quality of products, they will seek alternatives. For example, a recent television programme suggesting that intensively-farmed Scottish salmon contained elevated levels of dioxins led to a boost in demand for organically-farmed salmon (Intrafish 26/01/2001). Certain sectors of the industry need to maintain public confidence in the quality of their products – and this must involve transparency in areas such as quality assurance schemes.

As the industry has matured, there is an increasing realisation that it cannot, and probably should not, compete with bulk-producing countries such as Norway and some Latin American states in the production of farmed fish. Instead, Scotland is beginning to concentrate on producing a high-quality product and marketing it to the top end of the market. Recent initiatives in organic salmon have been popular with both retailers and consumers, and have demonstrated that a ready market exists, and that the price of premium products can be set at a relatively high level.

But consumers are seeking assurances that these products are not only safe and healthy to eat, but have also been grown in an environmentally sustainable and socially responsible way. A coordinated concentration in this higher-quality market by the Scottish industry would allow it to remain commercially successful and lead the development of truly sustainable aquaculture techniques and practices.

CHANGE FOR THE BETTER – PROGRESS TOWARDS SUSTAINABILITY, INNOVATION AND INCLUSION

WWF recognises that the aquaculture industry is extremely important to Scotland. We also believe that it can only continue to prosper if it moves towards a sustainable existence that takes into account the valid interests of environmental conservation and other stakeholders in the marine environment. It must also work to support the wellbeing of local communities among whom it operates. In WWF's view, some sectors of the industry are simply not environmentally sustainable in their current form, and urgent action is required to address this. To develop sustainable aquaculture, WWF recommends that:

- a comprehensive strategic review and environmental audit be undertaken to determine at national, regional and local levels the sustainability of the Scottish aquaculture industry. Once completed, the review and audit should be used to formulate a National Aquaculture Strategy for Scotland and to develop and implement local aquaculture framework plans. These should seek to bring about the sustainable functioning and development of the industry, while simultaneously initiating action to address its non-sustainable aspects. Until this strategic review has been undertaken and a national strategy is in place, a moratorium on the development of intensive aquaculture projects in Scotland should be introduced.
- Due regard should be given to the role of local communities and stakeholders. Multinational and locally-owned businesses have a social responsibility to ensure their developments take place in consultation with local communities and other sea users.

- Sufficient resources and investment should be committed by government to facilitate socially desirable levels of research and development in sustainable aquaculture. It has been noted that investment in R&D is insufficient to encourage lower-impact aquaculture such as shellfish farming. By investing in R&D, not only can such sectors be encouraged, but Scotland could also fulfil its potential as a world leader in the development of sustainable aquaculture techniques, thereby producing economic and social benefits at home and abroad.
- In developing a sustainable aquaculture industry in Scotland, the government should promote production techniques that utilise low-intensity finfish stocking, and are not dependent on the unsustainable exploitation of industrial fisheries to provide feed. Government and industry should work collaboratively to develop new markets for sustainable aquaculture products, which promote the added value and desirability of seafood reared with due regard for the wider marine environment. This should include the development and adoption of standards for aquaculture as part of the Common Fisheries Policy process.

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