Peach Cove Fish Farm Action Group **www.protectpeachcove.com**
Po Box 3014
Onerahi
3/11/03

Paul Batten
NZ Recreational Fishing Council

Dear Paul,

We are pleased that the NZRC is looking at the possible impacts of aquaculture in Northland on recreational fishing.
We have found ourselves wearing two hats as we go through the process with the Peach Cove Appeal as many of the issues will be pertinent to the potential or otherwise of aquaculture for NZ's coastline.
Whilst at this stage the Peach Cove Consent is our primary concern, we are becoming increasingly interested in the AMA concept and process, and wonder how it ties in with the comprehensive Coastal Strategy Planning process, cost/benefit evaluation against other opportunities, conflict with recreation use and conservation etc.

For your information enclosed is some of the material we have collected. A look at items 1 and 2 will give an overview, supporting material is provided in 3 & 4. (some of which you will have already seen)

1. Summary of potential issues.

2. Frequently asked questions. (Dr George Coulter).

3. The Global Situation (Summary) (Justin Murfitt).

4. 'Aquaculture in the European Union: Present Situation and Future Prospects', 1st October 2002: Five Fundamental Flaws of Fish Farming; (Don Staniford)

I understand that the NZ Yachting Federation, Boating Industry Association, Big game fish Council and others are also planning to have input into the AMA process.

Further info is available from the links on the www.protectpeachcove.com web site.

Regards,
Martin Hunt.

1. SUMMARY; Fin Fish Farming Issues

* Shell fish and fin fish farming potentially have high visual impact and can conflict with recreation, navigation, traditional use and directly conflict with tourism.
In terms of ecological impact they are fundamentally different operations.

* Fin Fish (feedlot) operation requires large quantities of foreign inputs, (Soya and fish meal feed pellets and chemicals) resulting in high volume uncontrolled discharges of nutrients, feed wastes and chemical residues. Shellfish (bivalves) feed on naturally occurring plankton.

* Ecological impacts have proven catastrophic wherever fish farming is practiced extensively (Europe, North and South America). Residue problems are already evident in Marlborough and Glory Bay Stewart Island

* The stock from **each** 20m-diameter standard fish cage will excrete waste equivalent of up to 1000 people in terms of nutrients. (An 'economic' sized operation of 25 cages could equal the waste equiv of 25,000 people)

* Nutrient imbalances are primary triggers for toxic algae blooms ('permit granted to dump up to 2800 ton of Salmon killed by algal bloom'). (Vancouver Sun Sept 13 2002)

*** International experience with finfish farms shows a high risk of contamination of feral stocks by disease, parasites, lice and genetic instability (In Scotland the salmon farms killed off sea trout fishing within a decade) (Time Magazine Nov 2002)**

* Farmed fish (salmon) are the most chemically contaminated food on supermarket shelves (UK Govt Committee on Toxicity of Chemicals in Food Oct 2002)

* Finfish operations are generally controlled and owned by multinational companies, New Zealand Marine consents are totally transferable.

* Finfish operations tend to low labour input (overall, there are no more jobs in aquaculture now than 10 years ago despite a 5 fold increase in world production).

* Noise and visual intrusion from service boats, barges tied along side, generators, spraying and feeding machinery can combine to transforming a peaceful marine environment into an industrial zone

* The current moratorium on aquaculture and AMA legislation gives New Zealand an ideal opportunity to decide how industries such as finfish aquaculture should be managed in our coastal waters. It is important that the consultation process used to develop AMA's is not captured by the aquaculture industry and supporters, and that wider concerns and views are aired.

The overseas experience with finfish aquaculture certainly demonstrates that caution should be exercised before such an industry is widely embraced in New Zealand.

2. FREQUENTLY ASKED QUESTIONS ABOUT FISH FARMING

Dr George.Coulter. (Aquactic Biologist) 19 Oct 2002

What is Sea Cage Aquaculture (fish-farming)?
Moored sea-cages. . Structure - above and below water surface
Fish fed with made-up foods (fish meal, soya, etc) - not like mussel/oyster farms.

Is much known about fish-farming?
Been around since 1950s. Currently a major producer almost world-wide. Fairly new in NZ.
A lot is known about fish farming now. Much of it should apply here.
Proven technology. Methods well known. Markets vast. So fish-farming could expand here rapidly
Plenty information available (Australia & rest of world). Can supply web-sites & references.

What does the operation entail economically?
Business done generally by big companies – links to large investment (most multinational)
Involves farm operation, distribution, marketing (esp. overseas), fish-feed industry
Not labour intensive. Feed imported. Product exported.
By far the largest profits go to distant shareholders. Little gain/benefit locally to District.

What environmental effects have been associated with fish-farming elsewhere?
Serious enviromental problems have shown up.
Rash of public protests, petitions, press releases, action groups, enquiries, moratoria, etc.
Fish-farming can be dirty business, with wide range of impacts; examples -

- *Wastes accumulating on sea-floor and released around in sea causing pollution,
- *Algal blooms degrading sea environment; certain blooms toxic,
- *Links between toxic blooms, shellfish poisoning, closure mussel/oyster farms,
- *Routine use toxic chemicals to control parasite infestations among the enclosed fish, cross infection with feral fish
- *Use of therapeutants, antifoulants, vitamins, fish-flesh dye, etc,
- *Introduction of pathogens and new genetic strains of fish,
- *Common addition of GM constituents in fish-feed, particularly soybean

What effects on people living around and using coastal waters?
Not resident- or tourist-friendly, eg.

- *Visual impact incompatible with natural values environment,
- *Pollution,
- *Navigation impediments, especially to yachties,
- *Conflict with recreational and commercial fishers, destruction of wild fisheries
- *Conflict with conservation aims,
- *Conflict in many cases with existing Planning for coastal use.

Will these sorts of things happen at Bream Head?
There is every reason to expect that they may; which is bad because -

- *Bream Head is one of highest category Conservation sites of natural value in NZ,
- *Commercial fish-farming would seriously compromise natural character of area,
- *If fish-farming is allowed in such a place, that has wide implications for rest of coast

Will a fish-farming industry started at Bream Head spread around coast?
Can expect that a well-proven, highly profitable industry will spread quickly (as rest of world)

What are potential effects upon Northland Coast?
Disastrous unless the industry is located in places where has least environmental impacts.
This, of course, is the chief point of current Government moratorium – to decide upon suitable AMAs. For a rational future, all developers should have to conform to this.

It is also inconsistent with the direction taken by the Whangarei Heads community in the planning process of the current Strategic Coastal plan.
A group of residents extending well beyond the immediate Whangarei Heads (the Manaia Vision Project, (MVP)), has been evaluating public opinion through wide consultation. It appears that the spread of a fish farming industry without carefull planning and siting is in direct conflict with this public opinion.

Conclusions
"This is a test case. It has serious immediate implications for the rest of the coast. If a fish farm is allowed in such a sensitive place as Bream Head, there is nothing to prevent that happening anywhere and everywhere up the coast - adversely affecting many people (to enrich just a few). This case must not be allowed to slip past the Government's 2-year Moratorium, which intends that fish farming should be properly planned and located."

3. THE POTENTIAL EFFECTS FINFISH SEA CAGE FARMING:
A Brief Summary ; Justin Murfitt

This paper attempts to highlight some of the environmental issues associated with the rapid growth and development of sea cage aquaculture as experienced overseas, particularly in Europe and the America's. These issues are particularly relevant to New Zealand given the recent moratorium on aquaculture imposed by the Government and the requirement for regional council's to define aquaculture management areas (AMA's) within the coastal marine area around New Zealand. Given the major role of public consultation in defining areas suitable for aquaculture, it is important that the potential effects of such activity are widely understood.

This paper does not examine potential economic or social benefits of the industry, nor is it intended as an exhaustive scientific analysis. The aim is merely to identify and raise awareness of environmental issues experienced over the last few decades, during which massive development and expansion of the aquaculture industry has occurred.

Sea Cage Farming:

Finfish farming in sea cages involves two stages: (1) Collection of larvae and the raising of these juveniles in a hatchery until they are able to cope with conditions in the sea cage. (2) The fish are then transported to the sea cages for on-growing to harvest size, where they are raised on added feed. Finfish farming in New Zealand has historically consisted of the rearing of salmon in colder South Island waters, such as the Marlborough Sounds and Big Glory Bay, Stewart Island. Recently other species, notably snapper and kingfish have been investigated for commercial farming in New Zealand's warmer waters, although the methodology and technology used is much the same.

Sea cages usually comprise a floating polythene ring 20-30m in diameter and between 1-2m in height above water from which circular nets are suspended to a varying depth between 6-12m. The mesh size of the nets must be small enough to restrain the smallest fish yet enable adequate water flow to remove wastes and bring in oxygenated water. These nets must be cleaned regularly (every few weeks in summer in warm water climates) to prevent the build up of algae and marine vegetation in order to maintain water flow. Antifoul (leachate chemicals painted onto nets) is often used to retard the fouling of the nets.

The cages are anchored to the sea floor with large mooring blocks, while bouys are used to identify the perimeter of the structures. Pelletised feed is added either manually or by automatic feeder on a daily basis to sustain the fish until harvest. Feeding rates vary with seasonal water temperature, with summer rates reaching 3-5% of body weight depending on the species farmed. Stocking rates in New Zealand for snapper are expected to be 10kg or so per cubic metre, while kingfish may reach up to 15kg/m^3 which is similar to that of salmon. Harvest rates vary between the species farmed, with kingfish expected to mature to a size of 3kg within 14 months, while snapper may take 18 months to reach a marketable size of 350g. These figures are largely speculative as very little on-growing of kingfish and snapper in sea cages has been undertaken on a commercial basis in New Zealand, although it is understood they are farmed in Australia.

The Global Picture:

Aquaculture is the fastest growing sector of the world food economy. As fisheries around the world experience increasing pressure, a marked transition from a capture to a culture economy has become evident. In 1984 aquaculture accounted for 8% of fisheries production, increasing to 25% in 2001 and by 2020 aquaculture is predicted to exceed capture fisheries. This is already the case with salmon (Staniford, D: 2002 QCC). This rapid growth has given rise to significant investment and the formation of large multinational companies, resulting in an escalating demand for fish meal and oil used in pelletised aquaculture feeds. The International Fishmeal and Oil Manufacturers Association predict that by 2010 aquaculture could consume 56% of the world's fishmeal and 90% of the world's fish oil.

This demand for fishmeal and oil stems from the fact that finfish aquaculture tends towards the farming of carnivorous species such as salmon, sea trout, sea bream and other species high up the food chain, which has been likened to farming tigers. This is in contrast to traditional land based agriculture, whereby herbivorous animals such as cattle, sheep and chickens are farmed. It has been calculated that it takes over 3 tonnes of wild fish to produce 1 tonne of salmon (and up to 5 tonnes for other marine fish) and such inefficiencies have given rise to a search for alternative feeds such as soya, seaweeds, krill and plankton.

The industry has also seen major advances in technology and efficiency, whereby the amount of labour required to operate a fish farm has been reduced significantly and this trend is set to continue. Press reports from Europe indicate that there are no more jobs in salmon farming now than there were 10 years ago despite output having risen fivefold. Last a year a major Norwegian company doubled its output while simultaneously reducing labour costs by 15%.

The rapid growth of the finfish aquaculture industry over the last few decades, particularly salmon farming, has advanced well ahead of the development of environmental and public health safeguards and often in the absence of appropriate monitoring. This has resulted in grave environmental concerns as early as the 1980's in countries where finfish aquaculture is well established, such as Scotland and Ireland. These concerns relate to a number of issues, including the use of antibiotics, pesticides and other chemicals to control pests and diseases, the spread of disease and lice to wild stock, large scale escapes of farmed fish displacing wild stock and the biological effects on marine ecosystems of wastes from farms discharged into the ocean. Nils Kautsky of the University of Stockholm in Sweden has suggested that the "footprint" of a fish farm (its influence on the local environment) can be up to 50,000 times larger than the physical farm itself.

These concerns are now widespread throughout other countries which have embraced sea cage finfish aquaculture on a large scale such as Chile, Canada, America, Australia and Norway and have given rise to widely publicised campaigns in opposition to the establishment of finfish farms by local communities and environmental groups. Of particular note is the "Save the Bay" campaign currently being run by the Queensland Conservation Council in opposition to a snapper and kingfish cage farm proposal in Moreton Bay.

Sea cage finfish aquaculture is relatively undeveloped in New Zealand, although shellfish farming is a well established and growing industry. However, the opportunities and threats inherent within the finfish farming industry are new and yet to be analysed in depth in this country. We can only learn from the overseas experience and the moratorium on aquaculture and the aquaculture management area (AMA) legislation provides a timely opportunity to examine the costs and benefits of such an industry in New Zealand.

Potential Effects:

The following is a brief summary of the potential adverse environmental effects associated with finfish aquaculture. The summary is by no means exhaustive and is somewhat hampered by the relatively recent development and explosive growth of the industry, coupled with an historic lack of baseline data and monitoring. Recently, in Europe particularly, rigorous environmental standards and guidelines have been

imposed upon the fish farming industry with a view to managing environmental impacts, while various moratoria similar to that imposed in New Zealand have been proposed. In some cases such as Scotland, parliamentary enquiries have been implemented, while in British Columbia, a salmon aquaculture review has been commissioned by Government. The overseas experience can largely be extrapolated into New Zealand conditions and provides a good indication of potential adverse environmental effects and management regimes.
It should also be noted that there are also potentially significant positive socio-economic effects associated with the development of such an industry and New Zealand's excellent water quality and range of fish species could provide unique economic opportunities in this regard. However, this potential must be balanced against environmental concerns and opportunity costs associated with other uses of our coastal waters.

Potential adverse effects of sea cage finfish farming include (no particular order):

1. **Landscape & Amenity:**
   Sea cages can have impacts upon landscape, natural character, aesthetic, wilderness and amenity values due to the introduction of structures into coastal environments. The necessity for high water quality means such farms are often located in undeveloped or pristine coastal environments with high landscape, aesthetic, conservation or wilderness values. They also require relatively deep water, usually between 15 and 20m and therefore cannot be sited in shallow or estuarine locations.

2. **Wastes:**
   Volumes of feed discharged daily into the coastal marine area as a result of sea cage finfish farming can be measured in the tonnes, even from small farms, consequently the amount of uneaten feed and metabolic wastes entering the coastal marine area is significant. The World Wide Fund for Nature (WWF) have estimated that the 115,000 tonnes of Scottish salmon produced in 1999 equated to the phosphorus and nitrogen sewage waste equivalent of 9.4 million and 3.2 million people respectively (Scotland's population is around 5.1 million). Furthermore, a report by Santiago based Terram Foundation indicates that the organic waste from Chile's fish farming industry is equivalent to the wastewater from 5 million people.
   These wastes are not collected or treated and therefore discharge directly into the marine environment. This material, if allowed to accumulate beyond the rate at which biota and sediments can assimilate the additional nutrient load, can smother benthic (sea floor) species and result in anoxia, the production of hydrogen sulphide and methane. Such conditions are toxic to most organisms and can result in the modification of benthic habitats and biodiversity beneath or near the cages. Research in New Zealand has shown that sea cage farming can reduce the diversity of a range of species including bryozoans, sponges, tunicates, crabs and starfish (Gillespie and McKenzie; 1994). Further research in Big Glory Bay, Stewart Island indicates that changes in species diversity can occur up to 200 metres from the cage (Southland United Council; 1988).

   Most sea cage finfish farms rely either upon "flushing" (by tidal currents) or "fallowing" (periodically moving the cages) to avoid localised deposition of wastes. The build up of such wastes can also result in an increased risk of toxic algal blooms such as pfiesteria and may also impact upon the health and human use of shellfish. The impact of salmon farms on the mortality rate, growth and taste of shellfish is currently the subject of a study in British Columbia. Siltation as a result of salmon farms has also been noted on beaches in British Columbia, which is of particular concern to First Nations in relation to the use of their traditional resources.

3. **Pest & Disease Control:**
   Farmed fish are often susceptible to parasitic sea lice which feed on the skin and mucous of the fish. Farmed fish are treated with antihelminthic drugs to control parasites such as sea lice and the monogenean worm prevalent in kingfish. These drugs are usually administered as an additive to feed and require a 48hr withholding period before the fish can be consumed. Products used in the control of sea lice include ivermectin and emamectin benzoate (SLICE).

   There has been some concern expressed overseas, particularly in Britain,that these drugs may adversely impact upon on crustaceans. A New Scientist article has revealed evidence suggesting that use of pesticides to kill sea lice may also impact upon marine biota. The research reveals an "almost complete absence" of certain key crustaceans and that "the possibility of a large scale effect that may be related to the use of chemicals on fish farms." (New Scientist; Apr 24 2002: The Big Catch). In addition to this, feed containing these chemicals cannot be confined to the farm and may be consumed by wild fish, which in turn could be caught and consumed by recreational or commercial fishers without knowledge of the chemical ingested or the typical 48hr withholding period applicable to these drugs.

Antibiotics are also commonly used in the finfish aquaculture industry to combat disease. When not absorbed by the fish, the antibiotic can enter the environment from uneaten feed and faeces and may impact upon naturally occurring bacteria in marine sediments. The most common and persistent form of antibiotic used is oxytetracycline, which although it degrades after 30 days in the water column, is detectable in marine sediments for several months. This may result in antibiotic resistant strains of bacteria, although there is relatively little research available as yet to fully assess potential impacts.

4. **Loss of Recreational and Economic Opportunities:**
   The location of sea cages in coastal waters can conflict with other uses of this public space, particularly recreational uses such as boating, fishing, kayaking and diving, as the cages necessarily exclude the use of these areas by the public. This especially evident where cages are located in, or adjacent to areas of high amenity or conservation value. The structures and servicing/maintenance required can also adversely impact upon the amenity value and aesthetic appreciation of the coastal environment via essentially industrial effects such as noise, lights and service/maintenance operations. There can also be potentially negative impacts upon other economic uses of coastal space, such as “eco and wilderness” tourism, fishing and traditional harvest by indigenous populations.

5. **Entanglements & Conflicts With Marine Mammals:**
   Structures in the coastal marine area can have negative consequences for marine mammals and other marine creatures, particularly if located within breeding, feeding or migratory routes/sites. Fur seals have been known to invade sea cages and feed on farm stock, tearing nets and resulting in the escape of fish. Other animals such as whales, dolphins and diving seabirds may also become entangled in the structures, particularly where these structures do not present an obvious physical barrier (e.g mooring ropes, semi-transparent nets etc).

6. **Cultural Impacts:**
   Water quality and the availability of traditional sources of seafood are of particular importance to Maori. Due to the above potential impacts of finfish farming, the industry can have significant impacts upon cultural and spiritual values and the use of traditional resources.

<u>Marine Farm Approvals:</u>
Finfish farming in New Zealand’s coastal marine area requires coastal permits for the erection of structures and the discharge of contaminants to water in terms of the Resource Management Act 1991 (RMA) and a permit in terms of the Fisheries Act 1983 to hold and harvest marine life. Opportunities for public comment are available via both these processes. A right of appeal to the Environment Court is available under the RMA, but the only avenue to dispute a decision made under the Fisheries Act is via Judicial Review, usually to the High Court.

The 2year moratorium on aquaculture currently prevents new applications for aquaculture development in the coastal marine area until aquaculture management areas (AMA’s) are defined and incorporated into the coastal planning regime under the RMA. However, applications notified prior to the imposition of the moratorium can still be assessed and approved as was the case with a finfish farm proposal adjacent to Bream Head, Northland, recently approved by the Northland Regional Council. This proposal is the subject of an appeal to the Environment Court

<u>Conclusions;</u>

The current moratorium on aquaculture and AMA legislation gives New Zealand with an ideal opportunity to decide how industries such as finfish aquaculture should be managed in our coastal waters. The Northland Regional Council is currently calling for public input and consultation on the establishment of aquaculture management areas, which will define areas suitable for aquaculture and how these are to be managed. It is therefore important that the consultation process used to develop AMA’s is not captured by proponents of the aquaculture industry and that wider concerns and views are aired. This requires an informed and motivated body of public, interest groups and stakeholders to get involved in the consultation process to determine the best way forward on a regional basis.

The concerns expressed overseas and outlined above must be taken into account in the development of AMA's in New Zealand, given the statutory duties and obligations imposed on Local Government via the Resource Management Act 1991 and the New Zealand Coastal Policy Statement, to manage the environmental effects of the use and development of natural and physical resources. Perhaps the most relevant obligation in this instance is the adoption of the precautionary approach promoted in the New Zealand Coastal Policy Statement and applicable where effects of activities on the coastal environment are unknown or uncertain. The overseas experience with finfish aquaculture certainly demonstrates that caution should be exercised before such an industry is widely embraced in New Zealand.

4. Sea cage fish farming: an evaluation of environmental and public health aspects (the five fundamental flaws of sea cage fish farming)

Excerpts from a paper presented by Don Staniford at the European Parliament's Committee on Fisheries public hearing on 'Aquaculture in the European Union: Present Situation and Future Prospects', 1st October 2002:

http://www.europarl.eu.int/hearings/20021001/pech/programme_en.pdf
http://www.europarl.eu.int/committees/pech_home.htm

For a full copy of the paper:

http://www.watershed-watch.org/ww/publications/sf/Staniford_Flaws_SeaCage.PDF

Introduction:

Aquaculture is the fastest growing sector of the world food economy but has proceeded way in advance of adequate environmental and public health safeguards. As fish have become privatised, the last two decades have seen a fundamental shift away from 'family' towards 'factory' fish farming and a marked transition from a capture to a culture economy. In 1984 aquaculture accounted for only 8% of fisheries production leaping to ca. 30% in 2002 and in the coming decades aquaculture is predicted to overtake capture fisheries (Williams: 1996, Tacon and Forster: 2001, FEAP: 2002). The development of this 'new' industry (OECD: 1989) has caused severe environmental problems. Aquaculture is nothing new of course: the new development has been in the global expansion of intensive sea cage fish farming. As a 'Forward Study of Community Aquaculture' commissioned by the European Commission (EC) states:

"As the aquaculture industry has developed and has incorporated technological advances, it has moved from extensive to intensive systems. This intensification of production methods has been accompanied by an increase in the potential threat to the already precarious ecological equilibrium in our streams, reservoirs and oceans….Recently, this intensification of aquaculture production has led to the industry being regarded as one of the leading polluters of the aquatic environment" (MacAllister and Partners: 1999, p55)

The development of intensive sea cage finfish farming has therefore overshadowed and encroached upon shellfish farming areas and traditional inshore fisheries. Such is sea cage fish farming's global reach that its demands on fish meal and fish oil is placing pressure on capture fisheries in the South Pacific, Africa, Asia and the Arctic.

Sea cage finfish farming in particular presents insurmountable problems in terms of mass escapes, GM fish, the spread of infectious diseases, parasite infestation, the reliance upon toxic chemicals, contamination of the seabed and the bioaccumulation of organochlorine pesticides such as dioxins and PCBs (Milewski: 2001, Staniford: 2002b). Nor is the problem restricted to Scottish salmon farming (SWCL: 1992, 1993, Ross: 1997, WWF: 2000, FoE: 2001a, Berry and Davison: 2001, Scottish Executive: 2002b, Scottish Parliament: 2002a); reports have also focussed on salmon farming in Ireland (O'Brien: 1989, O'Sullivan: 1989, Oliver and Colleran: 1990, Meldon: 1993), Norway (Ervik et al: 1997, DNM: 1999), Canada (Ellis: 1996, Milewski et al 1997, Sierra Legal Defense Fund: 1997), Chile (Claude et al: 2000) and the United States (Goldburg and Tripplett: 1997). More recently the expansion of tuna, sea bass and sea bream farming in the Mediterranean has received long overdue attention (MERAMED: 2002, Studela: 2002, WWF: 2002a). Sea cages have spread like a cancer around the European coastline. As Dr Sergei Tudela of WWF states:

"Intensive industrial scale aquaculture has become synonymous with pollution and destruction of the marine environment, conflicts with other resource users, and high levels of toxins in the fish produced. The spread of aquaculture, a cause of increasing concern and growing alarm, has been described as a cancer at the heart of the coastal environment" (Tudela: 2002)

That does not mean that all aquaculture operations are fatally flawed – shellfish farming is relatively environmentally benign compared with an intensive finfish farming industry that is reliant upon inputs of feed and chemicals and discharges contaminated wastes. In the UK, Scottish Natural Heritage noted the 'marked incompatibility' between the shellfish and finfish farming sectors (Fagan: 2001, SNH: 2001). Supporting the expansion of shellfish farming may therefore necessarily involve supporting a reduction in sea cage fish farming: it is a case of "either….or" not "both….and". The clash of cultures between finfish and shellfish farmers was seen last year when the Association of Scottish Salmon Growers voted for a moratorium on salmon farming (Ross and Holme: 2001). Far from criticising aquaculture per se, this paper highlights both the environmental and public health threats arising from sea cage fish farming focusing on five fundamental flaws of sea cage fish farming; namely wastes, escapes, diseases and parasites, chemicals and feed/food.

The Five fundamental flaws of sea cage fish farming:

1) Wastes:

Open sea cage fish farming, be it tuna, sea bass or sea bream farming in the Mediterranean or salmon farming in Scotland, Ireland and Norway, discharges untreated wastes directly into the sea. Nor are aquaculture wastes an insignificant source of nutrients and wastes (Staniford: 2002b). The EC admits in its 'Strategy for the Sustainable Development of European Aquaculture' that: "In areas with numerous farms, nutrient enrichment and the risk of eutrophication are significant issues" (EC: 2002c, p9). According to the Norwegian Directorate of Nature Management "in many countries, the aquaculture industry is the greatest source of human-created emissions of phosphorus and nitrogen" (DNM: 1999). WWF have estimated, for example (WWF Scotland: 2000), that Scottish salmon farms discharge the sewage waste equivalent of over 9 million people (Scotland's population is 5.1 million). Both OSPAR and HELCOM have recently highlighted the problem of nitrogen and phosphorus discharges from both freshwater and marine farming operations into the North Sea and Baltic (OSPAR: 2001, HELCOM: 2001). In April 2000 the Norwegian State Pollution Control Agency admitted that salmon farms were "now major polluters" (ENDS: 2000). In the Mediterranean the EC is sponsoring research into cutting wastes due to problems with poor feed conversion in sea bass and sea bream farms (EC: 2002i).

The link between toxic algal blooms (and shellfish poisoning events such as DSP, ASP and PSP) and fish farm wastes is the subject of attention both in the Mediterranean and Scotland (Gowen and Ezzi: 1992, Berry: 1996, 1999, Davies: 2000, Navarro: 2000, Ruiz et al: 2001, MERAMED: 2002, Scottish Executive: 2002b). The Scottish Executive, for example, have hired Professor Smayda from the University of Rhode Island and Professor Rydberg from Stockholm University to investigate such a link (Staniford: 2002b). Research has also focussed on Scandinavia (Ackefors and Rosen: 1979, Ruokolahti: 1988, Aure and Stigebrant: 1990, Persson: 1991, Ronnberg et al: 1992, Braaten: 1992, Enell: 1995), Ireland (Gowen: 1990), Europe as a whole (Alabaster: 1982, Rosenthal et al: 1993, GESAMP: 1996, OSPAR: 2001) as well as other countries around the world (Nishimura: 1982, Black: 1993, ICES: 1999b, Martin: 2000, Arzul et al: 2001). An EU-funded project (AQUATOXSAL) in Latin America, conducted by French and German researchers, is also due to report later this year (Arzul et al: 1999, 2002, EC: 2002g).

The Dutch multinational Nutreco, the largest fish farming and fish feed company in the world, has long been involved in research looking at the link between eutrophication and fish feed (Talbot and Hole: 1994) but continues to discharge wastes directly into pristine coastal waters. EC-sponsored research has also highlighted the negative effects of waste loadings on fish health (EC: 2000f). And there are public health concerns surrounding shellfish poisoning events such as Amnesic, Diarrhetic and Paralytic Shellfish Posioning (ASP, DSP and PSP) related to salmon farms. For example, DSP affected mussels collected from salmon cages in Loch Seaforth in Scotland (Sandison: 2000) led to 49 people in two London restaurants being treated for "nausea, vomiting, diarrhoea, abdominal pain, and feeling feverish" (Scoging and Bahl: 1998). The technology required for closed containment systems already exists (G3 Consulting:

2000) and is being commercially developed in Canada (Cutland: 2002) but it has not been adopted in Europe as farmers dismiss it as too expensive. The Commission's latest proposals for "new waste collection systems under cages" represent the bare minimum (EC: 2002c) – indeed, Scottish research has existed for years (SEPA: 1998a). The suggestion that Council Directive 91/676/EEC (which "aims to reduce water pollution caused or induced by nitrates from agricultural sources, including the spreading or discharge of livestock effluents") "should be extended to include intensive fish farming" is a welcome one but not before time (EC: 2002c). In allowing sea cages to discharge contaminated wastes into the sea, however, countries are permitting farmers the free use of pristine coastal waters as an open sewer (Folke and Kautsky: 1994). Closed containment systems would not only stem the tide of pollution from sea cages but would also prevent escapes, stop the spread of diseases and parasites to wild fish and reduce the need for chemicals.

2) Escapes:

EC-sponsored research has highlighted the negative impacts of farmed salmon escapees on wild fish in Norwegian, Irish, Scottish and Spanish rivers (McGinnity et al: 1997, Clifford et al: 1998, Fleming and Einum: 1997, EC: 2000e, EC: 2000h, Fleming et al: 2000, McGinnity et al: 2002, Scottish Executive: 2002b). AQUAWILD, for example, aims "to assess genetic and environmental impacts of cultured fish on wild conspecifics at various life stages through competition and interbreeding" (EC: 2002h). A forthcoming scientific paper by researchers at the Queens University Belfast will reveal the results of a 10-year Irish investigation (funded by the EC) into the impact of escaped farmed salmon on wild fish (McDowell: 2002). Preliminary results suggest that farmed fish escapes and hatchery-reared fish are having such an impact that wild salmon stocks are precipitating into an "extinction vortex" (McGinnity et al: 2002). As well as spreading parasites and 'genetic pollution' via interbreeding and hybridisation, escapees have the capacity to spread infectious diseases to wild fish populations. For example, in Scotland since May 2002 (when it became law to report escapes) 3 out of the 4 escapes (totalling 57,000 fish: equivalent to the entire wild salmon catch in Scotland) came from farms infected with Infectious Pancreatic Necrosis (IPN). New information from the Scottish Executive reveals that there have been 28 escape incidents (involving an estimated 500,000 farmed fish) from Scottish fish farms affected by IPN restrictions since 1998 (Scottish Parliament: 2002b).

The inevitable risk of escapes was something that the UK's Agriculture, Environment and Biotechnology Commission took into consideration in September 2002 when it recommended a ban on GM salmon in sea cages (AEBC: 2002). Such a precautionary position is reinforced by the EC's 'Strategy on the Sustainable Development of European Aquaculture' which states that: "The potential deliberate release of transgenic fish without containment measures raises public concern in terms of risk to the environment" (EC: 2002c). However, the EC's ongoing investment into GM fish technologies and research (including salmon, tilapia, trout and carp) does not inspire confidence that GM aquaculture species will not be commercially developed (EC: 2000d, EC: 2000g, Carrell: 2001a, 2001b, 2001c, 2001d, Carrell and Lean: 2001, EC: 2002k, EC: 2002l). Field trials of GM salmon took place in Scotland on the shores of Loch Fyne as far back as 1995-6 (BBC: 2000a). EC-funded GM salmon research has been conducted at the National University of Ireland in Galway (EC: 2000d, EC: 2000g) although the researchers involved have been reluctant to divulge details (Charron: 2001). And outside the EU, Hungary has already completed GM fish experiments with Chinook salmon, carp and zebrafish (EC: 2002j).

In February 2002 over half a million salmon escaped in a single incident in the Faroes (Gardar: 2002a). In Scotland alone there have been over 1 million reported escapes since 1997 (Aitken: 2002) with evidence of interbreeding with wild salmon and hybridisation with brown trout (Webb et al: 1991, 1993, Youngson et al: 1997, 1998). In Norway, such is the historical problem of mass escapes, that some rivers are comprised of up to 90% farm escapees (Saegrov et al: 1997, Fleming and Einum: 1997, Fleming et al: 2000). And in Ireland, some river systems have been found to contain more farmed fish than wild fish (Crozier: 1993, 2000, Clifford et al: 1998). The global problem of salmon escapes is so evident that Norwegian farmed salmon are now resident in the Faroes (Hansen et al: 1999) and salmon that escaped from an Irish farm in August 2001 were caught in English, Scottish and Welsh rivers (Milner and Evans: 2002). Moving cages further offshore will only increase the risk of escapes. Closed containment systems are the only safe solution. Yet given the sheer number of escaped farmed salmon and the negative impact of hatcheries on wild salmon (McGinnity et al: 2002) the very future of wild Atlantic salmon may already be in question. That tuna, sea bass, sea bream, sea trout, cod, halibut, haddock, turbot and sole are already being farmed (and are already escaping) is a disaster waiting to happen.

3) Diseases and parasites:

According to the EC "infectious disease poses the biggest single threat to aquaculture" (EC: 2002f). Infectious Pancreatic Necrosis (IPN) and Infectious Salmon Anaemia (ISA) are the latest in a long line of infectious diseases such as furunculosis to decimate the salmon farming industry. New diseases are appearing all the time. EC-sponsored research is now addressing the emerging problems of salmon pancreas disease (SPD) and sleeping disease (SD) in farmed salmon (EC: 2002d). Another EC-sponsored project, SALIMPACT, is investigating the impact of disease transmitted through the contact between farmed and wild fish (EC: 2002h). GM technology has also been applied to study ways of combating disease and conferring disease resistance (EC: 2002l).

Disease outbreaks have also affected the sea bass and sea bream industries in the Mediterranean. The European Aquaculture Society, for example, has referred to "enormous problems like Pasteurellosis and Nodavirosis" affecting sea bass and sea bream (EAS: 1996). The intensification of culture of sea bass and sea bream "has provoked some severe disease problems" (Agius and Tanti: 1997). The main parasitic infections include Ichtyobodo sp., Ceratomyxa sp., Amyloodinium ocellatum, Trichodina sp., Myxidium leei, and Diplectanum aequans. Cysts of unknown microsporidia found in skeletal muscles of market size sea bream at varying incidences have caused problems with marketing on European Union markets (Agius and Tanti: 1997). Given the current crisis in the sea bass and sea bream industry (Richardson: 2002b) the role of overproduction and the consequent spread of diseases and parasites must not be underestimated.

The spread of diseases and parasites, as in battery chicken farming, is a function of overstocking and intensive production (Paone: 2000b). It is therefore inevitable that new diseases on intensive fish farms will emerge (Meikle: 2002). A report by Compassion in World Farming published in January 2002 calculated that each farmed salmon had the equivalent water space as a single bath-tub of water and called for a halving of stocking densities (Lymberry: 2002). A forthcoming report by the Council of Europe on fish welfare may address the issue of stocking densities on fish farms (EC: 2002c). In the meantime, however, sea cage fish farms will continue to act as reservoirs for infectious diseases and parasitic infestations.

ISA has recently affected the Faroes (Gardar: 2002b) and it was reported in an escapee rainbow trout in Clew Bay, Ireland in August 2002 (Charron: 2002b). Ireland has taken a precautionary approach "putting in place full disease control measures consistent with the Irish ISA Withdrawal Plan" (Fennelly: 2002). Consequently, Ireland's only organic salmon farm at Clare Island has been closed to visitors and salmon sent off for ISA testing. In Scotland during 1998-9, for example, ISA led to the destruction of 4 million salmon, the setting up of a 'National Crisis Centre' and a quarter of the industry was placed in quarantine (Royal Society of Edinburgh: 2001). Supermarkets in the UK refused to sell farmed salmon from ISA affected farms (Edwards: 1999). In February 2000 the European Parliament's Fisheries Committee reported that: "clearly the containment of ISA is of concern not only to Scotland, but to the Community as a whole. ISA poses a threat to the Community salmon industry at present, and potentially a greater threat if it were to spread to the other Member States" (European Parliament: 2000). IPN is now "ubiquitous" in Scotland affecting 60-70% of salmon farms (Cameron: 2002f, Macaskill: 2002). In Norway, where 11 million farmed salmon died last year, both ISA and IPN have caused significant mortalities (Intrafish: 1999a,b, Intrafish: 2002c, Solsletten: 2001, 2002b). So serious is the IPN problem that the EC is now "developing recombinant DNA vaccines" (EC: 2002f). In view of the fact that IPN can infect turbot and halibut (European Parliament: 1996b) and the number of escapes of IPN infected farmed salmon (Scottish Parliament: 2002b) the risk of fish farms spreading diseases to wild fish should not be underestimated.

The scientific evidence linking sea lice infestation on wild salmon and sea trout with proximity to salmon farms has now been proved beyond reasonable doubt (Edwards: 1998, Butler and Watt: 2002, Bjorn and Finstadt: 2002, Gargan and Tully: 2002, Holst et al: 2002). As the EC explains:

"These parasites proliferate on farmed salmon, and the young wild fish of migratory species (mainly of sea trout) could be heavily infected during their estuarine movements. The reduction of wild salmonids abundance is also linked to other factors but there is more and more scientific evidence establishing a direct link between the number of lice-infested wild fish and the presence of cages in the same estuary" (EC: 2002c, p9)

Locating salmon cages, for example, at the mouth of salmon rivers and in sea trout areas is the antithesis of the precautionary principle. Surely the only sensible solution is to relocate farms away from such sensitive areas (Butler et al: 2001, FoE: 2001b). In view of the endemic disease and parasite problems and the build up of antibiotic and chemical resistance (EC: 2001e), chemical controls have patently failed to address the parasite problem.

4) Chemicals:

Intensive finfish farmers, unlike shellfish farmers, are reliant upon a suite of chemicals to control diseases and parasites (Schnick et al: 1997, Alderman: 1999, Roth: 2000, Costello: 2001). Reports by the World Health Organisation and GESAMP have highlighted the environmental and public health threats of chemical use on fish farms (GESAMP: 1997, WHO: 1999). However, despite a reduction in the use of antibiotics and organophosphates in salmon farming (OSPAR: 1994) the use of synthetic pyrethroids, artificial colorants, antifoulants, antiparasitics and other 'marine pollutants' warrants serious concern (Staniford: 2002a). The cocktail of toxic chemicals used on salmon farms, in particular, jeopardises not only the marine environment but also the safety of workers (Douglas: 1995, GESAMP: 1997, Kelleher et al: 1998, Connolly: 2002). In Danish trout farms, for example, the abuse of antibiotics has raised consumer and environmental concerns (Lutzhoft et al: 1999). Chemicals used on salmon farms include carcinogens, mutagens and a myriad of marine pollutants (Staniford: 2002b). Since many chemical 'treatments' are designed to kill sea lice (which are crustacea) shellfish farmers have raised concerns in relation to the negative effects other shellfish such as lobsters, crabs, mussels, oysters and scallops (Blythman: 2001, Ross and Holme: 2001).

Ongoing research in Scotland is investigating the impacts of the sea lice chemicals teflubenzuron, cypermethrin and emamectin benzoate on zooplankton and copepods (Edwards: 2002a, SAMS: 2002a, 2002b, 2002c). Cypermethrin, for example, has been recently linked to reproductive effects in wild salmon and significant impacts on shellfish over several hectares (Ernst et al: 2001, Moore and Waring: 2001). The European Medicines Evaluation Agency openly concedes that "the proposed use of Azamethiphos in fish farming means that deliberate contamination of the environment will occur" (EMEA: 1999) yet in Scotland over 700 licences to use cypermethrin, azamethiphos, teflubenzuron and emamectin have been issued since 1998 (Merritt: 2002). The decision to licence them is based more on economic expediency than consumer or environmental safety and is tantamount to state-sponsored pollution (Merritt: 2002). The scale of chemical use in European salmon farming has now led the EC to fund research into sea lice resistance to chemicals used on salmon farms (EC: 2001e).

Such was the historical use of chemicals like dichlorvos (Ross: 1989, 1990, Ross and Horsman: 1988) - banned by the UK in April 2002 as it was deemed carcinogenic (DEFRA: 2002) - that legal action from fish farm workers with cancers and other health issues is pending in the Scottish and Irish courts (Connolly: 2002, Staniford: 2002b). Significant clusters of testicular cancer in salmon farming areas have been reported in Ireland (Kelleher et al: 1998). Figures for the use of dichlorvos on Norwegian fish farms throughout the 1980s are also alarming (Grave et al: 1991, Horsberg: 2000). In Norway, the quantities of dichlorvos used were so high that fatal organophosphate poisoning of the farmed salmon took place (Salte et al: 1987, Horsberg et al: 1989) and residues were detected in the flesh of the salmon (Horsberg and Hoy: 1990). In the UK, the Government have estimated that up to 50 tonnes of dichlorvos (some four times more than all other household and agricultural uses combined) were used annually in the 1980s and early 1990s by Scottish salmon farmers (Davies: 1991, Department of the Environment: 1991, Scottish Office: 1992).

Chemicals such as DDT, dieldrin, chlordane, hexachloro-benzene, PCBs, toxaphene and dioxins, which all bioaccumulate via the fish feed, have been found both under salmon cages and in the flesh of farmed salmon (Hellou: 2002a, 2002b, Pirie: 2001, Cameron: 2002c, PRC: 2002). Anti-fouling paints containing TBT, copper and zinc have also been found under salmon cages (Davies et al: 1998, SEPA: 1998b). The World Health Organisation concedes that "veterinary drug residues or heavy metals may accumulate in aquaculture products at levels of concern for public health" (WHO: 1999). There is an alarming information gap:

"Information is needed on the transfer of feed contaminants to edible fish tissues and any implications of this for human health…As certain pesticides required in aquaculture can pose food safety hazards, more information is needed on the types of compounds used. Studies should be conducted to determine whether the use of pesticides can result in residue levels in fish tissue that are potentially harmful to human health" (WHO: 1999, pp 47-49)

Chemicals used illegally and detected in farmed salmon on sale in UK supermarkets include the recently banned carcinogen Malachite green (Department of Health: 1999, Cameron: 2002d, Scottish Executive:

2002a) and ivermectin (Cameron: 2001). So pervasive is the illegal use of toxic chemicals in Scotland that members of both Scottish Quality Salmon and the Shetland Salmon Farmers Association have both been caught using ivermectin and cypermethrin illegally (Intrafish: 1998, Barnett: 2000, BBC: 2000b, Cameron: 2002a) leading to calls by consumer groups for more testing of farmed salmon (Cameron: 2002b). Norwegian salmon farmers have also been caught using Malachite green illegally (Jensen: 2001) and in August this year Norway introduced new regulations allowing medicine residues in farmed salmon raising fears that there would be a negative impact on sales in the European market (Solsletten: 2002b). Elsewhere in sea bass and sea bream farming, reports of furazolidone, malachite green and ivermectin use in Malta hardly inspire confidence in the sector (EC: 2000c). A forthcoming report is to investigate chemical use in Mediterranean sea cage fish farming in much more detail.

5) Feed/Food:

Intensive sea cage fish farming's dependence upon a fast diminishing and increasingly contaminated resource – namely fish meal and fish oil – threatens to blow sea cage fish farming out of the water altogether. The fifth fundamental flaw – the unresolved and unsolvable feed/food issue - will ultimately be the final fatal flaw for sea cage fish farming. Aquaculture's appetite for fish meal and fish oil is rapidly impacting on the capture fisheries sector (Tacon: 1994, Naylor et al: 1998, Naylor et al: 2000, Pauly et al: 2002). Over 3 tonnes of wild fish are required to produce one tonne of farmed salmon, for example (for other marine fish this rises to over 5 tonnes) (Naylor et al: 2000) leading to a net loss on marine resources and a drain on the capture sector. Salmon farming is running on empty - it is literally running out of fuel. Such is aquaculture's insatiable growth that it already uses up ca. 70% of the world's fish oil and ca. 35% of the world's fish meal (Tacon and Forster: 2001, Tacon and Barg: 2001). In June 2001 the Research Council of Norway predicted that "within three to eight years" the lack of marine oil raw materials could hinder the growth of Norwegian salmon farming (Hjellestad: 2001a). A staggering 80 per cent of all fish caught by Norwegian trawlers is already used to provide feed for the fish farming industry and the International Fish Meal and Fish Oil Manufacturers Association (IFOMA) predict that aquaculture may consume 90 per cent of the world's fish oil by 2010 (Pike and Barlow: 1999). Moreover:

"It would be a mistake to abandon the significance of fish oils as subservient to that of fish meal. There is a risk that quality fish oils could prove to be the more finite commodity in the next decade as aquaculture is projected to use 87% of world supply in 2010. This has obvious implications for the salmon sector and others where much of the dietary energy is provided as oil at present" (MacAllister and Partners: 1999, p39)

Just as oil companies are looking further afield, fishing fleets are sinking to greater depths in search of fish oil – the new 'blue gold'. Feed companies are already harvesting sandeels, sprats, capelin, anchovies, herring, mackerel, blue whiting and even looking to exploit krill (Hjellestad: 2001b, 2002). Desperate to find an alternative fuel supply, salmon farmers have turned to vegetables, wheat, soya, seaweed and other non-fish meal and fish oil diets. Replacing fish oil in salmon diets with vegetable lipids has already lead to problems with the Japanese sending back consignments of farmed salmon as it tastes too 'earthy'. The problem of consumer acceptability of salmon fed on vegetables is something that the EC are now investigating (EC: 2001g). The search for fish feed substitutes (Hjellestad: 2001a) is addressed in the EC's "Strategy for the Sustainable Development of European Aquaculture":

"The Commission considers that research to find alternative protein sources for fish feed should be given top priority, in order to allow a further development of carnivorous fish farming and, at the same time, ensure the sustainability of industrial fisheries" (EC: 2002, p12)

However, turning a carnivore into an herbivore is ultimately doomed to failure. In fact, the EC is currently sponsoring a project looking into the welfare, disease and animal health implications of feeding vegetables to salmon (EC: 2001f). On land we only farm herbivores such as cattle, pigs, sheep and chickens so why do we not apply the same principles when farming in the sea? Why not continue farming shellfish such as mussels, oysters, clams and scallops that has been practised for millennia? When all the environmental, economic and social costs are internalised, sea cage fish farming makes precious little sense at all. Sadly, common sense is not a currency those bankrolling sea cage farming are used to dealing in (Staniford: 2001).

Not only is aquaculture's food supply fast running out but also what fish remains is contaminated with organochlorine pesticides. In the Northern hemisphere especially, the marine environment has been polluted to such an extent that the consequences are now being seen in the biomagnification of contaminants up through our food chain. EC measures designed to tackle the problem of PCB and dioxin contamination (EC: 2000a, 2000b, 2001a, 2002a, 2002b) have been met with fierce resistance by the fish feed industry whose products have been effectively labelled ‘hazardous goods’. For example, when the EC first proposed to lower the level of dioxins in fish meal and fish oil:

“The trade reacted immediately and went about lobbying various European ministries. Fishmeal producers from Peru and Chile e-mailed and faxed their embassies, the trade in Europe called for emergency meetings in Spain, Italy, Germany, UK, Iceland and Norway. Agriculture ministers from every country were bombarded with information and requests to postpone the meeting. One senior EU official was reported to have disconnected his telephone and fax line on the Friday afternoon because of the volume of information he was receiving” (Millar: 1999)

In November 2000 the EC’s Scientific Committee on Animal Nutrition stated that “fish meal and fish oil are the most heavily contaminated feed materials with products of European fish stocks more heavily contaminated than those from South Pacific stock by a factor of ca. eight” (EC: 2000a) whilst the EC’s Scientific Committee on Food stated that fish can contain ten times higher levels of dioxins than some other foodstuffs and can represent up to 63% of the average daily exposure to dioxins (EC: 2000b). In November 2001 the EC adopted new regulations on dioxins in food and feed (EC: 2001a, EC: 2002b) but failed to include PCBs “because of the scarcity of reliable data” (EC: 2000a). The Council Directive 2001/102/EC and Council Regulation (EC) 2375/2001 foresee that the maximum levels of dioxins in feed and food will be reviewed for the first time by 31 December 2004 at the latest in the light of new data on the presence of dioxins and dioxin-like PCBs, in particular with a view to the inclusion of dioxin-like PCBs in the levels to be set. A further review by 31 December 2006 at the latest will aim to significantly reducing the maximum levels (EC: 2002b, 2002c).

The repercussions for sea cage fish farmers are especially significant as they are dependent upon vast quantities of fish meal and fish oil (Millar: 2001). For example, the news that fish feed and farmed salmon was contaminated with dioxins led to Nutreco’s share price falling 15% (Intrafish: 2001). The farming of fish such as salmon so high up the food chain is an extremely efficient way of concentrating contaminants. Some fish feed is so contaminated it should be disposed of as hazardous goods rather than fed to farmed fish destined for human consumption. Yet, fish feed companies have known about PCB contamination, for example, for over 20 years (Mac: 1979). The pesticides toxaphene, DDT and chlordane have all been detected in farmed salmon and fish feed (Oetjen and Karl: 1998, PRC: 2002). Nutreco and IFOMA have both been involved in an EC-sponsored research project looking at ‘Dioxin and PCB Accumulation in Farmed Fish from Feed’ which has just been completed although when the results will be made publicly available is unclear (EC: 2002d). According to the project outline: “Contaminant levels will be determined in fillets, whole fish and in the faeces in order to measure contaminant accumulation, if any, in the edible flesh and their digestibilities” (EC: 2002d). The EC is in the process of establishing a database of 1,500 samples to compare PCB and dioxin contamination between different farmed and wild species and different countries.

Recent scientific research has revealed contamination in Canadian, Norwegian, Scottish and Irish farmed salmon (MAFF: 1999, Easton et al: 2002, FSAI: 2002, Jacobs et al: 2000, Jacobs et al: 2002a, 2002b, PRC: 2002). Dioxin contamination of fishery products is now well known with DDT, chlordane and hexachlorobenzene recently detected in 97% of ‘fresh’ (i.e. farmed) salmon on sale in the UK (the only negative sample was the one wild fresh salmon sample) (Cameron: 2002c, PRC: 2002). In 1997 all 161 samples of farmed salmon tested by the UK’s Veterinary Medicines Directorate contained PCBs (VMD: 1998). The Food Standards Agency in the UK have also detected PCB residues in Danish farmed trout and imported Chilean farmed salmon (Intrafish: 2002a). Both the Irish Food Safety Authority and the Pesticides Residues Committee in the UK have found that farmed salmon is four times more contaminated in terms of PCBs, DDT, hexachloro-benzene and chlordane than wild salmon (FSAI: 2002, PRC: 2002).

Baltic seafood is so contaminated there have been concerns over PCB contamination of fishery products (Kiviranta, 2002). Consequently, Finland and Sweden negotiated a derogation out of the EC dioxin regulations (ENDS: 2001b). The EC estimate that approximately 20% of all industrial fish (mainly sprat and herring) is by definition ‘contaminated’ and above the new limits set for dioxins and PCBs (European Parliament: 2001) but for some countries such as Italy, Greece and Denmark over 50% of their industrial fish catches have “high conflict potential” with the new dioxin regulations (i.e. more than half of their industrial fish is contaminated). For Finland and Sweden that figure rises to 100% and 90% respectively (European Parliament: 2001). Norwegian seafood products are also contaminated (Lundebye et al: 2000, ENDS: 2001a). The Institute of Marine Research in Norway explain how PCB contamination in fish meal has led them to seek substitutes further afield in the Arctic and further down the food chain in the shape of krill:

"PCB accumulates in fish, so there is more PCB higher in the food chain. That means that there is less PCB in krill, which is lower in the food chain" (Hjellestad: 2002)

Consumers, however, are increasingly concerned over higher levels of contaminants in farmed salmon (Edwards: 2002b). As well as containing more PCBs, dioxins and DDT, farmed fish contain more fat and less of the healthy Omega 3 fish oils (Vliet and Katan: 1990, Cronin et al: 1991, George and Bhopal: 1995, Paone: 2000a). According to the Food and Drug Administration in the US, farmed salmon, for example, are four times fatter than wild salmon (Paone: 2000a). And farmed sea bass and sea bream have been found to contain 17 and 7 times more fat than their wild cousins (the same survey showed farmed turbot contained three times more fat than wild turbot) (Richardson: 2001b). The notion that eating farmed salmon is universally good for public health is no more than a sales gimmick sold by supermarkets intent on boosting profits and Government agencies who have invested a great deal of money in bankrolling salmon farming at the expense of wild fisheries.

The glossy packaging does not even say the product is farmed let alone what other hidden extras it contains. Listeria in farmed salmon is becoming much more of problem in Europe (EC: 1998) with Irish, Scottish and Norwegian salmon recalled by the Food and Drug Administration in the United States (FDA: 2002). Following illegal use of ivermectin in Scotland two British supermarkets refused to sell farmed salmon from affected farms (New Scientist: 1997). The artificial colouring Canthaxanthin (E161g), due to health concerns over its links with eye defects in children, is now the subject of a EU-wide consultation with a view to a four-fold reduction in salmon and trout diets (EC: 2002a). Canthaxanthin use is so widespread that it has been detected both in salmon farm escapees (Poole et al: 2000), their offspring (Saegrov et al: 1997) and on the sabed (Girling: 2001). In the UK, Scottish Quality Salmon have been actively lobbying against any reduction whilst some supermarkets are calling for a complete ban. In the US, the law requires Canthaxanthin to be labelled on the packaging (Cherry: 2002). In the UK, France, Spain and across the European Union the new EC fish labelling regulations which came into force on 1st January 2002 (EC: 2001c) are being flouted (Blythman: 2002, Richardson: 2002a, FIS: 2002a).

Given surveys by the UK and French governments (Seafish: 2001, Browne: 2001c, Richardson: 2002c) showing the general public distrusts farmed fish products it is not altogether surprising that supermarkets are reluctant to reveal whether fish has been farmed in closed cages or caught in open ocean. More seriously, farmed salmon mis-labelled as 'wild' has led to an EC-sponsored project designed to detect food fraud. For example, it was revealed last year that 25% of 'wild' fish in France was actually farmed (Richardson: 2001a). Since September 2001 a consortium in France, Italy, the UK and Norway has been working to develop a validated method to enable official laboratories to determine exactly where fish come from, and whether or not they are wild (EC: 2001b). That consumers are still unaware they are buying farmed salmon let alone a tainted product that contains high levels of artificial colourings (and is contaminated with PCBs and dioxins) is a vital public health and public awareness issue. The World Health Organisation recently investigated 'Food Safety Issues Associated with Products from Aquaculture':

"The study group concluded that there were considerable needs for information associated with the aquaculture sector of food production. The gaps in knowledge hinder the process of risk assessment and the application of appropriate risk management strategies with respect to food safety strategy for products from aquaculture" (WHO: 1999, p45)

This view is echoed in research commissioned by the EC; namely that:

"Aquaculture brings with it new problems – not least it raises new food safety issues because of the human interference in the food production cycle….Concerns over sustainability, environmental degradation and food safety can only become more pronounced" (MacAllister and Partners: 1999, pp 36-43)

From a public health perspective, therefore, farmed fish is a poor relation and no substitute for wild fish. Environmental and public interest groups have campaigned directly against salmon farming and in support of wild salmon (Paone: 2000a, Ecotrust: 2002, David Suzuki: 2002, IATP: 2002). This month a coalition of groups in North America will launch a "Farmed and Dangerous" campaign outlining the public health risks of eating farmed salmon and another UK and Ireland protest raising public awareness of farmed salmon will take place on 26th October. With the European market already flooded with cheap farmed sea bass, sea bream and salmon, a consumer boycott of farmed fish products could be the final nail in the coffin of sea cage fish farming. If the financial markets are any barometer, the ailing world leader Nutreco is in a very poor state of health indeed (Intrafish: 2001, Charron: 2002a, Berge: 2002a, 2002b). The fifth fundamental flaw could be fatal to the future of sea cage fish farming in Europe.

Conclusions - closing the net on sea cage fish farming:

The pace of aquaculture expansion has meant that certain farmed fish products now represent a global threat to both the marine environment and consumer safety (e.g. the recent SANCO Rapid Food Alerts concerning chloramphenicol in farmed shrimp from Asia or the ongoing crisis over dioxins and PCBs in farmed salmon). Moreover, the need for increasing quantities of wild caught fish meal to fuel the expansion of sea cage fish farms (such as tuna, salmon, trout, halibut, cod, sea bass and sea bream) is jeopardising the very future of wild capture fisheries. As Dr Daniel Pauly points out in the scientific journal Nature:

"Modern aquaculture practices are largely unsustainable: they consume natural resources at a high rate and, because of their intensity, they are extremely vulnerable to the pollution and disease outbreaks they induce…..Much of what is described as aquaculture, at least in Europe, North America and other parts of the developed world, consists of feedlot operations in which carnivorous fish (mainly salmon, but also various sea bass and other species) are fattened on a diet rich in fish meal and oil. The idea makes commercial sense, as the farmed fish fetch a much higher market price than the fish ground up for fish meal (even though they may consist of species that are consumed by people, such as herring, sardine or mackerels, forming the bulk of the pelagic fishes). The point is that operations of this type, which are directed to wealthy consumers, use up much more fish flesh than they produce, and hence cannot replace capture fisheries, especially in developing countries, where very few can afford imported smoked salmon. Indeed, this form of aquaculture represents another source of pressure on wild fish populations (Pauly et al: 2002)

Therefore, by farming carnivores such as salmon, sea bass, sea bream and tuna at the top of the food chain it's a case of 'robbing Peter to pay Paul'. Given the net loss in fisheries resources it is no wonder fishermen feel short-changed (Staniford: 2001).

The future of fish farming lies in moving away from the intensive monoculture of finfish towards shellfish farming and integrated polyculture systems. This is something that the Commission's "Strategy for the Sustainable Development of European Aquaculture" tentatively addresses:

"The improvement of traditional aquaculture activities such as mollusc farming, that are important in maintaining the social and environmental tissue of specific areas, should be encouraged…. Efforts should possibly be oriented to species such as seaweed, molluscs and herbivorous fish, that are able to utilise the primary production more efficiently" (European Commission: 2002, p12)

The 'Forward Study of Community Aquaculture' proposed that:

"The EU should support research in the field of sustainable aquaculture, including: technical constraints to, and economic viability of offshore aquaculture, waste water treatment techniques, alternative protein sources to fish meal and oils, and development of polyculture options" (MacAllister and Partners: 1999, p60)

If sea cage fish farming is to have any long-term future it must be forced to treat its wastes and focus on non-carnivorous species that do not lead to a net deficit in fisheries resources (FoE: 2001a). Closed containment systems may solve the waste and escapes problems but the final fatal flaw lies in feed and food issues. Far from being a panacea for the decline in wild fisheries and the need for healthy food, sea cage fish farming serves only to compound the current crisis.

References:

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