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TITLE OF PAPER:
A REVIEW OF RESEARCH ON THE CAUSES AND QUANTITIES OF FARMED FISH ESCAPES FROM OPEN NET CAGE SYSTEMS AND A LITERATURE REVIEW OF THE IMPACT OF ESCAPES ON WILD FISH POPULATIONS, USING FARMED SALMON AS CASE STUDY

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SPECIFIC NOSB QUESTIONS ANSWERED:

This paper responds to the following "Specific NOSB Questions":

1. How can net pens be ecologically responsible? What requirements need to be included in the proposed regulation to assure this? How can the issues of water flow and rotational locations be included? What are the other issues?

3. Escape: What is the current rate of escape in the conventional aquaculture and developing organic aquaculture industry? How can the issue of escape be better controlled in an organic system than in a conventional ocean-based system? Are there any implications to containment farming of fish species not indigenous to that geographic area other than cross-breeding with native species?

The paper also touches upon Question #2 (Sea Lice), as the issue relates to escapes of farmed fish acting as a vector of disease (parasites).

Specific responses to these questions are included within Section C ("Conclusions").

EXECUTIVE SUMMARY

For the past year, the Pure Salmon Campaign has been attempting to determine the rate of escapes from open net cages, globally. This paper presents, for the first time, an international inventory of reported escapes. The data presented here is at best a very conservative estimate of escapes (see the "Introduction" for more information on the quality of the data). Key points of the paper include:

Global Rate of Escape

- There have been at least 10.2 million reported farmed salmonid escapes within 262 reported escape incidents from open net cages (2000-2006).

- Many major producing nations – such as Norway and Scotland - continue to report annual escapees in the 100,000s to 1,000,000s despite regulations aimed at controlling or eliminating escapes.

- Norway, the largest producer open net cage salmon, reports an increasing number of escapes. In 2006, it reported 1.2 million farmed fish escaped within 60 separate incidents. Chile, the second largest producer of open net cage salmon, reported over 2 million escapees in 2004 and 2005. Scotland, the third largest producer, reported over 1.3 million escaped farmed fish in 2005 and 2006 within 51 separate incidents.

- In Norway and Scotland, farmed salmonid escape ratios average about one escape per every 300 fish in production. Both Norway and Scotland reported increased escape ratios in the past five years – meaning escapees have increased per unit of production.

- Failure of equipment (net breakage, plant or equipment failure) is the leading cause of reported escapes in major producing regions. Weather (storms, ice, etc) is commonly the second largest cause of reported escapes in producing regions.

Trends in Escapes

- Farmed salmon escapes have occurred within and surrounding marine protected areas, where wild salmon and other species are, in theory, protected by national and international laws.

- Scottish data suggests that the recapture of escaped fish is imperfect. In Scotland, one out of every 1,000 escaped fish was recaptured from the wild.

- Other cage cultured marine species demonstrate significantly higher escape rates. In Norway in 2006, the escape ratio of farmed cod was 13 times greater than that of Atlantic salmon. The escape ratio for other marine species (Arctic char, halibut, turbot, etc) is at least three times greater than Atlantic salmon in 2006.

- Escapees have originated from diseased farms. In Scotland, 60 percent of farmed salmon escapees between 2000 and 2005 originated from IPN-infected farm sites.

- Escapees have originated from farm sites treated with chemicals, Since 2002, over 115,000 Scottish farmed salmon escapees came from sites that were treated with the sea lice chemical, emamectin benzoate.

Organic Salmon Farms

- Organic salmon farms certified by the Soil Association have reported over 122,962 escapees of farmed salmon in 12 separate escape incidents, between 2002 and 2006.

- Organic salmon farms certified by the Soil Association report a recapture rate of approximately one percent of escaped farmed salmon.

- In Norway, the first salmon farm to be investigated by the police using new DNA fingerprinting technology to track down escapes was an organic salmon farm.

- Diseases have also been reported on organic salmon farms in Scotland. These include: ‘Skin Pathology’, ‘Vibrio Species’ and ‘Suspect Bacterial infection.’

- Based on 2006 Irish data, organic salmon farm sites had some of the highest sea lice counts of any salmon farms operating in Ireland.

Peer-Reviewed Science

- Peer-reviewed science has clearly demonstrated significant ecological and genetic impacts of escaped farmed salmon on native wild fish populations.

- Escapes present risks of increasing disease outbreaks, proliferating possible disease transmission routes in the environment, and decreasing the immunity of wild fish to disease. Scientific research has linked open net cage salmon farms with sea lice infestations on wild fish populations

- Escapes from other species grown in open net cages such as cod, halibut, sea trout, kingfish and bream are now an emerging international issue.

While we have attempted to respond to the NOSB’s specific questions within this paper, we believe that the burden of proof should be on the proponents of organic open net cage aquaculture to prove that open net cage systems are not detrimental to the environment and that they are within the bounds of organic principles.

Before moving forward with an organic standard that includes open net cages, we ask the NOSB to require that proponents of organic open net cage systems respond directly to the following questions:

- Is it possible to consistently **eliminate** all escapes (including leakages) from an open net cage system, organic or conventional? If no, then:

- How many escapes are "too many"? Please provide the NOSB a **number** of escapes, which you would agree is too high?

- At what level are escapes a threat to wild fish populations? Please provide the NOSB with the **number** of escapes that would pose a threat?

- We know that nutrient pulses into a habitat alter species profiles – particularly parasites and diseases. What data are available showing that organic pollution from farms are not and will not drive additional disease/parasite burdens on wild fish?

- Can we **guarantee** that no diseases/parasites, including sea lice, occur on organic fish farmed in open net cages? And, if no:

- Is there proof that these diseases can be effectively treated and contained using treatments available within organic standards (i.e. no synthetic parasiticides)? And;

- Can we guarantee that diseases, including sea lice, will not spread from organic open net cage farms to wild fish? And;

- What ability would an organic open net cage farm manager have to predict and/or prevent new diseases?

- Are the potential increased genetic and disease/parasite risks inherent with culture of native species preferable to the potential genetic and ecological impacts associated with culture of exotic species?

- What is the current escape ratio (rate of escape per unit production) of farmed fish from organic open net cage farms? How does this compare to the conventional escape ratio in the region or production?

Principle 15 of the *1992 Rio Declaration on Environment and Development* explains the precautionary principle as:

"Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent degradation."

We believe the only solution to ensuring that escaped farmed fish have little to no impact of wild fish and marine biodiversity is to actually **prevent** escapes. The NOSB can avoid the difficult if not impossible task of determining at which level escapes become acceptable, by requiring that organic aquaculture takes place solely in closed containment systems.

INTRODUCTION

A lack of publicly available, official data on escapes from open net cage fish farming has hindered a comprehensive understanding of the rate of escapes globally.

Over the past year, the Pure Salmon Campaign has collected data to form an international inventory of reported escapes of salmon and other marine fish farmed in open net cages. Through Freedom of Information (FOIA) requests in Scotland, Norway, Chile, Maine and Australia – we have been able to obtain previously confidential data on escapes from fish farms in these regions. The North Atlantic Salmon Conservation Organization (NASCO) has also provided access to data made available through the 'North Atlantic Salmon Farming Industry and NASCO Liaison Group'.[1] Additionally, the Pure Salmon Campaign has accessed government figures on fish farm escapes in British Columbia and Washington. The data represents roughly 70% of salmon farming operations, a robust compellation globally, making it is highly indicative of the ability (or inability) of open net cages to control farmed fish escapes.

This paper presents, for the first time, the data we have collected on escapes from open net cage systems – the most complete set of data on escapes, of which we are aware.

It is intended to aid the NOSB in considering:

- The rate of escapes from open net cage systems, by species and region
- The trend in escapes over time
- The causes of escapes
- The overall ability of open net cage systems to control escapes
- The rate of escapes from emerging organic open net cage aquaculture operations
- The potential of proposed organic standards to provide adequate controls of escapes from open net cage systems

Within this paper, we also review the body of peer-reviewed science on the ecological impacts of fish farm escapes (Section B). This review is intended to aid the NOSB in determining the ecological impacts of escapes and whether or not, or to what extent, escapes from open net cage farms are acceptable within an organic aquaculture standard.

Notes on the Data

The data presented within this paper is at best a very conservative estimate of farmed salmon escapes. Of note, the data is largely self-reported by fish farming companies, and therein subject to the integrity of reporting entities. Further, local authorities have relatively minimal ability to confirm reported escapes figures. Some of the newer methods developed to track escapes, namely DNA testing and tagging, are costly and largely unavailable to local authorities.[2]

Some authorities on escapes speculate that escapes may be higher than reported.[3] [4] Regional authorities in the United States have raised this issue of underreporting.[5] A report published in December 2006 by the Directorate of Fisheries in Norway estimated the real number of Norwegian fish farm escapees as 4-5 times greater than reported official figures. [6] [7] Scientists such as Dr John Volpe of the University of Victoria in British Columbia have suggested that official Government figures for escapes from B.C. are underestimates of the true escapes total.[8] A report published by the University of British Columbia in 2005 urged caution when dealing with escapes figures in British Columbia.[9]

Reporting requirements also vary by region. Several major producing regions required reporting of escapes only recently. For example, the Scottish Executive did not introduce legislation requiring the mandatory notification of all escapes of farmed fish until May 2002.[10]

Regional authorities in some regions have provided incomplete data. The Chilean National Fisheries Ministry, for example, provided only 2004-2005 data. British Columbia has not yet publicly reported 2006 escape figures. Freedom of Information requests to government authorities in Eastern Canada (including New Brunswick, Newfoundland and Nova Scotia), the Faroe Islands, Ireland, Japan and New Zealand has not been answered. New Brunswick appears to collect no escapes data at all. [11]

It is common knowledge that open cage farms often experience "leakages" of farmed fish. While "leakages" may be a small fraction of fish in a cage, in absolute numbers, small percentages of escapes from cages with 500,000 may translate into large numbers of escapees that go unreported. For example, Scottish legislation requires reporting of "any suspected escape, or circumstance which gives rise to a significant risk of escape,"[12] but does not require estimation or reporting of persistent or unavoidable leakages from open net cages.

A USDA Forest Service report describes leakages: [13]

> In addition to mass escapes during storms, some fish are stocked in net pens but never harvested in normal operations. These fish are termed "leakage" because it is assumed they jump out of the pens or swim through the mesh openings in the nets or cages. Volpe (2001) estimated that leakage accounted for 0.5 to 1.0 percent of the total annual production of Pacific Northwest salmon-rearing operations. For Atlantic salmon farms in Washington and British Columbia, such an escape rate would amount to tens of thousands of fish per year.

A Norwegian scientific paper published in 2006 in the *ICES Journal of Marine Science* (Silbrei and Wennevik: 2006) also refers to this reporting problem:

> Several observations suggest that most of the salmon reported in this study were part of local small-scale escape incidents, or trickle losses, that are not reported to the authorities…. Currently, there is no systematic monitoring of escaped farmed salmon and rainbow trout in Norwegian coastal waters throughout the year. It is recognized that some of the large-scale escape events and most of the more frequent, smaller-scale escape events are not reported by fish farmers (Baarøy et al., 2004).

For salmon farms in Norway, Chile and Scotland where production is much higher such "leakage" would amount to several hundreds of thousands of fish per year. In 2005, data from the Norwegian industry research firm, *Kontali Analyse*, showed that Chile placed 385 million farmed Atlantic salmon and 109 million farmed Coho salmon into sea cages as smolts. At the same time Norway placed 162 million farmed Atlantic salmon and Scotland placed 42 million farmed Atlantic salmon into sea cages as smolts[14]. Therefore, if a "leakage" rate of 1% is assumed then farmed salmon escapees in Chile, for example, could be of the order of 5 million with over 1.5 million in Norway and over 400,000 in Scotland.

This paper largely reflects either farmed Atlantic salmon or farmed salmonids (salmon and trout), not escapes of other marine species such as cod and halibut. Norwegian data summarized in this paper indicates a three to thirteen-fold increase in the rate of escapes of other farmed marine fish.

Lastly, this paper does not include 2007 escape figures. Scottish figures, which are now published online by the Scottish Salmon Producers' Organisation (SSPO), report approximately 96,000 known escapees or "breaches of containment" between January and June 2007.[15] In spring 2007, Chilean media also reported "as many as 14 million fish" escaping following an April 2007 earthquake and resulting mini-tsunami.[16] It is still unclear how many farmed salmon escaped but in August 2007 the Pure Salmon Campaign repeated an FOI request for the Chilean Government to reveal exact farmed salmon escape figures for 2007 as well as 2006.

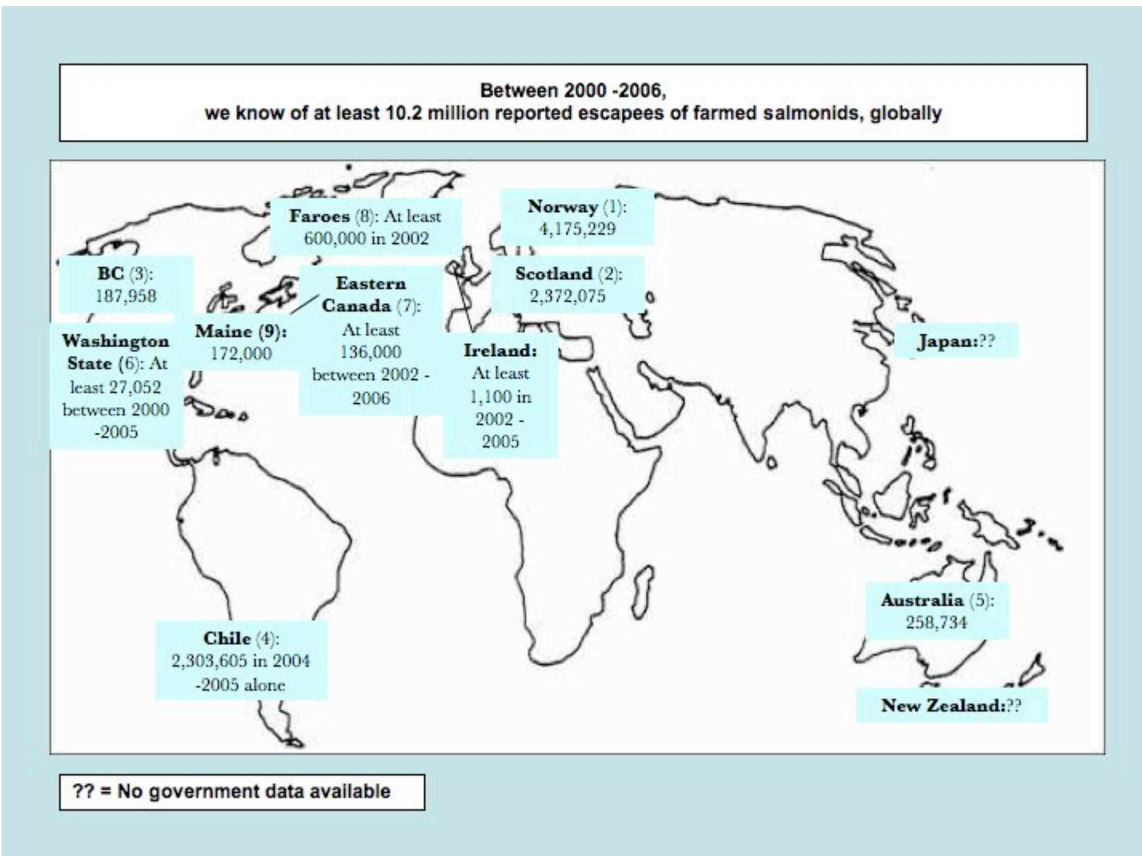
SECTION A

I. RATE OF FARMED FISH ESCAPES FROM OPEN NET CAGE SYSTEMS

Our international inventory of escapes data indicates **262 reported escape incidents involving salmonids farmed in open net cages with 10.2 million farmed fish escapes between 2000 and 2006**. As discussed thoroughly in the Introduction of this paper, this is likely an underestimate of actual escapes.

Figure 1 depicts reported escapes of salmonids from open net cage farms. The largest producers - Norway, Scotland, and Chile - report the highest level of escapees.

Figure 1: Reported Escapes of Farmed Salmonids Globally, 2000 -2006



(1) 2000 Norwegian escapes data estimate obtained from: http://www.fisheries.no/NR/rdonlyres/BAFC016E-B597-4089-A849-5A4B9E44345F/46071/Romming.pdfKyst.no. 2001 – 2005 escapes figures obtained from: http://www.kyst.no/index.php?page_id=59&article_id=77255. Norwegian Directorate of Fisheries (2006 data, only), http://www.fiskeridir.no/fiskeridir/kystsone_og_havbruk/r_mming/oversikt_over_meldinger_til_fiskeridirektoratet_om_r_mming_fra_akvakulturanlegg

(2) 2000 – 2001 escapes figures provided by the Scottish Executive in June 2006 via Freedom of Information requests by the Pure Salmon Campaign. Additional 2002 -2006 escapes data provided by the Scottish Executive in February 2007 via FOIA request by the Pure Salmon Campaign. Notes: In 2—4, one incident lists "unknown" number of escapees. In 2004, 1 escapee was from a hatchery. In 2005, 125,000 "escaped" fish were reported "dead." In 2006, another 130,000 were reported as "dead."

(3) *Annual Report on Marine Finfish Inspections for 2004 and 2005 Inspection Cycles.* Ministry of Agriculture and Lands, and Ministry of Environment, Graph 6, Number of Reported Fish Escapes 1999 -2005, p 29.

(4) Chile escapes data 1995,1996, 2002 provided in Volpe paper. 2004 -2005 data provided by Serapes, National Director of Fisheries, March 15, 2007 via Freedom of Information Request by the Pure Salmon Campaign dated 1.10.07.

(5) Australia Department of Primary Industries and Water. Obtained on April 25, 2007 in response to FOI request by Pure Salmon Campaign.

(6) The US Government's 'Aquatic Nuisance Species Project', 2006, detailed escapes in Washington in 2004 as 24,552 and in 2005 as 2,500: http://www.aquaticnuisance.org/docs/Atlantic%20Salmon%20Escape%20and%20Recovery%20%20Data.pdf However, the Washington Department of Fish and Wildlife reported no escapes from 2000 to 2006: http://wdfw.wa.gov/fish/atlantic/comcatch.htm

(7) NASCO, CNL29.287 attachment 3 – 2006, "There were four incidents reported during 2005, all confirmed acts of sabotage. In incidents in April and May, 13,300 fish of 2-3 kg weight and 13,000 fish averaging 1.5kg in weight were released. In August 2005, approximately 20,000 fish of about 0.5kg were released and in November 2005 about 100,000 market-sized fish valued at 3 million Canadian dollars were released."

(8) The European Commission also reported in 2003 that: "The largest single incident to date occurred in the Faroes in spring 2002 when 600,000 fish escaped during a storm accident," http://www.aquainnovation.net/aquainnovation/knowledgebase/afshowarticle_en.asp?aid=569&AFlg=en. *National Geographic Magazine* reported in 2003 that in 2002: "Over 600,000 came from a single farm in the Faroe Islands in the North Atlantic. The incident is believed to be the world's biggest salmon escape," http://news.nationalgeographic.com/news/2003/06/0616_030616_farmsalmon_2.html.

(9) Information obtained on October 1, 2007 from the Maine Department of Marine Resources via FOIA request by the Pure Salmon Campaign. Available: http://www.maine.gov/dmr/aquaculture/reports/documents/ReportedEscapesofFarmedAtlanticSalmoninMaine.pdf

The Rate of Escapees (Escapes Ratio) Globally

Figure 2 is modeled on "Table 1" of a paper titled *Ecological and Economic Impact Assessment of Sablefish Aquaculture in British Columbia*.[17] Sumalia et al (2005) calculated the "escape ratio" of farmed salmon in British Columbia, which enables a comparison of rates of escapees in major producing regions. According to the paper:

> Escape ratio is calculated by dividing estimated annual number of salmon in production by the reported number of escapees (e.g. 1 in 252 farmed salmon escaped in Norway in 2006). Number of fish in production is conservatively estimated by dividing annual production (tonnes) by 3 kilograms – this representing a mean size class of the O^+, 1^+ and 2^+ sea winter fish in marine net-pens during a given year. The actual figure would vary as market-ready adults (~4 kg) are harvested and replaced by a greater number of smolts (~70 g). A 3 kg average is a conservative net-pen standing stock estimator, resulting in a conservative estimate of proportional escapes.

The Pure Salmon Campaign has updated this information with newly available data from the four major salmon producing regions – Norway, Scotland, Chile, and British Columbia.

Figure 2 shows that Norway and Scotland have **escape ratios that average around one escape per every 300 fish in production**.[i] Norway's escape ratio has decreased consistently in recent years – indicating that Norwegian open net cage salmonid farms have actually reported increasing escaper per unit of production. Scotland's escape ratio does not decrease as consistently, but in 2006 Scottish salmonid farms reported an escapes ratio more than three-fold higher than reported in 2001.

Figure 2: Reported Farmed Salmonid Escapees and Escape Ratios in Major Producing Regions

Region	Year	Production (tonnes, wfe)	Reported Escapees	Escape Ratio	Average Escape Ratio
Norway (1)	2001	506,883	368,000	1:459	**1:331**
	2002	546,054	730,000	1:249	
	2003	578,475	550,000	1:350	
	2004	627,315	563,000	1:371	
	2005	645,387	722,000	1:298	
	2006	689,089	882,229	1:260	
Scotland (2)	2001	138,519	89,996	1:513	**1:304**
	2002	144,589	312,655	1:154	
	2003	169,736	151,853	1:373	
	2004	158,099	90,594	1:581	
	2005	129,588	1,002,883	1:43	
	2006	137,018	287,753	1:159	
Chile (3)	1995	98,287	315,133	1:104	**1:626**
	1996	144,315	111,706	1:431	
	2002	476,349	90,000	1:1,764	
	2004	569,500	2,023,365	1:94	
	2005	619,900	280,240	1:737	
British Columbia (4)	2001	68,000	55,167	1:411	**1:195,158**
	2002	84,200	20,455	1:1,372	
	2003	72,700	40	1:605,833	
	2004	61,800	43,985	1:468	
	2005	70,600	64	1:367,708	

(1) Norwegian production figures (salmon and trout production, 2006 estimate) from Statistics Norway, at: http://www.ssb.no/english/subjects/10/05/fiskeoppdrett_en/tab-2007-08-23-01-en.html. Sources of escapes figures (Atlantic salmon only) are Norwegian Fish Farmer http://www.kyst.no/index.php?page_id=59&article_id=77255 and the Norwegian Directorate of Fisheries: http://www.fiskeridir.no/fiskeridir/kystsone_og_havbruk/r_mming/oversikt_over_meldinger_til_fiskeridirektoratet_om_r_mming_fra_akvakulturanlegg and http://www.fisheries.no/NR/rdonlyres/BAFC016E-B597-4089-A849-5A4B9E44345F/46071/Romming.pdf

[i] The Norwegian Directorate of Fisheries states that: "The escaping itself is rather small for the period mentioned it is 2,57 per thousand of the fish in the grow-out farms." This Norwegian calculation (2.57 escapees: 1000 fish in grow out farms) parallels our average escape ratio calculation of 1 escapees: 331 fish in production).

(2) Scottish production figures (Atlantic salmon only) Fisheries Research Services, *Scottish Fish Farms Annual Report Survey 2005,* http://www.marlab.ac.uk/FRS.Web/Uploads/Documents/survey2005.pdf. 2002 – 2006 escapes data provided by Scottish Executive on February 23, 2007 via Freedom of Information Requests by the Pure Salmon Campaign. 2001 data provided by Scottish Executive in response to previous data request, November 2006.
(3) Chilean production figures 1995 -2002 from Fishstat Database, FAO, Rome, Italy, http://www.fao.org/fi/statist/FISOFT/FISHPLUS.asp (Volpe paper). 2004 production figures form Kontali Analyse, Salmon World 2005. 2005 production data from Kontali Analyse 2006. Chile escapes data 1995,1996, 2002 provided in Volpe paper. 2004 -2005 data provided by Sernapesca, National Director of Fisheries, March 15, 2007 via Freedom of Information Request by the Pure Salmon Campaign dated 1.10.07.
(4) British Columbian production figures for 2001 -2003 from BC Ministry of Agriculture, Fisheries and Food http://www.agf.gov.bc/ca/fish_stats/aqua-salmon.htm. 2004 production estimate from *The 2004 British Columbia Seafood Industry Year in Review*, Ministry of Environment, Ministry of Agriculture and Lands, http://www.agf.gov.bc.ca/fish_stats/pdf/seafood_industry_yir_2004.pdf. 2005 production figures from *Profile of the BC Farmed Salmon Industry in 2006,* May 2006, Report for the BC Salmon Farmers Association, PriceWaterhouseCoopers, http://www.salmonfarmers.org/files/2006productionsnapshot.pdf. Production figures are farmed salmon species only. British Columbian escapes data from *Annual Report on Marine Finfish Inspections for 2004 and 2005 Inspection Cycles.* Ministry of Agriculture and Lands, and Ministry of Environment, Graph 6, Number of Reported Fish Escapes 1999 -2005, p 29.

In March 2006, the Norwegian Directorate of Fisheries launched "Vision: No Escapees" – "an Action Plan to achieve a level of escapees from fish farms, which is as close to zero as practicable."[18] **If we assume that Norwegian salmon farms are in accordance with the "Vision: No Escapees" plan, than it is highly possible that 1.2 million escapees was truly the lowest achievable or "practicable" number of escapees in Norway last year.** [19]

Chile's escape ratio fluctuates between 1:1,764 to 1:94, with an average of one escape per 626 fish in production. However, Chile's 2007 escape ratio will likely be larger than its 2006 ratio, due to an earthquake/tsunami and reported massive escapes in the Aysen region.

British Columbia's escape ratio reflects variation. In some years, the province reports essentially no escapes.

Other Marine Species Escaping at a Higher Rate

Given the recent trend towards the farming of other marine finfish species – such as cod and halibut – the Pure Salmon Campaign has begun to collect data on escapes of these species from open net cage farms. 2006 data provided by the Norwegian Directorate of Fisheries has enabled us to compare escape ratio for salmon and trout to those of cod and other newly farmed marine finfish species.[iiiii]

[ii] While sources and ratio calculations differ, the concept for this table was developed by Bernt Rydland Olsen of Norges Naturvernforbund.
[iii] Similar to Figure 3, the escape ratio is modeled on Table 1 of Sumalia et al (2005). See Figure 3 for more details on escape ratio calcuation.

The Norwegian case study presented in Figure 3 indicates that **the escape ratio of farmed cod was at least 13 times greater than the Atlantic salmon escape ratio for Norwegian fish farms in 2006.** And, **the escape ratio for other marine species (Arctic char, halibut, turbot, etc) is at least three times greater than Atlantic salmon in 2006.**

Figure 3: Escapes of Cod and Other Marine Species Versus Farmed Salmon and Trout in Norway, 2006

Species	2006 Production (metric ton) (1)	2006 Reported Escapees, (2)	Escape Ratio
cod	10384	272,422	1:12
salmon/trout	689091	882,229	1:160
Other marine species	2,346	15,536	1:50
TOTAL	701,821	1,170,187	

(1) Directorate of Fisheries: http://www.fiskeridir.no/fiskeridir/english/statistics/norwegian_aquaculture/aquaculture_statistic

(2) Norwegian Directorate of Fisheries: http://www.fiskeridir.no/fiskeridir/kystsone_og_havbruk/r_mming/oversikt_over_meldinger_til_fiskeridirektoratet_om_r_mming_fra_akvakulturanlegg

If these Norwegian figures are representative of escape ratios for other marine finfish species farmed in open net cages throughout the world (including organic farmed fish), they raise obvious concerns that escape rates will significantly increase, rather than decrease, as aquaculture expands worldwide. These are also obviously relevant to the NOSB's consideration whether to include open net cages for all species within organic standards.

Review of Reported Escape Incidents

Figure 4 summarizes available data on escape incidents, globally, and calculates average incidents per year (in order to correct for gaps in annual data for each region). While many major salmon producing regions - such as Norway and Chile – have not publicly reported the number of incidents consistently between 2001 and 2006, the data that is available provides a glimpse into the escapes record in open net cage salmonid farming. In total, we know of at least 262 separate escape incidents reported by salmonid farmers globally since 2001.

The frequency of escape incidents is an important indicator of persistent problems with containment. British Columbian salmon farmers reported just 64 escapees in 2005. However, these escapees occurred in 35 separate incidents. In other words, while the number of reported escapes was relatively small, British Columbian open net cage salmon farms allowed for a breach of containment an average of three incidents per month or an escape every 10 days in 2004 and 2005.

Scottish salmon farming companies – which reported the number of escape incidents most consistently - have collectively reported increasing escape incidents over the past five years.

Figure 4: Global Inventory of Farmed Salmonids Escape Incidents, 2001 – 2006

Region	2001	2002	2003	2004	2005	2006	Regional Total 2001 -2006	Average # Incidents/Year
Norway						60	60	60.0
Chile				7	8		15	7.5
Scotland	12	9	14	14	24	25	98	16.3
Faroes Islands			1				1	1.0
Ireland		2		0	0		2	0.7
British Columbia, Canada				35	35		70	35.0
Eastern Canada					4	0	4	2.0
Australia	0	2	3	4	2	1	12	2.0
Annual Total	**12**	**13**	**18**	**60**	**73**	**86**	**262**	**43.7**

(1) Norwegian Directorate of Fisheries (2006 data, only): http://www.fiskeridir.no/fiskeridir/kystsone_og_havbruk/r_mming/oversikt_over_meldinger_til_fiskeridirektoratet_om_r_mming_fra_akvakulturanlegg
(2) Sernapesca, National Director of Fisheries, March 15, 2007 via Freedom of Information Request by the Pure Salmon Campaign dated 1.10.07.
(3) 2002 -2006 escapes data provided by Scottish Executive on February 23, 2007 via Freedom of Information Requests by the Pure Salmon Campaign. 2001 data provided by Scottish Executive in response to previous data request, November 2006. Notes: In 2—4, one incident lists "unknown" number of escapees. In 2004, 1 escapee was from a hatchery. In 2005, 125,000 "escaped" fish were reported "dead." In 2006, another 130,000 were reported as "dead."
(4) The European Commission reported in 2003: "The largest single incident to date occurred in the Faroes in spring 2002 when 600,000 fish escaped during a storm accident," http://www.aquainnovation.net/aquainnovation/knowledgebase/afshowarticle_en.asp?aid=569&AFlg=en.
(5) NASCO, CNL29.287 attachment 3 – 2006 and CNL29.287 attachment 3 – 2007.
(6) *Annual Report on Marine Finfish Inspections for 2004 and 2005 Inspection Cycles.* Ministry of Agriculture and Lands, and Ministry of Environment, Graph 6, Number of Reported Fish Escapes 1999 -2005, p 29.
(7) NASCO, CNL29.287 attachment 3 – 2006
(8) Australia Department of Primary Industries and Water. Obtained on April 25, 2007 in response to FOI request by Pure Salmon Campaign.

Data between 2004 and 2006 may represent the most accurate number of global escape incidents, given the availability of data. **During these years, the number of incidents jump from 18 incidents per year (in 2003) to 60, 73 and 86 in 2004 -2006 respectively.**

Escapes from Organic Salmon Farms

Escapees have the capacity to spread 'genetic pollution' whether they are from conventional or organic open net cage farms (see Section B). Given the paucity of site-specific data and the lack of publicly available data on organic salmon farms, it is difficult to pinpoint escapes from organic salmon farms. However, some data is available from Scotland, Ireland and Norway.

In October 2006,[20] the Soil Association – one of the two UK-based organic salmon certifiers – provided the Pure Salmon Campaign with a list of salmon farms in Scotland, which it certifies as organic. The Pure Salmon Campaign has compared this list of organic salmon farm sites to those salmon farm sites with reported escape incidents between 2002 and 2006, provided by the Scottish Executive in February 2007.[21] This comparison provides a rough picture of escapes from Soil Association organic certified farm sites in Scotland.[iv]

It is important to note that the information presented here provides only a partial glimpse into escapes from organic farmed salmon sites in the UK, however. The other organic farmed salmon certification body – the Organic Food Federation (OFF) – has thus far refused to provide any information on the Scottish salmon farms it certifies as organic. In March 2007, the Scottish Government reported that "the OFF organically certifies between thirty five and forty aquaculture units mainly situated in Scotland or Shetland with several in Northern Ireland"[22]. Following the OFF's [23] refusal to respond to requests for information in October and November 2006, the Pure Salmon Campaign lodged an official request for information with DEFRA's Advisory Committee on Organic Standards.[24] In January 2007, DEFRA replied that consumers would have to wait until 2009 before site specific information for organic salmon farms was required under European law.[25]

Figure 5 provides a comparison of site-specific escape incidents (as provided by the Scottish Executive in February 2007) to sites in Scotland certified as organic by the Soil Association.[v] Based upon our comparison of these two data sets, **organic salmon farms certified by the Soil Association have reported over 122,962 escapees of farmed salmon in 12 separate escape incidents, between 2002 -2006.** Only 1,300 of these escaped fish were reported as recaptured.

The Soil Association Organic Standards, January 2007 include regulations aimed at reducing escapes. Section 30.6.1 states "You must ensure you design and operate your holding facilities (for example net pens, ponds, ropes and moorings) so that you: minimize the risk of escapes." Additionally, Section 30.6.2 sites: "For all holding facilities, you must: keep them secure and well maintained, and monitor them regularly…" And, Section 30.6.3 (revised) includes additional requirements such as "inspect a net immediately if there is any suspicion that it may have been damaged."

[iv] The Soil Association provided us with a list of organic certified farms and hatcheries as of October 2006. Since the Scottish Executive escapes data pertains to escapes in 2002 -2006 there is a possibility that farms now certified as organic were not certified as such during the escape incident, if it occurred before 2006 (though this is doubtful).

[v] All of the sites included in Figure 12 are listed in the October 2006 list provided by the Soil Association to Pure Salmon Campaign. Lewis Salmon does not appear on the October 2006 list, however, the Soil Association website explains that "Lewis is one of the most recent converts to Soil Association organic production."(www.soilassociation.org/Web/SA/SAWeb.nsf/848d689047cb466780256a6b00298980/1c64e9109f8f7f78802571cb005486a2?OpenDocument)

Figure 5: Scottish Executive Site Specific Reported Farmed Salmon Escapes as Compared to Soil Association Organic-Certified Salmon Farms (2002-2006)

Scottish Executive Company, Site (1)	Soil Association Company, Site (2)	Date	# escapees	# recovered
Balta Island Seafare, Huney	Same	11/3/02	13,500	0
Balta Island Seafare, Huney	Same	12/24/02	14,000	0
Killean Salmon Hatchery, Sound of Ginga/Killean (salt-water)	Killean Salmon Hatchery	4/18/03	5,000	0
Balta Island Seafare, Balta Island	Balta Island Seafare, Balta (North & South)	4/29/04	11,300	0
Lewis Salmon, Arbhair	Lewis Salmon	5/10/04	4,227	0
Balta Island Seafare, Balta Island	Balta Island Seafare, Balta (North & South)	8/11/04	400	0
Lewis Salmon, Arbhair	Lewis Salmon	8/11/04	11,000	0
Mainstream, Bay of Vady	Same	11/1/05	1,998	0
Westray, Bay of Cleat North	Same	11/14/05	0	0
Mainstream, Bay of Vady	Same	2/17/06	25,018	1,300
Mainstream, Bay of Vady	Same	3/15/06	2,019	0
Mainstream, Kirk Noust	Mainsream, Kirknoust	5/29/06	34,500	0
Total			**122,962**	**1,300**

(1) Data provided by Scottish Executive to Pure Salmon Campaign via FOIA request, February 23, 2007.
(2) List of Soil Association certified sites provided by Peter Bridson of the Soil Association Scotland to the Pure Salmon Campaign upon request in October 2006.

Despite established organic standards, however, the data we have obtained from the Scottish Executive suggests that Soil Association organic certified salmon farms have not been able to prevent escapes. Additionally, these **organic farms have only been successful in recovering just over 1 percent of those escapes that have occurred from their farm sites.**

These reported escapes from Soil Association certified organic salmon farms represent close to 7% of all Scottish farmed salmon escapes between 2002 and 2006.

Production figures for organic certified salmon farm sites are not publicly available. Therefore, it is impossible for us to determine the escapes ratio from Soil Association organic salmon farm sites, no less the escape ratio of organic salmon farm sites globally.

In Norway, the first salmon farm to be investigated by the police using new DNA fingerprinting technology to track down escapes[26] was named in March and April 2007 in the Norwegian media as Villa Salmon.[27] Villa Salmon brand themselves as "Villa Organic"[28] and are certified as organic by the Norwegian certifier Debio.[29]

II. CAUSES OF REPORTED ESCAPES

While it is difficult to summarize global data on the "causes of escapes" given variations in reporting,[vi] basic observations indicate the following:

Failure of equipment (net breakage, plant or equipment failure) was the #1 cause of escapes in Norway, Scotland, Chile, and Australia.[vii] In each region, equipment failure (net breakage, etc) was responsible for between 32 to 58 percent of reported escapes in the reporting period.

In Scotland, Chile and Australia, **weather (storms, ice, etc) was the #2 cause of escapes** during the reporting period (reported as only 5 percent of escapes in Norway). In these regions, weather conditions led to 20 to 29 percent of all escapes in the reporting period. Severe weather in remote areas of Scotland such as the Western Isles, Shetland and Orkney – hot spots for escapes – is common. For example, **of the 46 escape incidents reported by the Scottish Executive in 2005 and 2006, 37% (17 incidents) occurred during the month of January.** In the space of one week during January 2005 (7th to 14th) a staggering 958,270 farmed salmon escaped – 83% of them from salmon farms located in the Western Isles.[30]

Human error (towing, collision, installation error, etc) factored somewhat further down the list of causes of escapes for most regions, except Norway where it was the #2 cause of escape. In all regions, however, human error played a role in escapes. It led to between 21 percent (Chile) to 7 percent (Australia) of escapes in the reporting period.

Predators (such as sea lions and seals) were reported as the #3 cause of escape in Norway, Chile and Australia and #4 in Chile.

Forty percent of Australia's escapes in the reporting period 2000-2007 were recorded as "unknown."

Several major salmon producing countries have established regulations in an attempt to eliminate the major causes of escapes, such as net breakage and human error. In 2004, the Norwegian Directorate of Fisheries established new regulations, known as NYTEK, "concerning technical standards for construction."[31] Yet, between 2005 and 2006, Norwegian salmon farms reported the escape of over 1.6 million fish. In 2006 alone, 60 separate escape incidents were reported.

Similarly, in 2000, the Scottish Executive published a working group report on escapes, which recommended site-specific containment measures and contingency plans for

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[vi] Categories of "causes of escapes" vary by region such that one region may classify the cause of escape as a "net breakage", where another region would more specifically document it as a towing incident. Pure Salmon Campaign has not summarized regional data into a global summary given these regional differences in classification. Additionally, time periods of escapes (combined annual data) varied.
[vii] This does not include "Other", "Unknown", or "Unspecified" causes.

escapes.[32] Since 2000, over 2 million farmed salmon have escaped in almost 100 reported incidents.[33]

Figure 6: Summary of Causes of Reported Farmed Fish Escapes, Globally

Region	Year	Cause	Percentage
Norway (1)	2001- April 2006	**Plant Failure**	53
		Collision	13
		Others	12
		Damage from Propellor	5
		Predator	5
		Drifting ice, etc.	5
		Failure at Smolt Plant	5
		Handling	2
		Towing	0
Scotland (2)	May 2002- Dec 2006	**Weather***	28
		Predator	23
		Equipment Failure	20
		Human Error	14
		Hole in Net	12
		Other	2
		Vandalism/Foul Play	1
Chile (3)	2004 -2005	**Net breakage**	36
		Storm/Wind & Rain	29
		Installation Error	7
		Predator**	7
		Towing	7
		Collision	7
		Unspecified	7
Australia (4)	2000-2007	**Unknown**	40
		Net tear/Hole	33
		Storm	20
		Fish transfer	7

*Includes 14 incidents during storms in January 2005
** Predator attack led to net breakage

(3) The Directorate of Fisheries, Norway. http://www.fisheries.no/NR/rdonlyres/BAFC016E-B597-4089-A849-5A4B9E44345F/46071/Romming.pdf
(4) NASCO CNL (07) 18, Council, Report of the Meeting of the Liaison Group with the North Atlantic Salmon Farming Industry, April 11, 2007.
(5) Sernapesca. Provided on March 15, 2007 via Freedom of Information request (January 10, 2007) by Pure Salmon Campaign.
(6) Australia Department of Primary Industries and Water. Obtained on April 25, 2007 in response to FOI request by Pure Salmon Campaign.

III. Trends in Escapes from Open Net Cage Systems

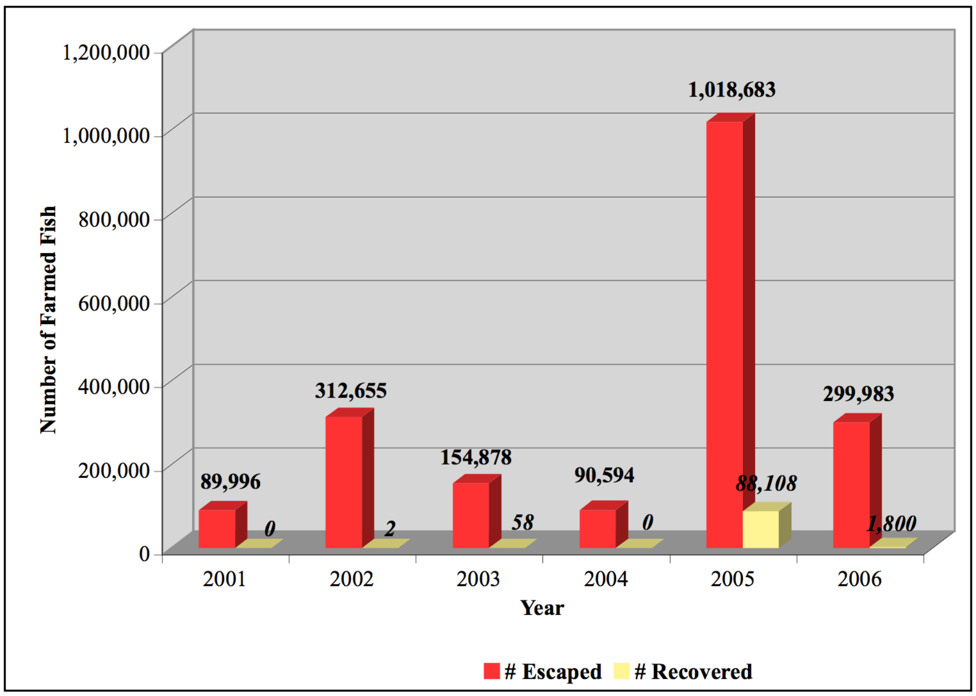
Below, we highlight some of the major trends that we have observed within the global data on escapes from open net pen systems.

Ineffective at Recovering Escaped Fish

The density of fish farms in most regions challenges the ability to identify which farm is responsible for an escape without a farm self-reporting the escape, tagging to identify the escaped fish or the using costly and new DNA-testing methods.[34]

Scottish data indicated that the record of recapture is imperfect. Out of a reported 1,885,789 escapees between 2001 -2006, 1,860 escapees were recovered, or 0.01 percent. **In other words, one out of every 1,000 escaped fish was recaptured from the wild.**[viii]

Figure 7: Reported Escaped Versus Recovered Marine Finfish in Scotland, 2001 -2006



Source: 2002 -2006 escapes data provided by Scottish Executive on February 23, 2007 via Freedom of Information Requests by the Pure Salmon Campaign. 2001 data provided by Scottish Executive in response to previous data request, November 2006. Notes: In 2004, one incident lists "unknown" number of escapees. In 2004, 1 escapee was from a hatchery. In 2005, 125,000 "escaped" fish were reported "dead." In 2006, another 130,000 were reported as "dead."

[viii] This recapture figure does not include 130,000 escapees that were reported "dead" in 2006 and 125,000 reported "dead," although some escapees listed as "dead" were included in the "recovered" category in Scottish Executive data. We did not include "dead" fish within this calculation, since those fish were likely still in the farm area and thus would not accurately represent the ability (or disability) to recover fish once they've escaped into the wild, marine environment.

Escapes of Diseased and Chemically-Treated Fish

Data provided to Pure Salmon Campaign by the Scottish Executive via FOIA requests has enabled us to get a glimpse into the potential of escapes acting as a vector of disease. We have requested similar data from other regiona, but thus far, the Scottish Executive is the only regional authority that has provided us this level of data on disease and chemically-treated fish.

Figure 8 list the frequency of occurrence of seven, specific diseases (IPN, BKD, Pancreas Disease, Winter Ulcer, CMS, Furunculosis and Vibriosis), for which we requested data from the Scottish Executive.

Figure 8: Frequency of Specific Diseases on Scottish Salmon Farms, 2000-2005

Agent/Disease	2000	2001	2002	2003	2004	2005
IPN	97	145	182	176	148	51
BKD	6	0	0	6	4	1
Pancreas Disease	2	2	0	4	1	3
Winter ulcer	1	7	3	1	0	1
CMS	0	1	0	0	0	3
Furunculosis	2	2	0	1	1	0
Vibriosis	0	45	30	24	37	31

Source: Compiled by the Pure Salmon Campaign from Scottish Executive data provided in June 2006.

As Figure 8 demonstrates, IPN, BKD, and Vibriosis are some of the more commonly identified, reported diseases affecting Scottish salmon farming operations. IPN is considered the most serious of these viral diseases in terms of its impact on Atlantic salmon production in the European Union.[35]

Via FOIA requests, the Pure Salmon Campaign has obtained data from the Scottish Executive on escapes from salmon farm sites infected with Infectious Pancreatic Necrosis (IPN). [ix]

As Figures 9 and 10 demonstrate, **60 percent of Scottish farmed salmon escapees between 2000 -2005 originated from IPN-infected farm sites.** In this time period, close to 1.2 million salmon escaped from IPN-infected sites. In 2004, all reported farmed salmon escapes in Scotland were from IPN-infected sites. Additionally, the last year of

[ix] There is a discrepancy in data provided by the Scottish Executive in June 2006 and data provided to Pure Salmon Campaign on February 23, 2007. The initial set of data reports approximately 1.5 million escapes from IPN-infected sites between 2000 -2005 (see Figures 8, 9). The more recent data indicates only 45, 892 escapees from IPN-infected sites between 2001 -2005. The Pure Salmon Campaign has asked the Scottish Executive to explain the differences in the data provided.

available data (2005) includes the highest number of escapees from IPN-infected sites in the 2000-2005 period.

Figure 9: Reported annual Escapes from IPN-Infected Sites in Scotland, 2000-2005

	# escapees	# escapees from IPN-infected sites	% escapees from IPN-infected sites
2000	420,541	370,357	**88**
2001	89,996	26,000	**29**
2002	367,405	336,746	**92**
2003	151,437	30,227	**20**
2004	82,647	82,647	**100**
2005	877,883	339,511	**39**
Total	**1,989,909**	**1,185,488**	**60**

Source: 2000 -2005 Escapes figures provided by the Scottish Executive in July 2006 via FOIA requests by the Pure Salmon Campaign (Important Note: These regional escapes figures for farmed salmon, specifically provided by the Scottish Executive in July 2006 differ from annual escapes (all species) figures provided by the Scottish Executive in February 2007). IPN-infected escapes figures provided by the Scottish Executive in June 2006 via FOIA requests by the Pure Salmon Campaign.

The Scottish Executive data also allows us to look at the regional distribution of escapes between 2000 and 2005. **Between 2000 and 2005, more than 85 percent of escaped farmed salmon in the Shetlands and Orkney were from IPN-infected farms.** Reports suggest that IPN "was almost ubiquitous in Shetland by 2001."[36]

Figure 10: Regional Reported Escapes from IPN-Infected Sites in Scotland, 2000 -2005

Region	# Escapees	# Escapees from Non IPN-Infected Sites*	# Escapees from IPN-Infected Sites	% Escapees from IPN-Infected Sites
Shetland	437,051	56,996	380,055	**87**
Orkney	407,501	55,483	352,018	**86**
Highland	302,799	236,295	66,504	**22**
Western Isles	783,105	416,146	366,959	**47**
Strathclyde	59,453	39,501	19,952	**34**
Total	**1,989,909**	**804,421**	**1,185,488**	**60**

Source: 2000 -2005 Escapes figures provided by the Scottish Executive in July 2006 via FOIA requests by the Pure Salmon Campaign. IPN-infected escapes figures provided by the Scottish Executive in June 2006 via FOIA requests by the Pure Salmon Campaign.

Additionally, in February 2007, in response to a FOIA request by Pure Salmon Campaign, the Scottish Executive relayed additional data on escapes from Atlantic salmon sites that had been treated with the sea lice chemicals SLICE (Emamectin benzoate) and Excis (Cypermethrin) and the antibiotic, Oxytetracycline, at the time of the reported escape. Use of these chemicals may serve as an indicator of disease (or recent disease) on the farm site.

Scottish Executive data show escapes from SLICE-treated fish farm sites since 2002. Since 2002, over 115,000 escapees came from sites that were treated with this sea lice chemical, Slice. And, 3,500 escapees were treated with another sea lice chemical, Excis. Both of these chemicals are permitted under the Soil Association organic standards. [37]

Figure 11: Chemically-Treated Escapes from Scottish Atlantic Salmon Farms

Year	# Escaped	# Recovered	Slice or Emamectin*	Excis*	OTC*
2002	312,655	2	8,647	0	0
2003	151,853	58	16,001	500	0
2004	90,594	0	15,946	0	0
2005	1,018,683	88,108	51,953	3,000	0
2006	287,753	1,300	24,318	0	1,950
Total	**1,861,538**	**89,468**	**116,865**	**3,500**	**1,950**

* From a sited treated with this chemical
Source: Scottish Executive, February 23, 2007, in response to FOIA request by the Pure Salmon Campaign.

Other species more recently introduced in open net pen systems, also represent a real disease risk. Based upon data obtained under FOIA from the Scottish Executive in June 2006 and May 2007, Vibrio *spp.* was reported on cod farms in the Western Isles in 2000, Orkney and Highland in 2002 and Shetland in 2004. Infectious Pancreatic Necrosis was reported in farmed cod in Highland in 2004 and *Vibrio anguillarum* in Shetland in 2006. In 2007, cod farms in Shetland tested positive for 'Gill Pathology' and 'Aeromonas salmonicida.'

Diseases have also been reported on organic salmon farms in Scotland. Data obtained under FOI by the Pure Salmon Campaign in May 2007 from the Scottish Executive reveals that West Minch Salmon tested positive during 2007 for 'Skin Pathology', 'Vibrio Species' and 'Suspect Bacterial infection.' West Minch Salmon has been certified as organic by the Soil Association since 2001.[x]

Hjaltland Seafarms also tested positive between January and May 2007 for 'Infectious Pancreatic Necrosis', 'Skin Pathology', '*Moritella viscosa*' and 'Vibrio Species.' In July 2007, Hjaltland Seafarms purchased 'the world's largest organic salmon farm North Atlantic Sea Farms.'[xi]

Section B outlines scientific research on the capacity of disease-infected farmed salmon (especially escapees) to spread diseases to wild fish.

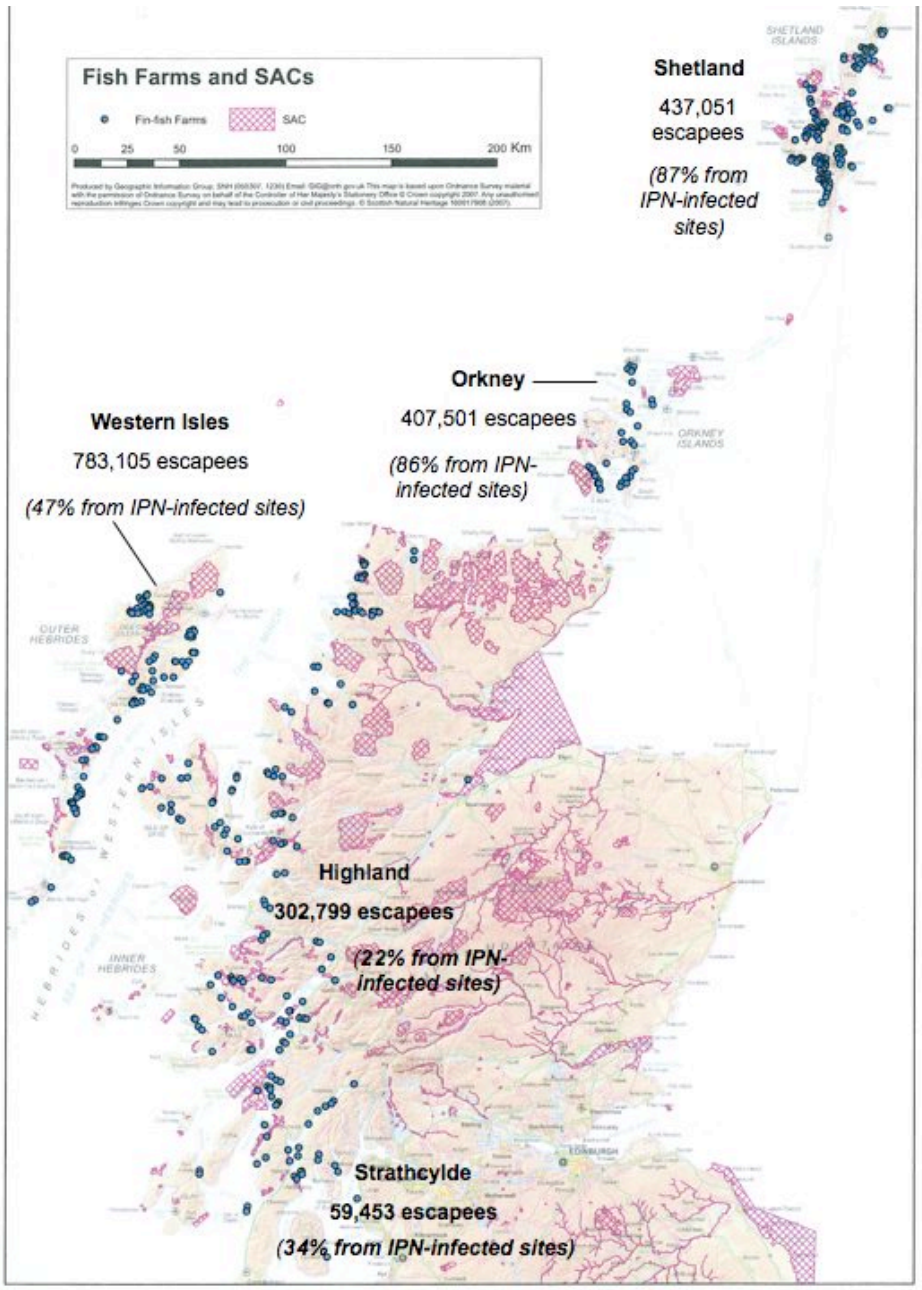
Escapes Affecting Marine Protected Areas

Escapees from salmon farms can travel for hundreds of kilometers and have been caught in rivers even where there are no salmon farms.[38] Farmed salmon escapes have occurred

[x] http://www.hebridesharvest.com/history.htm
[xi] http://www.shetlandmarine.com/2007/04%20Aquaculture/biggest_organic_salmon_farm_sold.htm

within and surrounding marine protected areas, where wild salmon and other species are, in theory, protected by national and international laws. In Scotland, for example, escapes have taken place within the boundaries and affecting rivers within Special Areas of Conservation. Data obtained in January by the Pure Salmon Campaign under FOIA from Scottish Natural Heritage reveals that there are 479 fish farms located either within or 40km from a Special Area of Conservation – areas protected under European Union law.

Figure 12: Scottish Fish Farms and Special Areas of Conservation (SACs) Compared to Number of Escapees Per Region, 2000 -2005



As Figure 12 demonstrates, if escape figures from Scotland are superimposed upon a map of Special Areas of Conservation and fish farms (obtained in March 2007 from Scottish Natural Heritage under FOIA) it is clear that farmed salmon escapees have the capacity to impact upon protected populations of wild salmon (and freshwater mussels whose life cycle depends upon wild salmon).

In Norway, too, escapes of farmed salmon have impacted upon Norway's 'Laksfjord' (National Salmon Rivers and Fjords) – a system of wild salmon rivers and fjords protected by legislation announced by the Environment Minister Helen Bjornoy in December 2006[39]. Escapes, however, are a prominent feature of rivers supposedly protected under the 'Laksfjord'. Research published in 2005 by WWF Norway, for example, calculated that farmed fish escapees comprised 81% of the fish populations in Hardangerfjorden, 57% in the Vosso River, 43% in Fordefjorden, 35% in the Namsen River and 26% in the Nausta River.[40]

In British Columbia, escapes have been a problem within the Clayoquot Sound UNESCO Biosphere Reserve since it was established in 2000 (there are over 20 open net cage salmon farms located within the boundary of the UNESCO Biosphere Reserve)[41]. Despite the UNESCO designation, farmed salmon escapes (and diseases) have been reported in Clayoquot Sound in 2002[42]. In September 2007, another escape or "spill" of farmed Atlantic salmon was reported in the Clayoquot Sound UNESCO Biosphere Reserve.[43]

Some have considered legal action.[xii]

[xii] In September 2007, following yet another escape within a Special Areas of Conservation in the Western Isles, the Association of Salmon Fishery Boards and the Rivers and Fisheries Trusts of Scotland announced that they are preparing a complaint to the European Commission. Andrew Wallace, Managing Director of the Association of Salmon Fishery Boards and the Rivers and Fisheries Trusts of Scotland commented:

"The escape of another 30,000 2.5 kg maturing fish close to spawning time near the mouth of one of the western Scotland's most iconic salmon rivers – the Grimersta – comes at the end of a long summer of discontent on the escapes front. How sophisticated multi-national companies can afford to lose such valuable stock and continue to play Russian roulette with wild stocks is beyond comprehension. This is the fourth escape from salmon farms in the Western Isles since May and the sheer numbers involved – this latest escape being over 30% of the entire Scottish rod catch – means that these incidents must be viewed with utmost seriousness. The River Grimersta is part of the Langavat Special Area of Conservation (SAC) designated under EU law to protect the wild salmon population. The proximity to the SAC, the time of year and maturity of the escaped fish present a serious risk to an internationally recognised conservation site and we will be reporting this matter to the European Commission immediately."[xii]

SECTION B

SCIENTIFIC REVIEW OF GENETIC AND ECOLOGICAL IMPACTS OF ESCAPES FROM OPEN NET CAGE SYSTEMS

Impacts of escaped farmed salmon have been well documented in the scientific literature since the early 1990s. There exists dozens of papers detailing ecological and genetic impacts of farmed salmon escapees. These include, by region of study (full citations provided in "Scientific References", page 42):

Norway
Gausen and Moen 1991
Hindar et al. 1991
Heggberget et al. 1993
Einum and Fleming 1997
Sægrov et al. 1997
Fleming et al. 2000
Bentsen and Thodesen 2006

Chile
Soto et al. 2001
Buschmann et al. 2006
Soto et al. 2007

Scotland
Webb et al. 1993a, 1993b
Youngson et al. 1993
Youngson and Verspoor 1998
Youngson et al. 2001
Butler and Watt 2003
Garant et al. 2003
Butler et al. 2005

Canada
Gross 1998
Volpe et al. 2000
Volpe et al. 2001
Whoriskey and Carr 2001a, 2001b
Weir and Fleming 2006

Ireland
Crozier 1993
McGinnity et al. 1997
Clifford et al. 1998a, 1998b
Crozier 2000
McGinnity et al. 2003

United States
Baum 2000
Baum 2001
Wakntiz et al. 2002
Bisson 2006

Two recent scientific reviews are a particularly useful frame of reference. A 2005 review paper (Naylor et al. 2005) cites 65 references on the escape research. A 2007 review (Ferguson et al. 2007) cites 167 references (both reviews are attached).

Additionally, a review published by the Canadian Government in 2006 (Weir and Fleming 2006) cites 116 references. A later review published in 2007 (Hindar and Diserud 2007) cites 81 references (mostly from the Norwegian literature).

Several scientific papers on escapes were also published by the *ICES Journal of Marine Science* in 2006 (Buschmann et al. 2006; Carr and Whoriskey 2006; Fiske et al. 2006; Hindar et al. 2006; Jonsson and Jonsson 2006; Skaala et al. 2006; Skilbrei and Wennevik 2006; Walker et al. 2006; Whoriskey et al. 2006).

And, a GENIMPACT scientific report published in July 2007 by the European Commission reviewed existing knowledge necessary to assess genetic effects of aquaculture on biodiversity (Svåsand et al. 2007a) – including a chapter on the genetic effects of farmed Atlantic salmon on wild populations (Verspoor et al. 2007).

Other papers published in 2007 (Soto et al. 2007; Barry and VanderZwaag 2007) have been referred to and scientists working on this issue in Norway and Canada have kindly provided access to the latest scientific research and references.

Significant Ecological and Genetic Impacts on Wild Fish

Peer-reviewed science has clearly demonstrated significant ecological and genetic impacts of escaped farmed salmon on native wild fish populations. An international team of scientists reviewed empirical evidence and assessed the risks posed by open net cage salmon farming in a paper published in 2005 in the journal *BioScience* (Naylor et al. 2005). In summary, the paper stated:

- Escapees can compete with native and non-native wild salmon species for mates, space and prey.
- Escapes may have a detrimental impact on vulnerable wild salmon populations at a regional scale.
- Escapes present risks of increasing disease outbreaks, proliferating possible disease transmission routes in the environment, and decreasing the immunity of wild fish to disease.
- Repeated farm escapes can establish self-sustaining feral populations and escapees can have significant impacts on wild fish whether or not escapees reproduce.
- Risks include potential reductions in the genetic diversity (and resulting ability to adapt to environmental change), productivity, and fitness of wild fish, leading to possible extinctions as well as the loss of unique gene pools.
- Escapes of all farm species raised in open net cages appear inevitable, and many new farm species such as cod and halibut share important characteristics with farm salmon.

A paper published in 2007 (Barry and VanderZwaag 2007), summarized the situation as follows:

> Impacts of concern include hybridization; colonization by establishing significant, self-sustaining runs; interbreeding causing reduced genetic diversity and fitness; predation of native species; competition for space or resources potentially disrupting wild salmon production; disease transmission; and modification or destruction of the habitat of native species.

A project - GENIMPACT – financed by the European Commission published a report in July 2007 (Svåsand et al. 2007a). The chapter on Atlantic salmon farming (Verspoor et al. 2007) details the following indirect and direct effects:

> In field studies indirect effects are seen due to behavioural, ecological, and disease interactions which can reduce effective sizes of wild populations and increase genetic drift; in particular, competition with farm fish and hybrids, which are larger, may depress smolt production. Direct effects occur due to interbreeding. Farm and farm-wild hybrid offspring show substantially reduced lifetime success with poorer survival in freshwater and at sea, causing reduced recruitment of wild fish. When farm escapees are re-occurring, fitness reductions may accumulate and can lead to the extinction of already depressed wild populations

Contributing scientists from Scotland, Norway and Ireland concluded within the GENIMPACT project:

> Around 0.5-2 million salmon (0.5-1.6% of production) escape each year into the North Atlantic, equal to ~ 50% of pre-fisheries abundance of wild fish, of which ~10% enter the rivers where many interbreed with wild salmon and trout.

The Global Spread of Genetic Pollution

Escaped Atlantic salmon populations have been found reproducing in rivers in British Columbia and in South America (Naylor et al. 2005, Weir and Grant 2005, Ferguson et al. 2007, Soto et al. 2007). Pacific farmed salmon have also escaped in large numbers in both British Columbia where they are native (Fleming 2005, Naylor et al. 2005) and in Chile where they are an introduced species (Soto et al. 2001, Soto et al. 2007).

A scientific review published in 2007 detailed how up to 80% of the spawners in some Norwegian rivers are of farm origin. On the East coast of North America, escaped farmed salmon outnumbered wild fish by as much as 10 to 1 in some rivers (Whoriksey and Carr 2001a). An international team of scientists from Norway, Ireland, Scotland and Canada concluded that no river is safe from escaped farmed salmon:

> There is a significant correlation between the intensity of fish farming in an area (estimated as density of farms, or total numbers of smolts put into net pens) and the occurrence of escaped farmed fish in the rivers (Lund et al. 1991). In Western Scotland in the period 1990-2001, Butler and Watt (2003) found a mean contribution of farm escapes to the salmon rod catch of 9% in rivers with salmon farms compared to 2% in rivers without farms. Due to the wide dispersal of escaped farm fish, no river can be regarded as having no farm fish.

Scientists reported escaped Irish farmed salmon, for example, caught in the weeks following an escape in Northern Ireland up to 250km away in Scottish, English and Welsh rivers on the other side of the Irish Sea in areas where salmon farms are absent (Milner and Evans 2003).

Escapees from salmon farms in the North Atlantic have been found as far afield as the Faroes, West Greenland, Iceland, Finland and in Denmark (Gudjonsson 1991, Hansen et al. 1993, 1997 and 1999, Fiske et al. 2001, Fiske: 2006, Niemelä et al. 2007). In Norway, escaped farmed salmon have been a huge problem since the 1980s (Moen and Gausen 1989, Hindar and Diserud 2007).

However, it took until 2007 for new DNA fingerprinting technology to be employed successfully to track down escaped farmed salmon to a particular cage at a specific site (Skaala 2007, Glover et al. 2007).

On the East coast of North America, a study published in 2001 calculated that farmed salmon escapees comprised more than half of the salmon entering Maine's rivers (Baum 2001) - many of them originating from farms in New Brunswick, Canada (Whoriskey and Carr 2001b, Rappaport 2005, Blackwell 2005). Scientists in New Brunswick working with the Atlantic Salmon Federation reported escaped farmed salmon in 2006.[44] [45]

In Western Northern America, escaped farmed Atlantic salmon as well as farmed Pacific salmon and have been caught in the Pacific waters off Washington, British Columbia and as far North as the Bering Sea and Alaska where salmon farming is currently banned (Moring 1989, Wing et al. 1992, McKinnell 1997, Brodeur and Busby 1997, Noakes et al. 2000, Volpe et al. 2000, Volpe et al. 2001, Gaudet 2002, Morton and Volpe 2002).

In British Columbia, Atlantic salmon have been found in more than 80 rivers with naturally reproduced feral juvenile populations found at three locations (Volpe et al. 2000).

In the United States, the USDA Forest Service reported in March 2007 that:[46]

> At present, breeding populations of escaped farm salmon are not known to exist on National Forest System lands, but the locations of Atlantic salmon farms and the sightings of escaped salmon indicate that streams on four national forests may be at risk: the Tongass and Chugach NF in Alaska, and the Olympic and Mount Baker-Snoqualmie NF in Washington.

In Chile, a paper published in 2007 reported that populations of Chinook salmon (a non-native species) are becoming established in several catchments of the Pacific coast of southern South America, including those draining directly from Chile and some draining from Argentina basins. "As seen in Petrohue, reproductive populations could import significant quantities of marine derived nutrients as they do in their original habitats thus disturbing natural cycles and balances," states the paper. "The establishment of Chinook is creating social conflicts and may have strong ecological effects especially on marine systems" (Soto et al. 2007).

The Legal Regime – Escapees as Pollutants

The ability of escaped salmon to move across national boundaries raises transboundary management issues and challenges (Barry and VanderZwaag 2007) – and various legal issues (Firestone and Barber 2003).

A legal review in 2003 concluded that the ecological, cultural and legal implications arising from even low numbers of escaping Atlantic salmon are sufficient for escapes to be considered legally as "pollutants" (Firestone and Barber 2003). Unlike many effluents that can be cleaned up, the biological pollution resulting from farm fish escapes can be irreversible in its ecological impact (Hutchings 1991, McGinnity et al. 2003, Naylor et al. 2005, Ferguson et al. 2007).

For example, in 2002 in Maine a court found two salmon farming companies liable for polluting marine waters because of their escaping non-native salmon species and concluded that "escapees can negatively affect endangered wild salmon by spreading pathogens and parasites and by competing for food, habitat, mates, and spawning sites" (Barry and VanderZwaag 2007).

And in September 2007, following recent farmed salmon escapes in the Western Isles fishing groups in Scotland announced a complaint to the European Commission.[47]

Escapees and the Spread of Diseases and Parasites

Diseases and parasites, like escapes, seem to be an inevitable problem of open net cage salmon farms.[48] As the Directorate of Fisheries in Norway states: [49]

> One of the greatest environmental challenges of the fish farming industry is the escape of farmed fish. Particular consideration has been given to the genetically impact, due to the fact that the escapees are spawning with the wild salmons, and that the escapees contribute to the spreading of salmon lice infection.

Scientific research linking open net cage salmon farms with sea lice infestations on wild salmon populations in addition to other species such as Arctic char and sea trout has been published in Norway, Canada, Scotland and Ireland (Bjorn et al. 2001, Bjorn and Finstad 2002, Butler 2002, Gargan et al. 2002, Holst et al. 2002, McKibben and Hay 2004, Morton et al. 2004, Penston et al. 2004, Krkosek et al. 2005, Heuch et al. 2005, Costello: 2006, Krkosek et al. 2006).

The data presented earlier from Scotland relating to IPN-infected escapees (over 1.1 million were reported between 2000 to 2005) represents just one case study of the potential of escapees to transfer diseases. Infectious diseases such as Infectious Salmon Anaemia (ISA), Infectious Pancreatic Necrosis (IPN), Infectious Haematopoietic Necrosis (IHN), Pancreas Disease (PD), Bacterial Kidney Disease (BKD) and Furunculosis have plagued the open net cage salmon farming industry since its inception (Hastein and Lindstad 1991, Kent and Poppe 1998, Kent 2000).

Given the open nature of the net cage system and the common proximity of farms, outbreaks of disease and parasites are often difficult if not impossible to quarantine. As a recent scientific review states (Ferguson et al 2007): "Fish farming operates in open aquatic systems, and there is a possibility that disease organisms may be transferred from farm to wild fish, or from wild to farm and back to wild at higher densities."

The USDA's Forest Service also reported in March 2007 that: "Atlantic salmon could transmit a serious disease or parasite to native fishes."[50] A report published by the

USDA's Forest Service in 2006 also stated that (Bisson 2006): "The two greatest threats appear to be that (1) Atlantic salmon could transmit a serious disease or parasite to native fishes, and (2) escaped salmon could eventually adapt to local conditions, leading to self-sustaining populations."

Disease interactions between farmed and wild salmon are not well understood (Hastein and Lindtstad 1991). The disease risks associated with farmed salmon escapees in particular has received limited attention (McVicar 1998, Olivier and MacKinnon 1998). Research specifically linking escapees with the spread of sea lice is similarly sparse but there have been some studies in Canada, Scotland and Norway. A study in New Brunswick reported sea lice infestation on escaped farmed Atlantic salmon entering the Magaguadavic River – with up to 100 sea lice recorded on escaped farmed salmon (Carr and Whoriskey 2004). A Scottish study reported sea lice on escaped farmed salmon caught in rivers on the West coast of Scotland with the potential of cross-infection between farmed, escaped and wild salmon (Butler 2002).

Norwegian researchers started catching escaped farmed salmon and counting sea lice levels in 1994 with an average of 10 sea lice reported in 1997 and 1998 (Grimnes et al. 1998, 1999, 2000). A Norwegian study published in 2001 (Heuch and Mo 2001) assumed that "there are 1.5 million escaped salmon which carry 10 lice each (Grimnes et al. 1998)" and "the contribution of louse eggs from escaped fish was estimated to be 15 billion, i.e. 6 times the production on wild salmon and sea trout". Since the numbers of escaped farmed salmon in Norway has increased since the 1990s the potential for escapees to spread sea lice is even greater.

Another paper published in 2006 (Skilbrei and Wennevik 2006) referred to Norwegian research on the capacity of escapes of rainbow trout to spread sea lice (Heuch and Mo 2001):

> Sea lice may have harmful impacts on wild sea trout and Atlantic salmon smolts migrating to sea (Finstad et al., 2000; Bjørn et al., 2001), and harvesting escaped salmonids may reduce the potential number of sea lice hosts. During a research fishery conducted in Region B in April 2000, 141 escaped rainbow trout were caught with a mean infestation of 3.6 adult female lice per fish (J. C. Holst, pers. comm.). Reducing the stock of escaped farmed rainbow trout and salmon during autumn and winter, therefore, may reduce the infestation rate of lice on sea trout and migrating salmon smolts during spring and summer and improve the control of sea lice in fish farms

A review paper in 2005 addressed the issue of escapees as a potential vector for the spread of parasites and diseases (Weir and Grant 2005). In a review of the available scientific literature the paper referred to two other studies that dealt with the escapes issue in the specific context of disease and parasite transfer. Jacobsen and Gaard (1997) found that sea lice abundance and density were higher on escaped farmed than on wild Atlantic salmon, though not in all age classes. Outbreaks of furunculosis, caused by the bacterial pathogen *Aeromonas salmonicida*, were hypothesized to have been caused by escapees from farm facilities (Johnsen and Jensen 1994). Weir and Grant (2005) concluded however that: "Evidence of disease transfer between farmed and wild salmon is largely correlational and deserves further experimental study."

In fact, the '7th International Conference: Sea Lice 2008' taking place in Chile in March/April 2008 will feature papers on "Sea Lice on Escaped Farmed Fish." The problem of sea lice is not only global but is already affecting other species such as farmed cod. As the conference outline states:[51]

> There is also a growing awareness of the importance of understanding the biology of species other than *L. salmonis*. This is perhaps most pressing for the case of *C. rogercresseyi,* given the problems being experienced within the Chilean aquaculture industry. However, *C. clemensi* and *C. elongatus* continue to be of interest in western Canada and in Scotland and Ireland respectively. It is also likely that a better understanding of these non host-specific parasites will become important as part of the emerging research on ectoparasitic infection of novel finfish species in commercial aquaculture (for example, *C. elongatus* has already been reported to be a problem in European cod farms).

In the meantime, an international team of scientists from Norway, Scotland and Ireland working on a European-Union funded project called GENIMPACT concluded in July 2007 (Verspoor et al. 2007):

> Effective containment and considered location of farms, involving epidemiological zones and vaccination programmes to control diseases and parasites, as well as maximizing domestication of farm strains, is the best way to ensure avoidance of direct and indirect genetic impacts.

Sea Lice Infestation on Organic Salmon Farms

The issue of open net cage salmon farms as a reservoir for sea lice was raised by the Pure Salmon Campaign in our submission to the NOSB in March 2007:[52]

> Sea lice infestation on Irish "organic" salmon farms has been a problem despite claims that a high tidal exchange rate at farm locations "prevents the accumulation of parasites and pollutants." According to sea lice data collated by the Irish government, Mannin Bay Salmon's Corhoughagh "organic" salmon farm site in November 2006 had the highest sea lice counts of any salmon farm operating in Ireland. Mannin Bay Salmon's Hawks Nest "organic" salmon farm site also had the third highest sea lice counts with Muirachmhainni Teo's Daonish salmon farm site the fifth highest for sea lice infestation (see enclosed Excel spreadsheet). Mannin Bay Salmon and Muirachmhainni Teo are certified as "organic" by Naturland (Germany), Bio Suisse (Switzerland), Qualité France, and IOFGA (Ireland).
>
> The Irish government also found sea lice problems at organic salmon farms during 2005 in a report published in May 2006.
>
> - Levels at Daonish (Muirachmhainni Teo), Kilkieran Bay, were in excess of treatment trigger levels for all inspections, 6 in the spring period and 2 outside the spring period.

> – At Hawk's Nest (Mannin Bay Salmon Co. Ltd.), Mannin Bay, levels exceeded treatment trigger levels at the start of the spring and remained so for the whole spring period even as the fish were moved to Corhounagh in April. These fish dropped below treatment trigger levels for August and September but rose again for the last inspection prior to harvest in October.
>
> - Lice levels at Portlea (Clare Island Seafarms Ltd), Clew Bay, were in excess of treatment trigger levels for 4 of the 5 inspections in spring and again in June, August, September, October, and November.

Site-specific sea lice data appears only to be available in Ireland – FOIA requests for comparable data in Scotland, Norway, Chile and Australia, for example, have either been refused or not answered.

Different Species, Same Problems with Diseases, Parasites and Escapes

Escapes from other species grown in open net cages such as cod, halibut, sea trout, kingfish and bream are now an emerging international issue. Escapes from cod and halibut farms in Norway in particular is a well known problem,[53] but there have also been reports, for example, of escapes of farmed kingfish in Southern Australia,[54] farmed barramundi in the Northern Territory in Australia,[55] and farmed seabream in the Mediterranean (Miggiano et al. 2005, Dimitriou et al. 2007).

Naylor et al. 2005 concluded:

> The inadequacy of efforts to prevent or reduce impacts of farm salmon escapes is worrisome in the face of growing farm production of other marine finfish species. Escapes of all farm species raised in open net cages appear inevitable, and many new farm species such as cod and halibut share important characteristics with farm salmon. Wild population of some these fish are small in projected farming areas. Examples include Atlantic cod and Atlantic halibut for farming in the United States and Canada.

A report published by the Scottish Executive in June 2005 warned of the risk of introducing new disease problems via farming new species such as cod: [56]

> Bringing new species onto a site will provide the opportunity for existing diseases to meet a new host for example IPNV and cod. On the other hand it could provide a pool of infection if one species is not seriously affected by a pathogen but can act as a carrier for the disease. A second species may be highly susceptible to the disease and show clinical signs following co-habitation with the carrier.

Scientists in Canada reported in 2006 that escapes of farmed cod could also have an impact on the severely depressed local Atlantic salmon populations in the Bay of Fundy, New Brunswick, if they occurred in the migration corridors of smolts at the time of their migration to sea (Brooking et al. 2006).

A scientific report published in July 2007 by the European Commission reviewed the genetic effects of cod, halibut, sea bass, seabream and turbot farming on wild fish populations (Svåsand et al. 2007a). Another report published in August 2007 by the Institute of Marine Research in Norway points out that farmed cod have a greater capacity for escape than farmed salmon (Svåsand et al. 2007b):

> Cod behave differently from salmon, and are more likely to escape if they find a hole in the sea-cage netting. Although the scope of cod farming is still very limited, serious escapes have already been reported, including 290,000 cod that escaped in 2006. This is an extremely high figure in view of the relatively low level of production.

And the report also addresses the problem of emerging new diseases on cod farms and the potential spread to wild fish as well as other farmed fish:

> In 2006, nodavirus, which is a well-know problem in halibut farming in Norway, has also hit farmed cod on three occasions. In general, juveniles are most vulnerable, developing the disease known as Viral Nervous Necrosis, which often has an extremely high mortality rate. The virus is known to be spread vertically, for example from mother via her eggs to larvae and fry. Since farmed cod often spawn in sea-cages, infections caused by viruses that spread vertically are yet another threat to the environment, in addition to their potential for having genetic impacts. We still know far too little about the extent of the hazard of infection when cod sea-cages are located in important spawning grounds for wild fish, or about the hazard to wild fish in general or to other farmed fish.

Farmed cod, like farmed salmon, have the potential to act as carriers for sea lice and the transmission of viruses (Svåsand et al. 2007b):

> A significant proportion of the salmon louse larvae found today in the sea have been produced by lice that infest farmed salmon in sea-cages. Wild salmonids are therefore exposed to a much higher infection pressure that they would have been in the absence of aquaculture. The question is whether the same thing will happen with lice on farmed cod. Large-scale cod farming may well increase infection pressure on wild fish, and there will be far more suitable hosts for cod lice than for salmon lice outside the seacages. It has been shown that salmon lice can transmit viruses between fish. We know little about whether cod lice or sea lice are capable of acting as disease carriers, but since these are more inclined to jump from one host to another than salmon lice, and since seacages often attract wild cod and other gadoids, the potential for spread would appear to be greater.

Another problem affecting open sea-cage cod farms in Norway is Francisella. First discovered on Norwegian cod farms in 2004, Francisella "constitutes a future threat, not only to cod production in Norway, but to all fish farming in the marine environment including salmonids" (Nylund et al. 2006). The Institute of Marine Research in Norway reported in August 2007 (Svåsand et al. 2007b):

> An epidemic outbreak of this disease has also been observed in the Skagerrak/Kattegat. Since both the coastal current and large numbers of farmed cod are transported in a northerly direction, it is likely that *Francisella* infections will be spread by water, wild fish and farmed fish.

In British Columbia, concerns have also been raised about the disease implications of sablefish (black cod) farming (Sumalia et al. 2005):

> A threat occurs with the creation of 'reservoirs', typically domesticated animals, from which diseases can 'spill-over' into threatened populations (McCallum and Dobson 1995; Daszak *et al.* 2000). Sablefish farms located within the native range of wild sablefish represent novel, spatially concentrated host populations that may perturb the dynamics of the extant sablefish host-parasite systems. Much of the recent debate surrounding ecological sustainability of industrial salmon farming in BC has focused on disease and parasite-related impacts on wild salmonids. Not surprisingly, how industrial scale sablefish farms may likewise alter epidemiological processes is a major concern. Unfortunately published literature available on this issue is neither abundant nor recent.

SECTION C

CONCLUSION

It is our view that this international inventory of escapes from open net cage systems strongly suggests that open net cages are ineffective containment systems. The figures presented within this paper suggest at least 10 million salmon and trout have escaped from open net pen systems globally since 2000. And, this is just the tip of the iceberg. Given numerous obstacles to collecting accurate escapes data – this estimate is likely less, and possibly exponentially less, than the actual number of escapes. Recent data on escapes of other marine species – such as cod, halibut, and Arctic charr –also suggests that other marine species now farmed in open net cages are escaping at three to ten times the rate of farmed salmon and trout.

Within this paper, we have done our best to respond to specific questions posed by the NOSB. Within this section, we provide answer your specific questions in more detail.

However, we believe that the burden of proof should be on the proponents of organic open net cage aquaculture to prove that these systems are not detrimental to the environment and that they are within the bounds of organic principles.

Many of the most critical questions related to the ecological impacts of open net cage aquaculture are still unanswered (and perhaps, unanswerable). We believe that these fundamental questions must be resolved before the NOSB considers moving forward with organic standards for open net cage systems.

We ask the NOSB to require that proponents of organic, open net cage systems respond directly to the following questions:

- Is it possible to consistently **eliminate** all escapes (including leakages) from an open net cage system, organic or conventional? If no, then:

- How many escapes are "too many"? Please provide the NOSB a **number** of escapes, which you would agree is too high?

- At what level are escapes a threat to wild fish populations? Please provide the NOSB with the **number** of escapes that would pose a threat?

- We know that nutrient pulses into a habitat alter species profiles – particularly parasites and diseases. What data are available showing that organic pollution from farms are not and will not drive additional disease/parasite burdens on wild fish?

- Can we **guarantee** that no diseases/parasites, including sea lice, occur on organic fish farmed in open net cages? And, if no:

- Is there proof that these diseases can be effectively treated and contained using treatments available within organic standards (i.e. no synthetic parasiticides)? And;

- Can we guarantee that diseases, including sea lice, will not spread from organic open net cage farms to wild fish? And;

- What ability would an organic open net cage farm manager have to predict and/or prevent new diseases?

- Are the potential increased genetic and disease/parasite risks inherent with culture of native species preferable to the potential genetic and ecological impacts associated with culture of exotic species?

- What is the current escape ratio (rate of escape per unit production) of farmed fish from organic open net cage farms? How does this compare to the conventional escape ratio in the region or production?

Principle 15 of the *1992 Rio Declaration on Environment and Development* explains the precautionary principle as:

"Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent degradation."

We believe the only solution to ensuring that escaped farmed fish have little to no impact of wild fish and marine biodiversity is to actually <u>prevent</u> escapes. The NOSB can avoid the difficult if not impossible task of determining at which level escapes become acceptable, by requiring that organic aquaculture takes place solely in closed containment systems.

The logic of conclusions of a 2007 legal review (Barry and VanderZwaag 2007) seems inescapable:

> Preventing the escape of farmed salmon could be quite simple. As in Alaska, a total ban on farming salmon in ocean net pens could be imposed. Raising finfish in landbased facilities with protective barriers to prevent escapes into watercourses and the sea is a trend being pushed under the [1992] Convention on Biological Diversity. However, getting a firmer grip on escape prevention in Canada and the USA is anything but easy. Most jurisdictions have allowed extensive farming of salmon at sea and, thus, powerful political and economic currents have been established against the tide of prohibition in favour of regulation or voluntary controls.

A 2007 scientific review published (Ferguson et al. 2007) points to closed containment as a solution to the escapes problem:

> Hindar (1992) has argued that the most important measure for marine aquaculture is to base it on closed culture, where the possibility for escape is eliminated and where inflowing and outflowing water are controlled.

Finally, we reiterate a May 23, 2007 submission to the NOSB supported by stakeholders in the organic and environmental communities:

> [W]e urge the NOSB to ensure that the "USDA Organic" standard is neither modified nor diluted to accommodate carnivorous finfish aquaculture in open net cages. It is our hope that the organic label will continue to provide consumers with a clear and consistent understanding of how their food was produced and ensure them that their choice of an organic food product supports a safer and more sustainable environment.

Below, we respond to specific questions posed by the NOSB. Support for the statements made within these responses can be found within this paper.

What is the current rate of escapes in the conventional aquaculture and developing organic aquaculture industry?

According to the best available data, we know that the very least 10.2 million farmed salmon and trout escaped into our world's oceans between 2000 -2006 (see Figure 1).

The average rate of escape from conventional open net pen systems for farmed salmon and trout spans from approximately 1 escapee per every 300 fish in production to 1 escapee per every 630 fish in production (see Figure 2).[xiii] Norwegian data suggests that the escape rate for other species is significantly higher (more fish escape per unit production). For example, our calculations suggest that 1 in every 12 cod in production escaped and 1 in every 50 other marine species (Arctic charr, halibut, turbot, etc) escaped in Norway in 2006 (see Figure 3).

Total escapes from open net cage fish farm sites certified as organic is uncertain. To date, Soil Association is the only organic farmed salmon certifier that has provided a list of organic certified sites to Pure Salmon Campaign. From this list, we are able to gain a rough estimate of the number of escape incidents and escapees from Soil Association certified salmon farm sites, only.

The Soil Association Organic Standards, January 2007 include regulations aimed at reducing escapes. Section 30.6.1 states "You must ensure you design and operate your holding facilities (for example net pens, ponds, ropes and moorings) so that you: minimize the risk of escapes." Additionally, Section 30.6.2 sites: "For all holding facilities, you must: keep them secure and well maintained, and monitor them regularly…" And, Section 30.6.3 (revised) includes additional requirements such as "inspect a net immediately if there is any suspicion that it may have been damaged."

Despite the Soil Association's organic standards, however, the data we have obtained from the Scottish Executive suggests that Soil Association organic certified salmon farms have not been able to prevent escapes.

[xiii] This range does not include the British Columbia escape ratio, which is an outliner from other regional data.

A comparison of site-specific escape incidents (as provided by the Scottish Executive in February 2007) to sites in Scotland certified as organic by the Soil Association,[xiv] suggests that organic salmon farms certified by the Soil Association have reported over 122,962 escapees of farmed salmon in 12 separate escape incidents, between 2002 and 2006 (see Figure 5).

These escapes represent close to 7% of all Scottish salmon farm escapes between 2002 and 2006. Of these escapes of organic farmed salmon, only 1,300 (or just about 1 percent) of these escaped fish were reported as recaptured.

Production figures for organic certified salmon farm sites are not publicly available. Therefore, it is impossible for us to determine the escapes ratio from Soil Association organic salmon farm sites, no less the escape ratio of organic salmon farm sites globally.

How can the issue of escape be better controlled in an organic system than in a conventional ocean-based system?

Farmed salmon producing regions, including Norway, Scotland and British Columbia, have established a variety of regulations aimed at controlling escapes from conventional open net pen farms. Norway has a "Vision: No Escapees" policy, in which provides guidelines for its aquaculture industry with the objective of achieving "a level of escapees from fish farms, which is as close to zero as practicable."[57] In Scotland, "a Containment Code of Practice, aimed at reducing escapes of farmed fish, was introduced in November 2000 (6). In the spring of 2002 notification of escapes and suspected escapes became mandatory." [58] Marine Harvest, the largest salmon farming company in the world, Marine Harvest, also has "zero tolerance for escapes."[59]

The proposed organic aquaculture standards included quite similar restrictions on escapes and regulations related to the containment systems. Section 202.250 Aquaculture General, states: " (7) Measures shall be taken to prevent escapes of cultivated animals and plants from aquaculture facility and to document any that do occur." Section 205.255 Aquaculture Facility, states:

"(i) Aquaculture facilities must be managed with all reasonable security measures (mechanical, physical, and biological barriers) with the goal of eliminating escapes caused by damage, or other causes. Facilities must be operated with preventative measures against possible escapes into the natural environment of the aquatic animals in production. The Organic System Plan must describe measures to prevent escape, procedures to detect and document escapes should they occur, and actions to be undertaken in the event of an escape."

[xiv] All of the sites included in Figure 12 are listed in the October 2006 list provided by the Soil Association to Pure Salmon Campaign. Lewis Salmon does not appear on the October 2006 list, however, the Soil Association website explains that "Lewis is one of the most recent converts to Soil Association organic production."(www.soilassociation.org/Web/SA/SAWeb.nsf/848d689047cb466780256a6b00298980/1c64e9109f8f7f78802571cb005486a2?OpenDocument)

If one assumes that open net cage fish farming companies in Norway, Scotland and so on are in compliance with regional escapes standards – and are therefore attempting to eliminate escapes as much as possible – than the only available conclusion is that the current rate of escapes in these regions is the lowest rate of escapes achievable or "practicable" in open net pen aquaculture.

So, what is the current rate of escapes?

In 2006, Norwegian salmon farms reported over 1.2 million escapees in 60 separate incidents. We calculate that between 2001-2006, Norway's escape ratio was 1 escape for every 330 fish in production. Scottish salmon farmers reported over 1 million escapees in 2005 and an additional 287,000 in 2006. Similar to Norway, Scotland's escape ratio was approximately 1 escapee per every 300 fish in production. Escapes of farmed salmon therefore outnumbered rod and line catches of wild salmon by 10 to 1. Such a high level of escapees represents an irreversible problem in areas like the West coast of Scotland where wild salmon stocks are even lower (less than 3,000 wild salmon were caught during 2005[60]).

The escapes record is just as daunting in other regions where fish are farmed in open net pens. During 2007 thus far, it is estimated that 14 million farmed salmon have escaped from Chilean open net salmon farms – largely due to a tsunami in a major producing region.[61] Figures provided by the Chilean agency, SERNAPESCA, report over 2 million farmed salmon escapes in 2004 alone. These reports do not include "leakages" of farmed fish from open net pens, which seem to be unavoidable and difficult to estimate.

A review of the "causes of escapes" as reported within Norwegian, Scottish, Australian and Chilean government figures further suggests that to some degree, escapes are unavoidable in open net pen systems. Failure of equipment (nets, plant equipment) was the number one cause of reported escapes in all of these regions during the reporting period. Weather conditions – such as storms or ice – ranked as the #2 cause of escapes in three of the four regions. And, predator attacks played a major role in escapes in Scotland and to a lesser extent Norway and Chile.

In most cases, it appears that a majority of the causes of escapes in each producing region are largely related to failures in the open net pen design as a containment system. Further, once an escape incident occurs – whether it be net tear caused by a storm or floating ice, or a sea lion attack – data and experience suggest that attempts to recapture escaped fish are highly unsuccessful. In 2005 alone, Scottish fish farmers reported over 800,000 escaped fish from net pens, only 605 of which were recovered. [62]

The data presented in this paper, at the very least, suggests that the NOSB should anticipate that there will a certain level of escapes from organic open net cage fish farms. And, it is unclear to us how a US organic open net cage standard, which mirrors current regional standards and other European organic fish standards, will be able to achieve a lower level of escapes than is currently experienced. Based on Norway's track record –

the region with arguably the most stringent escapes regulations and reporting – the lowest level of escapes may be over 1 million escapees, annually.

In what specific ways the current proposed aquaculture standards are, or are not, adequate in addressing the questions. If they are not adequate, what specific practices and language would they recommend to strengthen the proposed aquaculture standards to address specific questions?

It seems clear to us that the proposed organic aquaculture standards would be at the same disadvantage as conventional aquaculture regulations in controlling for escapes. Overall, the global data points to an inherent flaw in the open net pen design. As an international review stated in 2005, "escapes of all farm species raised in open net cages appear inevitable" (Naylor et al. 2005). A project funded by the European Commission (GENIMPACT) also concluded in 2007 that: "realistically, it is almost impossible to completely prevent escapes" (Triantafyllidis et al. 2007). And, once an escape occurs, there has been little success in recovering escaped fish from the wild.

Given the inevitability of escapes from open net cage systems, we believe the AWG Interim Final Report's proposed provisions that allow for the use of open net cage systems in organic aquaculture are inherently inconsistent with a number of key, organic principles as outlined by the *NOSB Principles of Organic Production and Handling* (March 29, 2007).[63] Despite several sections included within the NOSB Livestock Committee Aquaculture Standards[64] that attempt to control for, or reduce, ecological impacts associated with fish farming, available research on and experiences with open net pen farming to date leave us unconvinced that the proposed organic standards will ensure that of the farming of carnivorous finfish in open net pens will be consistent with core, organic principles.

Those organic principles outlined by the *NOSB Principles of Organic Production and Handling,* which are contradicted by finfish farming in open net pens as proposed by the AWG Interim Final Report:

1.1 Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity.

Any farming system which allows escapes that precipitate genetic and biological pollution and ultimately could lead to extinctions in wild salmon populations is obviously a threat to biodiversity (Hutchings 1991, McGinnity et al. 2003, Ferguson et al. 2007, Verspoor et al. 2007). Moreover, escapees could be a significant vector for the spread of pathogens, bacterial and viral diseases and parasites. Disease may be transferred to and from wild fish through the normal flow of tides and currents, and farmed fish may also spread diseases to wild fish through escapes into the wild environment.

The Livestock Committee's Aquaculture Standards and those open net pen provisions proposed in the AWG Interim Final Report do not require that only native fish of local genotype be farmed in open net pen systems. Given the propensity of escapes from open systems, the farming of exotic or non-native species (such as Atlantic salmon in the Pacific) appears to contradict this organic principle.

1.4.2 Organic products are not commingled with non-organic products, except when combining organic and non-organic ingredients in finished products which contain less than 100% organic ingredients

The open net pen system, by design, allows farmed organic fish to commingle with a variety of non-organic inputs such as wild fish, other marine organisms, parasites, and other potential contaminants in the marine environment. By including provisions for open net pen systems in organic production, the AWG Interim Final Report contradicts this key, organic principle.

So, how can we strengthen the proposed organic aquaculture standards so that they result in practices that are consistent with organic principles?

It has been suggested, including in a recent report of the Marine Aquaculture Task Force published in January 2007 (Marine Aquaculture Task Force: 2007), that regulations aiming to reduce the ecological impacts of escapes should:

> - Limit marine aquaculture to native species of the local wild genotype unless it can be demonstrated that the risk of harm to the marine environment from culturing other species is negligible.
>
> - Culture native species in a manner that ensures escapes will not harm the genetics of local wild fish populations.

But, would "native, local" standard lead to a series of secondary impacts for both farmed and wild fish? Below, we set out one possible scenario.

In order for escapes to pose a minimal threat in terms of genetic pollution of wild fish populations, broodstock would have to be changed over every year. In other words, culture fish could not be more than one generation removed from wild fish populations in the area. This would resemble a supplemental hatchery, such as the steelhead hatchery.

Thus, organic producers would essentially be required to farm "wild" fish. Unlike conventionally farmed Atlantic salmon, the organic fish would benefit from seven generations of selective farming. Since organic farmers would not have the ability to choose for individuals that respond less negatively to stress, their fish would likely have lower feed conversion ratios and higher incidents of disease than conventionally farmed fish due to higher stress levels.

Additionally, it is likely that their disease profile would increase since these native, organic fish species would be more prone to local pathogens. And, due to higher stress, the pathogens may appear in a greater magnitude than in less-stressed, conventionally farmed fish.

Another concern with this solution is the issue of obtaining a consistent, sustainable supply of broostock from the wild. In regions where Atlantic salmon, Atlantic cod or other finfish species are threatened or endangered, this would be an even greater concern. Thus, this organic standard would also need to require that broodstock are obtained from sustainable wild fish populations. This would essentially rule out many Atlantic salmon and cod populations and many Pacific salmon species as well.

Further, in the case of salmon, it seems impossible to truly define what is truly "native" or "local genotype." For instance, with salmon species, it could be argued that every river is significantly different than the next. So, how would local be defined in this case?

Several peer-reviewed papers have documented some of these ecological concerns of the farming of native species (Verspoor et al. 2007, Fleming 2005). Dr. Ian Fleming of Memorial University in Canada told the Natural Sciences and Engineering Research Council of Canada: **"The biggest environmental danger we face from salmon escapes is when farming species within their native range, such as Atlantic salmon in the Atlantic Ocean."**[xv]

A scientific risk assessment published by the USDA Forest Service in November 2006 stated (Bisson 2006):

> Within their native range of western Europe and eastern North America, farmed Atlantic salmon regularly escape and enter rivers where they encounter native salmon populations. Jonsson (1997) summarized the potential intraspecific impacts of farmed salmon on their native counterparts in fresh water. Major effects included competition for food, rearing habitat, and mates; altered predation regimes; and increased risks of diseases and parasites. Fleming et al. (2000) studied the population effects of farmed salmon in a Norwegian river and found that farmed fish were competitively and reproductively inferior to wild fish. Farmed salmon achieved less than one-third the reproductive success of native salmon, and the productivity of the native population was reduced by about 30 percent as a result of resource competition and competitive displacement.

To us, it appears that the only real solution to strengthen the organic aquaculture standards related to escapes of farmed fish – and ensure these standards are consistent with organic principles – is the exclusion of open net pen systems within organic standards. We strongly recommend that the NOSB include language that indicates that only fully closed containment systems are eligible for organic aquaculture standards.

Are there any implications to containment farming of fish species not indigenous to that geographic area other than cross-breeding with native species?

Section B of this paper documents the significant ecological impacts, especially those impacts on wild fish, associated with farming marine finfish in open net pen systems.

These impacts include, but are not limited to:

[xv] http://www.nserc.gc.ca/news/stories/050222-1_e.htm

- Escapees can compete with native and non-native wild salmon species for mates, space and prey.

- Escapes may have a detrimental impact on vulnerable wild salmon populations at a regional scale.

- Escapes present risks of increasing disease outbreaks, proliferating possible disease transmission routes in the environment, and decreasing the immunity of wild fish to disease.

- Repeated farm escapes can establish self-sustaining feral populations and escapees can have significant impacts on wild fish whether or not escapees reproduce.

- Risks include potential reductions in the genetic diversity (and resulting ability to adapt to environmental change), productivity, and fitness of wild fish, leading to possible extinctions as well as the loss of unique gene pools.

- Escapes of all farm species raised in open net cages appear inevitable, and many new farm species such as cod and halibut share important characteristics with farm salmon.

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