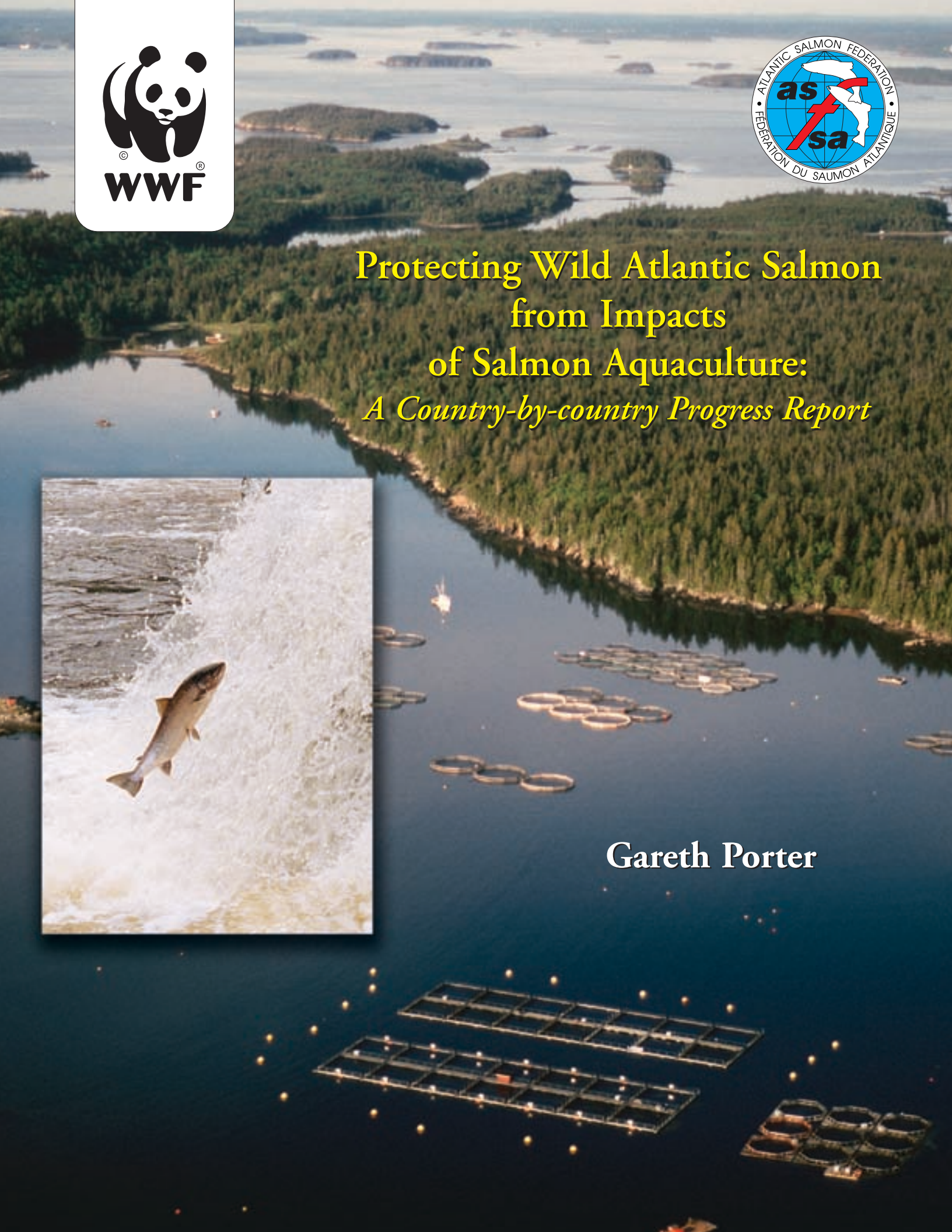

Protecting Wild Atlantic Salmon from Impacts of Salmon Aquaculture:

A Country-by-country Progress Report

Gareth Porter

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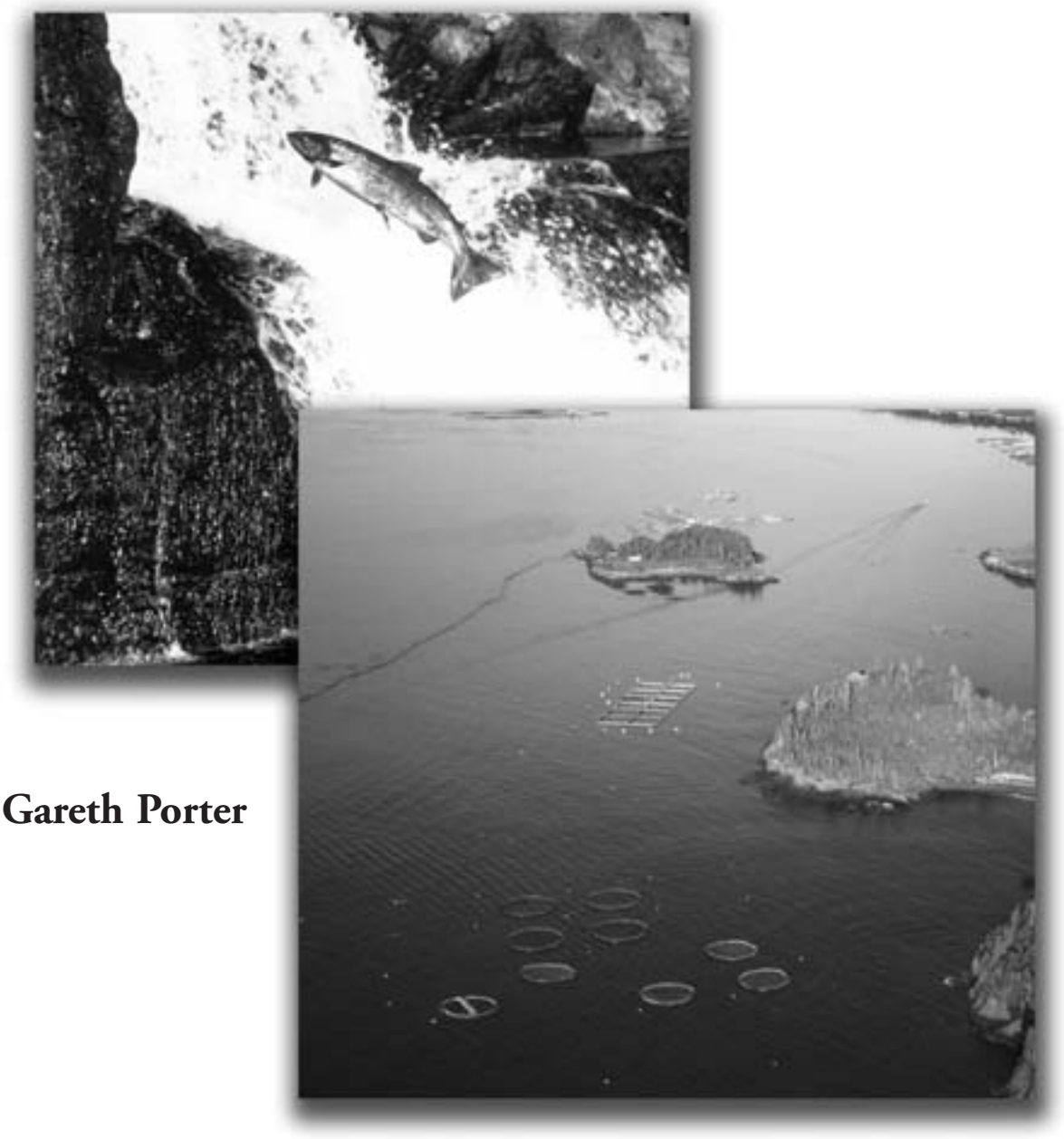

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Table of Contents

I. Introduction

In 1994, seven member countries of the North Atlantic Salmon Conservation Organization (NASCO) signed an agreement called the "Convention for the Conservation of Salmon in the North Atlantic Ocean to Minimize Impacts from Salmon Aquaculture on the Wild Salmon Stocks." The agreement, known as the "Oslo Resolution," was adopted by consensus at the annual NASCO meeting in Oslo, Norway. Articles of the Resolution provided recommended actions for nations to control impacts of salmon farming at a time when aquaculture was growing rapidly and wild populations were declining precipitously. It is important to note here that, since 1994, these trends have continued unabated.

Under article 5 of the Oslo Resolution, signatories were obliged to provide annual reports to NASCO on the measures they had adopted to comply with the terms of the resolution. Signatories included Canada, the United States of America, Norway, Scotland, Ireland, Iceland and the Faroe Islands, all of whom have significant salmon aquaculture industries.

Other than the reporting requirements, there exists no formal process to evaluate the progress of NASCO nations' compliance with the articles of the Oslo Resolution. Accordingly, after more than nine years of reporting by NASCO signatory countries, continuous decline of wild Atlantic salmon, and the exponential growth of the aquaculture industry, the Atlantic Salmon Federation (ASF) and World Wildlife Fund (WWF) agreed that an evaluation mechanism was necessary. Subsequently, 10 measurable criteria, based on the articles of the Oslo Resolution, were developed by WWF and ASF. A numerical scale for implementation was developed for each criterion based on adoption of legislation by governments to reduce harmful impacts on the wild salmon populations.

Development of the index of progress for each criterion is based on: evaluation of the national reports submitted annually to NASCO by the signatory nations; a review of documents as listed in the References; and requests to governments for any relevant information on actions or measures not covered in their reports to NASCO.

With Gareth Porter as the lead researcher and author, an expert panel composed of Dr. Fred Whoriskey, Jr. (Vice President Research and Environment, ASF), Dr. Simon Cripps (Director of WWF's Global Endangered Seas Program), Dr. Andrew Rosenberg, (Dean of Life Sciences and Agriculture at the University of New Hampshire), and Jason Clay (WWF Senior Fellow and aquaculture specialist), reviewed this report. In addition, it should be noted that WWF-Norway and WWF-Scotland provided critical input to the analysis.

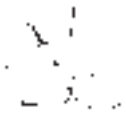
The results identify a lack of sufficient progress toward implementation of the articles of the Oslo Resolution, especially in the areas of fish husbandry and standards for design and deployment of equipment. The results are based on regulatory measures that were in force through February 14, 2003.

The greatest progress has been made by Norway, followed by Scotland, Canada, Ireland, Iceland, United States, and Faroe Islands, in that order. Nevertheless, the average result is slightly above 2 out of 10.

WWF and ASF note that there are numerous draft or developing measures which could not be adequately evaluated in this report. Such actions will be considered in future reports. ASF and WWF recognize that, in a few cases, governments plan on making significant changes that should improve the results of one or more criteria in further progress reports. Both organizations applaud these efforts.

ASF and WWF would like to point out that not all fish farming practices are destructive. In fact, we see evidence of constructive conservation advances in a few North Atlantic aquaculture industries beyond government initiatives. The Oslo Resolution applies solely to government actions, and this report does not presume to evaluate private sector initiatives. However, it may be appropriate to consider evaluating private sector industries in the context of a revised and updated Oslo Resolution. Indeed, we believe NASCO should consider this in its 2003 deliberations.

Lastly, this report contains a series of recommendations for revising and updating the Oslo Resolution. We note that the 2003 Williamsburg NASCO meeting made related suggestions. We anticipate working collaboratively to advance this important issue. We hope these science-based considerations will help encourage and guide Atlantic nations as they take more tangible steps toward controlling the impacts of salmon farming on wild Atlantic salmon.



Bill Taylor, President
Atlantic Salmon Federation

Tom Grasso, Director
WWF Marine Conservation Policy

II. Joint WWF-ASF Recommendations for Strengthening the Oslo Resolution

1. Require the adoption of a set of exclusion zones that would protect wild salmon stocks in a minimum set of rivers considered as most essential to the survival of wild salmon populations in the country

At present the Oslo Resolution requires the relevant member states only to undertake such exclusion zones on a trial basis "as appropriate." A few countries have implemented at least some minimal exclusion zones, but most countries have failed to establish such zones at all. Establishing such zones should be a central obligation of the Oslo Resolution.

2. Require monitoring and enforcement of management systems to minimize escapes.

The duty to take actions to prevent escapes is central to the potential of the Oslo Resolution to make a difference in the survival or extinction of wild Atlantic salmon populations in the NASCO countries. The existing language of the Oslo Resolution allows member states to maintain regulatory requirements without any system of accountability. Without accountability mechanisms accompanying it, a regulation requiring plans and management systems for escape prevention and minimization is meaningless.

3. Require monitoring and enforcement of fish husbandry practices and benthic ecosystem quality

These two provisions should reinforce one another. Monitoring and strict enforcement of regulations prohibiting excessive deposition of organic wastes, which is associated with growing too many fish per sea cage, is an insurance policy against stocking densities that exceed the carrying capacity of the site. Again, it is not sufficient to have a regulation with minimum standards for fish husbandry and minimum standards for benthic ecosystem quality if there is no accountability mechanism accompanying it.

4. Establish an obligation to take cumulative environmental impacts of multiple aquaculture sites in the same ecosystem into account in siting decisions

At present the Oslo Resolution strongly implies that NASCO member countries should take ecosystem carrying capacity into account by referring to the separation distance between aquaculture facilities at marine sites being "based on a general assessment of local conditions." The ASF-WWF analysis of implementation of the Oslo Resolution shows that only two countries have taken any measures to ensure that the impacts of multiple salmon aquaculture sites in the same ecosystem do not overstress the ecosystem.

5. Define more specifically the actions to be reported annually

Specify annual reporting requirements in terms of different types of measures or activities that should be reported for each provision of the Resolution (legislation, regulatory requirements, monitoring and enforcement activities, and Codes of Practice). It should be clear that simply reporting on alleged progress in the practices of industry is not evidence of measures complying with the obligations of the Oslo Resolution.

6. Establish an obligation of transparency in regard to industry compliance with regulations of central importance to the health of wild salmon.

Some states continue to keep confidential their data on industry compliance with major regulations dealing with such issues as fish husbandry and fish escapes. The Oslo Resolution should include language obligating states to make public all relevant data on the degree of industry compliance with a selected set of regulatory requirements.

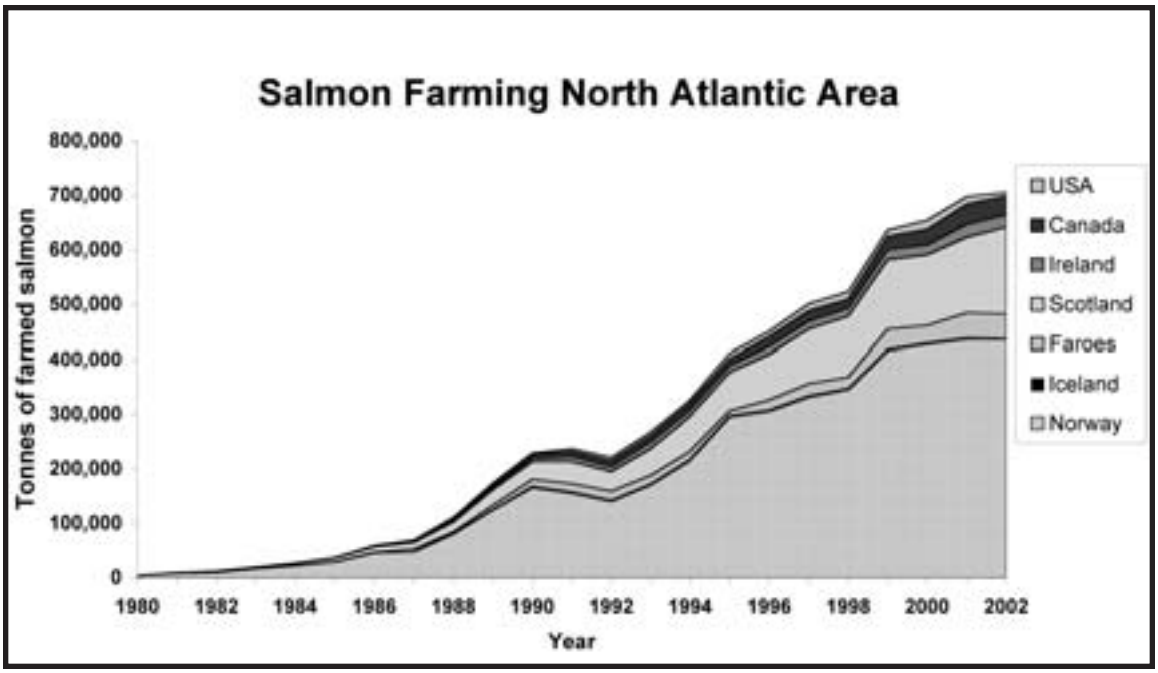


Fig. 2 - Farmed Atlantic salmon production in the North Atlantic Basin has increased massively since its beginnings in the 1970s. Graph based on ICES Aquaculture production numbers.

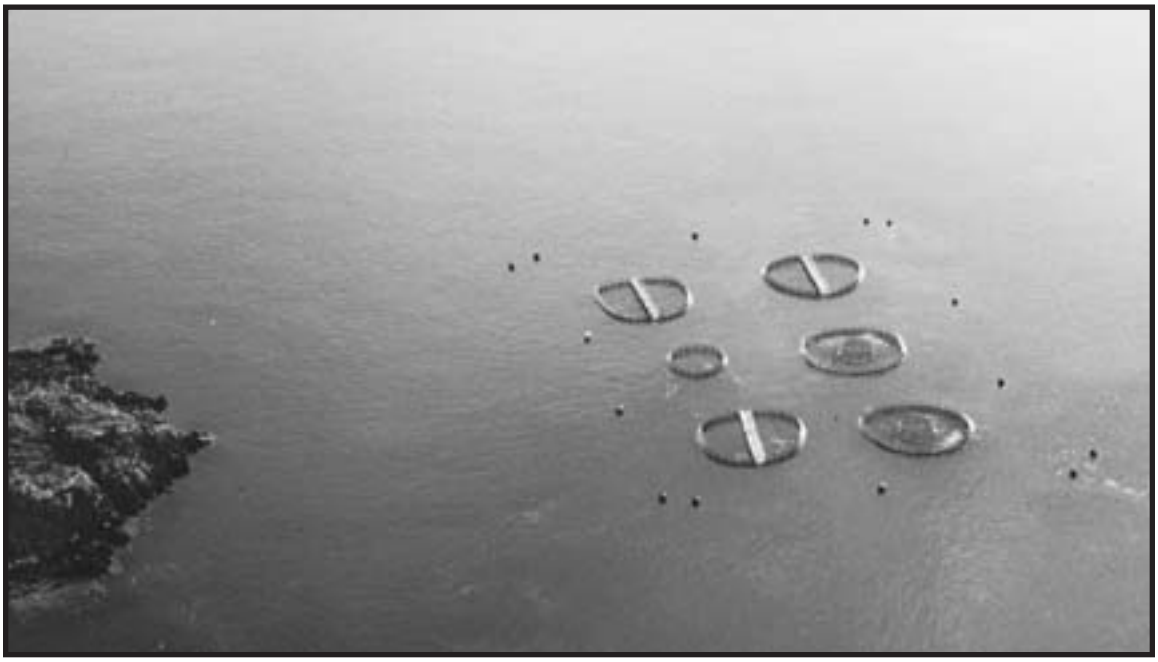


Fig. 3 - Farmed salmon are an issue when they escape. In August, 2000 mooring lines to four of these cages broke, releasing several thousand farmed Atlantic salmon into the open ocean. The site, at Tinker's Island in New Brunswick, Canada, is only a few miles from several important wild salmon rivers, including the U.S. federally listed Dennys River.

III. System for Evaluating the Implementation of the Oslo Resolution

The system used in this progress report to evaluate the implementation of the Oslo Resolution by the seven NASCO member countries with salmon aquaculture industries is based on three major issue areas that reflect the major concerns addressed by the Oslo Resolution. The three issues are:

Issue Area I: Regulatory requirements for siting of salmon aquaculture operations (See Oslo Resolution, Part 1. General Measures, Sites)

Issue Area II: Management of aquaculture units to prevent and control diseases and parasites (See Oslo Resolution, Part 1. Operation, and Part 3)

Issue Area III: Taking Precautions to prevent escapes of fish (See Oslo Resolution, Part 1: 1.2.2)

Within these three issue areas, we have adopted ten criteria for evaluating the implementation of the resolution. These ten criteria are:

Issue Area 1: Siting Policies

1. Adequacy of requirements for distance from salmon rivers in siting decisions.
2. Provision for "protection zones" for wild salmon in siting regulations.
3. Degree to which cumulative impacts of salmon farming on entire bay or other ecosystem are considered in siting decisions.

Issues Area 2: Prevention and Control of Diseases and Parasites

4. Adequacy of requirements for fish husbandry, including best industry practices, such as year-class separation, fallowing of sites, and adequate separation.
5. Adequacy of regulation of deposition of wastes beneath fish farms or regulation of benthic ecosystem quality to protect fish health.
6. Adequacy of monitoring and enforcement of requirements for fish husbandry plans.
7. Adequacy of monitoring and enforcement of regulation of waste deposition or benthic environmental quality to protect fish health.

Issues Area 3: Prevention of Fish Escapes

8. Adequacy of design standards for aquaculture systems to optimize containment of fish and minimize escapes.
9. Existence of authorities' mandatory escape prevention and response plans and management systems.
10. Adequacy of monitoring and enforcement of aquaculture systems and escape prevention and response plans.

For each of these criteria, we have established a set of scalar indicators that measure the relative performance of each salmon aquaculture country in regard to that criterion. The result received by each country on that criterion depends on which indicator is closest to its observed performance as shown in available documentation.

The scoring system uses numbers for each individual criterion rather than a grade, allowing more flexibility in regard to measuring various criteria and making the aggregation of individual results into an overall result more transparent. Some criteria have five distinct levels of possible performance, some have four and some have three. Thus the evaluation system for a five-level criterion is 10-7-5-3-0; for a four-level criterion, the scoring system is 10-7-4-0; for a three-level criterion it is 10-5-0.

In evaluating for Canada, where provincial regulatory systems in Newfoundland, Nova Scotia and New Brunswick sometimes diverge, and in Scotland, where the industry codes and government regulation diverge between Shetland and the mainland, and where the main industry code represents only a part of the national production, it has been necessary, in some cases, to base the national score on a formula using the weighted averages of different scores.

We have endeavored to take advantage of evidence available from all credible sources in evaluating the implementation of each criterion, including the country's own annual submissions of data to the NASCO Secretariat on that implementation. If the country in question has submitted no claim of any measure responding to elements in the Oslo Resolution reporting system, and no evidence has been found suggesting any such measure, the country receives a zero score on that issue. The rationale for this is that each country is obligated by the Oslo Resolution itself to provide full information on any actions it has taken to implement each and every provision of the Oslo Resolution. In the absence of specific information from the country itself, or any other source, it can be fairly inferred that the country has taken no meaningful action.

In aggregating all the data on specific criteria to arrive at an overall result for each country, we divide the aggregate by ten to get the average score across all 10 criteria.

Fig. 4 – Salmon farming requires great attention to detail, with both industry and government carefully monitoring such matters as the drop in net strength over time, the impact of ice on cage structures, and feed impact on benthic communities beneath the sites.

Table 1

Indicators for Criterion 1:

Adequacy of requirements for distance from salmon rivers in siting decisions

Indicators	Results
Minimum distance from mouth of salmon rivers required for aquaculture site is 30 kilometers	10
Minimum distance from mouth of salmon rivers required for aquaculture site is 20 to 30 kilometers	7
Minimum distance from mouth of salmon rivers required for aquaculture site is 5 to 20 kilometers	5
Minimum distance from mouth of salmon rivers required for aquaculture site is less than 5 kilometers	3
No minimum distance from mouth of salmon rivers is required for aquaculture site	0

Table 2

Indicators for Criterion 2:

Provisions in siting regulations for "exclusion zones," or restrictions on aquaculture operations in certain sensitive areas, to protect wild salmon

Indicators	Results
Aquaculture operations are excluded from many areas where wild salmon stocks would have been adversely affected	10
Aquaculture operations are excluded from a few areas where wild salmon stocks would have been adversely affected	7
Aquaculture operations are restricted in but not excluded from many areas that would have been adversely affected	5
Aquaculture operations are restricted in but not excluded from a few areas that would have been adversely affected	3
No areas that would have been threatened by aquaculture operations are subject to exclusion or restrictions on aquaculture operations	0

Table 3

Indicators for Criterion 3:

Degree to which cumulative environmental impacts of salmon farming on an entire bay or other ecosystem are considered in siting decisions.

Indicators	Results
Siting approval must take into account cumulative impacts of aquaculture operations on the entire ecosystem and the requirement has been consistently applied	10
Siting approval must take into account cumulative impacts of aquaculture operations on the entire ecosystem, but the requirement has not been consistently applied	5
No consideration of cumulative impacts of aquaculture operations on the entire ecosystem is required	0

Table 4

Indicators for Criterion 4:

Adequacy of requirements for plans to improve fish husbandry

Indicators	Results
Regulations require best fish husbandry practices, including year-class separation, adequate fallowing of sites, and limit stocking densities or an industry code of practice for fish husbandry practices has been adopted by the industry	10
Regulations do not reflect best industry practices on one major issue of fish husbandry practices	7
Regulations do not reflect best industry practices on two or more major issues of fish husbandry practices	4
Regulations do not reflect best industry practices on any of the major fish husbandry issues	0

Table 5

Indicators for Criterion 5:

Adequacy of standards for benthic ecosystem quality

Indicators	Results
Regulations provide adequate specific standards for benthic ecosystem quality beneath fish farms adequate to protect fish health	10
Regulations specify adequate standards for benthic ecosystem quality adequate to protect fish health, and regulations require full reporting on individual farm's practices	7
Regulations provide standards for benthic ecosystem quality, but the standard is not adequate to protect fish health	4
Regulations contain no standards for benthic ecosystem quality	0

Table 6

Indicators for Criterion 6:

Adequacy of monitoring and enforcement of fish husbandry practices

Indicators	Results
Authorities carry out on-site monitoring of compliance with requirements or industry codes of practice for fish husbandry practices annually, report publicly on compliance and hand out appropriate penalties for non-compliance	10
Authorities carry out on-site monitoring on compliance with requirements or industry code of practice for fish husbandry practices annually, and hand out adequate penalties for non-compliance but do not report publicly on non-compliance	7
Authorities do not carry out on-site monitoring of requirements or industry code of practice on-site, but do require industry reporting on and enforce such compliance	5
Industry is required to report annually on fish husbandry requirements or code of practice, but there is no enforcement	3
No system for regular monitoring or industry reporting on fish husbandry	0

Table 7

Indicators for Criterion 7:

Adequacy of monitoring and enforcement of standards of benthic environmental quality

Indicators	Results
Authorities carry out on-site monitoring at intervals appropriate to risk at each site, report on compliance with regulatory requirements, enforce compliance and report publicly on the state of industry compliance	10
Authorities carry out on-site monitoring on compliance with requirements, and enforce compliance but do not report on non-compliance	7
Authorities audit monitoring by industry based on agreed methods, and enforce compliance, but do not report on non-compliance	5
Authorities audit monitoring by industry based on agreed methods, but do not enforce compliance	3
Authorities do not carry out auditing or monitoring on compliance with requirements	0

Table 8

Indicators for Criterion 8:

Adequacy of requirements for design and deployment standards for aquaculture systems to optimize containment of fish and minimize escapes

Indicators	Results
Regulations provide technical requirements for aquaculture systems regarding stock containment that reflect industry best practices or require conformity with an industry of code of practice reflecting best available technologies	10
Regulations provide technical requirements for aquaculture systems regarding stock containment but they do not cover all relevant issues or reflect best available technologies	7
Regulations include only general requirements for aquaculture system design in regard to stock containment, lacking adequate specificity.	4
No regulations govern adequacy of aquaculture system design in regard to stock containment	0

Table 9

Indicators for Criterion 9:

Adequacy of requirements for escape prevention and response plans and management systems

Indicators	Results
Regulations require site-specific escape prevention plans and management systems, reflecting industry best practices, immediate notification and reporting and escaped fish recovery plans	10
Regulations require site-specific escape prevention plans and, notification and reporting and escaped fish recovery plans, but not management systems	7
Regulations require immediate reporting and escaped fish recovery plans but not escape prevention plans	5
Regulations require only immediate reporting of escapes and recovery	3
No regulatory requirements regarding fish escapes	0

Table 10

Indicators for Criterion 10:

Adequacy of monitoring and enforcement of aquaculture systems and escape prevention and response plans

Indicators	Results
Compliance with regulations is systematically monitored and results in enforcement actions, and degree of compliance is reported publicly	10
Compliance with regulations is systematically monitored and results in enforcement actions, but degree of compliance is not reported publicly	7
Compliance with regulations on aquaculture systems and requirements to minimize and respond to escapes is systematically monitored, but does not result in enforcement actions	5
Compliance with regulations is not monitored systematically or is monitored only in part	3
No monitoring of compliance regulations is carried out	0

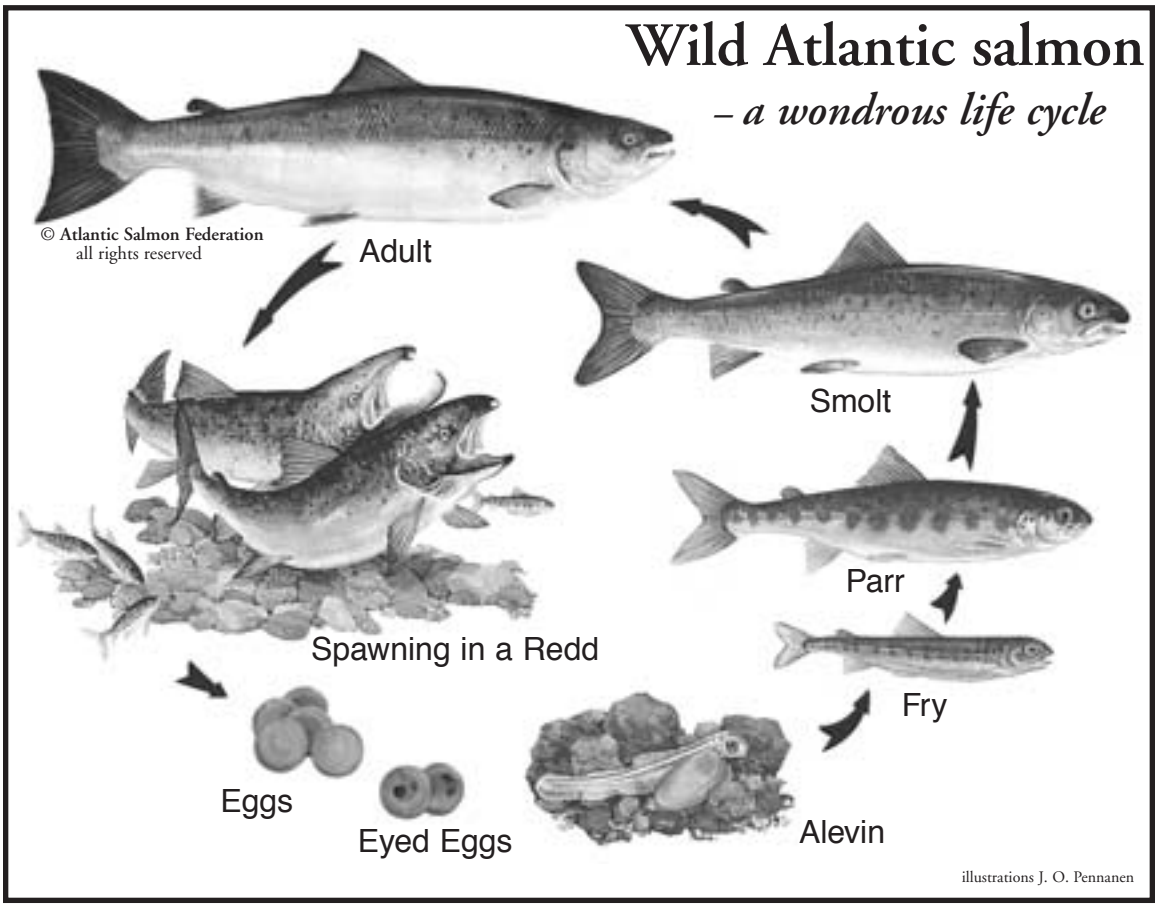


Fig. 5 – The life cycle of the wild Atlantic salmon begins with eggs deposited in streams, growth of young in freshwater, and the movement downstream to the sea. The potential for negative interactions with farmed salmon exists in both freshwater and in the ocean.

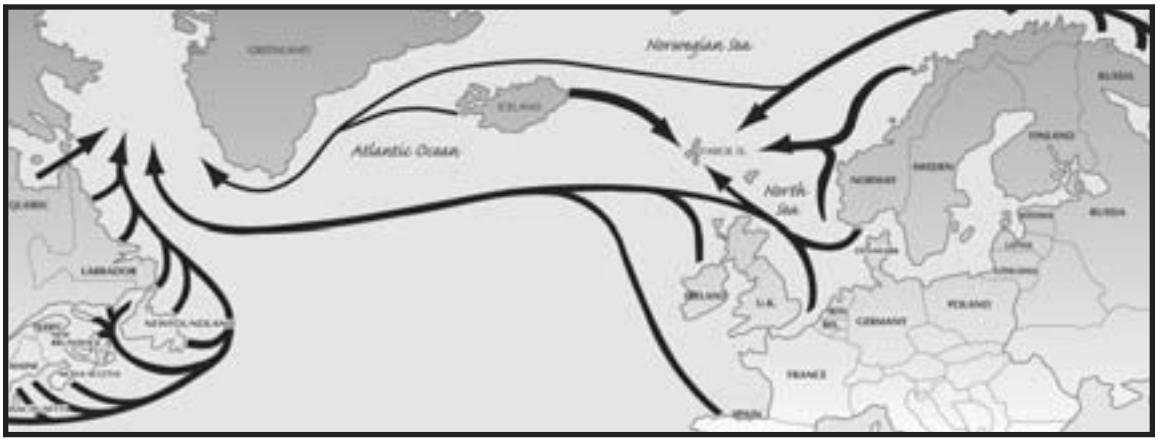


Fig. 6 – Many wild Atlantic salmon migrate to distant feeding grounds. Seas near southwest Greenland and near the Faroe Islands are especially important. In their migration, wild Atlantic salmon rely on adaptations developed over millenia to deal with specific conditions. Genetic or other interactions from farmed salmon harm the survival of wild populations.

IV. Country-by-Country Progress

CANADA

Table 11 Canada's Overall Progress	
Criterion	
1. Minimum distance from salmon rivers	0
2. Exclusion zones	0
3. Cumulative impacts and siting decisions	5
4. Standards for fish husbandry practices	6
5. Standards for benthic ecosystem quality	10
6. Fish husbandry monitoring and enforcement	2
7. Benthic ecosystem monitoring/enforcement	3
8. Standards for equipment design/deployment	1
9. Standards for fish containment	1
10. Fish containment monitoring and enforcement	0.5
Average	**2.95**

Criterion 1: Requirements for adequate distance from salmon rivers in siting approval decisions

Even though the Canadian federal government has the statutory power to review aquaculture siting decisions, it has chosen not to have a direct role in such decisions. Instead, each province has developed its own policies toward siting requirements (Canadian Parliament, 2001). Provincial regulations in Nova Scotia and Newfoundland contain no provisions regarding distance from salmon rivers (Nova Scotia, 2000; Newfoundland, 2000).

New Brunswick's Regulation 91-158 of 1991 activities does not provide any minimum distance from salmon rivers, although it does require minimum distances from other marine fish farms (Government of New Brunswick, 1991). New Brunswick has not adopted any specific limits on dis-

tance from salmon rivers in its aquaculture site allocation policy for the Bay of Fundy (New Brunswick, 2000).

Neither federal nor provincial governments in Canada have taken any measure that meets the minimum standard indicator for this criterion.

RESULTS FOR CRITERION ONE: 0

CRITERION 2: PROVISIONS IN SITING REGULATIONS FOR RESTRICTIONS ON AQUACULTURE OPERATIONS IN CERTAIN SENSITIVE AREAS TO PROTECT WILD SALMON

In 1998 and again in 2000, Canada reported in its response to Section 4.1 of NASCO's questionnaire ("Wild salmon protection areas") that "Marine Protected Areas" were "provided for in the Canada Oceans Act." (NASCO, 1998; NASCO, 2000) This is a disingenuous claim. No Marine Protected Areas had yet been officially created, nor had any action plan or timelines been established for creating a representative system of such areas by the year 2010 – the official target (Canadian Parliament, House of Commons Standing Committee on Fisheries, 2001). Nor did DFO documents indicate any intention of using the Marine Protected Areas as a device for protecting wild salmon from salmon farming development (DFO, 1997). The DFO's Marine Protected Areas advisers confirm that Canada has no existing or proposed Marine Protected Areas established to protect wild Atlantic salmon stocks from aquaculture development (Chute, pers. comm.).

Neither Newfoundland nor Nova Scotia has provisions in its regulations for restricting aquaculture in any areas in order to protect wild salmon (Newfoundland, 2000; Nova Scotia, 2000). In 2000, New Brunswick proposed a number of areas that would be identified as "strategic to support the traditional fishing sector" and in which new salmon aquaculture operations are not eligible, at least for the time being, although "boundary expansions" and production increases of existing aquaculture operations would be considered for approval (New Brunswick, 2000). However, the proposed areas do not coincide with salmon rivers in the region (Harvey, pers. comm.)

RESULTS FOR CRITERION TWO: 0

CRITERION 3: DEGREE TO WHICH CUMULATIVE ENVIRONMENTAL IMPACTS OF SALMON FARMING ON ENTIRE BAY OR OTHER ECOSYSTEM ARE CONSIDERED IN SITING DECISIONS

The question of analyzing the cumulative impacts of salmon aquaculture in relation to the carrying capacity of the larger ecosystem, rather than only one site at a time, has been raised for a number of years in regard to the Bay of Fundy, which has what some have argued is the highest concentration of aquaculture sites per square kilometer in the world (Canadian Parliament, Senate, 2001).

The Canadian Environmental Assessment Act (Government of Canada, 1992) requires that, before any project is authorized by the federal government, the environmental impacts must be assessed, including the "cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out." As of December 2000, the CEAA process was required for each new finfish aquaculture site in Canada. Early experiences with the CEAA process in approval of aquaculture applications in New Brunswick indicate that public participation has been effectively precluded by provincial invocation of confidentiali-

ty provisions of the Aquaculture Act (Coon and Harvey, 2002). Meanwhile, the DFO (2001) suggested that "cumulative impacts" of aquaculture operations were "not as well known" as near-field impacts, and would require "improved models".

It remains to be seen whether the governments of the Atlantic provinces will agree to take into account the cumulative effects of multiple salmon farms in their decisions on approval of finfish aquaculture licenses. The Deputy Minister for Agriculture and Fisheries of Nova Scotia, Peter Underwood, declared in May 2001 that he rejected the idea of input/output modeling of the bay, which is a fundamental tool in determining total pollutant load on an ecosystem. He insisted that the "more prudent" approach is to "proceed slowly and monitor the impact as you go (Canadian Parliament, Senate, 2001)."

The fate of the effort to establish the carrying capacity of the Bay d'Espoir in Newfoundland shows that politics has obstructed the search for scientifically-based policy toward cumulative impacts. In 1996, the Newfoundland Salmon Growers Association undertook a major research project to establish the carrying capacity of the Bay d'Espoir in terms of overwintering sites. The initial estimate of the study was that, using the most liberal values for the parameters being studied, the Bay could sustain 10,000 MT of finfish aquaculture production. Funding for the study was then cut off only half way through the planned four-year effort, despite a warning by the research director for the study that he placed little confidence in the values used in the initial modeling and that further modeling was necessary (Tlusty, pers. comm.). The Newfoundland Salmon Growers Association (1999) asserted that the study's "results to date" showed that the salmon farming industries had the potential to expand by "approximately 8400 metric tons" from the existing level of 2,200 MT.

In the absence of a clear pattern of application of the CEAA in aquaculture siting approval decisions, and in light of the evidence of considerable resistance to anticipating cumulative effects of multiple aquaculture sites in the same bay, Canada's requirement is considered to be applied but not consistently.

RESULTS FOR CRITERION THREE: 5

- ADEQUACY OF REQUIREMENTS FOR FISH HUSBANDRY, INCLUDING BEST INDUSTRY PRACTICES, SUCH AS YEAR-CLASS SEPARATION, FALLOWING OF SITES AND MAXIMUM STOCKING DENSITIES

According to Canada's 1998 annual report to NASCO (NASCO, 1998), "federal and provincial regulations and implementation guidelines are in place and enforced," in regard to production processes being conducted "in accordance with appropriate husbandry techniques to minimize risk of diseases." Canada also reported that requirements for restricting production to levels consistent with the site's "holding capacity" and stocking densities based on "good husbandry practices" are part of site licensing (NASCO, 1998; NASCO 1999). In later reports, moreover, Canada also reported "in progress" or "in progress in some provinces" for the specific practices of year class separation, fallowing of sites and adequate separation (NASCO 1998; NASCO, 1999). Significantly, however, Canada did not report adoption of any measures in reports from 2000 and 2001. In the 2002 report, it reported "in progress" for year class separation, fallowing of sites and adequate separation (NASCO, 2002)

In 1993, New Brunswick issued guidelines for production levels in aquaculture in the Bay of Fundy (New Brunswick Department of the Environment and Local Government, 2001). That document set a maximum stocking density of 18 kg per cubic meter of cage space, which remains the maximum allowable stocking density in the province. The guidelines do not indicate any requirement

for fallowing or single-year classes, however (New Brunswick Department of the Environment and Local Government, 2001).

The New Marine Site Allocation Policy for the Bay of Fundy (New Brunswick Department of Agriculture, Fisheries and Aquaculture, 2000) requires only a limited move toward single-year class production at finfish aquaculture sites in the Bay. The policy allows 20 percent of the total production on the site to be from a different year class. The same document calls for the establishment of voluntary "Bay Management Agreements" by aquaculture licensees in the same "Aquaculture Bay Management Area" (ABMA) that will contain agreed management standards and practices, including year class stocking and other practices related to fish husbandry and fish health. Any standards agreed to by the licensees under these agreements, which are not mandatory, are to be legislated by the province. However, these agreements have not dealt with fish husbandry issues at all, according to the salmon aquaculture industry organization in New Brunswick (Halse, pers. comm.).

The Nova Scotia Aquaculture License and Lease Regulations provide no authority to regulate fish husbandry and health management practices. The Nova Scotia regulations (Nova Scotia, 2000) provide only that the Provincial Fish Health Veterinarian may "isolate, quarantine, order treatment for, restrict the movement of, or destroy cultured fish infected or thought to be infected with a disease that the Provincial Health veterinarian considers a significant risk to wild or cultured fish." The Aquaculture Association of Nova Scotia (2000) has issued environmental management guidelines calling for stocking densities that "maximize economic output yet minimize stress to the fish and/or the environment." This guideline is too general, however, to provide a standard for the industry, and of course it remains voluntary rather than mandatory. On fallowing and year-class separation, the guidelines merely noted that both "can be valuable management tools" and aid farmers "explore options and logistics concerning cost-effective site fallowing and year-class separation programs as part of farm management and bio-security programs."

New Brunswick, which accounts for 90 percent of Canada's farmed salmon production, has provided a regulatory standard for stocking densities, and has at least made a start on a transition to requiring single year class production, but has not prescribed any practice in regard to fallowing. Canada is therefore considered to fall closer to the indicator for 7 points than the indicators for 4 points.

RESULTS FOR CRITERION FOUR: 6

CRITERION 5: ADEQUACY OF STANDARDS FOR BENTHIC ECOSYSTEM QUALITY

The Department of Fisheries and Oceans (DFO) has potential authority to set conditions on aquaculture licenses related to waste depositions under Sections 35 and 36 of the Fisheries Act. Section 35 deals with harmful alteration, disruption or destruction of fish habitat, whereas Section 36 deals with deposit of deleterious substances in waters frequented by the fish (Canadian Parliament, Senate Standing Committee on Fisheries, 2001). However, the Director General of the Department of Fisheries and Oceans Science Directorate testified to the House of Commons Standing Committee on Environment and Sustainable Development in early 1999 that no regulations on the generation of wastes from fish farms existed on which to base a judgment of compliance or non-compliance by aquaculture sites (Doubleday, 1999).

However, the New Brunswick "Environmental Guidelines for the Marine Finfish Cage Aquaculture Industry in New Brunswick (New Brunswick Department of the Environment and Local

Government, 2001) reports that DFO "has determined that for the purposes of the culture of Atlantic salmon in marine cages, all marine cage aquaculture sites should operate such that oxic conditions are achieved and or maintained," and that anoxic conditions "are in contravention of The Fisheries Act. Hypoxic conditions beneath the cages, it states, "would be of concern to DFO and would require remediation measures to prevent further progression to anoxia." The document provides specific maximum values allowable for a site to be considered oxic and assert that it is the "requirement of government that environmental quality at cage sites be in the oxic category or be in compliance with conditions of Approval to Operate that identify efforts to be undertaken to improve site conditions."

The guidelines issued by the New Brunswick provincial government are considered to be evidence that the federal government has promulgated regulatory standards for benthic ecosystem quality in aquaculture, which applies across Atlantic Canada. Canada therefore meets the requirement for the top indicator for this criterion.

RESULTS FOR CRITERION FIVE: 10

CRITERION 6: ADEQUACY OF MONITORING AND ENFORCEMENT OF FISH HUSBANDRY PRACTICES

New Brunswick monitors and enforces the terms of individual leases, which require no more than 20 percent "market fish" holdovers from the previous year class on the site. However, according to the New Brunswick Director of Aquaculture Development, it does not monitor or enforce the stocking density limit of 18 kilograms per cubic meter, because it has not devised a method of doing so without harming the fish. In regard to fallowing, there is no regulatory requirement to monitor or enforce, but the DAFA requires the temporary abandonment of high risk areas after the outbreak of ISA, based on the fish health status of the site, and it enforces those ad hoc fallowing requirements (McGeachy, pers. comm.).

Until 2003, New Brunswick had four fish health inspection officers, but none of them were solely devoted to aquaculture, and they did not have any personnel engaged in monitoring of compliance. In January 2003 it added six new enforcement personnel, which enforce compliance with the single-year class and ad hoc requirements for fallowing referred to above (McGeachy, pers. comm.).

Canada carries out monitoring and enforcement of one fish husbandry issue, which is single-year class production, on a systematic basis, but it does not monitor or enforce the limit on stocking density, and its enforcement of fallowing is only ad hoc decision-making after ISA outbreaks. Furthermore, Canada does not report publicly on compliance on fish husbandry issues. Therefore it meets one-third of the requirement for the the third highest score.

RESULTS FOR CRITERION SIX: 2

CRITERION 7: ADEQUACY OF MONITORING AND ENFORCEMENT OF STANDARDS FOR BENTHIC ENVIRONMENTAL QUALITY

In New Brunswick, the salmon aquaculture industry drafted, in cooperation with federal officials in the province, a plan for monitoring the environmental status of the seabed surrounding salmon aquaculture operations. The plan calls for private consultants hired directly by the industry but approved by the federal government, to carry out chemical samples and visual observations of indica-

tions of excessive nutrients at the sites and submit scientific reports to the DFO. The DFO audits 20 percent of the on-site monitoring operations each year to ensure the quality of the data (G3 Consulting, 2000; New Brunswick Department of Environment and Local Government, 2001). It is understood that the system has already been implemented in New Brunswick.

Although companies are required to undertake remedial actions when they fail to meet the standard for oxic conditions, the New Brunswick monitoring system does not involve any penalties for non-compliance (New Brunswick Department of Environment and Local Government, 2001), including loss of the license. The New Brunswick Salmon Growers Association took the position that no sanctions should be taken against a licensee until all efforts to persuade it to make the improvements have failed (Canadian Parliament, Senate Standing Committee on Fisheries, 2001).

The original concept of the program was that results of the monitoring would be reported to the public annually but without identifying the licensees associated with individual site results (G3 Consulting, 2000). A policy paper by the New Brunswick Department of Agriculture, Fisheries and Aquaculture (2000) indicated that it would carry the results of marine aquaculture site environmental monitoring program on its website. However, no such data was found on that website, and it appears that no data on compliance are available to the public.

New Brunswick's system of monitoring and enforcement meets the requirements of the minimum indicator, because it does not involve any penalties for non-compliance or any reporting to the public on industry compliance. There is no evidence of any similar system of monitoring and enforcement of benthic environmental quality in Nova Scotia or Newfoundland.

RESULTS FOR CRITERION SEVEN: 3

CRITERION 8: ADEQUACY OF DESIGN AND DEPLOYMENT STANDARDS FOR AQUACULTURE SYSTEMS TO OPTIMIZE CONTAINMENT OF FISH AND MINIMIZE ESCAPES

In 1998, Canada's submissions to the NASCO Secretariat (NASCO, 1998) promised that "Containment Codes of Practice", including standards, were under development that would lead to "area-specific standards required by provincial licensing authorities as basis for regulation." In 2000 and 2001, the same promise was repeated (NASCO, 2001). In 2002, after four years, Canada reported that the Newfoundland Code of Containment was being fully implemented, and said that Nova Scotia had developed a "draft Code of Containment (NASCO, 2002).

The Newfoundland Containment Code (Newfoundland Aquaculture Industry Association, 1999) appears to have the only set of standards for the design of aquaculture systems that has actually become operational in Canada. That code is broadly consistent with the guidelines issued by NASCO at its 2001 meeting (NASCO, 2001b). It requires cage design and specifications that are appropriate to prevailing weather conditions at the site, an annual 4-point stress test for all nets over 3 years old, minimum breaking strength for new nets, technical standards for cage and mooring design, proper treatment to ensure protection from UV, and proper securing of nets to the cage collar. It was also supposed to become an integral part of the "Bay d'Espoir Aquaculture Management Plan" and thus a condition of licensing (Anon., 1999).

Thus far, the Code of Containment for New Brunswick is only a draft that has not yet been officially adopted (Halse, pers.com.). The Aquaculture Association of Nova Scotia published an "Environmental Management Guidelines" document in September, 2000, which indicated that a draft code of containment was under development and should be adopted (Aquaculture Association of

Nova Scotia, 2000). But no evidence of adoption was found, despite inquiries to the AANS.

Although Newfoundland's Code of Containment meets the standard for the highest score for this criterion, other Atlantic provinces have not yet adopted such codes and do not qualify for the minimum score. Because Newfoundland represents only 7 percent of Canada's farmed salmon production, however, Canada's score is only one-tenth of the highest score for this criterion.

RESULTS FOR CRITERION EIGHT: 1

CRITERION 9: ADEQUACY OF REQUIREMENTS FOR ESCAPE PREVENTION AND RESPONSE PLANS AND MANAGEMENT SYSTEMS

In October, 2000, the British Columbia Ministry of Agriculture, Food and Fisheries (MAFF) introduced more concrete and stringent regulations regarding industry practices aimed at minimizing fish escapes, including escape prevention and escape response, farm record keeping and net maintenance activities. These regulations provided a set of specific standards and guidelines that could be used to measure industry compliance (British Columbia MAFF, 2001). Under the new BC regulation, every marine aquaculture site operator is required to have a written escape prevention and response plan detailing measures that are being taken to prevent escapes, avoid predators, maintain containment structures, and monitor and report on conditions (British Columbia MAFF, 2001). The industry practices required by these regulations are the standard by which Atlantic Canada's regulatory systems and industries are judged in regard to this criterion.

New Brunswick's aquaculture regulations give the Registrar authority to make licenses subject to terms and conditions aimed at preventing escapes from aquaculture operations (G3 Consulting, 2000). However, no standards or protocols for escape prevention and escape response plans have been promulgated by provincial authorities. Nor has the province made the reporting of escapes mandatory (McGeachy, pers. comm.).

The site allocation policy for the Bay of Fundy published by the New Brunswick Department of Agriculture, Fisheries and Aquaculture in October 2000 urges, but does not require "Bay Management Agreements" containing a code of practice to minimize escapees (New Brunswick DAFA, 2000). A New Brunswick Code of Containment exists in draft form, but it has not yet been officially adopted (Halse, pers. comm.).

Nova Scotia's voluntary environmental code of practice calls for farmers to "adopt and follow draft escape prevention and recapture guidelines for the region", but not site-specific plans (Aquaculture Association of Nova Scotia, 2000). As noted above, a Nova Scotia Code of Containment is under development but has not yet been adopted.

Newfoundland's Aquaculture Act (Newfoundland, as amended in 2001, authorizes an aquaculture inspector, "where he or she considers it necessary," to direct an aquaculture facility to "take measures…to prevent the escape of an organism" and allows the Minister of Agriculture, Fisheries and Aquaculture to suspend a facility's license if it fails to comply with the conditions of license. No information could be obtained on what measures have been taken thus far to enforce the regulatory requirement.

The Newfoundland aquaculture industry's Code of Containment, which is to be the basis for licensing decisions by provincial authorities, requires immediate notification of escapes, recapture plans, and keeping track of inventories on a cage-by-cage basis. It also requires a set of management

practices, such as system inspections and predator controls (Anonymous, 1999).

Newfoundland's requirements are considered, in the absence of information indicating non-enforcement, to qualify for the highest score for this criterion, but the score is less than one-tenth of the highest score.

RESULTS FOR CRITERION NINE: 1

CRITERION 10: ADEQUACY OF MONITORING AND ENFORCEMENT OF AQUACULTURE SYSTEMS AND ESCAPE PREVENTION AND RESPONSE PLANS

The only requirements at present relating to escape prevention and response plans are in Newfoundland's code of containment. A plan for implementing the set of standards for system design and deployment as well as procedures for minimizing the risk of fish escapes was set out by the Newfoundland Department of Fisheries and Aquaculture (1999). The plan includes annual testing of nets by the federal Department of Fisheries and Oceans and seasonal audits of cage and mooring systems. Predator Control Plans for each site had to be submitted to the DFA by October 1999. It also called for a semi-annual inventory review that would require reconciliation of numbers of fish introduced, mortalities, removals and escapes.

These measures would go far toward a system of monitoring of codes of containment. Enforcement of requirements in the Code of Containment implies that any escapes will be investigated thoroughly to determine whether any violations of the Code's provisions have taken place. No data was available for this assessment on whether instances of escapes in the Atlantic Provinces are now being investigated to determine whether they involve serious non-compliance with regulations.

The implementation plan for Newfoundland does not appear to include any public reporting on compliance with requirements in regard to fish containment such as British Columbia introduced in 2000.

In the absence of clear information on enforcement sanctions in Newfoundland, the new system of monitoring and enforcement is considered to meet the requirements for the second highest score, but the score for Canada as a whole is Newfoundland's score of 7 times Newfoundland's proportion of total farmed salmon production (.07).

RESULTS FOR CRITERION TEN: 0.5

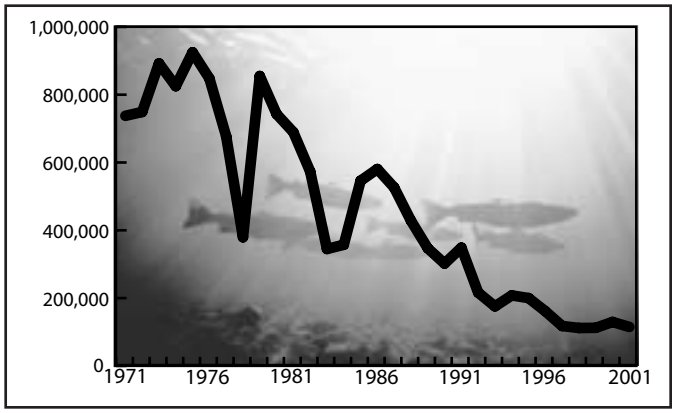


Fig. 7. The numbers of wild Atlantic salmon returning to North American rivers have declined precipitously in the past 20 years. The graph at right is based on prefishery abundance numbers of ICES, for two-sea-winter Atlantic salmon.

FAROE ISLANDS

TABLE 12 FAROE ISLANDS' OVERALL PROGRESS	
Criterion	
1. Minimum distance from salmon rivers	*NA*
2. Exclusion zones	*NA*
3. Cumulative impacts and siting decisions	0
4. Standards for fish husbandry practices	0
5. Standards for benthic ecosystem quality	*II**
6. Fish husbandry monitoring and enforcement	0
7. Benthic ecosystem monitoring/enforcement	*II**
8. Standards for equipment design/deployment	0
9. Standards for fish containment	0
10. Fish containment monitoring and enforcement	0
Average	**0**

* insufficient information

CRITERION 1: REQUIREMENTS FOR ADEQUATE DISTANCE FROM SALMON RIVERS IN SITING APPROVAL DECISIONS

The Faroe Islands has no wild Atlantic salmon rivers, so this criterion is not applicable. Although no wild salmon are found in domestic salmon rivers, the potential exists for interaction between farmed salmon produced in the Faroe Islands and wild salmon from the European mainland passing through waters nearby.

RESULTS FOR CRITERION ONE: NOT APPLICABLE

CRITERION 2: PROVISIONS IN SITING REGULATIONS FOR RESTRICTIONS ON AQUACULTURE OPERATIONS IN CERTAIN SENSITIVE AREAS TO PROTECT WILD SALMON

This criterion is also inapplicable to the Faroe Islands, because of the absence of domestic wild salmon.

RESULTS FOR CRITERION TWO: NOT APPLICABLE

CRITERION 3: DEGREE TO WHICH CUMULATIVE ENVIRONMENTAL IMPACTS OF SALMON FARMING ON ENTIRE BAY OR OTHER ECOSYSTEM ARE CONSIDERED IN SITING DECISIONS

Although a "long-term policy" of having only one company per fjord was reported by Denmark on behalf of the Faroes (NASCO,1968), no measures were reported in regard to adequate separation between sites, indicating that cumulative impacts need not be considered in siting decisions.

RESULTS FOR CRITERION THREE: 0

CRITERION 4: ADEQUACY OF REQUIREMENTS FOR FISH HUSBANDRY, INCLUDING BEST INDUSTRY PRACTICES, SUCH AS YEAR-CLASS SEPARATION, FALLOWING OF SITES AND MAXIMUM STOCKING DENSITIES

No regulatory measures have been reported in regard to stocking densities, year-class separation or fallowing. The report to NASCO by Denmark in 1968 attributed to companies the use of fallowing and year-class separation, but did not indicate that there was any industry code of conduct or other standards on fish husbandry (NASCO, 1998).

RESULTS FOR CRITERION FOUR: 0

CRITERION 5: ADEQUACY OF REGULATION OF DEPOSITION OF WASTES BENEATH FISH FARMS OR OF BENTHIC ECOSYSTEM QUALITY TO PROTECT FISH HEALTH

No specific information is available regarding regulation of waste deposition by fish farms in the Faroes.

RESULTS FOR CRITERION FIVE: INSUFFICIENT INFORMATION

CRITERION 6: ADEQUACY OF MONITORING AND ENFORCEMENT OF FISH HUSBANDRY PRACTICES

Because no measures have been adopted to require minimum standards or in regard to stocking densities, fallowing and year-class separation, it is assumed that there is neither monitoring nor enforcement of such practices.

RESULTS FOR CRITERION SIX: 0

CRITERION 7: ADEQUACY OF MONITORING AND ENFORCEMENT OF STANDARDS OF BENTHIC ENVIRONMENTAL QUALITY

No information is available on measures to monitor and enforce such standards, if they exist.

RESULTS FOR CRITERION SEVEN: INSUFFICIENT INFORMATION

CRITERION 8: ADEQUACY OF DESIGN AND DEPLOYMENT STANDARDS FOR AQUACULTURE SYSTEMS TO OPTIMIZE CONTAINMENT OF FISH AND MINIMIZE ESCAPES

Denmark reported on behalf of the Faroes in 1998 that no measures had been taken to ensure that design of aquaculture systems would minimize escapes (NASCO, 1998). No change in the status of regulations in the Faroes has been reported since then.

RESULTS FOR CRITERION EIGHT: 0

CRITERION 9: ADEQUACY OF REQUIREMENTS FOR ESCAPE PREVENTION AND RESPONSE PLANS AND MANAGEMENT SYSTEMS

Denmark reported in 1998 that no measures had been taken by the Faroes to require either escape prevention plans and management systems or contingency plans for escapes (NASCO, 1998), and has not indicated any change in the status of that issue since then.

RESULTS FOR CRITERION NINE: 0

CRITERION 10: ADEQUACY OF MONITORING AND ENFORCEMENT OF ESCAPE PREVENTION AND RESPONSE PLANS

In the absence of any regulatory requirements for escape prevention and response plans, it is assumed that no monitoring and enforcement on the issue exists.

RESULTS FOR CRITERION TEN: 0

ICELAND

Table 13 Iceland's Overall Progress	
Criterion	
1. Minimum distance from salmon rivers	3.3
2. Exclusion zones	5
3. Cumulative impacts and siting decisions	0
4. Standards for fish husbandry practices	0
5. Standards for benthic ecosystem quality	0
6. Fish husbandry monitoring and enforcement	0
7. Benthic ecosystem monitoring/enforcement	0
8. Standards for equipment design/deployment	0
9. Standards for fish containment	7
10. Fish containment monitoring and enforcement	7
Average	**2.23**

Criterion 1: Requirements for adequate distance from salmon rivers in siting approval decisions

The minimum distance between sea cages and salmon rivers with an annual catch exceeding 100 salmon is 5 kilometers, whereas sea cages must be at least 15 kilometers from a river with annual catch exceeding 500 salmon. However, if sterile salmon are used, the cages can be closer than 5 kilometers from a salmon river. A conditional two-year exemption can be granted by the Directorate with the approval of the Fish Disease Committee (Isaksson, 2001). However, no such exemption has been granted thus far (Isaksson, pers. comm.).

Although the minimum distance of 15 kilometers would merit a score of 5 if it applied to all salmon farming operations, allowing salmon farms using sterile salmon to be located less than 5 kilometers from salmon rivers significantly reduces the value of the rule. Although it reduces to some extent the potential genetic consequences of farmed salmon interactions with wild salmon, it does much less in regard to potential disease transition between farmed and wild salmon.

Because of the divergence between the rule for sterile salmon and fertile salmon, the Icelandic

regulation is scored as the average of half the full score of 3 for a minimum distance of 5 kilometers (reflecting the fact that genetic interactions are reduced but not disease interactions) and the score for the minimum distance of 15 kilometers.

RESULTS FOR CRITERION ONE: 3.3

CRITERION 2: PROVISIONS IN SITING REGULATIONS FOR RESTRICTIONS ON AQUACULTURE OPERATIONS IN CERTAIN SENSITIVE AREAS TO PROTECT WILD SALMON

Regulatory measure no. 226/2001 sets up Wild Salmon Coastal Protection Areas in certain bays and fjords where rearing of fertile salmon in sea cages is prohibited. Most of the fjords and bays on Iceland's northern and western coasts, where Iceland's Atlantic salmon stocks are located, are now Wild Salmon Coastal Protection Areas and are off limits for farming of fertile salmon (Isaksson, 2001.). Of the seven wild salmon bays and their associated fjords, only one bay on the Northern coast where wild salmon are fished is not such a Protection Area. The two major salmon rivers, the Rarigar and Olyusa, on the southwest coast, are also available for salmon farming (Isakkson, n.d.).

Again, the exemption of sterile salmon from the restrictions on salmon farms in sensitive areas represents a significant diminution of its effect. It does nothing to prevent farmed salmon from transmitting sea lice or other diseases to wild salmon. The exclusion zones in Iceland are scored, therefore, as the average between the highest score for farming of fertile salmon and the score of zero for farming of sterile salmon.

RESULTS FOR CRITERION TWO: 5

CRITERION 3: DEGREE TO WHICH CUMULATIVE ENVIRONMENTAL IMPACTS OF SALMON FARMING ON ENTIRE BAY OR OTHER ECOSYSTEM ARE CONSIDERED IN SITING DECISIONS

In reporting on its measures to implement the Oslo Resolution, Iceland has asserted that separation of aquaculture facilities based on a general assessment of local conditions is "not applicable" to Iceland (NASCO, 1998). No measures have been reported in more recent reports to NASCO. Furthermore, Iceland has no automatic environmental assessment of marine fish farms. The Icelandic Planning Agency has the discretion to decide whether an application for an operating license for such a fish farm must undergo an environmental impact assessment (Isaksson, 2001).

Iceland had almost no sea cage fish farms in the 1990s, the upsurge of salmon farms of the early 1980s having quickly collapsed in bankruptcy by the end of the decade (Vigfusson, pers. comm.) Only one marine-based salmon farm with an annual production of 500 tons had operated for some years (Intrafish, 2001a).

During 2001, however, salmon fish farming in Iceland was poised for a period of rapid growth. With 4,000-5,000 tons already being produced annually, Iceland had approved two salmon farming operations on the east coast, each of which could be as high as 8,000 tons a year, and licenses for six more operations were under consideration (Intrafish, 2001).

Thus the production context for Iceland's regulatory system has changed dramatically over the

past two years, requiring much greater attention to the ecosystem –wide consequences of aquaculture operations. The necessity to take account of the cumulative environmental impacts on a bay or fjord applies whether the impacts are from multiple salmon farm sites or a very large, single operation.

Nevertheless, in 2000, the government insisted that there was no need for an environmental impact assessment on a proposed salmon farming operation that would produce 8,000 tons per year (North Atlantic Salmon Fund, 2000). The total production of the three new operations is estimated to be 22,000 tons, and the fjord in which one of the major new salmon farms is reported to be located is narrow and has little current to sweep away waste products (North Atlantic Salmon Fund, 2000).

In the absence of any regulatory requirement for a review of the potential environmental impacts of large-scale production in a single bay or fjord, Iceland fails to meet the standards for a minimum score for this criterion.

RESULTS FOR CRITERION THREE: 0

CRITERION 4: ADEQUACY OF REQUIREMENTS FOR FISH HUSBANDRY, INCLUDING BEST INDUSTRY PRACTICES, SUCH AS YEAR-CLASS SEPARATION, FALLOWING OF SITES AND MAXIMUM STOCKING DENSITIES

During the first years of the Oslo Resolution, Iceland took the position that requirements for fish husbandry and fish health such as fallowing and year-class separation were irrelevant to Iceland's salmon farming industry. In 1999, Iceland's submission on its implementation of the Oslo Resolution (NASCO, 1999) on use of a fallowing regime was "Not applicable in the Icelandic situation." Similarly on year-class separation, Iceland's comment was, "Not practical in land-based operations." The following year, it had nothing to add to those remarks (NASCO, 2000).

As noted above, however, the rapid increase in sea-based salmon farming in Iceland raises new requirements for regulation over fish husbandry practices. Iceland has implicitly recognized that fact in changing the tone of Icelandic submissions to NASCO in 2001 from dismissive to supportive of such regulation, at least in principle. Its response on year-class separation (NASCO, 2001) simply said it was "[c]onsistent with Icelandic policy."

Iceland has not yet adopted any regulatory requirements governing fish husbandry practices, however. In regard to stocking density, for example, Iceland did not claim any regulatory measures but simply commented (NASCO, 1999) that "all facilities are subject to regular health inspection." Neither the original Icelandic Salmonid Fisheries Act passed in 2001 nor did the amendment to the aquaculture section of the law passed in 2001 specify any fish husbandry standards.

Iceland has not taken measures corresponding to the indicator for a minimum score for this criterion.

RESULTS FOR CRITERION FOUR: 0

CRITERION 5: ADEQUACY OF STANDARDS FOR BENTHIC ECOSYSTEM QUALITY

The Icelandic Salmonid Fisheries Act, as amended in 1998 (Government of Iceland, 1998) made no reference to environmental quality issues surrounding sea-cages, nor are waste deposition and

environmental quality of the sea floor included on the list of issues on which regulatory measures might be issued by the Ministry of Agriculture (Isaksson, 2001). The issue of pollution within and around the fish farm is covered by an "Environmental License," which provides that salmon farms must "discharge wastewater far enough to ensure rapid dilution of the effluent," according to Isaksson (2001). The license apparently does not regulate the release of fish feed and fish feces into the marine environment.

Iceland thus has no regulatory measures relating to this criterion.

RESULTS FOR CRITERION FIVE: 0

CRITERION 6: ADEQUACY OF MONITORING AND ENFORCEMENT OF FISH HUSBANDRY PRACTICES

All fish farms are subject to regular fish health inspections by the Office of the Fish Disease Veterinarian. The fish farming facility must maintain records of data on health status of fish and of the feeding regime, and "various other factors," and marine fish farms are inspected at least twice a year by the Directorate of Freshwater Fisheries, according to Isaksson (2001). The Directorate is responsible, however, for enforcing the Icelandic Salmonid Fisheries Act (Isaksson, 2001), and that law, as amended in 2001, does not deal with fish husbandry issues. Even though the Directorate monitors the "overall technical and rearing performance as well as compliance with operating license requirements (Isaksson, 2001)," this mandate does not cover enforcement of any of the most important fish husbandry practices.

RESULTS FOR CRITERION SIX: 0

CRITERION 7: ADEQUACY OF MONITORING AND ENFORCEMENT OF BENTHIC ECOSYSTEM QUALITY TO PROTECT FISH HEALTH

In the absence of a regulatory requirement, it is assumed that no monitoring and enforcement of any standard of benthic ecosystem quality is carried out.

RESULTS FOR CRITERION SEVEN: 0

CRITERION 8: ADEQUACY OF DESIGN AND DEPLOYMENT STANDARDS FOR AQUACULTURE SYSTEMS TO OPTIMIZE CONTAINMENT OF FISH AND MINIMIZE ESCAPES

In 1999, the Icelandic reply on this question (NASCO, 1999) said sea cage units were "subject to certain conditions in building and operating licenses." However, design standards for aquaculture cages and moorings are not on the list of items on which the Ministry of Agriculture can set regulatory measures, although the maintenance of sea cages is on the list (Isaksson, 2001). The amendment to the Icelandic Salmonid Fisheries Act in 2001, moreover, did not set any standards for the strength and reliability of sea-cage equipment in terms of standing up to weather conditions and predators (Isaksson, pers. comm.).

Iceland is found to have taken no measures relevant to this criterion.

RESULTS FOR CRITERION EIGHT: 0

CRITERION 9: ADEQUACY OF REQUIREMENTS FOR ESCAPE PREVENTION AND RESPONSE PLANS AND MANAGEMENT SYSTEMS

As recently as 1999, Iceland did not claim to have any regulations regarding escape prevention and response plans and management systems. The Icelandic response on this issue to NASCO in 1999 mentioned that units had to be approved by the Director of Freshwater Fisheries, not that they were required to have site-specific escape prevention or escape response plans (NASCO, 1999).

However, the 2001 amendment of the Fish Farming Act of 1985 specifies that the operating license must have clauses specifying precautionary measures that would be taken by the fish farm owners to minimize escapes from sea-cages as well as plans for re-catching escaped fish. Any escapes of fish are to be reported to the Directorate immediately. (Isaksson, pers. comm.). However, no mention is made of management systems in connection with such precautionary plans.

Iceland's regulatory requirements cover all the elements for the second highest score for this criterion.

RESULTS FOR CRITERION NINE: 7

CRITERION 10: ADEQUACY OF MONITORING AND ENFORCEMENT OF AQUACULTURE SYSTEMS AND ESCAPE PREVENTION AND RESPONSE PLANS.

The compliance of Iceland's fish farms with regard to fish containment requirements is apparently monitored as part of the Freshwater Fisheries Directorate's twice annual inspections of each fish farming site. According to the amendments to the Icelandic Salmonid Fisheries Act of 2001, if the fish farm operator does not comply with the requirements for precautionary measures and plans for recapture of escaped fish, the operator's license can be revoked. It can also be revoked if fish escapes take place repeatedly from the site (Isaksson, pers. comm.). However, there is no system of public reporting on compliance with the requirements for precautionary measures and recapture plans.

Iceland's actions meet the requirements for the second highest score for this criterion

RESULTS FOR CRITERION TEN: 7

IRELAND

TABLE 14 IRELAND'S OVERALL PROGRESS	
Criterion	
1. Minimum distance from salmon rivers	0
2. Exclusion zones	0
3. Cumulative impacts and siting decisions	0
4. Standards for fish husbandry practices	0
5. Standards for benthic ecosystem quality	10
6. Fish husbandry monitoring and enforcement	0
7. Benthic ecosystem monitoring/enforcement	5
8. Standards for equipment design/deployment	0
9. Standards for fish containment	10
10. Fish containment monitoring and enforcement	3
Average	**2.8**

CRITERION 1: REQUIREMENTS FOR ADEQUATE DISTANCE FROM SALMON RIVERS IN SITING APPROVAL DECISIONS

Ireland has adopted no requirement for a particular distance from salmon rivers in the siting of salmon farming operations. In 1994, a report by the Irish Ministry of the Marine recommended that fish farms not be allowed any closer than 20 kilometers from any wild salmon river, but the report was never published because of aquaculture industry pressure. In Lough Swilly, one of the two major inlets in Country Donegal on the Northern coast, a licensed salmon fish farm is only 3.5 kilometers from a salmon river (Save the Swilly, 2002).

RESULTS FOR CRITERION ONE: 0

CRITERION 2: PROVISIONS IN SITING REGULATIONS FOR RESTRICTIONS ON AQUACULTURE OPERATIONS IN CERTAIN SENSITIVE AREAS TO PROTECT WILD SALMON

Ireland's 1998 response on "wild salmon protection areas" (NASCO, 1998) indicated that

"specific coastal areas" had been "designated as to disallow aquaculture development." However, it did claim that the purpose of such designation was to protect wild salmon.

Since the 1998 declaration to NASCO, further evidence of the Irish government's resistance to designating salmon protection zones has come to light. In 1999, 5 Irish NGOs monitoring the designations of "Special Areas of Conservation"(SACs) and Special Protection Areas required by the European Commission's Habitats Directive and its NATURA 2000 program, discovered that Ireland had failed to include among the 145 sites it had designated a single site for wild salmon conservation (Irish Peatlands Conservation Council, 2000). After the European Court had determined in November, 2000 that all European Community member states had to submit "exhaustive lists" of sites for protection to the European Commission, the Irish government declared that it would not increase the number of its SACs (Crosbie, 2000). The government's Minister of Arts, Heritage, Gaeltacht and The Islands argued that no designations of salmon rivers as SACs were necessary, on the ground that the salmon species was widespread in Ireland and that SACs would not add anything to existing conservation mechanisms (Cleary, 2001).

In March, 2002, the EC sent a Letter of Formal Notice to Ireland of its failure to comply adequately with European Court of Justice ruling on designation of protected sites (European Commission, 2002). The Court had found that Ireland's list of proposed protected sites still had "significant omissions," including salmon rivers. Since then, Ireland has designated a number of rivers as SACs for salmon. However, the designation of such sites is not considered to rule out aquaculture development near the river. That decision is to be made on a case by case basis (Craig, pers. comm.).

Thus Ireland's designation of rivers as Special Areas of Conservation is not considered to ensure any protection of salmon stocks from aquaculture development and it does not meet the requirements for a minimum score on this criterion.

RESULTS FOR CRITERION TWO: 0

CRITERION 3: DEGREE TO WHICH CUMULATIVE ENVIRONMENTAL IMPACTS OF SALMON FARMING ON ENTIRE BAY OR OTHER ECOSYSTEM ARE CONSIDERED IN SITING DECISIONS

In response to the NASCO question about separation of aquaculture facilities on the basis of a "general assessment of local conditions," Ireland asserted that the matter was "covered in the EIS which accompanies each application (NASCO, 1998)." In two subsequent years it stated that such separation was being "carried out "(NASCO, 1999; NASCO, 2000). In 2001, Ireland asserted (NASCO, 2001) that the distance between facilities is decided by an "expert committee comprising engineers, biologists, fish health experts, oceanographers and administrators."

These responses, and particularly, the 2001 submission, implied that the cumulative effect on a wider area, taking into account existing aquaculture operations in the ecosystem is indeed being taken into account in making siting decisions. However, the requirement for dealing with broader ecosystem implications in an environmental assessment accompanying applications for aquaculture licenses is far more conditional than these responses suggested. The law (Government of Ireland, 1988) refers to "nature, size or location" of a proposed aquaculture site as the issue to be taken into account by the Crown Estate Commissioners in its decision on a license application, and does not imply that the scope of potential environmental impact to be considered is the entire ecosystem, in light of any existing aquaculture operations affecting the same ecosystem. The law specifies that a proposed aquacul-

ture development "shall only be taken to be likely to have a significant effect on the environment…where the Crown Estate Commissioners consider that this is the case."

The Crown Estate Commissioners determine whether the environmental impact is likely to be "significant," moreover, in the absence of any data about the carrying capacity of the ecosystem and the likely cumulative impact of all existing and proposed operations. Indeed, the operator is required to submit an environmental assessment only if and when the Crown Estate Commissioners have determined that such a significant impact is probable.

1997 legislation creating the Aquaculture Licenses Appeals Board mentions the "effect or likely effect on the environment generally in the vicinity," but again does not mention the issue of spacing of aquaculture facilities or of ecosystem carrying capacity. There is no implication in the law that such broader considerations are to be taken into account.

A careful review of Ireland's regulatory system (McMahon, 2000) noted that the issue of the carrying capacity of various locations had not been "formally or legislatively addressed." Because of the absence of any specific provision on the issue in question, existing regulatory requirements in Ireland are considered to fall short of the minimum score for this criterion.

RESULTS FOR CRITERION THREE: 0

CRITERION 4: ADEQUACY OF REQUIREMENTS FOR FISH HUSBANDRY, INCLUDING BEST INDUSTRY PRACTICES, SUCH AS YEAR-CLASS SEPARATION, FALLOWING OF SITES AND MAXIMUM STOCKING DENSITIES

In 1998, Ireland reported (NASCO, 1998) that fish health and veterinary controls and appropriate husbandry techniques, including stocking densities, were "being carried out." Year-class separation and fallowing regimes, on the other hand, were said to be "carried out in most production areas." Ireland refrained, however, from claiming that it had adopted any regulatory requirements on the latter two issues.

The 1997 legislation governing licensing of finfish aquaculture operations (Government of Ireland, 1997) lists "operational practices, including the fallowing of sites," as one of the subjects on which the aquaculture license may be subject to conditions. A monitoring protocol for fallowing of offshore finfish farms issued in 2000 (Department of the Marine and Natural Resources, Ireland, 2000b) requires that all finfish farms "undertake appropriate fallowing" as a technique to control disease and parasite problems. It specifies that the period of fallowing has to ensure that "all infective stages are dead, or gone, before restocking the site." But the protocol explicitly avoids specifying a minimum standard for fallowing. Instead it reserved the right to "prescribe specific fallowing requirements in particular cases if necessary." It calls for adjacent sites to fallow at the same time, while suggesting that "best results" are obtained when all production sites are fallowed annually for minimum of 30 continuous days."

No similar protocol has been issued for stocking density or for year-class separation (Department of the Marine and Natural Resources, Ireland 2000a). Apart from fallowing, therefore, fish husbandry practices are not singled out regulatory requirements.

The Department of Marine and Natural Resources established the Single Bay Management Initiative, in 1998, aimed at improving fish husbandry. Under this initiative, aquaculture operations in the same coastal areas reach agreement on local management strategy plans, called Coordinated Aquaculture Management Strategies, involving agreed procedures on such issues as separation of gen-

erations and annual fallowing of sites. These agreements would represent local codes of practice among the fish farm operators (Maroni, 2000). However, the single bay area management agreements are non-statutory and are clearly separated from the licensing process (Marine Institute, 2001a). They are not mechanisms for holding operators accountable for minimum standards of fish husbandry.

Ireland's regulations thus fail to require best practices in regard to any of the fish husbandry practices identified in the Oslo Resolution. Ireland's management scheme therefore fails to qualify for a minimum score for this criterion.

RESULTS FOR CRITERION FOUR: 0

CRITERION 5: ADEQUACY OF STANDARDS FOR BENTHIC ECOSYSTEM QUALITY

In its monitoring protocol on benthic monitoring, the Department of the Marine and Natural Resources (2000c) prescribes environmental quality standards for impacts up to the 20 meters from the edge of the cage site, from 20 to 50 meters from the cage site and up to 100 meters from the cage site in terms of bacterial mats, faunal diversity and redox. These parameters provide a minimum set of measures of benthic ecosystem quality, although redox is generally considered only a secondary indicator that is less reliable than measures of sulfides in the sediment (British Columbia Ministry of Water, Land and Air Protection Special Advisory Group, 2001).

These standards are considered to meet the requirements for the highest score for this criterion.

RESULTS FOR CRITERION FIVE: 10

CRITERION 6: ADEQUACY OF MONITORING AND ENFORCEMENT OF FISH HUSBANDRY PRACTICES

The single bay area management agreements that have been strongly encouraged by the Irish government are non-statutory and are clearly separated from the licensing process (Marine Institute, 2001a). They are not mechanisms for holding operators accountable for minimum standards of fish husbandry.

The Department of Marine and Natural Resources Fish Health Unit Laboratory inspects all aquaculture sites in the country at least once annually in regard to weak or abnormally behaving fish, mortality records and samples and fish movement and medicinal usage records (Marine Institute, 2001b). In addition the Department of the Marine and Natural Resources undertakes regular on-site inspections of the farm's operations. However, the monitoring protocol for such inspections does not cover the major fish husbandry practices identified in the Oslo Resolution (Department of the Marine and Natural Resources, 2000d).

The current regulatory system does not meet the requirement for a minimum score for this criterion.

RESULTS FOR CRITERION SIX: 0

CRITERION 7: ADEQUACY OF MONITORING AND ENFORCEMENT OF STANDARDS OF BENTHIC ENVIRONMENTAL QUALITY

Finfish farms in Ireland are required to carry out an annual benthic survey in accordance with a detailed protocol specifying the timing, methods and locations for video or photographic recordings, redox potential samples and biological samples. In addition to examination of the raw data by DOMNR, the Marine Institute undertakes an annual independent environmental audit of a randomly selected, limited number of reports.

The enforcement of the benthic ecosystem quality standards does not include any penalties for failure to maintain the standards. Rather, the finfish farm licensee must submit a plan for achieving the required standards as soon as possible and must establish a feed waste control system that reduces the volume of fish feed introduced into the area. Repeated failure to meet the environmental quality standards results only in further requirements for reduction in feed inputs until the standards have been achieved (Department of Marine and Natural Resources, Ireland, 2000c). There is no public reporting on compliance with ecosystem quality standards.

Although the monitoring of benthic ecosystem quality appears adequate, the system lacks either adequate enforcement in the form of meaningful penalties for failure to comply or public reporting on compliance. It meets the requirements for middle-ranking score on this criterion.

RESULTS FOR CRITERION SEVEN: 5

CRITERION 8: ADEQUACY OF DESIGN AND DEPLOYMENT STANDARDS FOR AQUACULTURE SYSTEMS TO OPTIMIZE CONTAINMENT OF FISH AND MINIMIZE ESCAPES

Ireland's first response to the NASCO Secretariat in regard to "standards and technical specifications for the design and deployment of aquaculture units" (NASCO, 1998) suggested that DOMNR engineers had to approve the "gratings in hatcheries and design and construction of holding tanks." With regard to optimizing containment of fish through use of appropriate technology, however, Ireland conceded that it had no specific regulation on the subject. It argued that it is in the interests of its companies to "maintain the highest standards of containment."

No reference to the technical specifications of hatcheries and tanks is included in the legislation on licenses and no other regulations on that matter had been issued as of 1998 (Government of Ireland, 1997; McMahon, 2000). Since then, no further protocols on the subject have been issued (Department of the Marine and Natural Resources, Ireland, 2000a).

Ireland has not passed any regulations pertaining to the subject and does not meet the requirements for a minimum score for this criterion.

RESULTS FOR CRITERION EIGHT: 0

CRITERION 9: ADEQUACY OF REQUIREMENTS FOR ESCAPE PREVENTION AND RESPONSE PLANS AND MANAGEMENT SYSTEMS

The "Fisheries (Amendment) Act" of 1997 (Government of Ireland, 1997) provides a statutory basis for Ireland to require that all finfish aquaculture license holders must have plans and manage-

ment systems for escape prevention and response. Salmon farmers are required as a general condition for licenses to take measures necessary to prevent the escape of salmon from their cages (McMahon, 2000), although it is not clear whether this requires having a written plan covering the management actions to be taken routinely to prevent escapes.

In 2001 Ireland reported that it required all prospective fish farm owners to have an "Emergency Plan" for fish escapes, which is submitted to the Department of the Marine and Natural Resources with the application for a license (NASCO, 2001). For this reason, Ireland's regulations on fish escapes are considered to cover immediate reporting of fish escapes, and contingency plans but not plans for preventing escapes.

In the absence of clear information to the contrary, and because the legislation provides a clear statutory basis for such regulation, it is assumed that license holders are required to have escape prevention plans. Thus Ireland's requirements include all three elements for the highest score for this criterion.

RESULTS FOR CRITERION NINE: 10

CRITERION 10: ADEQUACY OF MONITORING AND ENFORCEMENT OF AQUACULTURE SYSTEMS AND ESCAPE PREVENTION AND RESPONSE PLANS

Section 7 of the Fisheries (Amendment) Act of 1997 gives the licensing authority the power to require as a condition of holding a license "measures for preventing escapes of fish, and arrangement for the reporting of escapes." However, the monitoring protocol on the integrated audit of aquaculture operations (Department of the Marine and Natural Resources, Ireland, 2000d) does not include within its scope any systematic collection of data on contingency plans for fish escapes or plans for escape prevention.

However, the monitoring protocol does call for on-site audits of wear or fatigue on key elements of aquaculture systems.

Ireland monitors compliance with regulations to minimize fish escapes only partially, and therefore meets the requirement for lowest score.

RESULTS FOR CRITERION TEN: 3

NORWAY

Table 15 Norway's Overall Progress	
Criterion	
1. Minimum distance from salmon rivers	4
2. Exclusion zones	10
3. Cumulative impacts and siting decisions	0
4. Standards for fish husbandry practices	3
5. Standards for benthic ecosystem quality	0
6. Fish husbandry monitoring and enforcement	3
7. Benthic ecosystem monitoring/enforcement	0
8. Standards for equipment design/deployment	0
9. Standards for fish containment	9
10. Fish containment monitoring and enforcement	5
Average	**3.4**

Criterion 1: Requirements for adequate distance from salmon rivers in siting approval decisions

Norwegian regulations require no minimum distance between salmon farms and salmon rivers but specify that salmon farms cannot be closer than 5 kilometers to an "important" river. Since part of this regulation qualifies for a minimum score and part for a middle-ranking score, the score for this criterion is the average of the two.

RESULTS FOR CRITERION ONE: 4

Criterion 2: Degree of restrictions on aquaculture operations in certain sensitive areas to protect wild salmon

Since 1989, 52 Norwegian salmon rivers and fjords have been off-limits for aquaculture development as an interim measure to protect wild salmon runs (Norwegian Ministry of Environment, 1999a). Most of the areas on which there have been restrictions on new salmon farm sites already had

salmon farms prior to the establishment of the restrictions. At least 100 such farms are located in these national salmon fjords and rivers. Furthermore, the salmon farms that were already occupying sites in these fjords and rivers have no particular restrictions on their operations and are even permitted to increases their production (Norwegian Ministry of Environment, 2002).

After several years of debate over whether this policy should be continued, expanded or otherwise changed, the government produced a Green Paper in July 2001 proposing that 22 fjords and 39 rivers would become "national salmon fjords" and "national salmon rivers." The proposed system involved both areas in which salmon farming would be prohibited and those in which it would be restricted and subject to more rigorous controls (Hjellestad, 2001). One year later, the policy of creating protected rivers and salmon to save wild salmon stocks was officially confirmed (Norwegian Ministry of the Environment, 2002), and the system was approved by parliament in February 2003. Of 21 officially protected salmon rivers, 13 are free of salmon farming, whereas 8 still permit salmon farming to continue.

The current policy of Norway prohibits salmon farming in many areas, and therefore meets the requirement for the highest score for this criterion.

RESULTS FOR CRITERION TWO: 10

CRITERION 3: DEGREE TO WHICH CUMULATIVE ENVIRONMENTAL IMPACTS OF SALMON FARMING ON ENTIRE BAY OR OTHER ECOSYSTEM ARE CONSIDERED IN SITING DECISIONS

In order to assess the potential for aquaculture along the coast, during 1987-90, Norway developed a methodology for quantifying the gross available capacity for aquaculture production in a given marine zone, called Nationwide Assessment of the Suitability of the Norwegian Coastal Zone and Rivers for Aquaculture, or LENKA in its Norwegian acronym. However, the system was not mandatory and was never widely used. A newer technical standard for monitoring cumulative environmental impacts of salmon farming in an entire fjord, the MOM, is also voluntary (MTB Working Group, 2002).

In discussing its policies toward siting and license approvals, the Norwegian Environment Ministry (2000) said "considerable emphasis should be placed on environmental impacts and recipient capacity," in the siting of fish farms, which is not quite the same as a requirement that cumulative impacts should be calculated for each ecosystem and that no fish farm should be allowed to be located where cumulative impacts are beyond the ecosystem's carrying capacity. These points have not been revised on the Ministry website since 1999, indicating that the situation has not fundamentally changed.

Despite the existence of an analytical system for calculating the ecosystem carrying capacity for a given fjord, and a declaratory policy urging that such cumulative impacts be taken into account in siting decisions, there is still no statutory requirement to reject those applications for sites in areas where carrying capacity is not sufficient, and it is not in fact being widely taken into account.

RESULTS FOR CRITERION THREE: 0

CRITERION 4: ADEQUACY OF REQUIREMENTS FOR FISH HUSBANDRY, INCLUDING BEST INDUSTRY PRACTICES, SUCH AS YEAR-CLASS SEPARATION, FALLOWING OF SITES AND MAXIMUM STOCKING DENSITIES

The basic law on aquaculture now in force (Government of Norway, 1998) establishes certain fish husbandry standards, including a maximum stock density and regular fallowing. However, it appears to fall short of reflecting the best practices in the industry in regard to any of the standards. It calls for a maximum stock density of 25 kg per cubic meter, which is more than 250 percent greater than the 9 kg per cubic meter actual average stocking density in Scotland, despite the fact that both Scotland and Norway have roughly similarly low current speed and longer required flushing times in the fjords where most of their salmon farm industry is concentrated.

It requires fallowing "regularly", but indicates that the length depends on "relevant guidelines" issued by the Norwegian Animal Health Authority (NAHA). According to the NAHA, the guideline for fallowing periods in salmon farming is two months each year (Lyngstad, pers. comm.). Practices vary widely from country to county, and in some the minimum fallowing period is six months. The law does not specifically require single-year class stocking at fish farm sites.

Local management plans agreed by the industry and authorities in the regions, which are valid for two years but are revised each year, cover fallowing of sites (Maroni, 2002).

The Norwegian regulatory scheme for fish husbandry practices provides a standard for stocking densities which appears extremely high for flushing conditions in most Norwegian salmon farming sites, and the scheme fails to require best industry practices on two of the three major fish husbandry issues. The present pattern of regulation therefore falls just below the second lowest score.

RESULTS FOR CRITERION FOUR: 3

CRITERION 5: ADEQUACY OF STANDARDS FOR BENTHIC ECOSYSTEM QUALITY

Norwegian regulations require that each fish farm license holder operates the sites for which the license is held in "an environmentally acceptable way." (G3 Consulting, 2000). But it does not establish a specific standard for environmental quality of the benthic ecosystem beneath and around the fish farm. In 1999, the Ministry of Environment set the short-term target of having "relevant national standards" as the basis for monitoring of fish farms' waste deposition (Norwegian Ministry of Environment, 1999b).

Thus far, no such national standards have been promulgated. A report by the Environment Ministry on the environmental quality of Norway's coastal and marine areas (Norwegian Ministry of Environment, 2001) recognized the potential threat of regional eutrophication from discharges of nutrients at aquaculture sites, but made no reference to any establishment of new national standards for nutrient discharges.

It appears that statutory regulations do not provide a specific standard of water column or benthic ecosystem quality for which fish farms can be held accountable. The so-called MOM standard includes benthic sampling and sediment sampling twice a year on locations with bad benthic conditions and every second year on locations with good conditions. However, the system is not yet obligatory, although a working group within the Directorate of Fisheries recommended in 2002 that it be made mandatory (MTB Working Group, 2002). Therefore the allowable thresholds for various parameters are not used for compliance purposes.

Once the new integrated system has been adopted, it should provide a mechanism for accounta-

bility in regard to water quality and benthic ecosystem quality. Based on the present regulatory situation, however, Norway does not qualify for the minimum score.

The Norwegian regulatory scheme is therefore considered to fall short of the indicator for a minimum score for this criterion.

RESULTS FOR CRITERION FIVE: 0

CRITERION 6: ADEQUACY OF MONITORING AND ENFORCEMENT OF FISH HUSBANDRY PRACTICES

The basic Norwegian regulation (Government of Norway, 1998) requires regular reporting to the government, on some management issues, but not on all major fish husbandry practices. Farmers must report on chemicals used, on stocking density, fish diseases, and other fish health information. The regulation also requires that fish farms have a management plan for two years specifying at a minimum which sites will be left fallow and for how long. That plan must be approved by the Directorate of Fisheries' regional office in consultation with the chief county veterinary officer. Records to be kept at the site for five years are to indicate stock densities, numbers of lice on salmonids and consumption of medical products.

Failure to report can result in fines, but no enforcement actions are taken in regard to fallowing, stocking density and other fish husbandry issues themselves. Nor are the data from the reporting made available to the public. Therefore, Norway's actions meet the requirements for the next to lowest score for this criterion.

RESULTS FOR CRITERION SIX: 3

CRITERION 7: ADEQUACY OF MONITORING AND ENFORCEMENT OF BENTHIC ENVIRONMENTAL QUALITY TO PROTECT FISH HEALTH

Since the late 1990s, many fish farm operators have been using a system developed by the government for monitoring health of the sediment under the farm, but it has not been actually made a requirement (Norwegian Directorate of Fisheries, MTB Working Group, 2002). Each fish farm is also required to submit certain environmental information to the government annually (Maroni, 2000). But neither the voluntary use of the monitoring tools nor the submission of selected information represents a full-fledged monitoring system for environmental quality or nutrient deposition.

According to a report by a representative of the Norwegian Fish Farmers Association, at least 15 percent of Norwegian marine aquaculture farms are inspected annually (Maroni, 2000). Fish farmers collect data on the environmental quality of water columns and benthic communities and report to the government (Maroni, 2000).

Even this self-monitoring by fish farms using agreed methods is not yet a regulatory requirement. The government has been talking about remedying this problem with its regulatory scheme for years. In 1999, the Norwegian Ministry of Environment (1999b) said that "monitoring routines" were being established to "make it possible to follow changes in environmental conditions and respond before recipients are damaged by pollution." The Ministry of Environment declared last year that the fish farm operators "may be required to take responsibility for environmental monitoring of their own

plants using approved methods," with the resulting data to be used to assess the capacity of different aquaculture sites (Norwegian Ministry of Environment, 2001). The Minister of Fisheries also declared in January 2001 that he had plans for new requirements for fish farmers to monitor environmental conditions in and around their own installations using methods approved by the ministry (Gregussen, 2001). A working group in the Directorate of Fisheries proposed that it be made obligatory in August 2002 (MTB Working Group, 2002).

Despite plans by Norway to create a statutory requirement for monitoring by fish farms based on agreed methods, no system had been adopted as of the time of this publication. Norway fails to meet the requirement for a minimum score for this criterion.

RESULTS FOR CRITERION SEVEN: 0

CRITERION 8: ADEQUACY OF DESIGN AND DEPLOYMENT STANDARDS FOR AQUACULTURE SYSTEMS TO OPTIMIZE CONTAINMENT OF FISH AND MINIMIZE ESCAPES

As early as 1991, Norway's Aquaculture Act was amended to allow for a new system of obligatory standards for technical equipment used by the aquaculture industry (Norwegian Ministry of Fisheries, 1985). From 1998 through 2000, Norway promised in its reports to NASCO a new "system of classification of technical equipment for use in the aquaculture industry" that would be the basis for new regulations (NASCO, 1998; NASCO, 1999; NASCO, 2000). However, it failed to mention such a system in its 2001 or 2002 reports.

The government working group on a technical standard began its work in 1996, but did not produce an official proposal. In 2002 a new working group was set up to come up with a scheme for technical requirements for fish farm equipment. The work of the new group is not expected to be completed until mid-2003, with new regulations expected to enter into force in January 2004 for all new floating aquaculture equipment. It will then be another four years before existing equipment must be converted to the new standard (FIS Europe, 2002; Anfinsen, pers. comm.).

The fact that no technical standard has yet been adopted means that Norway's actions fall short of the requirements for a minimum score for this criterion. Even after it is adopted, however, it would not apply to the vast majority of Norway's fish farms for several years.

RESULTS ON CRITERION EIGHT: 0

CRITERION 9: ADEQUACY OF REQUIREMENTS FOR ESCAPE PREVENTION AND RESPONSE PLANS AND MANAGEMENT SYSTEMS

Norway reported under item 2.4.3 ("Establishment of site specific contingency plan in the event of large escapes") in 2000 that new regulations for aquaculture operations that took effect on January 1, 1999 included provisions for "specific contingency plans" (NASCO, 2000). The 1998 Norwegian regulation of fish farming (Government of Norway, 1998) requires that fish farms keep up-to-date contingency plans for limiting the size of escapes and recovering escaped fish, and that they report any escapes immediately by fax or phone. The regulation further requires that the plan include "safety precautions for the towing of sea cages and for the handling of fish during loading and unloading." An additional requirement is to set up nets within 20 meters from the fish farm in order to monitor for

escaped fish. The regulation does not appear to cover the full range of management practices necessary to minimize escapes.

The Regulation on Operation and Diseases Regulation on fish farms (Norwegian Ministries of Fisheries and Agriculture, 1998) required license holders to report immediately to the Directorate of Fisheries if any fish escape is suspected and to recover escaped fish. It also required turning over complete information on any escapes.

Norwegian regulations cover all of the requirements for the highest score except for the omission of basic management routines for minimizing escapes. Therefore Norway's actions are considered to fall just below the requirements for the highest score.

RESULTS FOR CRITERION NINE: 9

CRITERION 10: ADEQUACY OF MONITORING AND ENFORCEMENT OF AQUACULTURE SYSTEMS AND ESCAPE PREVENTION AND RESPONSE PLANS

Since 2000, the Norwegian government has carried out a "national program of action against escapes" and has increased its monitoring of the industry in regard to fish escapes. This has consisted of examining the contingency plans of license holders and their record-keeping on operational routines (Anfinsen, pers. comm.). However, the only enforcement actions available are the coercive fines provided under the 1998 regulation for violations of its provisions. That means that the failure to have a contingency plan can result in a fine, but not a failure to establish the management practices necessary to prevent escapes.

According to the government report to the Storting in 2001 (Norwegian Ministry of Environment, 2001), the action plan against escapes called for "internal checks" that were being translated into new regulations. These checks were to take the form of an audit of the fish farm's management system, based on the ISO 14001 standard of environmental management. Thus the government would audit whether certain generic management procedures are in place. This system has not yet been adopted for monitoring and enforcement of escape prevention and escape response plans (Anfinsen, pers. comm.).

The present regulation meets the requirement for monitoring of escape prevention and escape contingency plans but not for adequate enforcement.

RESULTS FOR CRITERION TEN: 5

SCOTLAND

TABLE 16 SCOTLAND'S OVERALL PROGRESS	
Criterion	
1. Minimum distance from salmon rivers	0
2. Exclusion zones	3
3. Cumulative impacts and siting decisions	5
4. Standards for fish husbandry practices	1
5. Standards for benthic ecosystem quality	10
6. Fish husbandry monitoring and enforcement	3
7. Benthic ecosystem monitoring/enforcement	5
8. Standards for equipment design/deployment	0
9. Standards for fish containment	2
10. Fish containment monitoring and enforcement	3
Average	**3.2**

CRITERION 1: REQUIREMENTS FOR ADEQUATE DISTANCE FROM SALMON RIVERS IN SITING APPROVAL DECISIONS

On the west coast of Scotland, where most salmon farms are concentrated, the fish farm sites are almost invariably located near the mouths of salmon rivers (Butler and Watt, 2002). In the locational guidelines adopted by the Scottish Executive in 1999, no restrictions were established on the distance of fish farms from salmon rivers (Scottish Executive 1999).

Both before and after these guidelines were issued, non-government and governmental organizations concerned with wild salmon conservation have urged that minimum distances from some or all salmon rivers be introduced for salmon farm sites. In 1995, the West Highland Sea Trout and Salmon Group recommended that no new sites be allowed within 5 kilometers of river mouths (Butler and Watt, 2002). In reviewing the 1999 guidelines at the request of the Scottish Executive, the Royal Society of Edinburgh noted that it was concerned over the siting of farms "at the mouths of important salmon rivers" (Royal Society of Edinburgh, 2002). And Scottish Natural Heritage (2002a) has recommended "precautionary separation distances from key salmonid sites and migration routes, to be implemented through the revision of locational guidelines." However, no regulation on the distance of salmon farms from salmon rivers has yet been adopted (Butler and Watt, 2002).

RESULTS FOR CRITERION ONE: 0

CRITERION 2: DEGREE OF RESTRICTIONS ON AQUACULTURE OPERATIONS IN CERTAIN SENSITIVE AREAS TO PROTECT WILD SALMON

In 1999, the Scottish Ministers declared that "there should be the presumption against further development of marine finfish farming developments on the east and north coasts (Scottish Executive, 1999)." The east coast encompasses Scotland's largest salmon rivers, such as Spey, Tay and Tweed, representing roughly 70 percent of the national salmon catch. However, new aquaculture development would have been very unlikely on either the eastern or northern coasts, even in the absence of this moratorium, because both those coasts lack the sheltered moorings for sea cages that are provided by the fjord-like lochs in the west. The only such sheltered spot for aquaculture development on the east coast, the Moray firth, already has one active salmon farm and two more that have already been approved. The northern coast has much rougher weather than the west coast, and those few sea lochs on the north coast that provide the necessary shelter also are already occupied by salmon farms (Butler and Watt, 2001; Butler, pers. comm.).

The 1999 locational guidelines also listed eleven areas where development of new marine fish farms or expansion of existing farms would be acceptable only in "exceptional circumstances". The location of wild salmon rivers was not a factor, however, in the selection of any of these areas. The annex explaining the choice of the latter category does not mention protection of wild salmon in a single case. In the view of the Research Officer of the Royal Society of Edinburgh, which reviewed these guidelines after three years, none of the eleven areas chosen for presumption against new or additional fish farm development would help protect salmon stocks (Rands, pers. comm.). As noted above, Scottish salmon farms are concentrated overwhelmingly on the west coast. None of the 38 salmon rivers in Wester Ross and Lochaber that have been seriously affected by salmon farms on the West Coast (Butler and Watt, 2002) were among the 11 areas in which new or increased development will be acceptable only in exceptional circumstances.

Significantly, Scotland's submissions to NASCO in both of the two years prior to this announcement in regard to "wild salmon protection areas" (NASCO, 1998; NASCO, 1999) dismissed the idea of taking measures to ban the further development of aquaculture from some areas to protect wild salmon. "The effectiveness of such measures has not yet been established and experimental work to establish a case would be very expensive," it argued in 1999. The same report added, "In Scotland the debate might be somewhat academic in that most of the future growth in the industry is anticipated by increasing the size of current units rather than by increasing the number of sites." This response avoided the issue of whether any existing aquaculture operations would be restricted in any way in order to protect wild salmon stocks.

The presumption against aquaculture development on the north and east coasts of Scotland and in 11 other areas, therefore, will not protect salmon rivers that are otherwise likely to be threatened by future aquaculture development, nor does it appear to be motivated by such an intention.

The same Scottish Executive declaration referred to 68 areas in which "further substantial developments are likely to be limited." The statement did not rule out increases in either the size of existing leases or the amount of production permitted on existing sites in those areas. Two of the rivers on the list of 68 are mentioned by the Scotland Natural Heritage as special conservation areas specifically because of their salmon stocks (Scottish Natural Heritage, 2002b). Four of the rivers in Wester Ross and Lochaber that are threatened by fish farm development were included among those on the list of areas in which fish farm development would be restricted (Butler and Watt, 2002).

For these reasons, the Scottish measures in 1999 are considered to meet the requirements for a minimal score for this criterion.

RESULTS FOR CRITERION TWO: 3

CRITERION 3: DEGREE TO WHICH CUMULATIVE ENVIRONMENTAL IMPACTS OF SALMON FARMING ON ENTIRE BAY OR OTHER ECOSYSTEM ARE CONSIDERED IN SITING DECISIONS

Scotland's locational guidelines for fish farming sites (Scottish Executive, 1999) emphasize the need to take into account the cumulative environmental impacts on the ecosystem as a whole in a particular loch. The same document also included an "indicative separation standard" of 8 kilometers between finfish farms, indicating a general policy of taking cumulative impacts into account.

Although it published a list of areas where carrying capacity was considered to be a factor in restricting or prohibiting future development of fish farms, the Scottish Executive determined that it was necessary to continually redefine areas where further development of finfish aquaculture should be restricted through regular administrative review (Scottish Executive, 1999).

The expected degree of nutrient enrichment, taking into account the existing and expected levels of fish farming operations in the ecosystem, has been the key consideration in this siting policy (Scottish Environmental Protection Agency, 2001). The Scottish Environmental Protection Agency (SEPA) has argued, moreover, that it does not have sufficient scientific understanding to calculate the environmental carrying capacity of any specific Scottish loch system and is therefore inclined to limit aquaculture development on the basis of the precautionary principle (Scottish Parliament, 2002b).

However, this policy of taking cumulative, ecosystem-wide environmental impacts into account has not been consistently applied across all fish farms in Scotland. As noted by the Royal Society of Edinburgh, this siting policy has not been applied at all to salmon farm cages in freshwater lochs, which are much more vulnerable to the risks of eutrophication and diseases associated with salmon cages than those situated in sea lochs (Royal Society of Edinburgh, 2002).

RESULTS FOR CRITERION THREE: 5

CRITERION 4: ADEQUACY OF REQUIREMENTS FOR FISH HUSBANDRY, INCLUDING BEST INDUSTRY PRACTICES, SUCH AS YEAR-CLASS SEPARATION, FALLOWING OF SITES AND MAXIMUM STOCKING DENSITIES

The Scottish Executive has not adopted any specific regulatory requirements for fish husbandry or fish health management. Its submissions to NASCO for 1998 and 1999 indicated that no regulatory measures had been taken to require best practices of its salmon farming industry. In both years, it reported that there were no "formal controls" in regard to fallowing, although the industry had been "strongly advised" to adopt a fallowing strategy, with fallowing periods that were "as long as possible." Similarly year class separation was "widespread" and "strongly encouraged", but not required, by the Scottish Office of Agriculture, Environment and Fisheries Department. It also stated that limiting stocking densities to levels based on good practice was left to the "voluntary controls through the industry codes of practice" and to pressures from consumers, rather than being regulated (NASCO, 1998; NASCO, 1999). In 2000, Scotland reported that year class separation was "becoming accepted practice" in the industry, and that a "new fallowing regime" had been established, but only for sites that were being controlled because of an outbreak of ISA (NASCO, 2000).

The Scottish Environmental Protection Agency (2000a) observed that its ability to promote best practices in fish husbandry was limited by the Scottish Office's strict interpretation of its legislative requirement of "steps necessary to minimize the polluting effects of the discharge" to exclude techniques that might reduce the threat of sea-lice infection and therefore treatment frequency.

The Joint Government/Industry Working Group on Infectious Salmon Anemia (ISA) called for

management agreements between operators to harmonize operational practices by individual fish farm operations, including fallowing, stocking densities, and year-class separation (Scottish Executive, 1999). The finfish aquaculture industry has resisted any move to introduce statutory regulation over these issues, however. The industry trade association has taken the position that, even if the Scottish Executive were to consider such regulation, it should delay its introduction for another five years, and the Parliamentary Transport and Environment Committee has expressed concern at the "prospect that the industry may not be subject to regulation until 2005 (Scottish Parliament, 2002a)."

In 2000, Scottish Quality Salmon, the industry organization for mainland Scotland, adopted a "Code of Practice to Avoid and Minimise the Impact of Infectious Salmon Anemia (ISA)" (Scottish Quality Salmon, 2000). Although the code deals with many issues surrounding the risk of this disease, and calls for salmon farmers to minimize stress on smolts, it does not specify best practices in fish husbandry such as limiting stocking densities and requiring minimum fallowing periods. Nor has the Scottish Executive made compliance with such fish husbandry practices a condition of maintaining a license for salmon farming, although financing for salmon farms to restart after closure resulting from ISA is conditional on implementation of such best practices (NASCO, 2001). Scottish Natural Heritage (2002a) notes the absence of codification of best practices in fish farm management and called for establishment of such a code to ensure their implementation.

The Shetland Salmon Farmer's Association adopted a Code of Best Practice in March 2000 that emphasizes a set of fish husbandry practices aimed at minimizing stress on the fish to reduce the risk of disease. These include site rotation, site fallowing for a minimum of six weeks, a maximum stocking density of 20 kilograms of fish per cubic meter of cage volume, single-year classes on each site, site rotation and no routine or prophylactic uses of therapeutants. This code was also adopted by the Shetland Islands Council as an integral part of its licensing of salmon farm operations, with non-compliance to result in revocation of the operator's license (Shetland Island Salmon Farmers' Association, 2000). The standard for fallowing periods appears particularly weak, in light of the fact that the SEPA has found that a fallowing period of at least 3 months is needed to break the sea lice life-cycle (Scottish Environmental Protection Agency, 2000).

Even if the Shetland Salmon Farmers Association's code of practice were considered to represent best industry practices in the country, however, it represents only 15 percent of Scottish salmon production. The Scottish mainland has no such regulatory requirements, nor any industry code of best practices for fish husbandry and fish health management. Therefore Scotland's requirements in regard to fish husbandry practices at present would qualify for only 15 percent of the top score or 1.5 points. Given its failure to reflect best industry practices in regard to fallowing, it merits somewhat less than that.

RESULTS FOR CRITERION FOUR: 1

CRITERION 5: ADEQUACY OF REGULATION OF DEPOSITION OF WASTES BENEATH FISH FARMS OR BENTHIC ECOSYSTEM QUALITY TO PROTECT FISH HEALTH

The Environmental Act of 1995 defines wastes from fish farms as "trade effluent" which requires a permit. Scottish Environmental Protection Agency (SEPA) has established a number of Environmental Quality Standards in the form of specific concentration limits for chemicals and sediment quality standards. SEPA allows an "allowable zone of effects (AZE)" – an area up to 25 meters from the fish cage in which these standards may be exceeded. However, limits on various parameters are set even within the AZE (Henderson and Davies, 2000).

This regulatory system is considered to meet the requirement for the top score for this criterion.

RESULTS FOR CRITERION FIVE: 10

CRITERION 6: ADEQUACY OF MONITORING AND ENFORCEMENT OF FISH HUSBANDRY PRACTICES

Neither the Scottish Executive nor local authorities on the Scottish mainland undertake regular on-site monitoring of fish husbandry practices. Instead, the Scottish Executive Environment and Rural Affairs Department (SEERAD) Fisheries Research Services sends a questionnaire to aquaculture operators each year with questions on some critical fish husbandry issues (fallowing, stocking densities), but not all of them (SEERAD, 2001). Furthermore, there are no regulations on which to report compliance, so the only data provided to the public are overall totals and averages per operator – not data on actual compliance. Nor does SEERAD undertake on-site spot audits to verify the accuracy of data it receives from operators.

The Shetland Islands Council (SIC) has adopted the SSFA Code of Practice as part of the basis for licensing decisions. However, it has not yet settled on a compliance monitoring system, which appears to be under negotiation with the industry (Sandison, pers. comm.). Once the license has been issued, moreover, the SIC lacks the power to enforce compliance. According to an SIC official, the SIC had tried on a very few occasions to refer cases against a fish farm operation that was in "flagrant breach" of one or another conditions of the license to the procurator fiscal, but the legal authorities have refused to be involved (Johnson, 2002b).

Scottish authorities do not monitor on-site, do require reporting by industry on fish husbandry practices, but do not enforce compliance, and do not issue reports on compliance. Thus, Scotland's measures meet the requirements for only the minimum score for this criterion.

RESULTS FOR CRITERION SIX: 3

CRITERION 7: ADEQUACY OF MONITORING AND ENFORCEMENT OF BENTHIC ECOSYSTEM QUALITY STANDARDS TO PROTECT FISH HEALTH

The Scottish Environmental Protection Agency (SEPA) has frequently recommended that it be given a mandate to undertake on-site inspections regarding the deposition of organic wastes by fish farm operations, which would require the expenditure of additional resources (British Columbia Environmental Assessment Office (BCEAO), 1997). However, SEPA does not monitor compliance with Environmental Quality Standards through regular on-site inspections. Instead it receives monthly paper or electronic records reporting by industry. Occasional on-site audits may be carried out, but at present, SEPA has no mandate to do so within any given period of time (Henderson and Davies, 2000; Berry and Davidson, 2001).

If Environmental Quality Standards conditions are found to be breached, SEPA has the authority to either prosecute or establish remedial action to reduce pollution impacts (G-3 Consulting, 2000). No data on compliance is reported to the public, however.

Scotland is presumed to audit industry on the state of benthic ecosystem quality and to enforce benthic ecosystem quality standards, and therefore meets the requirement for a medium score on this

criterion.

RESULTS FOR CRITERION SEVEN: 5

CRITERION 8: ADEQUACY OF REQUIREMENTS FOR DESIGN AND DEPLOYMENT STANDARDS FOR AQUACULTURE SYSTEMS TO OPTIMIZE CONTAINMENT OF FISH AND MINIMIZE ESCAPES

The Scottish salmon farming industry, with the apparent involvement of the Scottish Executive, adopted a Code of Practice for stock containment that addresses design and construction of aquaculture equipment. The treatment of cage systems refers to the need for the cage to be "capable of dealing with weather and other environmental conditions likely to be experienced on the site." The code covers cage and mooring design, net design, construction and testing, and maintenance of equipment (Scottish Quality Salmon and the Shetland Salmon Farmers Association, 1999).

The question remains whether the Scottish Executive regards the industry Code of Practice as having any regulatory status. If the Executive had indicated its intention to hold finfish farm operators accountable for conformity to the Code of Practice adopted by the industry, the Code could be assigned the highest score for this criterion. However, the Scottish submissions to NASCO in 1998 and 1999 made it clear that the Scottish Executive considered the technical requirements for the design and deployment of aquaculture units so as to optimize containment to be left to the aquaculture industry, suggesting that the standards remained voluntary (NASCO, 1998; NASCO, 1999). Therefore Scotland's measures do not meet the requirements for a minimum score for this criterion.

RESULTS FOR CRITERION EIGHT: 0

CRITERION 9: ADEQUACY OF REQUIREMENTS FOR ESCAPE PREVENTION AND RESPONSE PLANS AND MANAGEMENT SYSTEMS

In 1998 and 1999, Scotland reported (NASCO, 1998; NASCO, 1999) that it was requiring "site specific contingency plans to deal with fish farm escapes, in line with NASCO recommendations, which would be agreed with the fish farming industry and representatives of wild salmon interests." The Scottish Executive (1999) also referred to the development of a code of practice on containment that would be "supported by site specific contingency plans to effect recapture should escapes occur," and that the code would be "underpinned by a mandatory legislative requirement to notify escapes."

A Code of Practice for containment was adopted by the salmon farming industry in 1999 (Scottish Quality Salmon and the Shetland Salmon Farmers Association, 1999), which requires record keeping on all procedures that could affect escapes, and contingency plans for recapturing escaped fish. The document notes that there was still no official requirement for reporting of escapes from fish farming sites, but that SERAD had proposed legislation mandating notification of SERAD of such escapes. The introductory paragraph refers to the adoption by the members of the two industry associations of "principles and practices," including "official notification of any escape of their stock…." In May 2002, however, SEERAD issued a requirement that fish farmers notify Scottish Ministers of escapes (SEERAD, 2002; Johnson, 2002a).

Strangely, in its first report to NASCO after the Code of Practice was adopted by the Scottish Quality Salmon and SSFA, rather than claiming it as an important measure in implementing the Oslo

Resolution, Scotland simply asserted "Not applicable" in regard to item 2.4.3. The significance of this disclaimer appears to have been that the Scottish Executive was assuming no responsibility for escapes.

The Scottish Executive requires that escape prevention and contingency plans be included in the environmental statement accompanying all application for a new fish farming site. Furthermore, this requirement does not affect those who had already acquired sites before the requirement was established.

Based on the evidence that the Scottish Executive does not view the industry Code of Containment as having any regulatory status, and because its requirement for escape prevention and contingency plans does not apply to most of the salmon aquaculture license holders, these measures are not considered to meet the requirements for the second highest score. However, because there is a general requirement affecting a significant number of license holders, we consider it to merit a minimal score.

RESULTS FOR CRITERION NINE: 2

CRITERION 10: ADEQUACY OF MONITORING AND ENFORCEMENT OF AQUACULTURE SYSTEMS AND ESCAPE PREVENTION AND RESPONSE PLANS

There is no evidence of any government monitoring of procedures for preventing escapes or of contingency plans for escapes beyond receiving them as part of the environmental statement accompanying applications for aquaculture sites. Similarly, the Code of Practice for containment does not indicate that any system for monitoring and compliance of the code has been established or is to be established. Nor does it indicate that compliance will be monitored by or reported to the government (Scottish Quality Salmon and the Shetland Salmon Farmers Association, 1999).

Because escape prevention and response plans are reviewed at the time that new applications for licenses are received, but not otherwise, Scotland meets the requirements for a minimum score for this criterion.

RESULTS FOR CRITERION TEN: 3

Fig 8 – The Dennys River in easternmost Maine, USA, is an example of a wild Atlantic salmon stream near aquaculture sites. The salmon population of this river is one of eight that have been listed as endangered by U.S. federal authorities. Several instances of cage failure have resulted in large numbers of escaped aquaculture salmon entering the Dennys from Cobscook Bay.

UNITED STATES

TABLE 17 UNITED STATES' OVERALL PROGRESS	
Criterion	
1. Minimum distance from salmon rivers	0
2. Exclusion zones	0
3. Cumulative impacts and siting decisions	2
4. Standards for fish husbandry practices	0
5. Standards for benthic ecosystem quality	3
6. Fish husbandry monitoring and enforcement	0
7. Benthic ecosystem monitoring/enforcement	0
8. Standards for equipment design/deployment	0
9. Standards for fish containment	0
10. Fish containment monitoring and enforcement	0
Average	**0.5**

CRITERION 1: REQUIREMENTS FOR ADEQUATE DISTANCE FROM SALMON RIVERS IN SITING APPROVAL DECISIONS

Neither the federal government nor the State of Maine has adopted any requirement for minimum distance between salmon aquaculture sites and salmon rivers. Conservationists have called for at least 20 kilometers (12.5 miles) minimum distance from salmon rivers, but the Maine Aquaculture Association has opposed such a requirement on the ground that the industry would be put out of business if it had to move from its present location, which provides the best temperature and tide for aquaculture (Associated Press, 1998).

RESULTS FOR CRITERION ONE: 0

CRITERION 2: DEGREE OF RESTRICTIONS ON AQUACULTURE OPERATIONS IN CERTAIN SENSITIVE AREAS TO PROTECT WILD SALMON

For the same reason that the United States has adopted no minimum distances between salmon aquaculture sites and salmon rivers — the concentration of the industry in waters that are very close to Maine's salmon rivers — no move has been made toward the adoption of protecting any salmon rivers from aquaculture operations.

RESULTS FOR CRITERION TWO: 0

CRITERION 3: DEGREE TO WHICH CUMULATIVE ENVIRONMENTAL IMPACTS OF SALMON FARMING ON ENTIRE BAY OR OTHER ECOSYSTEM ARE CONSIDERED IN SITING DECISIONS

The U.S. 1998 report on measures taken on separation of aquaculture facilities "on the basis of a general assessment of local conditions" (NASCO, 1998) said applicants are "required to label location of federal projects, navigation channels and existing facilities within 2000 feet or parks within 1000 feet." Since this element of the NASCO questionnaire clearly related to the separation of aquaculture facilities from one another in light of cumulative impacts of multiple sites in the same ecosystem, this was clearly irrelevant to the issue. It indicated further that the United States had taken no measures to ensure that cumulative impacts are taken into account in siting decisions. The United States has reported no measures on this issue since then.

Under the Federal NEPA statute, the U.S. Corps of Engineers is required to approve the permit for any aquaculture operation and must carry out an assessment of the environmental impact of the operation on the ecosystem. However, the Corps has never actually carried out the requirement (Rosenberg, pers. comm.). There is a statutory requirement, therefore, that has not been translated into an effective regulation

In its 2002 aquaculture lease regulations, Maine established a minimum distance of 2,000 feet (.6 kilometers) between any two finfish lease sites, but two finfish farm operators could be granted an exception if both consent to be located even closer (State of Maine, 2002b). This minimum distance requirement is clearly too small and equivocal to reflect a concern for cumulative impacts of multiple leases in the same area.

The need to consider carrying capacity is especially acute in the case of Blue Hill Bay, in many areas of which data collected by University of Maine researchers in 1999 showed the dissolved oxygen levels were already low, even without finfish farming operations (Marine Environmental Research Institute, n.d.). Despite the absence of any explicit policy to take broader area carrying capacity into account, the Maine Department of Marine Resources has in practice turned down applications for salmon farm sites in Blue Hill Bay, in part because of the fear that it would further reduce dissolved oxygen levels (Williams, 2000). These decisions appear to reflect the extreme vulnerability of that ecosystem, however, rather than a more general pattern of decision-making in Maine aquaculture policy. In the Cobscook Bay, where 80 percent of Maine's aquaculture production is concentrated, no similar pattern of rejection on carrying capacity grounds has appeared.

Despite the ad hoc application of carrying capacity as a screen for siting decisions in Blue Hill Bay, no general policy or regulation requiring that cumulative impacts be taken into account has been adopted in the United States. However, a federal statute exists which should result in regulatory action. Therefore the United States meets a minimal score for this criterion.

RESULTS FOR CRITERION THREE: 2

CRITERION 4: ADEQUACY OF REQUIREMENTS FOR FISH HUSBANDRY, INCLUDING BEST INDUSTRY PRACTICE IN REGARD TO YEAR-CLASS SEPARATION, FALLOWING OF SITES AND MAXIMUM STOCKING DENSITIES

The State of Maine's regulatory system has a statutory basis for holding licensees accountable for minimum standards of fish husbandry in the provision requiring adherence to all conditions of the lease. The statute (State of Maine, 2002a) provides that aquaculture must not be "substantially injurious to marine organisms." The regulations on aquaculture leasing (State of Maine, 2002b) authorize the Commissioner to establish requirements for stocking limits and husbandry techniques, among other conditions on the lease. It also provides that the lease may be revoked if the lease-holder fails to comply with any lease condition or violates any law. Finally, the regulation provides that the Commissioner "shall conduct an annual review of each aquaculture lease."

According to the state's Aquaculture Coordinator (Fisk, 2002), the language of the aquaculture lease itself provides that the lease can be lost through noncompliance with any provision of the lease within 30 days after notice by the State. The Maine Department of Marine Resources (DMR) does review all leases annually for compliance, but according to the coordinator, it has not spelled out specific standards for fish husbandry and fish health management (Fisk, 2002).

In 1997, the Maine Atlantic Salmon Conservation Plan called for the Maine Aquaculture Association to adopt a Fish Health Code of Practices with the help of the University of Maine by the end of 1999 (Maine Atlantic Salmon Task Force, 1997). No such Code of Practices was adopted by the industry for the next four years, However, after the serious outbreak of ISA in 2001, which required salmon farms in Maine to empty their pens, the nine companies comprising the industry reached a "Finfish Bay Management Agreement" that constituted a Code of Practice for fish husbandry and fish health management. That agreement (Maine Aquaculture Association, 2002) identified among its goals:

- the implementation of a Bay Management Plan aimed at minimizing fish health risks,
- establishing single-year class sites and avoiding any reversion to multi-year sites, and
- achieving minimum fallowing periods between year classes.

This agreement was severely limited, however, by the caveat that achieving these objectives was a "long term target" and, in the meantime, operating practices would be "transition mechanisms." These transitional mechanisms included "year class carry over on a single year class site," provided that the carry-over fish cages had tested negative for ISA for two consecutive months prior to stocking of a new year class on the same site, and had been treated for sea lice during the month prior to stocking of the new year class. It was also limited by failing to specify any minimum fallowing time. Finally, the agreement did not address the issue of stocking densities. This de facto Code of Practice in the Finfish Bay Management Agreement thus still falls short of best industry practices in fish husbandry. A Bay Area Management Plan for Cobscook Bay has been under negotiation but has not been finalized (Costigan, pers. comm.).

The State of Maine appeared in 2002 to be ready to take one step beyond the industry agreement. It included conditions relating to fish husbandry in a new permitting system for salmon aquaculture operations that were at least slightly more rigorous than the Bay Management Agreement. A draft Pollutant Discharge Elimination System General Permit for Finfish Aquaculture (State of Maine, 2002), requires all facilities raising salmon to stock only a single year class of fish – without a transition period -- and to fallow the site for a sufficient (unspecified) period. Like the Bay Management Agreement, the proposed permitting system would not require limiting stocking densities. The proposed system must still be approved by the Maine Board of Environmental Protection before it can be adopted officially by the U.S. Environmental Protection Agency.

The new permitting system will provide some fish husbandry standards related to industry best practices, although its coverage would be incomplete, in terms of both geography and fish husbandry

issues. Until the new system takes effect, however, the United States will still lack regulatory standards for fish husbandry and fish health management practices and does not qualify for a minimum score for this criterion.

RESULTS FOR CRITERION FOUR: 0

CRITERION 5: ADEQUACY OF REGULATION OF DEPOSITION OF WASTES BENEATH FISH FARMS AND/OR BENTHIC ECOSYSTEM AND WATER QUALITY TO PROTECT FISH HEALTH

Until the late 1990s, Maine's aquaculture industry was exempt from the regulatory system for discharge of pollutants into marine waters. The EPA did not require finfish aquaculture units in Maine to obtain a discharge permit, and Maine's statute did not require such facilities to have a State Waste Discharge License (Maine DEP, 2002b). In 1998, a new subsection was added to state law on water quality requiring aquaculture operations to have discharge licenses (Maine DEP, 2002b).

However, the problem of discharge standards for aquaculture operations remained unresolved. Maine's law requires technology-based pollution control standards, which means best available technology economically achievable for non-conventional pollutants. EPA still has not established Federal Effluent Guidelines, or minimum technology-based requirements for controlling discharges of pollutants, for concentrated finfish aquaculture facilities. However, it has proposed a rule and is expected to produce such guidelines by 2004 (U.S. EPA, 2002; State of Maine, DEP, 2002b). Nevertheless, there are still no enforceable discharge or water quality standards for the aquaculture industry in Maine.

Under the Maine Water Quality Act, the Maine Department of Environment Protection must issue a water quality certification for salmon farms in Maine, and these have been routinely issued, despite the absence of enforceable standards (Kratka, pers. comm.).

The proposed permitting system that is now ready for final approval would require certain "Best Management Practices" (BMP) in regard to minimizing the introduction of wastes and other pollutants into marine waters. The key BMP would be the use of control methods to monitor and limit the amount of uneaten feed lost from net pens. A maximum conversion ratio of 1.3 kg of feed to 1 kilogram of fish harvested over the entire growing cycle is contemplated as the standard to be achieved (State of Maine, DEP, 2002b).

The United States has not yet produced nutrient discharge, water quality or benthic ecosystem quality standards. Therefore the United States does not yet meet the requirements for a minimum score for this criterion.

RESULTS FOR CRITERION FIVE: 0

CRITERION 6: ADEQUACY OF MONITORING AND ENFORCEMENT OF FISH HUSBANDRY PRACTICES

Using its own informal, uncodified standards for fish husbandry practices referred to under Criterion 4 above, the DMR has been unable to actually enforce any standards on the industry. The DMR has not monitored fish husbandry practices per se, but instead has suggested remedial adjustments in management strategies to lease-holders, based on monitoring data on dissolved oxygen levels and benthic ecosystem status at the site (Fisk, 2002). Thus the DMR has never made any formal determinations of compliance or non-compliance with the conditions of the lease (Fisk, 2002).

The State's Aquaculture Coordinator has explained that the present statute makes any non-compliance a felony, which imposes an administrative and judicial burden to prove guilt that has discouraged any effort to prosecute companies that have been found informally to be out of compliance (Fisk, 2002). The Coordinator proposed in early 2002 that the law be revised to allow the State to impose civil fines on companies (Fisk, 2002), but no changes in the law have been made thus far (Fisk, pers. comm.). The State of Maine has never revoked the finfish aquaculture license of a single operator over the history of the industry in that state for failing to comply with conditions attached to the license, despite the authority given it both in statute and in the aquaculture regulation (Fisk, pers. comm.).

Maine does not compile and publish any data on compliance with fish husbandry standards, eliminating another potential tool for accountability for the industry as a whole (Fisk, pers. comm.).

The result of this system of monitoring and enforcement has been that that fallowing, year-class separation and limited stocking densities to sustainable levels have very often not been practiced by the industry. The three major salmon aquaculture companies operating in Maine conceded in depositions taken in lawsuits against them by US Public Interest Research Group (USPIRG) that they had not implemented good fish husbandry practices in Maine as much as they had in Norway and Canada (Kratka, 2002).

The present monitoring and enforcement system appears to involve informal monitoring of specific husbandry practices through exchanges with those lease-holders whose sites have shown evidence of violating environmental standards in or around the fish farm sites, but it does not provide any real accountability, allowing no effective enforcement of standards and lacks any system of public reporting.

RESULTS FOR CRITERION SIX: 0

CRITERION 7: ADEQUACY OF MONITORING AND ENFORCEMENT OF REGULATION OF WASTE DEPOSITION OR BENTHIC ENVIRONMENTAL QUALITY TO PROTECT FISH HEALTH

Maine's Finfish Aquaculture Monitoring Program (FAMP) is geared to the requirements of Maine's Water Quality Standards. The Maine statute governing the program (State of Maine, 2002a) provides that data must be collected on benthic habitat effects and water column effects of aquaculture operations. The monitoring system includes an annual semi-quantitative diver survey, which documents visually the presence of bacterial mats and the relative abundance of macroflora and macrofauna; benthic monitoring at irregular intervals through collection of physical samples and the measuring of dissolved oxygen by taking water samples from three stations, all based on specified methods.

These standard monitoring techniques would be a sufficient basis for enforcement of environmental standards for aquaculture sites and surrounding areas if an enforcement system existed. According to testimony by the private contractor who has implemented it, the FAMP revealed serious deterioration of water quality and benthic ecosystems during the 1990s at sites belonging to three major aquaculture companies operating in Maine, including toxic mats of bacteria. However, no penalties were ever levied against any of those companies (Kratka, 2002). Only one lease has ever been revoked during the entire history of the aquaculture program and that was for lack of use of the lease (Fisk, 2002).

The United States has carried out on-site monitoring of water column and benthic environmental quality, but has neither reported on compliance nor adequately enforced compliance. Measures adopted by the United States are therefore considered to meet the requirements for the minimum score.

RESULTS FOR CRITERION SEVEN: 3

CRITERION 8: ADEQUACY OF REQUIREMENTS FOR DESIGN STANDARDS FOR AQUACULTURE SYSTEMS TO OPTIMIZE CONTAINMENT OF FISH AND MINIMIZE ESCAPES

The Maine Aquaculture Association adopted a Code of Practice for Responsible Containment of Farmed Atlantic Salmon in Maine Waters in 1998 which specified net strength, annual four-point net stress test, and equipment integrity (Maine Aquaculture Association, 1998). But the United States did not mention it in its reports to NASCO. In 1999, the industry association joined with Fish and Wildlife Service and the State of Maine to form a "Working Group on Aquaculture" that agreed on minimum containment standards for the industry. However there was an unresolved dispute within the group over whether it would result in a binding regulation or a voluntary agreement. The standards were never translated into a regulatory requirement, nor have they been published (Rosenberg, pers. comm.).

In May 2001, three major salmon aquaculture companies active in Maine, along with the Maine Aquaculture Association (MAA), reached agreement with the Atlantic Salmon Federation, Conservation Law Foundation and Trout Unlimited on a "Framework for a Salmon Aquaculture Containment Policy in the State of Maine." The agreement was the result of eight months of negotiations to develop a better system to prevent escapes across the entire industry. Since mid-2001, the parties to the original agreement have met, along with state and federal officials, to develop a generic "Containment Management System" that would then be the basis for site-specific CMS plans by each company (Goode, pers. comm.). The generic CMS includes technical standards for aquaculture equipment and its deployment (Ostergaard, 2002). The State of Maine and the federal government both agreed that the implementation of the CSM standards and procedures would be a requirement for obtaining and maintaining a Maine Pollutant Discharge Elimination System Permit (Goode, pers. comm.)

The State of Maine drafted a Pollutant Discharge Elimination System Permit that includes these technical requirements for equipment design and deployment among its conditions (State of Maine Department of Environment, 2002b). The new permitting system, which is expected to be adopted in 2003, would qualify for the highest score for Criterion 8. However, pending that adoption, the United States does not have measures in place that meet the requirements of a minimum score.

RESULTS FOR CRITERION EIGHT: 0

CRITERION 9: ADEQUACY OF REQUIREMENTS FOR ESCAPE PREVENTION AND RESPONSE PLANS AND MANAGEMENT SYSTEMS

The United States has reported no measures to require site-specific contingency plans or precautionary management measures to minimize escapes to NASCO. It reported in 1998 that an unidentified working group would "look at" the issue (NASCO, 1998), but in the next three years, it did not report the adoption of any new measures.

The October 1998 Maine Aquaculture Association Code of Practice for the Responsible Containment of Farmed Atlantic Salmon in Marine Waters provided detailed standards for some escape-related issues, including operating procedures for fish transfers, predator control and storm preparation. Similarly the Working Group on Aquaculture formed in 1999 by the State of Maine, the Fish and Wildlife Service, National Marine Fisheries Service and the Maine Aquaculture Association agreed on the need for such plans, but the resulting document remained a voluntary agreement and was not published (Rosenberg, pers. comm.). Because it was a voluntary measure, it was not reported to NASCO by the United States.

The agreement reached in May 2001 between the salmon farming industry in Maine and the

three salmon conservation organizations led to the development of a generic "Containment Management System" (CSM) that called for inventory control procedures, predator control procedures, escape response procedures, unusual event management and severe weather procedures, written containment management system documents, maintenance records on the all operating systems, and escape response procedures. The CMS also included mandatory reporting within 24 hours of all escapes over 50 fish. This CSM provided the template for site-specific CMS escape prevention systems and escape contingency plans by each company for each site. The State of Maine made the standards for escape prevention and recapture in the CSM conditions for the Maine Pollutant Discharge Elimination System Permit under the proposed draft prepared during 2002 (State of Maine Department of Environment, 2002a)

It is expected that the new standards for escape prevention and response plans to come into force in 2003 will bring U.S. requirements up to the top score for this criterion. As of the time of this publication, however, the United States is considered to have no measure in force that meets the requirements for a minimum score.

SCORE FOR CRITERION NINE: 0

CRITERION 10: ADEQUACY OF MONITORING AND ENFORCEMENT OF AQUACULTURE SYSTEMS AND ESCAPE PREVENTION AND RESPONSE PLANS

Neither the United States federal government nor the State of Maine have monitored or enforced escape prevention plans or containment management systems of salmon aquaculture operations. When the Maine Aquaculture Association adopted its Code of Practice for the Responsible Containment of Farmed Atlantic Salmon in Marine Waters in 1998, the means by which the Code was to be monitored and enforced remained unresolved (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1999).

The proposed new permitting scheme (State of Maine, DEP, 2002a) would have its own system of verifying the existence of these systems, based on audits once a year and within 30 days of any reportable escape by a third party approved by the Maine DEP. The system contemplates the auditor providing a written report within 30 days of the audit, which would include any actions needed to correct deficiencies found. The aquaculture operation is responsible for notifying the DEP of the completion of any corrective actions required. According to Maine's aquaculture coordinator (Fisk, pers. comm.), the system of auditing was tested on sites operated by each company in 2002. Full-scale audits are expected to begin sometime in the spring or summer of 2003.

Again, the proposed system would bring the score for U.S. measures for this criterion up to the highest level. Because this scoring is based on regulations and monitoring and enforcement systems that are actually in force, however, the United States does not at present meet the requirements for a minimum score for this criterion.

RESULTS FOR CRITERION TEN: 0

V. Analysis of the Results:

Little Progress toward Achieving Oslo Vision

The foregoing analysis demonstrates that the NASCO member nations with salmon aquaculture industries have yet to fulfill the basic obligations set forth in the ten criteria derived from the Oslo Resolution. Table 18 compares all seven NASCO members on criteria derived from the Oslo Resolution. While some countries fared better than others, it is clear that all countries need to do much more to meet the obligations of the Oslo Resolution to protect wild Atlantic salmon from impacts of aquaculture.

The average for all seven countries was just above 2 out of 10. Five of the countries were clustered between 2.2 and 3.4, while the average U.S. score was close to zero. The Faroe Islands had no points at all, although it was not scored on four of the criteria, either because they were not applicable, or because no information was available. However, even if the Faroe Islands is eliminated from the overall results, the average results of the six remaining countries is only 2.25. Most of the results for individual criteria – 36 out of the total of 66 – were zeros, indicating that the specified country had done nothing to meet even the most minimal requirements for that criterion.

For most criteria, one or two countries had mid-level results. The exception to this pattern appeared in the criterion of benthic ecosystem quality standards (#5), on which Canada, Ireland and Scotland all received the highest results. The worst collective results pointed to the minimum distance from salmon rivers (#1), the monitoring and enforcement of fish husbandry issues (#6) and the standards for the design and deployment of equipment (#8).

In a few cases, governments are proposing constructive changes in their management of aquaculture that will significantly change scores for one or more criteria in the future. In particular, the United States is creating new requirements and new monitoring and enforcement systems expected to come into force this year that should affect its progress on several criteria. Further changes are emerging in New Brunswick and other Atlantic Canadian provinces, both in Codes of Containment and regulatory reforms. These long overdue changes should help breathe new life into the Oslo Resolution. But the NASCO member countries with salmon aquaculture industries have been slow to start the process of coming into compliance with their international obligations. All seven nations have been slow to fulfill their promise to regulate salmon farming industries toward protecting the remaining North Atlantic populations of the fragile, wild species. In addition, WWF and ASF have made a series of recommendations for improvements to the Oslo Resolution that should be considered by NASCO signatories.

Table 18

Cross-Country Comparisions of Results by Criteria

	Canada	Faroe Islands	Iceland	Ireland	Norway	Scotland	United States	Average
ONE	0	*NA*	3.3	0	4	0	0	1.2
TWO	0	*NA*	5	0	10	3	0	3
THREE	5	0	0	0	0	5	2	1.71
FOUR	6	0	0	0	3	1	0	1.43
FIVE	10	*II**	0	10	0	10	0	5
SIX	2	0	0	0	3	3	0	1.29
SEVEN	3	*II**	0	5	0	5	3	2.66
EIGHT	1	0	0	0	0	0	0	.14
NINE	1	0	7	10	9	2	0	4.14
TEN	.5	0	7	3	5	3	0	2.64
Average	2.85	0	2.23	2.8	3.4	3.2	.50	

*Insufficient Information

Criteria

1. Minimum distance from salmon rivers
2. Exclusion zones
3. Cumulative impacts and siting decisions
4. Standards for fish husbandry practices
5. Standards for benthic ecosystem quality
6. Fish husbandry monitoring and enforcement
7. Benthic ecosystem monitoring/enforcement
8. Standards for equipment design/deployment
9. Standards for fish containment
10. Fish containment monitoring and enforcement

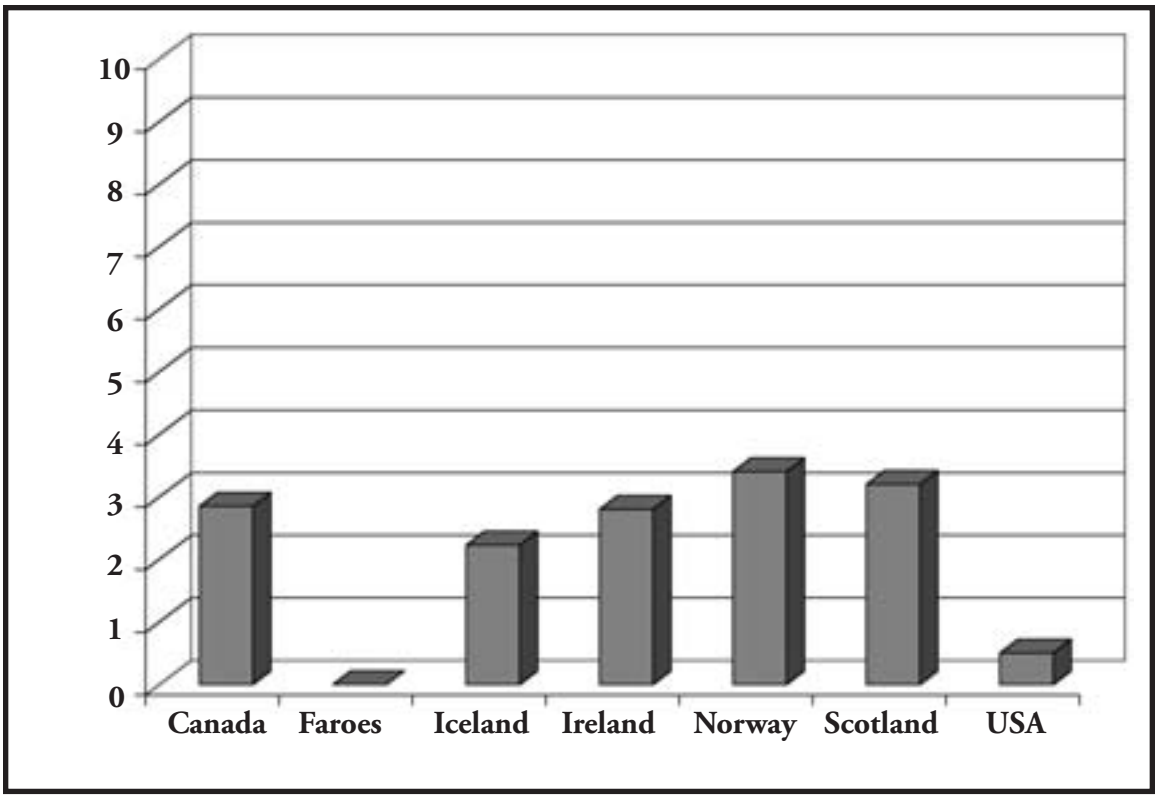


Fig 9 – A country-by-country comparison of results that includes all the criteria measured for progress on the Oslo Resolutions.

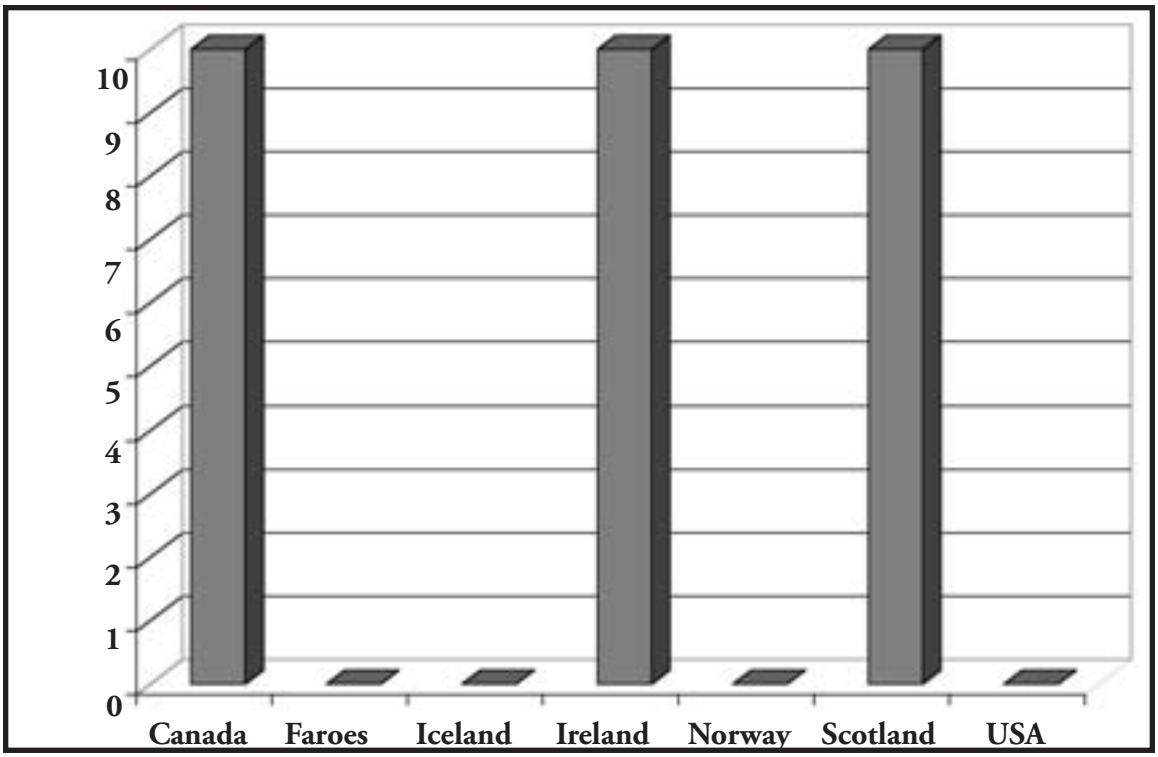


Fig 10 – Criterion 5, standards for benthic quality, has been addressed in a comprehensive way by three nations, resulting in the greatest overall progress among the criteria measured.

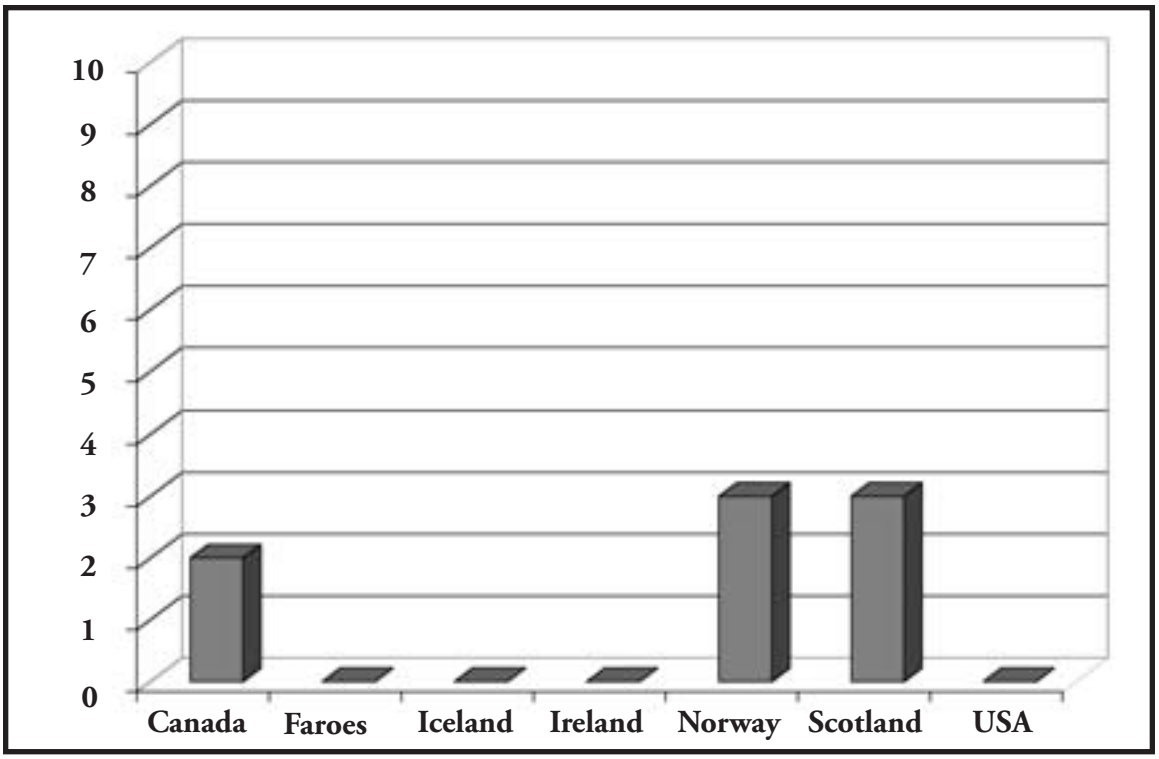


Fig 11 – Criterion 6, fish husbandry monitoring and enforcement, has seen little improvement.

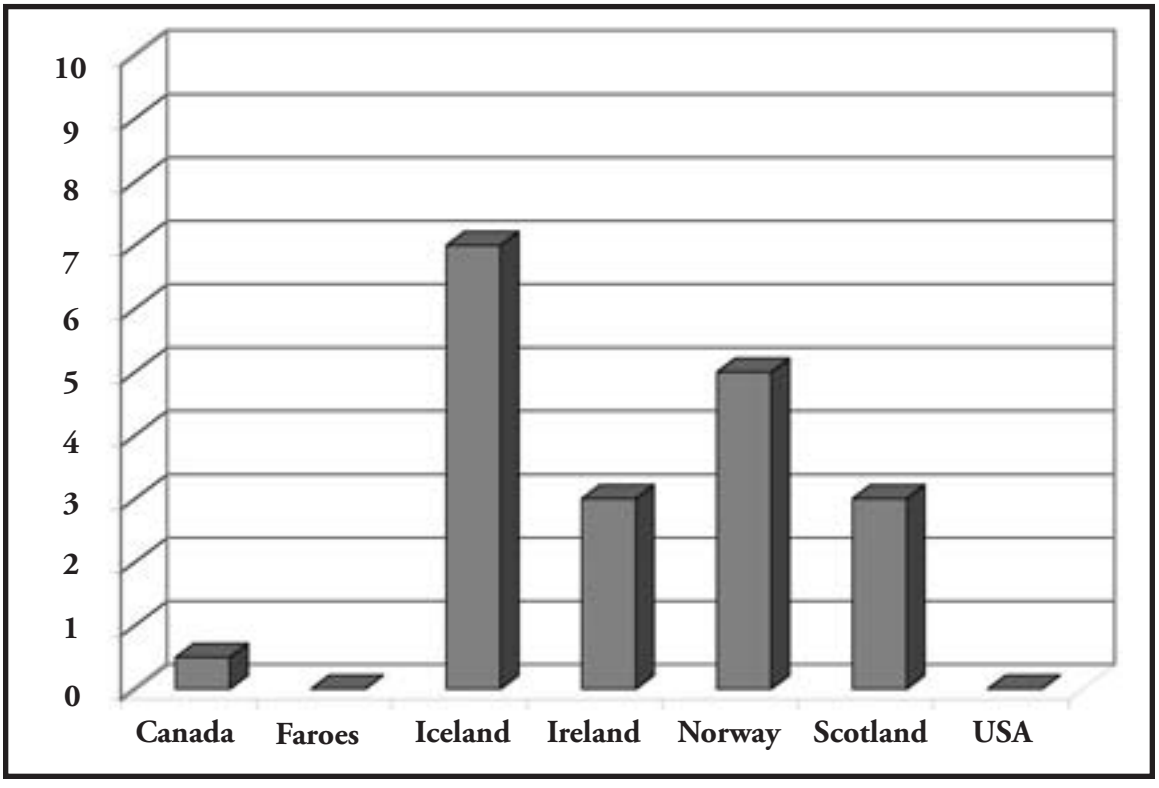


Fig 12 – A comparison of progress on Criterion 10 – the monitoring and enforcement of farmed fish containment and plans to deal with escapes

Annex 1: Why These Criteria and Indicators?

Criterion 1: Adequacy of requirements for distance from salmon rivers in siting decisions

Part 1, paragraph 1 of the *Annex to the Oslo Resolution* notes that sites for salmon aquaculture "shall only be assigned where …biological and ecological standards are met." The paragraph specifically says that "separation distances…from salmon rivers" should be taken into account. The Scientific Working Group on Salmonid Introductions and Transfers wrote a draft report in 1994 recommending that salmon pens be kept a minimum of 20 miles from the mouths of any Class 1 river, defined as "pristine".

However, the Working Group on Impacts of Salmon Aquaculture's 1994 report notes in paragraph 5.21 that "all rivers should be considered to be important, irrespective of their size, and efforts should be made to ensure their protection." It noted, moreover, that "rivers with small stocks may be more vulnerable to the impacts of aquaculture."

This system of criteria and indicators has taken the standard of a minimum distance of 20 miles from a salmon river as the highest standard for the purpose of comparing regulatory measures in support of the Resolution.

Criterion 2: Provisions in siting regulations for "exclusion zones" or restrictions on aquaculture operations in certain sensitive areas to protect wild salmon

Part 4, paragraph 16 of the *Annex to the Oslo Resolution* provides, "Research, small-scale testing and full-scale implementation should be carried out, as appropriate, in support of this Resolution" and refers specifically to "Wild salmon protection areas". It defines such areas as areas where salmon aquaculture is "restricted or prohibited." The purpose of such areas, as noted in the first subparagraph is to "minimize genetic, disease, parasite and environmental impacts."

The Working Group on Impacts of Salmon Aquaculture, which was responsible for the development of the Oslo Resolution text, also pointed out in its 1994 report that there was "support for the concept of such areas although the need for careful consideration of the size of the areas was recognized." The document indicated that experience had shown the incidence of escaped salmon in rivers under such protection was reduced.

NASCO member countries have been asked to report on measures in support of this provision of the agreement under point 4.1.1.

Criterion 3: Degree to which cumulative environmental impacts of salmon farming on an entire bay or other ecosystem are considered in siting decisions

Part 3, paragraph 11, of the *Annex to the Oslo Resolution*, under the heading of "Adequate separation", provides that the "separation distance between aquaculture facilities at marine sites should be based on a general assessment of local conditions." Although this wording is not as clear as it should be about need for adequate separation, it is clear that the reason such separation is needed is the risk of cumulative impacts of more than one aquaculture operation in the same ecosystem.

Studies in New Brunswick, Canada, of potential aquaculture impacts on habitats and the envi-

ronment showed that, even though impacts on a site-by-site basis are generally minimal, there are area-wide impacts when a relatively large number of sites are clustered (New Brunswick Department of Fisheries and Aquaculture, 1997). These impacts on water quality and habitats can affect both the health of farmed salmon and of wild salmon traveling through or spawning in the ecosystem.

CRITERION 4: ADEQUACY OF REQUIREMENTS FOR PLANS TO IMPROVE FISH HUSBANDRY

Paragraphs 8, 9, 12 and 13 of Part 3 of the *Annex to the Oslo Resolution* all relate to the importance of adequate fish husbandry practices to the objective of minimizing disease and parasite interactions. These paragraphs single out stocking densities "based on good husbandry practices", year class separation and fallowing of sites as particularly fish important husbandry requirements.

The significance of these husbandry practices to fish health is well documented in the scientific literature. Although farmed fish may be better adapted to higher year-round densities than wild fish, the stress of high densities causes fish to produce hormones that have been shown to suppress the animal's immune system (Barton and Iwama, 1991). That potential impact in turn raises the risk of rapid disease transmission (Paone, 2000).

Identifying a minimum standard or even the best industry standard for stocking density is complicated by physical variables that can make a site more or less prone to fish disease. Farmed fish at sites with rapid flushing rates because of strong tides and large, open sea areas can tolerate higher density rates than those in narrower ecosystems and slow flushing rates. However, the 9 kg per cubic meter actual average stocking density in Scotland can be taken as the maximum that should be allowed at sites with relatively low current speed and longer flushing times. Those sites with higher current speed and shorter flushing times could have a stocking density that is twice that.

Annual fallowing of sites and separation of fish generations have been generally recognized as central to any strategy for lice control (Jackson and O'Carroll, 1999). Adequate fallowing periods are known to be necessary for ensuring that disease pathogens have been dispersed from an aquaculture site. When fallowing is used, it is frequently only two months in duration, which European studies have shown to be too short for vibriosis and furunculosis pathogens to disperse (Husevag and Lunestad, 1991; Husevag and Lunestad, 1995). Research on Infectious Salmon Anemia (ISA) in Atlantic Canada showed that multiple year class sites are 5.9 times more likely than single year class sites to have Infectious Salmon Anemia in 50 percent or more of their cages (Hammell and Dohoo, 1999).

CRITERION 5: ADEQUACY OF STANDARDS FOR BENTHIC ECOSYSTEM QUALITY

In addition to creating higher levels of stress on fish, stocking densities that exceed the carrying capacity of the site cause the accumulation of fish sewage under the cages that contains disease pathogens, mainly fish feces and uneaten food. Excessive accumulation not only degrades benthic ecosystem quality but is a factor that increases the risk of disease outbreak (Needham, 1995). Establishing standards for benthic ecosystem quality, therefore, is also a way of protecting against the accumulation of pathogens that threaten fish health.

In light of the absence of other reliable indicators that stocking densities are at sustainable levels, therefore, we consider the regulation of benthic ecosystem quality as an essential measure in support of the objective of minimizing disease and parasite interactions and in particular of ensuring that stocking densities do not exceed levels based on good husbandry practices.

CRITERION 6: ADEQUACY OF MONITORING AND ENFORCEMENT OF FISH HUSBANDRY PRACTICES

CRITERION 7: ADEQUACY OF MONITORING AND ENFORCEMENT OF STANDARDS OF BENTHIC ENVIRONMENTAL QUALITY

CRITERION 10: ADEQUACY OF MONITORING AND ENFORCEMENT OF AQUACULTURE SYSTEMS AND ESCAPE PREVENTION AND RESPONSE PLANS

The Oslo Resolution does not address the need for monitoring and enforcement of measures to implement the resolution. As in the case of any international environmental agreement, it is taken for granted that meaningful implementation of commitments requires that the signatories will monitor and enforce the necessary measures. In evaluating the relative extent and effectiveness of implementation, however, this system of criteria and indicators focuses on whether certain management practices called for by the Oslo Resolution are being monitored and enforced. These three criteria are all related to what states or sub-state actors have done to ensure that aquaculture operations are conforming to regulatory requirements. Obviously, if no regulatory requirements have been established, the state in question receives a grade of 0 on the monitoring and enforcement of the relevant standard.

CRITERION 8: ADEQUACY OF REQUIREMENTS FOR DESIGN AND DEPLOYMENT STANDARDS FOR AQUACULTURE SYSTEMS TO OPTIMIZE CONTAINMENT OF FISH AND MINIMIZE ESCAPES.

Paragraph 4, under Part 2 of the Annex to the Oslo Resolution on "Measures to Minimise Genetic and Other Biological Interactions", provides, "Standards and technical specifications should be established for the design and deployment of marine and freshwater aquaculture units."

A working group formed by NASCO and the North Atlantic Salmon Farming Industry spelled out the chief elements of such standards or technical specifications in the guidelines on containment of farmed salmon" published at the 2001 NASCO meeting. These included, inter alia, adequate records of nets and cages in use, nets compatible with cadres with which they are used and UV-protected, appropriately-designed tank system, and effective predator deterrence methods (Liaison Group, 2001). This criterion thus measures how closely existing regulations conform to the agreed guidelines for design and deployment standards for aquaculture systems.

CRITERION 9: ADEQUACY OF REQUIREMENTS FOR ESCAPE PREVENTION AND RESPONSE PLANS AND MANAGEMENT SYSTEMS

Part 1, paragraph 2 provides that aquaculture units "should be managed…taking precautions to prevent the escape of fish." Part 12, paragraph 4 requires "regular monitoring and the use of efficient security systems." The guidelines adopted by the NASCO-Aquaculture industry Liaison Group expands on these very rudimentary points, calling, inter alia, for the adoption of routine procedures during stocking, counting, grading, transport, transfers and net changes and cleaning, to ensure prevention of escapes, and for the details of management systems to be recorded and retained for audit. It calls for storm preparation procedures, and for site-specific contingency plans for efforts at recapture of escaped fish, and for record-keeping that will make it possible to estimate the number of escapes.

These guidelines for escape prevention and response plans and management systems have been translated into reporting requirements regarding "Efforts to recapture escaped farmed salmon" (2.4.2), and "Establishment of site specific contingency plan in the event of large escapes" (2.4.3). These same guidelines provide the standards against which measures adopted by NASCO member governments are evaluated in regard to this criterion.

Fig. 13 – Aquaculture operation in the Faroe Islands. While the Faroes have no wild Atlantic salmon rivers nearby, the islands are close to a major ocean feeding ground. Several large escapes of farmed salmon from Faroes sites have taken place. The interactions of these farm escapees with wild Atlantic salmon remains unknown, but a cause for concern.

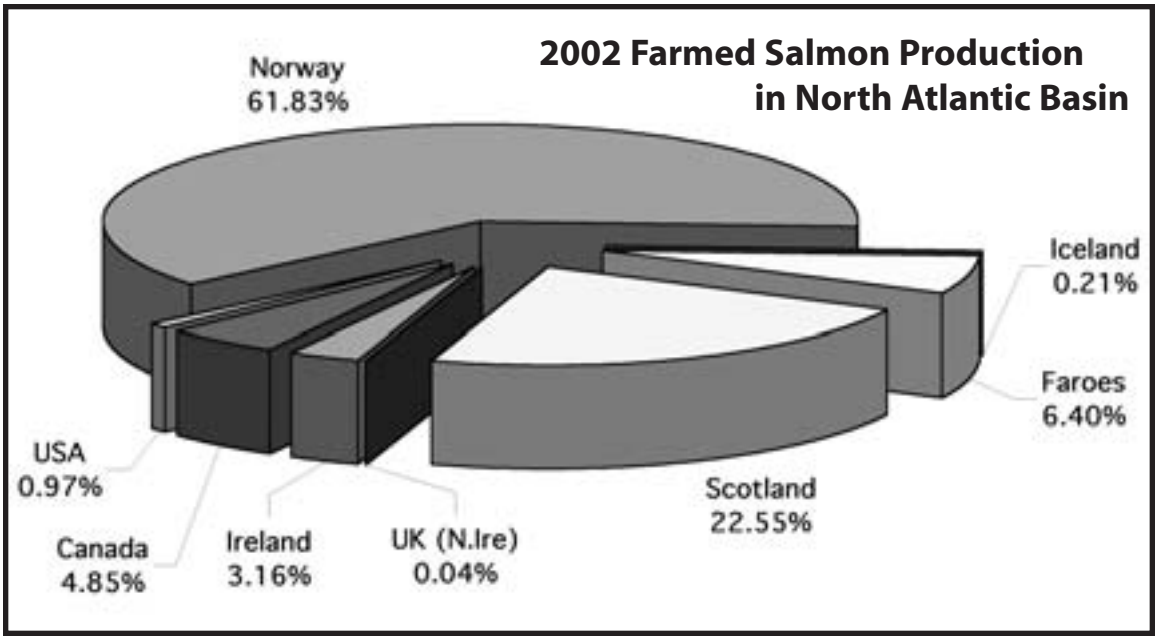


Fig. 14 – 2002 production of farmed Atlantic salmon in the North Atlantic Basin reached an all-time high of 705,307 tonnes, according to ICES figures. Largest producers were Norway, Scotland, Faroes and Canada, in that order.

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