# Aquaculture Physical Remediation

## WORKSHOP PROCEEDINGS

September 20-21, 2001

June 2003

Gulf of Maine
Council on the
Marine Environment

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Jay Clement[1] and Marianne Janowicz[2]

[1]United States Army Corps of Engineers,
[2]New Brunswick Department of Environment and Local Government

Gulf of Maine Council Mission

*The Gulf of Maine Council on the Marine Environment was established to maintain and enhance environmental quality in the Gulf of Maine to allow for sustainable resource use by existing and future generations.*

Gulf of Maine Council on the Marine Environment

New Nouveau Brunswick

Environment Canada Environnement Canada

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Marianne Janowicz
Dept. of Environment & Local Gov't.
P. O. Box 6000
Fredericton, N.B. E3B 5H1
Telephone: (506) 457-4846
Fax: (506) 457-7823
E-Mail: marianne.janowicz@gnb.ca

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# Preface

The idea for this workshop came out of an expression by New Brunswick salmon farmers of an interest in researching ways to physically manipulate sediments under cage sites to stimulate improved conditions. This idea received mixed response from regulators as well as the public, in part due to doubt as to its effectiveness and in part due to the feeling that benthic degradation should be handled in other ways.

The Gulf of Maine Council has identified site remediation as a priority topic. In particular, they are interested in research needs, the status of remediation around the world, the state of the art and whether there is a consensus on the need for remediation. The Council anticipated that this workshop would be an opportunity to provide some guidance to regulators regarding the appropriateness of physical remediation. The conclusion, as you will see in the Recommendations that came out of the workshop, did not close the door on physical remediation, but suggested that it be a tactic of last resort. The overwhelming position from both the aquaculture industry representatives present and the other participants is that the ideal situation is to site aquaculture operations in locations where continued activity will have minimal impact on the benthic environment.

The Committee hopes that the information provided in this workshop report will be of use of industry, regulators, and the public as they review aquaculture industry activities and identify research priorities in the years to come.

Marianne Janowicz and Jay Clement
Co-Chairs of the GOM Aquaculture Committee

# Acknowledgements

A number of individuals and agencies made contributions either in time or funds to make this workshop happen. We wish to give them special thanks for their contribution. Special thanks to John Henningson for making the journey and the important contribution to the program so soon after the very personal experience of September 11. Thank you to Roy Parker for all the work he put into this workshop before, during, and after. Thanks to the organizing committee for providing advice and logistical support. It included Barry Hargrave, (DFO), John Sowles (Maine DMR), and Roy Parker (Environment Canada). A number of other workshop participants provided valuable scribe services during the event to ensure the report reflects questions and discussion. Thank you to Environment Canada and NB DELG for its contribution to the budget. Ethan Nedeau provided copy editing and layout services for the report. The photograph on the front cover was provided by Canada Department of Fisheries and Oceans in St. Andrews. And lastly, thanks to the Gulf of Maine Council for the special grant to make this workshop happen.

# Executive Summary

Clement, J. and M. Janowicz (Editors). 2003. Aquaculture Physical Remediation: Workshop Proceedings. Gulf of Maine Council on the Marine Environment, www.gulfofmaine.org

This report is a compilation of presentations and discussions that occurred at the Workshop on September 20 and 21, 2001. The intent of the workshop was to determine whether managers, aquaculture representatives, scientists and coastal stakeholders were prepared to use manipulation of the benthic environment under cage sites as a finfish aquaculture remediation technique.

The report also identifies the conclusions that were drawn by the participants from the information provided. Generally, these conclusions identify:

- Front-end planning as the key to preventing environmental degradation,
- Physical remediation as impractical on a large scale at this time,
- The approaches to aquaculture development, siting and management should constantly evolve as new information is available,
- Greater transparency is needed in all aspects of aquaculture development and management so that the public is better informed about the industry.

# Introduction

## Introductory Remarks

Byron James, Deputy Minister, New Brunswick Department of the Environment and Local Government

Good morning. On behalf of the Gulf of Maine Council on the Marine Environment, I welcome you to this workshop on Aquaculture Physical Remediation. I very specifically wish to welcome the representatives of the Maine aquaculture industry here, the US regulators, the US consultants who have done considerable work in the marine environment, the US NGO's and the US scientists who are present. I know that after the events of the past week, it is not easy being away from home. I thank you for being here.

The Gulf of Maine Council has taken an interest in the concept of this workshop developed by the GOM Aquaculture Committee because it is targeting a potential tool for enhancing the opportunities for sustainable aquaculture development in the Gulf of Maine.

The idea of physical remediation—moving or removing waste material from beneath aquaculture sites—is a controversial tool because the public on both sides of the border holds on to their rights to the marine environment as common property. In the case of aquaculture, the public assumes that no one should undertake activities to the point where clean up is necessary. In the case of fisheries resources, no one should exploit the resources of the ocean so those resources are depleted. Yet from a practical point of view, we do not fully understand the capacity of areas to sustain activities. Sometimes our best guesses are not enough. This goes for oil spill prevention as it does for aquaculture. Therefore, the use of physical remediation requires the thought and discussion that will be taking place here today and tomorrow.

I would also like to provide you with a little background on why the staff of my department and I are interested in the outcomes of this workshop. The simple answer is that we have a new regulatory responsibility toward aquaculture. We also recognize that there is a need for dialogue among all of those who have an interest in marine activities

This workshop includes many coastal stakeholders. It provides an opportunity for dialogue to occur, this time on aquaculture physical remediation. Another important component of this workshop is that the participants and where they come from reflect the fact that the waters of southwest New Brunswick are part of the larger picture—the Gulf of Maine. It is important that we review policy and implementation methods in relation to the entire marine ecosystem within which we are operating.

Approximately two years ago, the government of the Premier of New Brunswick, Bernard Lord, initiated a review of government activities and services. The review determined that my department should have a larger involvement in activities undertaken in the marine environment. These additional activities include developing a Coastal Lands Management Policy to include both the coastal features and the marine areas of the Province. It also includes aquaculture as it relates to the marine environment. This is consistent with the Clean Environment Act and the Clean Water Act of New Brunswick.

Over the past year, my department has been initiating a response to the requirement that we take on regulatory duties related to aquaculture. We will be issuing approvals to construct and operate aquaculture sites. We will be receiving the annual environmental management reports from each aquaculture site and acting upon them if the results warrant. Our activities related to aquaculture are new to us and we are taking a measured approach to becoming fully operational. Our intention is "to guide the long-term environmental

sustainability of the marine finfish cage aquaculture industry in New Brunswick in the context of a healthy marine environment."

From our perspective, this workshop is very timely. Clear environmental quality objectives, as utilized in the monitoring program that will be required under our Approvals to Operate, identify when the sea floor conditions jeopardize the long-term environmental well being of a site. Response is then necessary from the farmer and the regulators.

Within the next year, we will be reviewing remediation options that site owners suggest when their sites require response. The Remediation Guide that has been developed for the Marine Finfish Cage Aquaculture Industry in New Brunswick identifies physical remediation as one of the possible remediation actions.

The information provided at this workshop will assist my staff and the other federal and provincial agencies in evaluating remediation options. The workshop will provide the opportunity for an open and informed discussion on the environmental implications of physical remediation, the regulatory framework that it fits within, and policy implications.

Most importantly, the workshop will provide the opportunity for aquaculture industry representatives, regulators, NGO's, scientists, and managers, to better understand a framework for physical remediation and better understand each other's position on the question. Fully understanding the reasons why others support or question actions are the best way to make progress.

I challenge you here today to be open-minded and creative in assessing the information that is provided. I challenge you to come up with recommendations that will help the aquaculture industry, and all the other interested parties to make the right decisions about physical remediation.

Thank you and best wishes in your deliberations.

# Workshop Objectives

## Jay Clement

United States Army Corps of Engineers

- Remediation is supported by the public and is of interest to both the industry and to regulatory and resource agencies
- Aquaculture sites (finfish and shellfish) will be vacated for a number of reasons, such as: economically not viable (abandoned by operator), forced abandonment by regulators (due to monitoring, unforeseen navigation impacts, disease, or limited permit life), court action by third parties, and rotational process (fallowing)
- Regulators and the public need to know about short-term, long-term and cumulative impacts to make decisions. Will there be a permanent effect on the aquatic environment? Industry needs to know what kinds of logistical or economical hurdles they will face if forced to abandon and remediate.
- The GOM Council has identified site remediation as a priority topic. In particular, they are interested in research needs, the status of remediation around the world (success and failure), the state of the art, and whether there is consensus on the need for remediation.
- The workshop should identify remediation protocols for aquaculture sites within the jurisdictions of the Gulf of Maine; if that is not practical, it should identify information gaps and research needs.
- Ultimately, the recommendations from the workshop will be provided to the GOM Council.

## Nell Halse

New Brunswick Salmon Growers Association

- Gave an overview of the industry in New Brunswick
- The industry has a code of practice to “develop sustainable aquaculture”
- Bay Management Agreements are pending between farms that will be based on single year classes. They also have a fish health surveillance program in place.
- The ISA Management Strategy calls for testing, biosecurity, waste management, coordinated treatments, and coordinated best management practices (BMPs).
- They have suggestions for remediation actions and BMPs to be taken in lieu of physical remediation. Physical remediation should be the last resort.

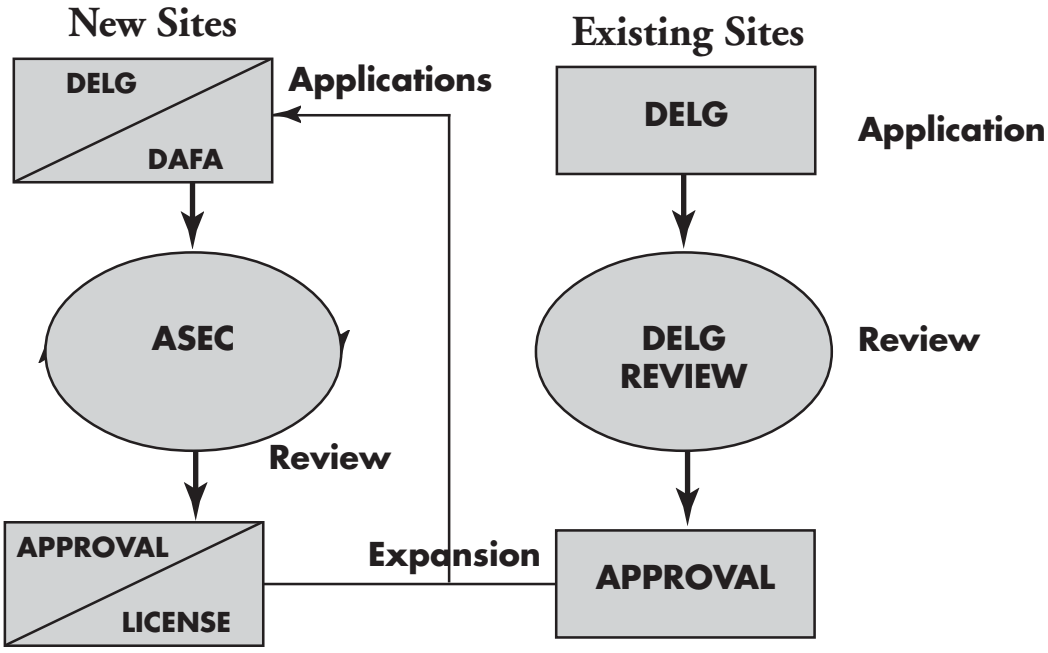
# Regulatory Perspective

## Setting the State: Regulatory Perspective

Darrell Welles, New Brunswick Dept. of Environment & Local Government

***Editors Note:*** *This text was taken directly from a MS Powerpoint presentation*

**REGULATORY MODEL**




Two approvals vs. one previously; delineation of responsibilities—Environment vs. Development
Interim model until all existing sites are approved
Will eventually switch entirely to the model on the left

**APPROVAL TO OPERATE** (*Water Quality Regulation: Clean Environment Act*)

- The Minister has the authority to set operational conditions and limits through the Approval, or through orders, to limit or stop the discharge of a contaminant to waters of the province.
- It is the role of the Department to establish policies respecting environmental quality objectives and discharge limits.
- The Department of the Environment and Local Government is currently developing a marine aquaculture protocol. This protocol is detailed in a document entitled "Environmental Management Guidelines for the Marine Finfish Cage Aquaculture Industry in New Brunswick" (EMG).
- All sources of contaminant, as defined in the Act, require an Approval.

**ENVIRONMENTAL MANAGEMENT GUIDELINES (EMG)**

- Specifies roles and responsibilities of stakeholders.
- Contains environmental quality limits for seafloor conditions (sulfide & redox).
- Outlines monitoring and auditing protocols.
- Stipulates remediation protocols.

**EMG REMEDIATION PROTOCOLS**

Two levels of response:

1. Hypoxic: Notification from DELG that the site may need attention. Full remediation plans are not likely required
2. Anoxic: Automatic requirement for a remediation plan and review by the Aquaculture Site Remediation Committee (ASRC)

**ASRC & REMEDIATION PLANS**

- The ASRC is comprised of representatives from the New Brunswick Department of Environment and Local Government (DELG), the Department of Agriculture Fisheries and Aquaculture (DAFA), the Federal Department of Fisheries and Oceans (DFO), and Environment Canada (EC).
- The primary purpose of the ASRC is to work cooperatively with site operators to develop effective remediation plans for anoxic sites.
- The secondary purpose of the ASRC is to provide expert advice to DELG on incorporating remediation plans into the Operating Approvals for the sites.
- Remediation plans may incorporate a wide variety of strategies including:
  - i Altered husbandry practices
  - ii Reconfiguration of the site
  - iii Operational Changes
  - iv Physical Remediation

**PHYSICAL REMEDIATION**

- It is recognized that the current federal and provincial regulatory framework presents significant hurdles for physical remediation.
- DELG has a long history of remediation activities in other sectors: mine reclamation, contaminated soil remediation, abandoned site clean up, etc. Ideally, this philosophy can carry-over into the marine aquaculture industry.
- DELG is not responsible for any legislation that would prevent the consideration of physical remediation activities, provided the activity does not result in an unfavorable release (or redistribution) of contaminants. Cleaning up a site should not result in a more significant environmental impact than leaving it alone.

**THE BOTTOM LINE**

- The ASRC will consider any remediation option for a given site, limited only by what is physically possible, and the imagination of the site operator.
- Should the ASRC recommend physical remediation as part of a remediation plan, DELG would have no reason to exclude it.

## Environmental Management of Finfish Aquaculture in Maine

John Sowles, Director of Ecology Division, State of Maine Department of Marine Resources

Maine currently has 44 lease sites for finfish aquaculture. Thirty-four of the finfish leases are currently active. Atlantic salmon is the predominant species raised, with rainbow trout and halibut raised on occasion. Leases are required by law and are granted only after applicants satisfy criteria designed to assure that the operation does not conflict with the public interest. The criteria include protection of significant flora and fauna, water quality, navigation, existing uses (including fishing), and public and private access. Once a finfish lease is granted, with minor exceptions, video transects under the nets are done twice each year, spring and fall.

Dissolved oxygen profiles are collected at each site each fall and benthic infauna communities are collected every other fall.

At this time, Maine relies on environmental policy that evolved over a decade ago through consensus with state and federal agencies having jurisdiction over finfish aquaculture. This policy is designed to satisfy the intent of statutory narrative standards to protect water quality. Maine has used a 2-tier approach to manage impacts from finfish aquaculture. The pen shadow (an area equivalent to the surface area of the pens) is considered the area within which impacts must be confined. We have found that if conditions within the shadow are controlled, then conditions beyond the shadow, but still within the lease, meet the spirit of the law to protect the biological integrity and water quality standards. The conditions Maine has targeted to avoid include hyperdominance of any infauna species, extensive Beggiatoa mats, out-gassing of methane and hydrogen sulfide, and build-up of feed.

Early on, Maine opted to rely heavily on monitoring in lieu of prematurely setting permit limits or standards in regulation. This strategy served the State well by enabling both regulators and industry to understand the environmental response from aquaculture in the context of the larger natural system. During the 1990s, predictive models and prescriptive discharge conditions still had not been developed to be sufficiently accurate or useful. Through monitoring, we have been able to accrue data to refine predictions to a point where now standards are being developed that will be meaningful and protective.

How does this relate to physical remediation? Through the monitoring program, Maine actively works to avoid the need for physical remediation. Maine does not consider chronic failure to meet standards as a sustainable or acceptable practice. Not only does physical remediation mask the true effect of an operation, it has the potential to cause longer-term physical damage to habitat structure while attempting to correct a short-term change in sediment chemistry. Currently, of the 34 active finfish sites, 28 operate well within environmental expectations. Recent changes in husbandry, ownership or stocking are responsible for six sites to either approach or exceed the “triggers”. Five of the six sites have, in the past, successfully raised fish without adverse impacts to the environment and the sixth just began operation. The challenge is for the operators to regain or find that “balance” between husbandry and site conditions. We have found that efficient operations have far less impact and that, not surprisingly, environmental benefits generally translate to better economic return and vice versa. Rather than relying on physical remediation as a management tool, Maine prefers to emphasize matching an appropriate scale of husbandry to environmental site conditions. If unacceptable impacts develop, we try to intervene early to enable natural passive recovery.

Some additional thoughts the audience might consider is the message that physical remediation carries. Is the use of public waters well served by a use that relies on remediation as an ongoing management tool? What message does such a policy send? Are the industry and natural resources well served?

In conclusion, Maine is unwilling to incorporate physical remediation as an acceptable practice for sustainable aquaculture. Rather, Maine prefers to avoid the need for physical remediation through a continuous feedback loop of monitoring and adaptive management.

# The Canadian Ocean Disposal Permitting System

Victor Li, Environment Canada

***Editors Note:*** *This text was taken directly from a MS Powerpoint presentation*

**LEGISLATION**

- The Canadian Environmental Protection Act (CEPA) regulates what can and cannot be disposed of in the sea.
- The jurisdiction under the federal responsibility is anything below the normal high tide watermark.
- A permit is required to dispose of any item noted under the definition of Disposal. The permit usually takes about 9 weeks to process.

**WHAT IS OCEAN DISPOSAL?**

- Deliberate disposal of a substance at sea from a ship, an aircraft, a platform, or another structure
- Deliberate disposal of dredged material into the sea from any source not mentioned above (includes harrowing in any form or waste material under the pens and fish offal)
- Deliberate disposal at sea of a ship or aircraft, a platform or another structure
- Disposal of a substance by placing it on ice in an area of the sea

**STEPS INVOLVED IN OBTAINING A PERMIT**

1. Fill out Application Form
2. Conduct sampling of the dredge and disposal site if required. Disposal site is required if new, for baseline data.
3. Consult public of work via newspaper ads, public meetings etc
4. Conduct environmental assessment of the project to identify any environmental impacts from the project.
5. Environment Canada (EC) receives the permit application and sends it out for comments to various government agencies (DFO, CWS, and Province). Other possible groups include First Nations and people with historical backgrounds.
6. Once comments are received, EC reviews comments for concerns and addresses them before approval.
7. If all issues are addressed, then the permit goes for approval by the Regional Director. If all issues are addressed, then the permit goes for approval by the Regional Director.
8. Once the permit is approved, it goes to Gazette where there is a 30-day public review period before the permit can be used.
9. After the 30 days have passed, unless there are concerns raised, the permit is valid and can be implemented.

**PERMIT FEES**

- Application Fee: $2500 non-refundable fee to process the application. Permit may not be granted if the impacts from the activity being applied for are detrimental to the environment.
- Monitoring fee: Applies only to dredged material being disposed in the sea, the fee is $470/1000 m3 of dredged material. It is used to verify mitigation measures (things done to protect the environment) required in the permit. The federal government usually contracts this work out.

**PENALTIES FOR VIOLATIONS**

- Section 272 (2) of the Act (CEPA) states “Every person who commits an offence under subsection (1) is liable
- On conviction on indictment to a fine of not more than $1,000,000 or imprisonment for a term of not more than 3 years or both
- On summary conviction to a fine of not more than $300,000 or imprisonment for a term of not more than 6 months or to both

## Regulatory Perspective: Questions and Answers

**NELL HALSE**

No questions asked

**DARRELL WELLES**

Q: John Sowles: Where do the environmental quality objectives apply?

A: A 50 meter transect is placed right under the cage leading in the direction of the main water flow. Three samples are collected along the transect and the rating is determined using the median results for Eh and sulphide measurements.

A: Comment about the remediation requirements and the possible disposal of contaminated sediment from under cages—for other industries (e.g. mining, petroleum) the contaminated sediments must go to a contained and approved site; this should also be required for fish farm sediments.

**JOHN SOWLES**

Comment from John Henningson: There should be some consideration of the "natural balance" between organic loading and utilization of nutrients in a natural system; how can we predict when we will overload an ecosystem; i.e. exceeds its assimilative capacity?

A: Maine is just beginning to look at carrying capacity, e.g. Cobscook Bay, but doesn't have any real answers yet.

Comment from Inka Mileski: There is a need to look at more than just effects at a salmon farm site; cumulative effects and far-field effects, bay-wide effects should also be considered.

A: Agreed; should look at bay area carrying capacity for nutrients.

**VICTOR LI**

Q: Jay Clements: If harrowing were used for physical remediation, is there some flexibility to shorten the approval process?

A: Not really, but it may be possible to reduce the level of screening and application review.

Q: John Henningson: Does the federal government in Canada require ocean disposal permits for the operation releases of organic material from the pens?

A: No, only if the farmer wants to move the accumulated sediment around.

Comment from Inka M.: EC should be controlling releases from the pens under its Fisheries Act responsibilities related to the deposit of deleterious substances.

Q: Is EC looking at discharge constituents as part of harrowing?

A: No.

Q: Peter Strain: The original Ocean Dumping Control Act from the 1980s was rolled over to become a regulation under the Canadian Environmental Protection Act (CEPA). The act has been used primarily to control the disposal of dredged harbor sediments. Have the CEPA regulations been modified to include other chemicals that would be more pertinent to aquaculture?

A: The Ocean Disposal regulations of CEPA are under going a technical review and that aspect will be covered by that review.

# How Recovery Occurs Naturally

## Natural Recovery: Benthic Fallowing

D.J. Wildish, Canada Department of Fisheries and Oceans

Recovery associated with an organic enrichment event begins as soon as the organic input ceases. The processes involved are mediated by both physical and biological factors. Water movement, including tidal and wind/wave forces, brings oxygenated seawater more intimately in contact with the sediments where chemical oxidations occur. This reduces the toxic, acid-volatile sulfides present and may preferentially remove organic particles. Biological factors include the action of microbiological and macrofaunal organisms (see Poole and Wildish, 1979) which enhances the rate of change to a more oxidized environment. The changes include further removal of toxic compounds and a change in the microbial flora assisted by the activities of the macrofauna—including burrowing, irrigation, and feeding—all of which drive the system toward oxidized conditions.

From these generalized principles we designed a preliminary study to determine how quickly the chemical conditions within surface sediments of the most impacted locations under salmon sea pens recovered following a two-year fallow precipitated by a serious viral disease outbreak. Two sediment geochemical measures—total sulfides and redox—were determined by ion analytical techniques. The results (Wildish et al., 2001) suggest that the chemical nature of surface sediments had returned to background levels within 18 months of initiating fallowing. Because we were unable to take grab samples directly under the sea-pens we were unable to observe the role of macrofauna in the recovery, although locations at the sea-pen edge suggested that macrofauna were at the transitory stage of succession as defined by Pearson and Rosenberg (1978).

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Wildish, D.J., H.M. Akagi, and N. Hamilton. 2001. Sedimentary changes at a Bay of Fundy salmon farm associated with site fallowing. Bulletin of the Aquaculture Association of Canada.

Pearson, T.H. and R. Rosenberg. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanography and Marine Biology Annual Review 16:229-311.

## How Recovery Occurs Naturally: Benthic Effects of Fallowing and Cessation of Operations at a Salmon Farm in the Letang Inlet

Gerhard Pohle, Atlantic Reference Centre, Huntsman Marine Science Centre

Benthic, or largely immobile bottom-dwelling organisms, are a useful and convenient way to evaluate environmental impacts of fish farming. There are data on the recovery of the benthos following enrichment events in temperate areas of the Pacific and Eastern Atlantic, but there is little published evidence for such recovery in the Northwest Atlantic, particularly from Canada. Data suggests that benthic community recovery from enrichment effects may take six months to over two years following the cessation of farming activity. The present study was undertaken to evaluate recovery over a five-year period at a mariculture site in the Bay of Fundy, which had been in operation from 1982 to 1998.

A sampling station was established at a salmon farm in Lime Kiln Bay immediately after relocation of net-pens to monitor recovery of the benthic macroinvertebrate community. From June 1995 to 2000, triplicate benthic samples were taken below where cages were located. Results were compared to data from a reference station about 40 m from the cages (monitored at an equivalent distance to relocated cages prior to repositioning), and to data from a second reference station toward the middle of the Bay. Samples were taken from substrates with comparable sediment characteristics and at the same time of year. The total evidence approach was based on an evaluation of community structure by non-metric multidimensional scaling (MDS), k-dominance curves, diversity indices, and indicator species. The biological data was coupled with environmental enrichment measures, including percent organic matter, bacterial biomass, and sediment impact index.

Results from multivariate and graphical analyses, and univariate diversity indices, showed an initial limited recovery over the first two years that subsequently stagnated. Indicator species, established from an analysis of reference sites, corroborated this trend. The sludge worm *Capitella capitata*, that is indicative of highly enriched conditions, was prevalent during the first year at the recovery station but dropped to near-absent levels after two years. The polychaete *Aglaophamus neotenus*, abundant in areas of more moderate impact, appeared after two years and remained established thereafter. However, the polychaete *Ampharete lindstroemi*, characteristically abundant at both reference stations, was absent from the recovery station over the entire five-year sampling period.

Overall, community structure in the recovery station never attained characteristics found at either reference stations. Environmental data indicate that enrichment levels decreased within about a year after fallowing in near-surface sediments. However, sediments below 3-5 cm of the surface appeared to have changed little during the recovery period, as confirmed by the sediment index. It is concluded that while there has been some recovery at this site, located in a depositional area, it is incomplete five years after relocation and two years after cessation of operations. This is consistent with published predictions that normalization of the benthic community in relatively quiescent waters takes longer than at sites that are more dynamic.

## How Recovery Occurs Naturally: Questions and Answers

Notes by George Lindsay and Barry Hargrave

**DAVE WILDISH**

Q: Peter Strain: I question whether the phrase "pollution gradient" that you quote from Pearson and Rosenberg is correct. "Organic enrichment gradient" would be more general and applicable since it includes all sources of organic matter input.

A: I agree unless the location is one where a specific source of enrichment is identified that can be linked directly to organic matter input (e.g. sewage discharges). Gradients can result whether the input is from natural occurrences (leaves) or anthropogenic inputs.

Q: Fred Page: What is a typical sulphide level under a highly impacted cage? Is it 6000 or higher?

A: Geochemical analysis at this study site only started 11 months after fish were removed—readings before that would be speculative. But the study showed that if left alone, the site returned to an A-rated site after 22 months.

Q: Fred Page: Is this reflective of newer site?

A: Only to say that net depositional sites will be longer in recovery.

Q: Fred Page: Were current measurements done in concert with the actual sediment work?

A: No concurrent measurements were made, but currents have been established since the work was done with values at 9 cm/s and with good duration.

Q: Fred Page: Single year class sites, will the fallow period be sufficient?
A: Normally fallowing is not as long as 2 years.

Q: Fred Page: Would the fallowing period be defined by current speed?
A: There is no experience to correlate this.

Q: Nell Halse: The study site you investigated was classified as B+ in 1997. It should have been well flushed.
A: Yes, this should have been a tidally-energetic site and although no current meter measurements are available, the site was not depositional.

Q: Unidentified: Studies in other marine sites in North America have shown that a threshold for changes from erosional to depositional sediments exists at a current speed of about 9 cm/s.
Q: Fred Page asked if this was a maximum, minimum or mean value and over what duration? Currents reported in this way are meaningless without some indication of duration and number of observations.
A: The general comment from the floor was that this was probably a mean value.

Q: Unidentified: Was this a multi-year site before your study?
A: Nell Halse: Yes, it probably was with no fallow period. Normally, fallowing would not be for two years. There are no guidelines for fallowing in New Brunswick.

Q: Inka Milewski: Would sediments with high sulfide and low Eh potentials as you observed ever occur naturally without human intervention (e.g. all organic matter is from natural sources)?
A: Wrack (accumulated macroalgae) collects in high intertidal areas; equally high organic loading might occur in these areas. It might also be observed in sub tidal areas where fine-grained mud accumulates suspended organic matter in "depo-centers" (i.e., center of anoxic basin).

Q: Barry Hargrave: Can you distinguish between natural events (such as settling of products from the spring phytoplankton bloom) that add organic matter to sediments in pulses over time from the continuous addition of organic matter as under finfish farm pens?
A: Yes, all organic matter additions to sediments have the same effect (decrease in oxygen) irrespective of source of addition. The rate (timing and duration) of supply is important in determining decomposition rates and organic matter burial.

Q: Where would natural enrichment occur in the Bay? (i.e., matching or overlapping with the aquaculture site situation studied/found?
A: The exact area(s) are not defined, but, in general, these would be further out than the intertidal zone and there has to be carbon deposition.

Q: Are naturally occurring conditions found for "C" sites?
A: That would be rare. B ratings are probably more common but usually of short duration. But in sites having continuous deposition, there would be a shift in the benthic ecosystem to unnatural processes. However, there would be no significant difference between microalgae deposition vs. fish feed deposition.

Q: What is the spatial context of deposition that is occurring under these cage sites?
A: Monitoring is carried out where the heavier deposition is occurring. Transects are put in place which cover the depositional area under cage, plus periphery.

Q: John Sowles: How is the benthic enrichment classification system applied in New Brunswick, i.e., where are samples obtained relative to location of net pens?
A: Transects with sampling sites arranged linearly are established from the center of a pen to the edge depending on numbers of fish in a cages (<100,00=one transect, 200,000=2, 300,000=3).

Comment from Eric Garnier: The SWNB annual finfish farm survey is focused on areas of high production. Thus, cages with the greatest numbers of fish are selected and transects established in the direction of the potential plume inferred from current meter observations.

Q: What is the time scale for recovery?
A: The recovery time scale is not precisely predictable. The number of fish on the site can predict or be a factor in getting to or arriving at a C rating, but removing the fish does not necessarily equate to an equal time factor or influence for a recovery period.

Q: Janice Harvey: What is the lag time when you see chemical recovery vs. animal recovery
A: Macrofauna recolonized the site 9 months after fish were removed. The microfauna begin to move in about two months. The average classification as B+ for the site was based on the general sampling results but it did not reflect the fact that 'hot spots' could still be detected under cages by the geochemical methods 12 months later.
A: Gerhard Pohle: Recolonization rates by benthic macrofauna may take weeks to months depending on species and site-specific conditions. The fauna react to all variables (physical, chemical, biological) and not just organic matter. For example the presence of therapeutants could delay recolonization that otherwise would have occurred more rapidly.
A: Nell Halse: There has been an industry-wide improvement in husbandry (e.g. food type and how feed is delivered) that reduces organic matter buildup under pens. There are no guidelines for fallowing, but the move toward single year-class culture has evolved rapidly and this should reduce organic matter accumulation even more.

Q: Inka Milewski: With less waste and better feed conversions, this is a scenario that is improving, but if a "C" site is arrived at, then remediation is a necessary consideration.
A: Possibly, but, the expectation is that there should not be a continuation in the proliferation of C sites.

**GERHARD POHLE**

Q: Was the Scotland site example a "depositional" site as well (similar to conditions in Limekiln Bay?)
A: Jamie Smith: It was confirmed that this was his understanding.

Q: Unidentified: How did you determine the sediment quality index (1 through 3)?
A: This was done by appearance and smell (1=black, sulfide rich; 3=brown, no odor).

Q: When comparing studies, is there significance in the specific species that you look at?
A: *Capitella* is fairly universal in highly enriched sediments, but after that, you have to look for analogous species (site by site basis).

Q: Victor Li: When comparing results of macrofauna community changes during fallowing in different studies, is it necessary to account for species differences?
A: This depends on what the question is. In this study, we were not looking for indicator species. Using analogous species, we can show the same ecological response.

Comment from John Henningson: The experience in the eastern U.S. following physical removal of sediments was that 2-3 years were required for recolonization to begin but that was followed by a prolonged period of 'stagnation' when few changes occurred. That is, recolonization only occurred up to a point and then stopped before the 'natural', pre-existing community was re-established. In U.S., recovery is highly influenced by persistent organics.

A: If persistent organics are removed, then the recovery is rapid (2 years), but then recovery levels off.

Q: What are the causes of the successional changes you observed?
A: Macrofauna respond to many factors. Multivariate analysis shows that many factors may be involved.

Q: Fred Page: With regard to species diversity, why the change as it was found?
A: We are usually looking at microfauna; thus, differences could be a function of technique, and possibly other inputs (therapeutants)

Q: Barry Hargrave: Were there changes in sediment grain size during the recolonization period?
A: Sediment characteristic is not a significant factor. Silt/clay fraction is typically
80% to 90% throughout study period for average of whole grab sample.

Q: Fred Page: If a therapeutant was the cause of the benthic shift, do we know which species would respond to the chemical?
A: No, there is no specific information that reflects specific species response to any one of these chemicals

Q: Fred Page: Therapeutants for sea lice were used in 1995/96. Would this account for some of the changes that you observed, since crustaceans are targeted by these chemicals.
A: All species showed changes during the recovery in community composition. Crustaceans were not different from other species. Also, there was no significant impact on crustaceans at the control sites. Our regional studies, that I have not presented, show subtle changes in species composition throughout the area over this time but the differences were not large.

Q: John Sowles: In the consideration of recovery vs. enrichment, the State of Maine has never said aquaculture will not cause change. The question is, what is an ecologically acceptable change? Moderate enrichment can be tolerated but what is the threshold for acceptable change?
A: This is the reason that we chose to sample at a reference station (distant from the under-pen transect) as well as the middle-of-the-bay site. There were changes in macrofauna during recovery with a final species composition along the transect that, while different from the reference station, brought it closer to the reference site.

Q: John Sowles: Have you looked at trophic levels, functional groups in the recovery process?
A: No, hasn't been done.

Q: Jamie Smith: Ocean dumping looks at physical, biological, benthic, and toxicological aspects in a hierarchical sense. Do you plan to look at using a similar approach with the data?
A: Not for the moment.

Q: Unidentified: Did you examine other factors (sediment, chemical, physical, ecotoxicological properties) as used in the triad approach or do you have the intention to do this to compare erosional and depositional sites?
A: No, this is dependent on funding. There has been a lack of interest in supporting this type of community analysis approach in recent years.

Q: Jamie Smith: What about more dynamic sites, more regional scales?
A: Resources are needed to continue the work at more dynamic sites, but, some work is now being done looking at more sites on a regional basis.

Q: Inka Milewski: There is a gap in understanding in our ability to move from local to regional scales of observations. How does you work give a regional overview?
A: I agree but our work was actually directed toward regional aspects of macrofauna distribution. Site-specific observations are important and required for monitoring but an ecosystem approach is also required.

# Efforts to Stimulate Recovery

## Retrospective Comments

John C. Henningson, P.E., Hart Crowser, Inc.

When I was invited to participate in the program, I did not have a good understanding of the aquaculture industry or the problems associated with detritus and waste buildup. By the time the two days was over I had gained a far greater insight and can now see the applicability of some techniques used in the environmental management of sediments in the US. An outline of my presentation is attached. Unfortunately, it was an overview of US experience but not very relevant to the specific issues associated with concentrated fish wastes.

Perhaps the most applicable condition in the US is the concentration of nutrients associated with the discharges of combined sewer outfalls (CSOs) in older urban areas. There have also been a few catastrophic releases of waste from lagoons at pig farms and other intensive farming facilities. These types of releases have caused unique localized oxygen deficit problems. In each case, the common remedial practice was to dredge the material out of the waterway and place it in a landfill. The most difficult challenges were to dewater the material for transport.

The discharge of primary sewage from treatment plants also resulted in similar problems. The so-called "Albany Pool" below Albany, NY is perhaps a good example. The remedy was to install secondary treatment in the 1980's that reduced the load to the waterway. Within a few years, the benthic oxygen demand was used up and natural recovery occurred. The key was to reduce the loading to a level in balance with the assimilative capacity of the waterway.

Recently, capping was used to reduce the problems associated with wood waste at great depths at the Ketchikan Pulp mill in Alaska. A thick cap of sand was used to reduce the oxygen demand on the overlying water column. However, it is possible that, in the future, anaerobic decomposition will result in gasses, which will bubble up through the cap and reduce the effectiveness. Floating aerators and bubbler systems (Air Guard) have been used in the remediation of organic deposits in paper waste lagoons and depositional areas in waterways. However, the have an ongoing energy and maintenance costs.

In summary, it seems that the problem is simply the exceedances of the assimilative capacity in a localized area. Unless the waste input is matched to the ability of the aquatic system to convert it without depleting the oxygen, the problem will continue to require expensive repetitive remedial activities. Therefore, the most obvious mitigation options for consideration are:

- Proper siting of future facilities to match the assimilative capacity of the water body to waste generation
- Removing the pens and performing periodic dredging of wastes with upland disposal in a landfill or processing for bio-waste products or fuel
- Reduction of fish densities in the pens (not likely to be economically feasible)
- Reducing waste by controlling excess food
- Installing removal systems composed of trays or bags under the nets which may be emptied periodically
- Installing aerators or bubblers to increase the localized assimilation capacity

I greatly appreciated the opportunity to learn more about the aquaculture industry and its problems and hope the foregoing comments are useful.

## Physical Remediation of Sediments at a Salmon Growing Site in Passamaquoddy Bay, New Brunswick

Roy Parker, Environment Canada

Annual environmental monitoring of finfish aquaculture sites in the Bay of Fundy has been developed and implemented to assess conditions of undercage sediments and to rate those conditions. The lowest rating (C) indicates that sea floor conditions are poor for the long-term environmental and economic well being of the site. When degraded conditions exist, corrective action must be taken by the operator to reduce the habitat impacts of the operation. Site remediation can involve changes to operating practices, site fallowing, or actual physical remediation.

The purpose of this project was to evaluate methods of physical remediation to determine if they were technically feasible, practical, effective, legal, and cost effective. A Steering Committee, consisting of government and industry representatives, was formed to guide the project and funding for the study was provided by the salmon aquaculture industry and the federal and provincial governments.

In August 2000, a salmon farm located in Passamaquoddy Bay was selected for the study. The salmon farm consisted of nine 70-metre polar circle net pens covering an area of about 1.6 hectares and holding about 150,000 odd year class market-sized fish. Initial site surveys were conducted in September 2000 using scuba divers to collect core tubes of sediment, to report on the visual condition of the bottom and to take video tape recordings of the bottom conditions on the site. In addition, oxidation-reduction potential (Eh) and sulphide were measured on the core tube samples and sediment samples were collected for chemical and physical analyses.

In May 2001, the site was harrowed using a steel drag towed behind a lobster boat for 3 hours on three different days, always on a falling tide. Pre-remediation and post remediation monitoring were conducted to assess the effectiveness of the harrowing. The results indicated a slight improved in Eh and sulphide results three days after the harrowing was completed. However, nine days post -remediation, the site had mostly returned to the pre-remediation conditions. The chemical analyses of the sediment samples indicated that there were no concerns with persistent organic chemicals such as PCB, DDT and PAH. Azamethiphos, cypermethrin, and ivermectin were not detected in any samples and trace amounts of emamectin benzoate were found. Copper and zinc concentrations were elevated above background levels, and all other metal levels appeared normal for the area.

Harrowing, as was conducted on this site, was technically feasible, practical, inexpensive, legal, but largely ineffective at improving sediment conditions. This study was limited in several ways. Due to market conditions, fish were held over the winter of 2000-2001 at the farm that left a very small window of opportunity to work there. The ownership of the site changed hands during the project creating some complications for the remediation plans. As well, this site has very low tidal current velocities, which limits the dispersion of waste material.

## Non-Governmental Organization Perspective

Roger Fleming, Staff Attorney, Conservation Law Foundation Rockland, Maine

The Conservation Law Foundation (CLF) is a regional, not-for-profit conservation organization with approximately 15,000 members in New England. We may be best known for our court cases focusing on issues like the clean up of Boston Harbor, preventing off-shore oil and gas drilling on Georges Bank, and forcing the U.S. government to take measures to conserve the groundfish fishery in the Gulf of Maine. However, we have also achieved results through community organizing and innovative economic strategies. I work out of our

State of Maine advocacy center located Rockland, Maine. Our office has recently launched a new initiative we are calling "The Maine Coastal Defense Project" in which one of our highest priorities is protecting the biological integrity of the Gulf of Maine.

Prior to joining CLF earlier this summer, I was an attorney with the US EPA's New England Office located in Boston, Massachusetts. Much of my work at the EPA focused on the Clean Water Act (CWA) and the Agency's obligations under the Endangered Species Act (ESA).

While at the EPA, I was legal counsel for the Agency during its consultations with the US Fish and Wildlife Service and the National Marine Fisheries Service regarding the potential impacts from EPA's delegation of the federal pollutant discharge program to the State of Maine. This is called the National Pollution Discharge Elimination System, or NPDES, program. The consultation itself focused on the impacts of Maine salmon farms to the Gulf of Maine population of wild Atlantic salmon, listed as an endangered species while the delegation was taking place. The consultation resulted in commitments from EPA to assure that Maine includes conditions protective of the wild salmon in its NPDES permits issued to Maine salmon farms.

I was also counsel for the Agency on the initial drafts of the federal NPDES permit for Acadia Aquaculture, which will be the first NPDES permit issued by the US EPA for a salmon net pen operation. CLF anticipates, and hopes, that this federal permit will be the model upon which the State of Maine, through its Department of Environmental Protection, bases its permits for salmon farms under the federal NPDES program.

I have been asked to present an NGO perspective on physical site remediation, including its potential usefulness as a means to satisfy regulatory requirements. While I have spoken with different organizations about physical site remediation, and believe that my views are likely to be quite consistent with many other NGO views, the views I am sharing are obviously only those of our organization. I should also apologize now because my comments and policy views are unavoidably legally weighted. But I hope think they will be useful because they should help you to understand the basis for our views and in understanding when physical site remediation may be appropriate, if at all.

## CLF Position on Aquaculture and Outline

I want to make a couple of brief comments regarding the CLF position on the future of aquaculture in the Gulf of Maine. As a general matter, CLF is not opposed to aquaculture and will support it so long as it is conducted in a sustainable, environmentally protective way. Our general goal is simply to assure that aquaculture activities are permitted in a reasonable manner that protects water quality and is compatible with multiple uses of our coastal waters including fishing, navigation, and other coastal water uses.

With specific regard to physical site remediation, although I had some experience with the concept in my former job, CLF has no historic position and had not thought much about it as an organization before this workshop was scheduled. However, once we sat down to think about what our interests and concerns might be, we found it to be a fairly straightforward issue to analyze.

My comments will track the basic framework as we saw it for analyzing this issue as follows:

- Key Principals of relevant U.S. Federal Law (CWA)
- Key Principals of relevant Maine State Law (Water Quality Standards)
- U.S. EPA's Indicated Approach to this Issue
- Our Conclusions

## CWA

Congress passed the CWA in 1972 to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." When it did so, it set out to eliminate the discharge of all pollutants into U.S. waters by 1985. In order to help achieve that goal, the Act contains a general prohibition in § 301(a) making " . . . the discharge of any pollutant by any person unlawful." And of course, the definition of pollutant is broad and would clearly include the organic matter that we could expect to accumulate under finfish aquaculture pens.

To me, these fundamental CWA goals are the starting points for the discussion about site remediation. They represent the core principals supporting U.S. environmental law, and general U.S. environmental policy, and demonstrate how the law approaches this type of an issue. These broad goals are looked to by Courts in interpreting the CWA, and it has been held over and over again by U.S. courts that there is no right to pollute in U.S. waters – in fact, the whole premise of the CWA is entirely the opposite.

So beginning there, the notion that waste material, in any instance, will build up on the benthos to the point that it needs to be physically remediated is difficult to accept. The Act is designed to prevent such pollution. From our perspective, there should never be a need for physical site remediation in U.S. waters, and I can not conceive of any way we could support this approach as a means for industry to satisfy regulatory requirements.

Of course, notwithstanding the broad prohibition of pollutant discharges, we know that pollutants are still legally discharged to U.S. waters in compliance with the CWA. Section 402 of the Act is the principal exception to the prohibition and provides a comprehensive framework for regulating discharges of pollutants from point sources, including most finfish net pens, through the NPDES permitting system I mentioned earlier.

This permitting system, in a nutshell, relies on a combination of industry-wide effluent limitations and federally mandated state water quality standards to determine what pollutants may be discharged and at what levels. Some of you may know, that the EPA has never issued effluent limitations for the aquaculture industry, however, as a result of a recent lawsuit (not by us) the U.S. EPA will be required to promulgate such effluent limitations by 2005. If effluent limitations did exist, they would represent the minimum standards the industry would be required to meet. However, regardless of those industry-wide effluent limitations, discharges from each aquaculture facility must still meet water quality standards.

## ME Water Quality Standards

Water quality standards, are designed to protect and maintain both designated uses and existing uses of a state's waters. Designated uses are specifically listed in the standards and in Maine generally include uses like recreation, fishing, navigation, aquaculture and as habitat for fish and other aquatic life. Existing uses are covered in what is referred to as the "anti-degradation policy" and include both the designated uses and non-designated uses, occurring in the water on or after November 28, 1975.

The reason I am discussing water quality standards is simple. No permit may be issued for a discharge that would cause a violation of water quality standards. And I don't think a salmon net pen could be permitted in U.S. waters, at least as a legal matter, if it would cause a significant accumulation of waste material on the benthos.

Maine's water quality standards are referred to as the "Water Classification Program." There are three specific provisions worth mentioning here. First, the anti-degradation policy in Maine provides that existing uses are determined on a case-by-case basis taking into account a number of factors including the designated uses of that water and: existing marine life present in the water; habitat maintained by the water that supports

marine life; and any other evidence supporting the ecological significance or rarity to the ecosystem of such marine life or habitat. See 38 M.S.A. § 464.4(B).

I isolated the anti-degradation policy in part because it raises some complex questions whose analysis probably goes beyond the scope of this discussion. But it should be apparent that any net pen whose discharge results in a significant amount of depositional material on the benthos could easily run afoul of the anti-degradation policy because of the potential negative impacts to marine life and habitat present that are part of the benthic community. Also, note that aside from impacts to what we might immediately think of as the resident benthic community, that much of the Gulf of Maine is essential fish habitat for a variety of fish including the nearly extinct Gulf of Maine population of wild Atlantic salmon. This should also be a significant factor considered by the permitting agencies when determining whether a particular site can be permitted.

The other two water quality standard provisions I want to mention are a bit more straightforward.

- The general provisions for Maine's water quality standards provide that "[a]ll surface waters of the state shall be free of settled substances which alter the physical or chemical nature of bottom material . . . ." 38 M.S.A. § 464.4(B).
- The specific standards for Class SB waters, which would include most finfish aquaculture pen sites, provide that benthic conditions shall not be impaired to the extent they cause detrimental changes to the resident biological community. See 38 M.S.A. § 465-B(2)(C).

I think these provisions more directly make essentially the same point as the anti-degradation policy regarding whether or not a net pen could receive a permit at a site where a build-up of waste material is likely to occur. I also think that even if for some reason a permit were issued, if the kinds of effects we have been discussing occurred they would be clear violations of the CWA subject to the full suite of enforcement options by state or federal governments and interested citizens through the CWA's citizen suit provisions.

And again, based on my experience and understanding of the CWA, physical site remediation would not help to satisfy U.S. regulatory requirements because the whole objective is to prevent and deter CWA violations. There is no CWA provision that would allow water quality standards to be violated, even with the understanding the impacts from those violations would later be remediated.

In my opinion, the EPA in its draft permit has outlined a useful approach to dealing with the legal issues I have discussed so far. This is based on the last draft of the permit in the public domain, and may change when it comes out in final form.

## US EPA Draft Permit

EPA's draft permit picks up on the CWA provisions I have identified, including water quality standards. I believe it is instructional to look at EPA's approach because it is designed to avoid problems that would trigger the need for physical site remediation.

The key relevant provisions in the draft permit create two sediment impact zones with corresponding Warning Levels and Impact Limits (violation thresholds) for each identified metric. Essentially, the impact zones allow for a minimal level of impact to the benthos under the pens, with the allowable impact decreasing outward until full water quality standards are met 30 meters from the pens. There are a number of metrics identified, including those discussed by Dr. Wildish and Dr. Pohle, including redox potential, gas formation, beggiatoa coverage, anoxic sediments, pollutant-tolerant taxa, azoic conditions, pollutant sensitive taxa, taxa richness, and RP profile. Zone I includes the area of seafloor directly beneath the net pens, and extending 5 meters out in all directions from the perimeter of the net pens. Zone II extends from 5 meters to 30 meters from

the pen system in all directions. Beyond the sediment impact zones, full water quality standards must be met; specifically noted is the provision discussed above that benthic conditions shall not be impaired to the extent they cause detrimental changes in the resident biological community. An exceedence of the Impact Limits within any zone is considered a violation of Maine's narrative water quality standards, and thus is also a NPDES permit violation.

I think what is innovative about the permit is that most of the identified metrics include thresholds which provide a warning that benthic impacts are approaching unacceptable levels. If warning levels are reached for any particular metric, the permittee is advised to consider modifications in order to maintain conditions within acceptable limits. Suggested modifications include, but are not limited to, reducing standing stock, reducing feeding, fallowing of the site, and collecting settleable solids before they reach the bottom. If one or more metrics exceed the Impact Limits, the permittee is required to modify operations sufficient to enable conditions to recover to acceptable levels, and to develop and submit to EPA and DEP for review and concurrence a recovery plan designed to restore benthic conditions to acceptable levels in a timely manner. Physical disturbance such as harrowing, dragging, or other mechanical means are specifically prohibited in the permit as a means to mitigate bottom conditions. If the enacted recovery plan fails to result in sufficient recovery, based on the results of the next scheduled benthic monitoring, the permit may be modified or revoked.

I have laid this part of the draft EPA permit out in some detail because I think, for the most part, it speaks for itself. It think it reflects the broad purposes and the specific means articulated in the CWA and Maine State water quality standards to restore and maintain the chemical, physical, and biological integrity of our waters by proscribing detrimental impacts to the benthic community. But I think it takes a useful approach that accommodates the realities of the current industry by

- allowing for some minimal level of impact to the benthos under the pen that will not be considered a water quality standard violation, and
- establishing an active monitoring program, and articulating in detail through a variety of metrics, warning levels that should alert operators that something is wrong before the problem becomes so serious it is a permit violation or will require physical site remediation.

It is worth noting that the draft EPA permit also includes specific provisions for benthic monitoring, benthic monitoring reference sites, and video/photo surveys among other provisions.

One last provision worth mentioning that I believe may be of some interest is the requirement that "[t]he permittee submit written notification to EPA following termination of operations, and within 60 days of site abandonment, that all facility structures, equipment, nets, and any other debris associated with its operation have been removed from the seafloor, and waters and shores surrounding the facility."

I think this is a useful provision, but it may not go far enough from an overall regulatory perspective because it does not seem to specifically provide for the clean-up of settled waste material that could be left behind, nor require that the actual cost of either natural or physical site remediation be paid for by the permittee. EPA's view of these issues focuses on deterrence; that the discharger will not leave behind a degraded site because he could be penalized for the covered actions. Failure to complete the permit requirements would be considered a permit violation, subject to fines of up to $27,500 per day, per violation. However, deterrence doesn't always work and because any money actually collected from the violations would go to the federal treasury, the public could still be left holding the bag for the actual cost of cleanup. I think performance bonding and/or some type of site remediation fund should be considered when permitting facilities to assure that in a situation in which a degraded site is abandoned, any costs associated with clean-up, including physical site remediation, is paid for by the permittee.

## Conclusion: CLF's View of Physical Site Remediation

CLF has not taken a position on physical site remediation, but I cannot see our organization supporting it in any way as a means to satisfy regulatory requirements because doing so assumes discharges of pollutants at levels we would view to be in violation of both the letter and spirit of the CWA. What we clearly support are sustainable practices such as:

- identification of appropriate sites in the first instance
- technologies and best management practices that minimize discharges
- good husbandry and operational practices including regular fallowing of sites
- active monitoring of water column and sediment impacts
- modifications of site management when sediment impacts begin to occur including:
- reductions in standing stock
- reductions in feeding
- fallowing, and
- collection of settleable solids
- natural regeneration processes when necessary
- performance bonding to assure clean up of abandoned sites – whether natural regeneration processes or some form of physical site remediation which becomes necessary only as a last resort

To the extent I know and understand how the final permit being issued by the EPA will address organic loading impacts, I believe CLF will generally support that approach, though we could quibble with it around its edges. It provides for many of the important protections we support including active monitoring of sites and an opportunity to take measures to mitigate problems before they become CWA violations, or so serious that physical site remediation could become necessary.

Finally, I think that to the extent we can learn more about physical site remediation without expending the scarce resources available for the support of the sustainable practices I have noted above and research on cumulative and far-field impacts, then we should do so before it is considered a viable tool in our toolbox. Some of our immediate concerns have been discussed, including habitat destruction, species impacts, turbidity and, as I believe John Sowles noted, the message physical site remediation would send to the public.

Even as a tool of last resort, I believe physical site remediation should be viewed within a hierarchy similar to that discussed by Mr. Henningson, which I recall proceeding in order of consideration from natural recovery, to enhanced recovery, to true or composite caps, and finally to harrowing and dredging-type activities only as a last choice.

Thank you again to the Aquaculture Committee of the Gulf of Maine Council on the Marine Environment for asking us to participate and share our views on physical site remediation.

## New Brunswick Salmon Growers Perspective

Nell Halse, New Brunswick Salmon Growers Association

***Editors Note:*** *This text was taken directly from a MS Powerpoint presentation*

**PERSPECTIVE**

Need to evaluate aquaculture in broad context of marine environment—not in a vacuum.

**ENVIRONMENTAL SUSTAINABILITY**

Industry's Intent Regarding Environmental Management And Remediation of Sites:

- Choose A-rated sites
- Properly manage depositional sites
- Management techniques
- Feed technologies
- Husbandry Techniques

**ENVIRONMENTAL IMPACT**

- What is the impact?
- Manage impact so that remediation is not required
- Site by site (case by case) basis
- EMG has requirement for remediation plan if site is C-rated

**SCOPE OF THE IMPACT**

- Leases occupy < 1% of suitable coast of Grand Manan, Western Isles, Passamaquoddy Bay, and eastern Charlotte County
- 2000 hectares of sites, 1000 hectares for production
- Less than 10% is C-rated
- Less than 100 hectares are at issue
- What is best way to manage that 100 hectares?

**RECOMMENDATIONS**

- Need to focus on Risk Assessment Approach
- Major issues are addressed in Site Approval Process
- Environmental sustainability is a prerequisite for successful salmon farming

## Efforts to Stimulate Recovery: Questions and Answers

**JOHN HENNINGSON**

Q: How do you think capping would work?

A: I think that a thin cap to allow for mixing with the organic matter might work best, as it would enhance natural recovery. Bad sites may need a heavy cap. One could do it with sand off a barge, deep or shallow. Cap can be placed several ways -clamshell bucket, scow dumping, pumped down and spread with a hose, conveyors, etc. In confined areas, I found that distributing slurry with a hose is effective to place the material where you want it.

Possible remediation actions and priorities for implementation

| LEVEL | ACTION | COMMENT |
|---|---|---|
| 1 | Husbandry Practice Alterations | Improvements or changes to the husbandry practices such as feeding regime, feed type, record keeping on feed usage, stocking density, net cleaning practices, adjusting feed usage, and/or employing new methods for determining when fish are satiated. |
| 2 | Changes to Site Configuration | Re-orientation of site configuration based on examination of current speed and direction and sediment conditions.<br>Use a different cage design or configuration.<br>Application of cage technology that may reduce waste loss or benthic accumulation. |
| 3 | Operational Changes | Fallowing of cage rafts<br>Year-class separation<br>Site fallowing<br>Boundary expansions<br>License production decreases<br>Abandonment of site |
| 4 | Direct Sediment Remediation | Physical removal of waste materials from under the cages for disposal on land or sea with appropriates permits.<br>Bacterial remediation of undercage sediments (although not permitted at this time).<br>Physical remediation of undercage sediments that could include harrowing or other physical disturbance (although not permitted at this time). |

Q: In the Bay of Fundy tides, how effective will capping be, particularly in terms of staying in place?
A: I don't know but on the west coast, we have strong currents and it works. It depends on how you grade the material and the conditions of the site.

Q: Non-persistent organics are the main problem vERSUS persistent organics or metals. Are there any examples with non-persistent constituents; e.g. injecting treatments?
A: No. Frankly, this would be a new application for me. I know that the lab work has been done but it doesn't seem to have worked as well in the field, at least not in the Hudson River.

Q: Is capping only appropriate in areas where there's no subsequent loading?
A: Not necessarily. For example, we have experience with coal tar that does break through. It is really a question of weighting the costs versus benefits. Certainly one would want to continually monitor, maintain, and repair as necessary. You may have to do repetitive caps based on monitoring studies.

Q: Have there been any vacuuming techniques done?
A: Yes. Diver assisted suction dredges have been used on a small scale but you're still left with the question of what to do with the material. It works well in fine-grained situations.

Comment by JH: You might be interested in considering what Washington State has done in the way of Sediment Criteria and defining sediment impact zones for aquaculture.

**ROY PARKER**

Q: How did you choose the drag type, what about a bottom trawl?
A: Agreed that it would work but the partners in this study provided the drag. Other options might be more effective.

Comment from Inka Mileski: She's not sure based on what she's seen with traditional drag sites that it would make a difference.

Q: What guidance was sought in the landfilling option?
A: They spoke to the government and the municipalities as well as to waste handlers and composters.

Q: An AirGuard bubbler system keeps material in suspension, could it work?
A: They were aware of it, considered similar things, but feared too much spread of material, contaminants, disease, etc.

Q: What about mixing with sand in order to facilitate upland disposal?
A: It's possible.

Q: A CB analysis; is it worthwhile?
A: This will be determined in the future. Dave Wildish then made a statement that fish have been on the site for 3-4 years and it probably was a poor site to begin with. They probably wouldn't apply this technique on a large site. There was a chemical imbalance on the site to begin with. High sulfides reacted too quickly with limited oxygen generated by dragging, leaving too much excess sulfide left over. Roy agreed but noted that there was no diminishing of DO levels.

Q: Could you do it with fish present on the site?
A: Not a smart idea. Ammonia, turbidity, methane, sulfide, etc. is probably not a good environment for salmon. The obstruction of nets, tackle, etc, also presents a logistical problem.

**ROGER FLEMING**

Q: Victor Li. When EPA sets standards for a state, there's normally an acceptable range given. How about for aquaculture?
A: He's not sure at this point. EPA will have issued only one permit. The rest of them will be from Maine DEP.

Q: Will impacts be based on aquaculture standards and not the standards of other industries e.g. pulp & paper?
A: (John Sowles). They are looking at BMPs and impact thresholds. Aquaculture is a new animal that will require separate provisions.

Q: Do quality limits apply to Zone 3?
A: Yes. Five and thirty meters out are the zones and it gets more rigorous as you go further out.

Q: Warning levels. What about timing levels? The warning may come to late to render a timely change and avoid negative impact levels.
A: Good point. The system should enable that flexibility.

Q: How often will monitoring be conducted?

A: In the draft permit, its annually.

Q: Will the monitoring results be public?
A: Yes, it is all public.

Q: Is there a tendency in the US to require remediation performance bonds?
A: In Maine there's a requirement for a bond of $5000 but someone may have to think about higher amounts in the future.

**NELL HALSE**
Q: Does the association include all growers?
A: Yes.

Statement: Don't lose site of the fact that the overall environment is the issue, not just the site.
A: That's the value of proposed Bay Management Agreements.

Statement: Bay Management Agreements are good but what really needs to occur is bay wide environmental monitoring to assess far field effects.
A: (John Sowles) There are so many contaminant sources, how do you point to an aquaculture site as the only source to focus in on? Other stressors should play a role. There was a lot of discussion in agreement with this statement but no consensus on who pays for the studies.

Statement: A farmer who operates a C site should have a priority in terms of getting a new site as a replacement if his original site will not ever get to a B or better without physical remediation.
A: She agrees. Farmers want better sites. One farmer in the audience concurred and reviewed several things they're proposing to minimize the effects at a depositional site e.g. polyculture, less biomass, removing nets for off site cleaning, etc.

Statement: Management and mitigation might be a more appropriate goal than physical remediation.

# Recommendations for the Gulf of Maine Council

## Panel Discussion

Pierre Lemieux, DFO Habitat Management Branch, Ottawa
Stephen Chase, Atlantic Salmon Federation
Peter Strain, DFO Marine Environmental Sciences Division, Bedford Institute of Oceanography
Sebastian Belle, Maine Aquaculture Association

**PIERRE LEMIEUX**

There are similar issues in the Canada and USA. In Canada, the main regulatory tool is the Fisheries Act, especially Section 35 dealing with habitat protection and Section 36 dealing with pollution prevention. DFO is in the process of clarifying how the Fisheries Act applies specifically to aquaculture. More recently, the Canadian Environmental Assessment Act (CEAA) has been applied to aquaculture, so that all aquaculture operations now require an environmental assessment, which includes consideration of cumulative effects. DFO recognizes the need for a clear, science-based approach to aquaculture management.

Some principles used by DFO Habitat Management:

- Consistency: This is a national program and therefore requires consistency in its application throughout the country. At the same time, the program must be harmonized with Provincial governments that may have different approaches. There is also a need for a level playing field in comparison to other industries, while also recognizing the need to customize a program in order to make it applicable to aquaculture.
- User pay principle
- Precautionary approach: Err on the side of caution
- Adaptive management: Programs must be flexible to allow adjustments as needed.

Physical remediation is considered a last resort. The DFO No Net Loss Policy has a hierarchical approach to situations where habitat loss may occur:

- Relocation or redesign of project to avoid habitat loss. It is recognized that DFO has not done a good job at the "front end" (i.e. at the initial site selection stage).
- Mitigation, such as improved husbandry. Industry has done a good job in improving husbandry, but more can be done. Best Management Practices must be applied.
- Authorization of a HADD. This must include compensation to replace the loss of productive capacity.

Where does physical remediation fit in?

- This could be a condition for an authorization for a HADD
- In an enforcement situation, such as the result of a court order or an Inspector's Order (under the Fisheries Act)
- In a restoration situation, such as restoration of an "orphan" site as compensation for giving the proponent a new site
- Within an adaptive management framework

Some observations about remediation:

- There is still a long way to go
- Would like to see more work done on this
- Can be part of the "tool box" but only as a last resort
- Need much more emphasis on site selection, mitigation, integrated management, and far-field and cumulative effects

**STEPHEN CHASE**

Remediation is of interest, but not as direct a concern as other issues. The interest in remediation illustrates that aquaculture (like all other human activities) has an impact, but also shows the willingness to address the impacts, while allowing the aquaculture industry to continue. ASF acknowledges that industry is trying to address environmental impacts. There is a concern, however, that there are limits to the technological improvements that can be made in this regard. The ASF approach has been to develop partnerships with industry to address issues such as preventing escapes from salmon cages.

Recommendations

- Collaboration: the concerns are largely known and industry recognizes the problem. There is need for more research, but this must be done collaboratively, involving all stakeholders.
- Consultation: Involving government, industry, and NGOs, which will foster understanding and provide different perspectives on the issues.
- Consistency: Regarding industry regulation and between industries and regions
- Clarity: Must be transparent and open to scrutiny
- Commitment: More is needed
- Comprehensiveness: Environmental sustainability must go beyond single issues
- Cumulative impacts, not just near-field effects
- Closure of C-rated sites may be required.

**PETER STRAIN**

There is a dichotomy within DFO: the Department both promotes aquaculture development and at the same time tries to protect the environment. This dichotomy is not always as clear in science, since scientific projects often involve aspects of both.

Physical remediation is not a high priority for DFO Science. Cumulative and area-wide impacts are a higher priority. There are only a few C-rated sites and it appears that these may recover naturally within a few years. It is not certain how physical remediation will help. As can be seen by the project results presented by Roy Parker, physical remediation is not an easy problem to deal with. Science must look at remediation and mitigation issues in a more general way (not just regarding aquaculture).

**SEBASTIAN BELLE**

He agreed that research emphasis should be on far-field and cumulative effects. These issues are much more important than physical remediation. He rejected the assertion that human activity can have no impact. He noted that even mitigation has an impact.

- No matter how much research is done, it is still a subjective decision as to where to draw the line in determining when there is an impact.
- If we find ourselves in a situation where physical remediation is required, then we have failed (both industry and regulatory agencies).
- Industry has made many improvements. However, as new people come into the industry there is a need for constant education.

Site selection is a complex exercise. The relationship between site selection and resulting fish performance is an iterative process: you cannot accurately predict how fish will do on a new site. For this reason, there are concerns with attempts to predict carrying capacity. There is a need for constant monitoring to verify predictions.

## Summary Comments

Stephen Chase

It is important that the issue of physical remediation of aquaculture sites is being discussed as it illustrates that aquaculture operations are having impacts on the environment. It is a fact that all human activities have some impact on the environment, whether it is more or less severe. It is also a fact that measures can be taken by humans to mitigate or eliminate those impacts, provided the will to do so exists.

The calling of this conference, with the wide-ranging interests being invited, should be seen by all as an important and positive step in addressing aquaculture related environmental matters. The Gulf of Maine Council and the New Brunswick Department of Environment and Local Government are to be commended for providing the forum in which to discuss a major environmental issue. The aquaculture producers and the environmental NGOs are to be commended for rising to challenge of addressing this issue in a (hopefully) collegial manner.

This event should be considered as a "start" in acknowledging the other impacts of aquaculture and addressing them in a similar manner, so we can find solutions to all environmental concerns that do not necessarily adversely the productivity of the aquaculture operations.

It is true that the salmon farming industry and other aquaculture producers are very much aware of the need to gain control of serious environmental problems, especially those that impact the ability of the industry to produce healthy products. From the perspective of the Atlantic Salmon Federation, it does not matter what provides the motivation, so long as progress is being made in dealing with environmental maters that are of concern to us.

For our part, ASF is not directly concerned with the environmental quality of the benthic substrate under salmon farm sites, but since it represents a factor in the overall quality of the environment, we do harbor some interest in the area. Other environmental NGOs could speak more effectively on those concerns, and I will not attempt to speak for them.

ASF has been working quite hard to develop a good working relationship with salmon farming aquaculture industry representatives for quite some time. We are, in fact, quite proud of the role we played in establishing the salmon farming industry in this area through the Salmon Genetics Research Program (SGRP) which played, and still plays a major role (via Huntsman) in supporting the industry.

Our approach to the industry has been based on the mutual concerns of keeping salmonids from escaping into the environment where there are adverse interactions with wild salmon populations, and keeping the fish healthy, to reduce the spread of disease. The industry shares these concerns, albeit for somewhat different reasons. The reasons should not matter so long as we attain mutually beneficial solutions. We remain hopeful that we will be able to generate results that benefit wild salmon populations in the Bay of Fundy, Gulf of Maine, and elsewhere, populations on which the environment depends and on which the industry depends for access to local wild genetic stock.

Here are my recommendations, based on what I have heard, as well as what I would add that was not heard:

- Collaboration: As several speakers noted yesterday, the concerns with salmon farming are largely known. The industry has acknowledged the needs and has indicated that it is committed to controlling its problems. Everyone seems to agree on the need for research toward finding the solutions to address the impacts of aquaculture on the environment. Moreover, that this be conducted in a collaborative fashion with governments and, I would add, with other competent, research-based conservation organizations.

- Consultation: There is a clear need for more genuine consultative opportunities where the key stakeholders are brought together in a collaborative forum: both government to stakeholders and industry to stakeholders. Events of this kind are much more likely to foster understanding and build appreciation of differing perspectives on environmental matters than will negotiating through the media.

- Consistency: There is a clear need for consistency in approaching regulation of this industry, on the part of both the regulators and the regulatees. Clearly, this need transcends more than aquaculture, but it is not a given. Regulators need to apply the regulations in the same manner between sites and between regions in fairness so that those being regulated know what to expect, whether it is for site related environmental issues or any other regulatory subject.

- Clarity: All regulatory practices, licensing and other governance matters should be clearly transparent and open to scrutiny. This will ensure fairness prevails and that the rules are seen to be applied, fairly.

- Commitment: To give life to all the above, there needs to be a commitment among the parties to work together toward improvement. Where this is not possible, regulations and policy must be established to ensure improvement is achieved.

- Comprehensiveness: Environmental sustainability must extend beyond consideration of single environmental impact issues. There must be assurance that all reasonable aspects associated with environmentally sustainable aquaculture are considered. The focus on site remediation is a start. Other adverse impacts must also be dealt with in a way that meets the tests outlined above.

- Closure: Maybe we need to contemplate closure and replacement of so called “C” sites. I heard that remediation of such sites is too difficult, that the risks to the industry are too high and that too much scarce regulatory time is used-up on “C” sites. Perhaps it would be more productive to close these sites and move on.

In addition, this event seemed to agree on the need to consider the broader environment when examining environmental issues. In an aquatic environment, we need to consider the impacts of aquaculture operations on a large scale, rather than focusing on site-specific regulation.

## General Discussion

**Marianne Janowicz:** Two common themes from the panelist's presentations were:

- Front end planning (site selection, farm sizes, operational practices) is key to preventing problems. There is an overriding feeling that we have to monitor carefully and assess cumulative effects.
- Do we need the ability to conduct physical remediation in our toolbox?

**Janice Harvey**

- Physical remediation is the last issue that we should be discussing
- We should not go away thinking that physical remediation can provide short-term fixes for problem sites
- We should all acknowledge that there are a few "C" sites and we should be putting our efforts into finding replacement sites for these operations so that they can be abandoned and remediated. Operators with "C" sites should have the highest priority for replacement sites. There should be no "C" sites and they should not be allowed to continue operating indefinitely
- The panelists showed good consensus about the important issues
- Natural recovery should be allowed to proceed and the sites monitored carefully to assess recovery; physical remediation should only be used as a last resort
- The environmental management of the bay management areas should consider all loading to the area and integrate the concerns and inputs from all of the other users of the bay
- CCNB raised these issues 12 years ago but were ignored by both government & industry
- Sacrificial zones around salmon farms are not acceptable
- Although there are only a few "C" sites and they only represent 10 hectares in total; due to the lack of access to information, she is not aware of where the problems are but suspects that the sites are concentrated in a couple of areas like Lime Kiln Bay or Passamaquoddy Bay and are not evenly distributed over the whole area used by salmon farmers.

**Art MacKay:** There are between 2000 and 3000 direct workers who depend on this industry in NB for their livelihood. They constantly face issues of salmon prices, disease outbreaks, competition, etc. These are not esoteric things but real people and real businesses. The imposition of CEAA by DFO on the new site allocation process earlier this year was very onerous to the industry.

**Inka Mileski:** Aimed her comments at DFO Habitat (Pierre Lemieux)

- The lack of consistent enforcement of fish a habitat issues among sectors and across the country was a big problem; there are big inequalities.
- The current standards are too low, the bar must be raised; there is no one addressing biodiversity issues.

**Gerhard Pohle**

- Remediation should be in the tool box but as a last resort
- However, we don't understand remediation so if we want it in the tool box it needs much more study and research
- Assessing cumulative effects is a difficult issue because of the many potential threats to an ecosystem; it is difficult to assess effects to particular sources. Government should be taking the lead on this issue by recruiting the right players and providing financial support to research dedicated to addressing this issue

**Art MacKay:** The industry's move to single year class production with fallowing between cycles represents a big step forward in protecting the environment.

**Janice Harvey:** In order to understand what is going on at salmon farm sites, we need to monitor. If the move to single year class and fallowing is successful, we need to monitor the sites to confirm that. There is not enough investment in this either by the industry or by government. Ninety-percent of the investment is directed toward development and expansion of the industry and only 10% of the resources are directed at environmental issues.

**Steve Chase:** There is a pressing need for transparency. The public needs to be informed about the results of monitoring and of the environmental conditions around the farm sites. There is also a pressing need for leadership in this area by government.

**Sebastian Belle**

- On the contrary, in the USA, the relative assignment of funds has been 90% toward the environment and only 10% on development.
- In Norway, they have the best water quality monitoring data in the world. About 750 farms serve as monitoring platforms for the government.
- The goals for a healthy environment and productive salmon farms are the same; the farmers are closer to the environment than most of the scientists. There are good opportunities for collaboration.
- Transparency is a big legal issue in the USA.

**Marianne Janowicz:** I see a few common themes in terms of an environmental management system for aquaculture coming out of our dialogue:

- Front end planning is important in terms of sound site selection
- Operating farms in a manner to mitigate any adverse impacts
- Integrated management of bay areas or watersheds
- Assessment of cumulative effects
- Monitoring

**Dave Wildish:** There is good consensus that "C" rated sites are not acceptable.

**Fred Page:** A priority for industry and government should be to replace "C" rated sites.

**Karen Coombs:** The priority at present is to allocate sites in order to implement the single year class structuring. The next priority will be to replace "C" rated sites.

**Susan Atkinson:** Action must be taken if a site is consistently degraded

**Sebastian Belle:** If a site is degraded and remains degraded even with changes to husbandry and operating practices, the site should be abandoned. The farmer should be given one growing cycle to fix the problem. If the monitoring indicates that the site is still degraded and shows no improvement, then the site should be abandoned.

**Barry Hargrave:** In the recent BC court case of the Suzuki Foundation vs. Stolt Sea Farms, the company moved their operations off the site. Each farm site should have a site specific environmental management plan that is aimed at achieving compliance, (i.e. no degradation of the environment however that is defined by the various authorities). The plan should include an increased level of monitoring for impaired sites and the plan requires an effective and expedient site replacement plan.

**Peter Strain:** The need for remediation really comes down to two issues- poor site selection and poor site management.

**Susan Atkinson:** We still need more information about the effectiveness and methods for physical remediation. Physical remediation has the potential to be the tool of last resort but more study is required so that we can better understand what methods could be utilized and how effective they really are.

**Dave Wildish:** I have some concerns that harrowing may do more damage than good because of the physical damage to the benthic organisms that could result. The biological community can play a big role in the natural processes involved in site recovery.

**Pierre Lemieux:** The Minister has the discretion to authorize a degraded site (HADD authority). The Fish Habitat policy would require some sort of compensation—usually the enhancement of similar habitat in the area. It would be a matter of whether the industry would want to keep a site that was not valuable fish habitat?

**Marianne Janowicz:** A decision to apply for a HADD authorization could come from the review by the Remediation Committee.

**Sebastian Belle:** Our experience in the USA has been that if a site exceeds the established environmental quality standards, the economic performance of the farm is probably jeopardized. There are no economic subsidies for a poorly performing site so the effects on the grower a direct and immediate.

**Karen Coombs:** If abandonment of a site is required, those operators should get priority for the allocation of a new site.

**Marianne Janowicz:** There is a public perception issue related to the authorization of a HADD. It could give the impression that the whole industry is damaging fish habitat. What kind of compensation could be implemented?

**Sebastian Belle:** There is a need for more applied research related to site carrying capacity and methods that can be used to prevent a site from becoming overstocked. As well, there is a risk of giving priority for new sites to operators who have degraded sites. This should not be used to allow sloppy operations.

**Hugh Madill:** The reality of this is that there are currently 94 salmon farm sites and established exclusion zones. So there are very limited options for finding new sites. So, although in theory, it sounds god to give operators of poor sites priority for new sites, there are very few options for new sites out there.

**Fred Page:** The regulations must be consistently applied. All of the regulatory agencies should be striving to get their respective regulatory tools and policies working together. How do we determine if the operators are following the established codes of practice? What auditing mechanisms are in place or need to be implemented? How can the government ensure that a site is being properly operated?

**Steve Chase:** I agree with the previous comment but there is a transparency issue related to this. How can the public be assured that the farms are not causing any environmental problems?

**Fred Page:** Regarding the priority for new sites, the onus should not be entirely on the industry to find new sites; government has some responsibilities to help find new sites because the government has already approved the existing sites.

**Maria-Ines Buzeta:** It seems to me that the real key in preventing degradation of a farm site lies in site selection. The site selection process should follow a precautionary approach. The time for preparing applications and for technical reviews for the 2001 site allocation was too short. As more and more sites are established within the permitted boundaries, assessment of potential cumulative effects are the most important and least understood aspect. The data requirements for knowledgeable decision-making should be well defined and the industry should be given adequate time to acquire that data.

**Unknown man:** It is important that we get out the good news and tell the public what the industry is doing right.

**Vance Pendleton:** The whole issue of leasing sites based on an approved number of fish is an issue that should be considered. The growers would prefer a performance-based standard; i.e. they can grow as many fish as they like as long as there are no resulting environmental or fish health problem.

**Marianne Janowicz:** The committee time frame for the recommendations from the input received is to have to workshop proceedings completed by mid-February, 2002.

# Recommendations

- Front end planning including site selection criteria, farm size, operational practices, site-specific mitigation plans, etc. are key to preventing environmental degradation at sites. Exiting policies should be reviewed and overhauled where necessary to ensure they are fulfilling the requirements of regulators, the industry, and the public.

- Efforts should continue to develop and implement new approaches to aquaculture development, siting, and management. This should include:
- The application of a precautionary approach when siting aquaculture facilities.
- The application of performance based production limits or the thorough assessment of site capacity prior to determining a production number.
- Government taking a more active role in identifying areas where aquaculture development would least impact fisheries activities, habitat and the marine ecosystem generally.
- Integrated management of bay area could be a tool for maintaining the marine ecosystem.

- Monitoring is a necessary component of aquaculture management and more emphasis should be placed on assessing cumulative effects. While at this point, assessing cumulative effects is difficult due to the many influences to the marine ecosystem in a specific location, this is an area where more dedicated research should be initiated. This research should include the development of an assessment methodology.

- All available and practical mitigation measures need to be identified so that a complete toolbox is available to all stakeholders.

- Physical remediation is not practical on a large scale at this time. It has potential to be a tool but only as a last resort in most cases. Physical remediation research and study (methodologies) should continue within a policy-making framework.

- Sites that continue to be degraded should be targeted for abandonment. If abandonment is required, a framework should be developed to provide operators with priority alternative sites.

- Greater transparency is needed so that the public is better informed about environmental conditions around aquaculture sites.

- It is important that the positive news about industry initiatives be available to the public.

# WORKSHOP AGENDA
## Aquaculture Physical Remediation

September 20, 2001

WELCOME AND WORKSHOP OVERVIEW

1000 Introductory Remarks
Byron James, New Brunswick Department of Environment and Local Government

1015 Workshop Goals and Objectives
Jay Clement, U.S. Army Corps of Engineers
Nell Halse, New Brunswick Salmon Growers Association

REGULATORY PERSPECTIVE

1045 Setting the Stage: Regulatory Perspective
Darrell Welles, New Brunswick Department of Environment and Local Government

1100 Environmental Management of Finfish Aquaculture in Maine
John Sowles, Maine Department of Marine Resources

1115 The Canadian Ocean Disposal Permitting System
Victor Li, Environment Canada

HOW RECOVERY OCCURS NATURALLY

1130 Natural Recovery: Benthic Fallowing
David Wildish, Canada Department of Fisheries and Oceans

1215 LUNCH PROVIDED

HOW RECOVERY OCCURS NATURALLY (continued)

1315 How Recovery Occurs Naturally: Benthic Effects of Fallowing and Cessation of Operations at a Salmon Farm in the Letang Inlet
Gerhard Pohle, Huntsman Marine Science Centre

EFFORTS TO STIMULATE RECOVERY

1345 Retrospective Comments*
John Henningson, Hart Crowser, Inc.

1430 Physical remediation of Sediments at a Salmon Growing Site in Passamaquoddy Bay, New Brunswick*
Roy Parker, Environment Canada

1515 BREAK

EFFORTS TO STIMULATE RECOVERY (continued)

1530 NGO Perspective
Roger Fleming, Conservation Law Foundation

1615 Industry Perspective
Nell Halse, New Brunswick Salmon Growers Association

1730 RECEPTION

September 21, 2001

DEVELOPING RECOMMENDATIONS FOR THE GULF OF MAINE COUNCIL

830 Roundtable Discussion
Pierre Lemieux, Department of Fisheries & Oceans
Peter Strain, Bedford Institute of Oceanography
Sebastian Belle, Maine Aquaculture Association
Stephen Chase, Atlantic Salmon Federation

945 Recommendation Development

1100 Final Summation

1200 WORKSHOP ADJOURNS

* Keynote Speaker

# Workshop Participants


### Susan Atkinson
Director - Regional Services
Dept. of Environment & Local Gov't.
8 Castle Street
P. O. Box 5001
Saint John, N.B. E2L 4Y9
Telephone: (506) 658-2116
Fax: (506) 658-3046
E-Mail: susan.atkinson@gnb.ca

### Andrew G. Bagnall
Supervisor of Extension Services
N.S. Fisheries and Aquaculture
Aquaculture Division
P. O. Box 2223
5151 George St., 7th Floor
Halifax, N.S. B3J 3C4
Telephone: (902) 424-0355
Fax: (902) 424-1766
E-Mail: bagnalag@gov.ns.ca

### Ed Baum
Atlantic Salmon Unlimited
P. O. Box 6185
Hermon, ME 04402
Telephone: (208) 848-5590
Fax: (207) 848-5591
E-Mail: asunlimitd@aol.com

### Christopher Blanar
UNBSJ
Huntsman Marine Science Centre
213 Water St.
St. Andrews, N.B. E5B 1B3
Telephone: (506) 529-8271
Fax: (506) 529-1212
E-Mail: cblanar@hotmail.com

### Cyril Boudreau
Development Officer
N.S. Agriculture and Fisheries
Aquaculture Division
5151 George St., 7th Floor
P. O. Box 2223
Halifax, N.S. B3J 3C4
Telephone: (902) 424-0324
Fax: (902) 424-1766
E-Mail: boudrecy@gov.ns.ca

### M. Buzeta
DFO
SABS
Telephone: (506) 529-8854
E-Mail: buzetam@mar.dfo-mpo.gc.ca

### Steven Chase
ASF
P. O. Box 5200
St. Andrews, N.B. E5B 3S8
Telephone: (506) 529-1057
Fax: (506) 529-4985
E-Mail: schase@nb.aibn.com

### Tanya Cholmondeley
Water Resources Technologist
Environmental Technician
Jacques Whitford Environment Limited
Jacques Whitford Building
3 Spectacle Lake Drive
Dartmouth, N.S. B3B 1W8
Telephone: (902) 468-7777, Ext. 229
Fax: (902) 468-9009
E-Mail: tcholmon@jacqueswhitford.com

### Chiu L. Chou
BIO
P. O. Box 1006
Dartmouth, N. S.
Telephone: (902) 426-6277
Fax: (902) 426-7866
E-Mail: chouc@mar.dfo-mpo.gc.ca

### Jay Clement
U.S. Army Corps of Engineers
675 Western Ave. #3
Manchester, Maine 04351
Telephone: (207) 623-8367
Fax: (207) 623-8206
E-Mail: jay.l.clement@usace.army.mil

### Karen Coombs
N.B. Dept. of Agriculture, Fisheries & Aquaculture
P. O. Box 6000
Fredericton, N.B. E3B 5H1
Telephone: (506) 755-4000
Fax: (506) 755-4001
E-Mail: karen.coombs@gnb.ca

### Mark J. Costello
Huntsman Marine Science Centre
1 Lower Campus Road
St. Andrews, N.B. E5B 2L7
Telephone: (506) 529-1200
Fax: (506) 529-1212
E-Mail: costello@huntsmanmarine.ca

### Steve Cross
Aquametrix Research Ltd. and BCSFA
2541 Conrad Road
Telephone: (250) 338-9255
Fax: (250) 338-9288
E-Mail: cross@aquametrix-research.com

### D.R. (Dave) Duggan
Oceans & Coastal Management Division
Oceans & Environment Branch
Fisheries and Oceans Canada
1 Challenger Drive, 5th Floor Polaris
P. O. Box 1006
Dartmouth, Nova Scotia B2Y 4A2
Telephone: (902) 426-6183
Fax: (902) 426-3855
E-Mail: duggand@mar.dfo.mpo.gc.ca

### Peter L. Fenety
St. Croix Estuary Project
94 Queen Street
St. Andrews, N.B. E5B 1C6
Telephone: (506) 529-1084
Fax: (506) 529-3652
E-Mail: geolcons@sympatico.nb.ca

### Roger Fleming
Conservation Law Foundation - Maine
120 Tillson Avenue
Rockland, ME
Telephone: (207) 594-8107
Fax: (207) 596-7706
E-Mail: rfleming@clf.org

### Eric Garnier
Dominator Marine
P. O. Box 6191
Saint John, N.B.
Telephone: (506) 697-2021
Fax: (506) 763-3483
E-Mail: dominate@nb.sympatico.ca

### Jennifer Graham
Centre for Community Management
248 Water Street
St. Andrews, N.B. E5B 1L3
Telephone: (506) 529-8357
E-Mail: grahamj@cnb.sympatico.ca

### Nell Halse
General Manager
New Brunswick Salmon Growers' Association
226 Lime Kiln Road
Letang, N.B. E5C 2A8
Telephone: (506) 755-3526
Fax: (506) 755-6237
E-Mail: nbsganh@nb.aibn.com

### Loretta Hardwick
Jacques Whitford Environment Limited
590 North River Road
Telephone: (902) 566-2866
Fax: (902) 566-2004
E-Mail: hardwick@jacqueswhitford.com

### Janice Harvey
Marine Conservation Program Director
Conservation Council of New Brunswick
45 Libbey Lane
Waweig, New Brunswick E3L 5Z1
Telephone: (506) 466-4033
Fax: (506) 466-2911
E-Mail: ccnbharvey@nb.aibn.com

### Kats Haya
DFO/SABS
St. Andrews, N.B.
Telephone: (506) 529-8854

### Barry Hayward
DFO/BIO
P. O. Box 1006
Dartmouth, N.S. B2Y 4A2
Telephone: (902) 426-3188
E-Mail: haywardb@dfo-wpn.gc.ca

### John C. Henningson
Hart Crowser Inc.
150 Warren Street, 2nd Floor
Jersey City, NJ 07302
Telephone: (201) 485-8100
Fax: (201) 985-8182
E-Mail: john.henningson@hartcrowser.com

### Barry Hill
Dept. of Fisheries and Aquaculture
P. O. Box 129
85 Mount Pleasant Road
St. George, N.B. E0G 2Y0
Telephone: (506) 755-4000
Fax: (506) 755-4001
E-Mail: barryh@gnb.ca

### Craig Hominick
Environmental Assessment Technician
Habitat Management Division
Oceans & Environment Branch
Maritimes Region
1 Challenger Drive, 5th Floor Polaris BIO
P. O. Box 1006
Dartmouth, N.S. B2Y 4A2
Telephone: (902) 426-3622
Fax: (902) 426-1489
E-Mail: HominickC@mar.dfo-mpo.gc.ca

### Marianne Janowicz
Dept. of Environment & Local Gov't.
P. O. Box 6000
Fredericton, N.B. E3B 5H1
Telephone: (506) 457-4846
Fax: (506) 457-7823
E-Mail: marianne.janowicz@gnb.ca

### Gary Julien
Environment Canada, Env. Protection
45 Alderney Dr.
Dartmouth, N.S. B2Y 2N6
Telephone: (902) 426-4486
Fax: (902) 426-8373
E-Mail: gary.julien@ec.gc.ca

### Melanie Laird
Dept. of Agriculture, Fisheries and Aquaculture
P. O. Box 6000
Fredericton, N.B. E3B 5H1
Telephone: (506) 453-2253
Fax: (506) 453-5210
E-Mail: melanie.laird@gnb.ca

### Pierre Lemieux
DFO
200 Kent
Ottawa, Ontario
Telephone: (613) 993-1854
E-Mail: LemieuxPie@DFO-MPO.GC.CA

### Victor Li
Environment Canada
Telephone: (902) 426-8305
Fax: (902) 490-0705
E-Mail: victor.li@bc.gc.ca

### George D. Lindsay
Manager, Environmental Protection Branch
Environment Canada
77 Westmorland Street, Suite 450
Fredericton, N.B. E3B 6Z3
Telephone: (506) 452-3286
Fax: (506) 452-3003
E-Mail: george.lindsay@ec.gc.ca

### Art MacKay
Art MacKay & Associates
5476 Route 127
Telephone: (506) 529-3858
Fax: (506) 529-8441
E-Mail: amackay@nbnet.nb.ca

### Hugh Madill
Dept. of Agriculture, Fisheries & Aquaculture
Telephone: (506) 755-4000
Fax: (506) 755-4001
E-Mail: hugh.madill@gnb.ca

### Shawn Mahaney
U.S. Army Corps of Engineers
675 Western Ave., #3
Manchester, Maine, USA 04351
Telephone: (207) 623-8367
Fax: (207) 623-8206
E-Mail: shawn.b.mahaney@usace.army.mil

### Inka Milewski
Conservation Council of N.B.
254 Douglasfield Road
Miramichi, N.B. E1N 4S5
Telephone: (506) 622-2460
Fax: (506) 622-2438
E-Mail: milewski@nbnet.nb.ca

### Mary Mills
DFO
203 Water St.
St. Andrews, N.B.
Telephone: (506) 529-5855
Fax: (506) 529-5818
E-Mail: millsm@dfo.mpo.gv.ca

### Simona Motnikar
MAPAQ, QUEBEC, CAMGR
5, rue du Parc
Grande-Rivière, Québec
Telephone: (418) 385-2251 (Loc 228)
Fax: (418) 385-3343
E-Mail: simona.motnikar@agr.gouv.qc.ca

### Fred Page
DFO
531 Brandy Cove Road
Biological Station
St. Andrews, N.B. E5B 2L9
Telephone: (506) 529-5935
Fax: (506) 529-5862
E-Mail: pagef@mar.dfo-mpo.gc.ca

### Roy Parker
Environment Canada
77 Westmorland St., Suite 450
Fredericton, N.B. E3B 9K1
Telephone: (506) 452-3234
Fax: (506) 452-3003
E-Mail: royparker@ec.gc.ca

### George Parson
158 Kerrs Ridge Rd.
Telephone: (506) 529-4652
E-Mail: parsong@nbnet.nb.ca

### Vance Pendleton
AANB
248 Main St.
Upper L'etang, N.B. E5C 3V1
Fax: (506) 755-7701

### Phillip Peters
Director of Business Development
Barrington Environmental Services
720 Grandview Ave.
P. O. Box 3400, Station B
Saint John, N.B. E2M 4X9
Telephone: (506) 632-4745
Fax: (506) 635-5608
E-Mail: Peters.Phillip@irvingequipment.com

### Gerhard Pohle
HMSC
1 Lower Campus Road
St. Andrews, N.B.
Telephone: (506) 529-1203
Fax: (506) 529-1212
E-Mail: arc@mar.dfo-mpo.gc.ca

### Guy Robichaud
DFO - Habitat Management
C. P. 5030
Moncton, N.B. E1C 9B6
Telephone: (506) 851-2993
E-Mail: robichaud.guy@mar.dfo-mpo.gc.ca

### Tom Sephton
SABS
DFO
St. Andrews, N.B.
Telephone: (506) 529-8854
E-Mail: sephtont@dfo-mpo.gc.ca

### Gregory Shanks
Director, Stewardship
Environmental Management Division
Department of Environment & Local Government
P. O. Box 6000
Fredericton, N.B. E3B 5H1
Telephone: (506) 453-7945
Fax: (506) 453-2390
E-Mail: greg.shanks@gnb.ca

### Jennifer Smith
Heritage Salmon Inc.
Estes Head
Eastport, Maine
Telephone: (207) 853-6081
Fax: (207) 853-6056
E-Mail: jennifer.smith@heritage.ca

### James A. Smith
CoastalSmith Inc.
120 Mount Pleasant Ave.
Saint John, N.B. E2K 3V1
Telephone: (506) 642-4814
Fax: (506) 642-4818
E-Mail: james@coastalsmith.com

### John W. Sowles
Department of Maine Resources
Bureau of Resource Management
P. O. Box 8
McKown Point Road
West Boothbay Harbor, ME 04575
Telephone: (207) 633-9518
Fax: (207) 633-9579
E-Mail: john.sowles@state.me.us

### Ian Stewart
Assistant General Manager
Atlantic Silver
2 Salar Court
St. George, N.B. E5L 3N1
Telephone: (506) 755-3304
Fax: (506) 755-6361

### Peter Strain
DFO
Box 1006
Dartmouth, N.S. B2Y 4A2
Telephone: (902) 426-3639
Fax: (902) 426-6695
E-Mail: strainp@mar.dfo-mpo.gc.ca

### Steve Tinker
Atlantic Salmon Federation
P. O. Box 5200
St. Andrews, N.B. E5B 3S8
Telephone: (506) 529-1062
Fax: (506) 529-4985
E-Mail: stevet@nb.aibn.com

### Darrell Welles
Dept. of Environment & Local Gov't.
P. O. Box 6000
Fredericton, N.B. E3B 5H1
Telephone: (506) 453-6633
E-Mail: darrell.welles@gnb.ca

### D.J. Wildish
DFO
Fax No.: (506) 529-5862
E-Mail: wildishd@dfo-mpo.gc.ca

### Steve Zwicker
Environmental Assessment Section
Pollution Prevention Division
Environment Canada - Atlantic Region
16th Floor, Queen Square
45 Alderney Drive
Dartmouth, N.S. B2Y 2N6
Telephone: (902) 426-0992
Fax: (902) 426-8373
E-Mail: stephen.zwicker@ec.gc.ca

# Keynote Speakers

## John Henningson

Hart Crowser, Inc.

Mr. Henningson is the Principal Sediment Remediation Design Engineer for the Eastern Region of Hart Crowser, Inc. He is licensed as a professional engineer in seven states including MA, CT, NJ and NY and has over 30 years of experience in environmental science and engineering. He has a BA from Syracuse University in Science Education (Biology and Earth Science) and a MS in Environmental Engineering from Rensselaer Polytechnic Institute.

His first contaminated sediment project involved the planning and design of the removal of 250,000 CY of PCB sediment contaminated from the upper Hudson River in the late 70's. He has been involved with the remediation of contaminated sediments and navigational dredging projects ever since including remedial programs at 7 federal superfund sites and numerous former manufactured gas plant (MGP) sites. He has also been responsible for conducting bench and pilot tests of sediment remediation technologies including both decontamination and fixation/stabilization under funding from WRDA and from the private sector.

## Roy Parker, B.Sc. and MES

Environment Canada

Roy has been employed by the federal government since 1970 in a variety of positions related to environmental science, environmental protection and environmental management. At the present time, he is the Environmental Science Advisor in the Environment Canada office in Fredericton. He has been involved with the development and implementation of the regulatory environmental effects monitoring (EEM) program for pulp and paper mills and more recently with the development of an EEM program for metal mining operations.

He has considerable experience working with multi-stakeholder groups on a variety of environmental issues. For the past few years, he has been focusing his attention on the evaluation of potential environmental impacts from shellfish and finfish aquaculture and on management strategies for dealing with these issues.