Atlantic Canada Fish Farmers Association

ACFFA Annual Technical Workshop And Research Review 2013

FINAL REPORT

November 6 and 7, 2013

Huntsman Marine Science Center

St. Andrews, NB

Table of Contents

Introduction

The Atlantic Canada Fish Farmers Association hosted its annual technical workshop and research review on November 6th and 7th, 2013 at the Huntsman Marine Science Centre in St. Andrews, New Brunswick. This annual workshop is designed to support the review and discussion of R&D results, identification of new technologies and communication on various regional and federal activities.

Presentations continue to increase environmental knowledge, enhance farm management practices and support conservation / enhancement projects. The Inner Bay of Fundy Atlantic salmon recovery project between ACFFA and Fundy National Park provided data which can be used to inform future recovery strategies in the Park and potential new collaborations. A presentation on climate change provided information for thoughtful consideration while other presentations discussed the practical aspects of benthic monitoring and offshore aquaculture.

Regional and global fish health presentations focused on ISA and cold water ulcer disease. A review of National Aquatic Animal Health Program (NAAHP) program under CFIA and the new import requirements for farming companies and potential changes under the domestic control program were presented.

Alternative control methods / management tools to support a fully operational integrated pest management (IPMP) for sea lice continued to be a primary focus of research for the salmon aquaculture industry in Atlantic Canada. The research presented focused on resistance and alternative management tools and cleaner fish research. Information on a new technology and treatment delivery system was presented that may be evaluated for use in local conditions.

Over 130 individuals attended the technical workshop and included aquaculture industry representatives from across Canada, researchers (local, national and international), pharmaceutical company representatives, federal and provincial regulators and other stakeholders including fishery and conservation interests

Acknowledgements

The ACFFA wishes to acknowledge the support of:

Fish Vet Group

Merck Animal Health

Novartis Animal Health

Skretting

Solvay Chemicals

Aqua Pharma

Canada Cryogenetics

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In addition, the participation of all of the speakers at this session is greatly appreciated by the ACFFA.

Agenda

Atlantic Canada Fish Farmers Association

Annual Workshop and Research Review 2013

November 6th and 7th, 2013

Huntsman Fundy Discovery Aquarium, St. Andrews, NB

WEDNESDAY, NOVEMBER 6, 2013

8:00 **Registration and Coffee / Muffins**

8:30 Welcome and Introduction – Pamela Parker, ACFFA
8:40 DFO National Update - Eric Gilbert, DFO
9:10 DFO Maritimes Regional Update - Faith Scattolon, DFO
9:40 National Aquaculture Development – Ruth Salmon, CAIA
10:10 Climate Change and Implications for Aquaculture – Gregor Reid, CIMTAN/UNB

10:35 **Refreshment Break**

10:50 Funding Opportunities for Genomics Research and Development – Shelley King, Genome Atlantic
11:10 Aquaculture Technician Program at NBCC: 35 Years and Counting - Nelson Alward, NBCC
11:40 Exploring Opportunities to Engage the Research, Development and Innovation Cluster of Expertise in South West New Brunswick - Jamey Smith, Huntsman Marine Science Centre

12:30 **Lunch**

1:45 Overview of the Aquatic Import Program – Lisa Myers, CFIA
2:10 CFIA Domestic Movement Control for Finfish and Mollusc – Wole Oguntona, CFIA
2:35 Harmful Algal Blooms and the Finfish Industry - Jennifer Martin, DFO-SABS
3:05 Early Environmental Exposure Effects on Fitness in a Population of Endangered Atlantic Salmon – Corey Clarke, Fundy National Park

3:30 **Refreshment Break**

3:45 Monitoring Aquaculture Ecosystems: Progress and Evolution - Jon Grant, Dalhousie
4:05 Development of a Robust Methodology for Sulphide Probe Calibration – Blythe Chang, DFO-SABS & Bob Sweeney, SimCorp
5:00 Developments in Offshore Aquaculture - Terry Drost, 4 Links Marketing

5:30 **Adjournment & Networking Reception**

THURSDAY, NOVEMBER 7, 2013

8:00 **Coffee and Muffins**

8:30 Welcome and Introduction
8:40 ISA: Past and Present – Michael Beattie, NB DAAF
9:05 Updates on Cold Water Ulcer Disease in Canada – Allison MacKinnon, Novartis Animal Health
9:30 Fish Feeds, Yesterday Today and Tomorrow – Steve Backman, Skretting
9:55 Bacteria, what are they good for? – Ben Forward, RPC

10:30 **Refreshment Break**

10:45 Sea Lice Trends, Trials, and Tribulations - Larry Hammell, AVC
11:05 Genomic Tools to Resolve Environmental Impact & Treatment Resistance in Sea Lice - Sara Purcell, AVC
11:30 Best Practice: Closed Tarpaulin Sea Lice Treatments - Nils Steine, Pharmaq
12:00 Progress Report: Trapping Technology on Salmon Aquaculture Sites - Shawn Robinson, DFO-SABS

12:30 **Lunch**

1:45 Cunner as Cleaner Fish and Cunner Breeding Program - Keng Pee Ang, Kelly Cove Salmon
2:10 Optical Sea Lice Treatment - John Arne Breivik & Esben Beck, Stingray Marine Solutions AS
2:40 Development of a New Bio-pesticide Against Sea Lice - Dr. Delphine Ditlecadet, Soricimed Biopharma
3:05 OFFSPRING DNA Traceability System – Ben Forward, RPC

3:35 **Wrap Up**

4:00 **Adjournment**

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We make aquaculture progress!

Presentation Synopses and Speaker Biographies

The following synopses were completed by the speakers or prepared by ACFFA and approved by the speakers.

Wednesday, November 6, 2013

DFO NATIONAL HEADQUARTERS WORK-PLAN PRIORITIES FOR AQUACULTURE IN CANADA

– Eric Gilbert, Director General, Aquaculture Management Directorate, Fisheries and Oceans Canada (DFO) Ottawa

Mr. Gilbert' provided an overview of the changes that have been taking place within DFO to both the organizational structure and work plan priorities.

In response to the 2013 Budget the Program Policy and Ecosystems and Fisheries Management sectors were merged, integrating Aquaculture Policy and Operations within one Directorate. The new organizational chart was presented; the Director of Aquaculture Operations has yet to be determined. The budget provided for a renewal of the Sustainable Aquaculture Program for another 5 year term, with the three pillars including regulatory reform, regulatory science, and regulatory and sustainability reporting. Under regulatory reform, DFO expects the Aquaculture Activities Regulation will be in place for the 2014 growing season and the new Fisheries Act to be in place by the end of this year.

An update on changes within the BC aquaculture industry were identified in reference to the Cohen commission recommendations. The 2013 highlights of Canadian Shellfish Sanitation Program (CCSP), now coordinated under Aquaculture Management Division, were reviewed.

To address the interest of First Nations communities in aquaculture, a new Aboriginal Aquaculture in Canada Initiative (AACI) has been established with a three year, $3.15 million budget. Three groups have already taken advantage of this program and hired staff technicians to assist with aquaculture business development.

See Attached Presentation

<u>Eric Gilbert</u>
Éric Gilbert was appointed to the position of Director General, Aquaculture Management with the Department of Fisheries and Oceans in October, 2013. Éric is a biologist and obtained a Master Degree in Natural Resource Management. He has more than 25 years of provincial and federal experience in the fisheries and aquaculture sectors. He has been providing leadership and direction in the development and implementation of the federal government's and Fisheries and Oceans Canada's policy and regulatory frameworks in support of the sustainable development aquaculture sector.

DFO Maritimes Regional Update

– Faith Scattolon, Regional Director General, Maritimes Region, Fisheries and Oceans Canada (DFO)

Ms Scattolon discussed some of the regulatory changes being implemented as the new Fisheries Protection Provisions under the *Fisheries Act* come in to force. Under the revised *Fisheries Act,* causing serious harm to fish that are part of or that support a commercial, recreational or Aboriginal fishery is prohibited. "Serious harm" is defined as the death of fish or the permanent alteration or destruction of fish habitat. The audience was told that new information would be on the DFO web site soon and an order bringing into effect the new provisions of the *Fisheries Act* would be posted in the Canadian Gazette II November 25th. Ms. Scattolon also noted that amendments to the *Canadian Environmental Assessment Act* and associated regulations have resulted in changes to the types of projects requiring a federal environmental assessment.

Outer Bay of Fundy (oBoF), Southern Upland (SU) and Eastern Cape Breton (ECB) Atlantic salmon populations are currently under review for potential listing under the *Species at Risk Act (SARA)*. All three populations have been assessed as endangered by the Committee on the Status of Endangered Wildlife in Canada, an independent scientific body. Over the past year, DFO conducted Recovery Potential Assessments for each of the three populations, to synthesize the best available scientific information regarding their status, potential threats, and recovery feasibility and targets. The next step is to evaluate the socio-economic impacts of listing each population under SARA and to conduct consultations with partners and stakeholders. Consultations for the Southern Uplands populations are expected to begin in late 2013, with consultations for the remaining two populations following in 2014. The Inner Bay of Fundy population of Atlantic salmon is already listed as endangered under SARA.

The National Code on Introductions and Transfers has been renewed and will be implemented with the full implementation of the National Aquatic Animal Health Program (NAAHP), which is projected to occur in 2014/15. Reference was made to the importance of the various science projects undertaken by staff located at the St. Andrews Biological Station and the Bedford Institute of Oceanography (BIO) under funding for the Program for Aquaculture Regulatory Research (PARR) and the Aquaculture Collaborative Research and Development Program (ACRDP).

DFOs role in supporting infrastructure was also highlighted. This includes 159 harbours managed by 119 Harbour Authorities and over $30 million of recent investment in facilities in the local area. Aquaculture development, changes in weather patterns and the increasing size of vessels used is now being considered as five-year plans are being created for the harbours.

<u>Faith Scattolon</u>
Faith graduated from Dalhousie University in 1980 with a Bachelor of Science degree in Biology. She began her career with DFO in 1981 and worked in positions at various levels in Science and Fisheries Management. Faith was appointed Regional Director, Oceans and Habitat Branch, on January 1, 1999 with responsibility for leading DFO's Environmental Research and Habitat Management programs and implementation of the *Oceans Act.* In September 2005, she was named in the position of Associate Regional Director-General in the Maritimes Region. Faith was appointed Regional Director-General, Maritimes Region in September 2006. In addition to her position as Regional Director-General, Maritimes Region, Faith was appointed Head of the Canadian Delegation to the International Commission for the Conservation of Atlantic Tuna in 2009.

OVERVIEW OF DEVELOPMENTS ON CANADA'S NATIONAL AQUACULTURE STRATEGY

- *Ruth Salmon, Canadian Aquaculture Industry Alliance*

As a fundamental starting point to the presentation, Ruth Salmon reminded the audience that those involved in the aquaculture industry are internationally recognized as farmers and provided the following definition from FAO Technical Guidelines for Responsible Fisheries #5:

"Aquaculture is the **farming** of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. **Farming** implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. **Farming** also implies individual or corporate ownership of the stock being cultivated. "

Salmon went on to remind the audience that the Canadian industry is regulated by the *Fisheries Act* - a wildlife management act that was never intended for an innovative, food production sector and that this Act dates back to Confederation when commercial aquaculture in Canada did not exist.

This fundamental inconsistency with the existing regulatory framework and the resulting consequences for aquaculture operations is the basis for CAIA's work to develop a national strategy for the Canadian aquaculture industry. This was demonstrated through a table identifying the cost / impact of current regulation and production graphs showing that despite enormous competitive advantages, Canada's production has flat-lined and our market share has fallen by 40% during the past decade - while our competitors' production has increased significantly. Canada, with current production at 2002 levels, now accounts for only 0.2% of global aquaculture production. The Canadian aquaculture industry is also losing investment to other countries at a time when it should be growing to meet the rising global demand for farmed seafood.

The establishment of an Industry/Government Working Group (which includes Agriculture and AgriFood Canada and DFO) was is an important part of the process to develop and implement a national strategy. This group can take immediate action on some key issues, while working toward the modernization of the legal and regulatory framework along with policy and program reforms.

CAIA's Technical Committee supports the work of the Working Group. They have undertaken a rigorous process to rank legislative, regulatory, policy and program priorities and from that work CAIA has been preparing evidence-based documents to facilitate discussion, recommendations and actions. Some of these documents include:

- Predictable Tenure/Lease/License Framework (March 2013)
- Overview/Broad Elements of a new Aquaculture Act (March 2013) and Legal Elements of an Aquaculture Act (May 2013)
- Improved Access to Feed & Fish Health Products (May 2013)

Other documents under development include:
- Farmed Seafood and Canadian Health (November 2013)
- Policy and Program Reform (February 2014)
- Building an Effective BRM Model for Canadian Aquaculture Based on Worldwide Best Practices

See Attached Presentation

<u>Ruth Salmon</u>
Ruth Salmon brings more than a decade of aquaculture experience to the Canadian Aquaculture Industry Alliance, having served five years as Executive Director of the BC Shellfish Growers Association and seven years as a private consultant. She has held senior positions with the Canadian agri-food industry – as General Manager of the Alberta Milk Producers Association and Advertising Manager with the Dairy Bureau of Canada. Having worked at both the provincial and national levels, Ruth takes a special interest in the promotion and expansion of the aquaculture industry across Canada.

CLIMATE CHANGE IMPLICATIONS FOR AQUACULTURE

– Gregor Reid, Canadian Integrated Multi-Trophic Aquaculture Network, University of New Brunswick

Research on climate change has been increasing exponentially in recent years, with several research journals now dedicated to the subject. While this attention is encouraging, the pace of development makes it difficult to keep up with the literature and in particular, extrapolating how climate change may affect aquaculture. This presentation aims to explore climate change issues as a means to encourage discussion. A combination of both peer-reviewed publications and industry reports are explored as a means to provide an encompassing view on how climate change is potentially affecting aquaculture.

The Intergovernmental Panel on Climate Change (IPCC) released its 5th Assessment Report (AR5), which was produced by over 600 contributing authors from 32 countries. The oceans have become a sink for 93% of the earth's additional energy inventory (between 1971-2010). Sea level rise (mean 0.19m increase in mean sea level since 1901 to 2010) has resulted mainly from thermal expansion of seawater and glacier melting. There is evidence of increased stratification, size of oxygen minima zones and wave heights. Greater precipitation is projected in some areas (e.g. Poles, North America), less in others (e.g. Southern Europe, Central America), changes to hurricanes are uncertain. Anthropogenic CO_2 has caused a gradual decrease in pH, by 0.1 (≈ 26%) since the beginning of the industrial era. Graphical data from the report indicates that at the latitude and depth at which aquaculture is practiced in Atlantic Canada, there will be a general warming trend of 0.10-0.15 °C mean increase per decade, an influx of fresher water and an increase in acidity.

Some extrapolations can be made to aquaculture and these are supported to varying degree by peer–reviewed studies and industry reports. While there may be some anecdotal inferences from industry publications, such information will at least provide a basis for investigation. Most climate change related effects reported in industry publications focus on temperature and acidity; and to a lesser degree freshwater user conflict, disease and severe weather issues. There have been no apparent industry reports to date, suggesting climate related issues with low oxygen, sea-level rise or salinity change that have directly affected aquaculture.

Discussions on potential response and adaptation of the aquaculture industry to climate change are warranted and should be a priority. This may be challenging in light of the effect uncertainty. A ranking exercise of the most pressing issue may help direct efforts. Regional mitigation solutions' may warrant particular attention moving forward, given the highly diversity of aquaculture practices, species and regional scales.

See Attached Presentation

Gregor Reid

Gregor has pursued numerous works in aquaculture and ecological sustainability over the last two decades, and liaises with academia, industry, government, and non-government organizations on related topics. His present research activities involve measuring and modelling ecological interactions of aquaculture, and nutrient transfer in open-water, IMTA (Integrated Multi-Trophic Aquaculture) systems. Gregor Reid works for the Natural Sciences and Engineering Research Council of Canada (NSERC) Strategic Network, the Canadian Integrated Multi-Trophic Aquaculture Network (CIMTAN), through the University of New Brunswick (UNB). He is located at the St. Andrews Biological Station (SABS) of Fisheries and Oceans Canada (DFO) and this presentation was developed in association with S Leadbeater and N Feindel, both working at SABS.

Helping the Fisheries and Aquaculture Sectors Leverage the Power of Genomics

- Shelley King, VP Research and Business Development, Genome Atlantic

Genomics is the combination of biology, genetics and computer science used to help understand the role of genes in the function and health of all living organisms. Areas in which genomics can aid the aquaculture industry in development and growth have been identified under the headings of production, fish health, conservation and population genomics, and ecosystem integrity. Examples of previous Genome Atlantic projects have included work with halibut genome mapping, cod broodstock development, and development of camelina as a fishmeal / fish oil replacement.

A national strategy document has been developed to identify key opportunities for the use of genomics in fisheries and aquaculture which includes discussions on:

- The need for practical, affordable, and trusted **genomics tools** that can be used in the field for farmed stock monitoring, tracking and management
- **Health and nutrition** as a research theme that can ensure the conservation of wild stocks and satisfy the needs of consumers for quality protein.
- The requirement for **species-specific research** to understand the genomes of traditional, novel and invasive species

One of the ways Genome Atlantic can help the local industry is to support their applications for funding programs such as Genome Canada's Genomics Application Partnership Program (GAPP). The program will invest in projects of six (6) months to three (3) years. This program has a budget available of between $300K - $6M dollars, providing a maximum one-third of the total project cost. Jointly led by industry and a research institution, it is designed to move technology into hands of companies.

There is also the Genome Canada Large Scale Applied Research Project (LSARP) which focuses on industry/end user need, but the three-year projects must include research on societal (GE3LS) aspects of the genomics work i.e. ethical, economic, environmental, legal, and or social.

Genome Atlantic also administers the Genomics Opportunity Review Program, designed to help companies identify and develop areas where genomics can improve productivity and profitability. Through the Program, Genome Atlantic can help companies:

- **Identify** industry need
- **Connect** industry need with genomics expertise
- **Shape** research parameters
- **Define** budget and help procure funding
- **Manage** R&D projects
- **Direct** integration/commercialization

See Attached Presentation

Shelley King

Shelley King, VP Research and Business Development, Genome Atlantic. Genome Atlantic has a vision to help Atlantic Canada reap the benefits of genomics innovations. Shelley draws on her extensive knowledge of the aquaculture sector to help companies and researchers develop genomics-based solutions to challenges such as feed development, growth rates, disease and pest management. She holds an MSc and an MBA from Memorial University, and has translated that into a broad range of experience in technology commercialization, business development, strategic partnership development and intellectual property management in both the private and academic sectors.

AQUACULTURE TECHNICIAN PROGRAM - 35 YEARS AND COUNTING

– Nelson Alward, NBCC Department Head– Trades, Technology & Marine

The New Brunswick Community College's Aquaculture Technician Program began in 1978 based on the needs of the provincial river restocking program while supporting the first salmon aquaculture cage trials on Deer Island. The next 30 years saw interest in the course increase, then decrease as the salmon aquaculture industry expanded rapidly and then begin to consolidate. Data demonstrated the number of enrollments / graduates increasing from 2006 to 2009, and then decreasing to 2013 which has a total enrollment of 6 students. The class capacity of 16 has not been reached in the last eight years.

The uniqueness of the NBCC program and the range of incorporated study topics were discussed culminating in the question posed to the audience: "So, given the national demand for labor and the relative scarcity of educational programs for aquaculture, "What's the Problem?"

- Is it an awareness issue?
- Is it a negative industry image?
- Are young people not "career" minded today?
- Or do they think aquaculture is it's too dangerous?
- Is it St. Andrews?
- Has the student market changed?
-

Alward facilitated a brainstorming session where other potential answers / course suggestions were made. Input included: the addition of shellfish culture to the course topics, marketing of the course as an option to those individuals who do not want to leave their small coastal community, influencing students at a younger age, and increasing industry awareness to students.

See Attached Presentation

<u>Nelson Alward</u>

Nelson Alward has worked in and around the aquaculture industry for 30 years in various positions including hatchery and marine grow out production, programs coordinator for NBSGA, fish health surveillance coordinator for the province of NB, instructor or the Aquaculture Technician Program and his current position of Department Head of Trades, Technology and Marine at NBCC St. Andrews. Nelson Alward holds a Masters in Adult Education from University of New Brunswick, a BSc from Mount Allison University and the Aquaculture Technician Certificate from NBCC St. Andrews.

EXPLORING OPPORTUNITIES TO ENGAGE THE EXPERTISE IN RESEARCH, DEVELOPMENT, INNOVATION, AND EDUCATION OF NEW BRUNSWICK SOUTHWEST

– Jamey Smith, Executive Director, Huntsman Marine Science Centre

Smith began with a description of the Huntsman Marine Science Centre's capabilities, departments and current collaborations to provide the context for a discussion on the opportunity of creating a research cluster in southwest New Brunswick. The local expertise, academic and research facilities, government departments, and industry sectors was identified along with the rationale for timely movement on the proposed idea.

The Province has listed bioscience as one of six priority areas for New Brunswick; DFO has re-committed to the Sustainable Aquaculture Program and there are provincial and federal programs available that focus on commercial development needs, so opportunities exist. Stronger collaborations will address industry concerns and allow us to compete for funding.

A Coastal Economy Interdisciplinary Research and Education initiative has already started to address practical research and education needs for environmental, economic and social sustainability of coastal industries. A NSERC workshop is planned for spring 2014 to discuss the scope of this program.

See Attached Presentation

Jamey Smith

Dr. Jamey Smith presently serves as the Executive Director of the Huntsman Marine Science Centre in St. Andrews, New Brunswick. Prior to this, Jamey was the Director of Certification and Sustainability Reporting for the Aquaculture Management Directorate of Fisheries and Oceans Canada. He previously served as the Executive Director of the New Brunswick Salmon Growers Association, an appointment made after working with the NBSGA for over 10 years in various capacities, including Research and Environmental Management Coordinator. Jamey received his BSc (Hons. Biology) in 1985 from the University of New Brunswick in Saint John. He attended the University of Stirling in Scotland as a Commonwealth Scholar and received his PhD in 1990. Jamey's field of research was aquaculture-environment interactions.

SUMMARY OF IMPORT COMPONENT OF THE NATIONAL AQUATIC ANIMAL HEALTH PROGRAM (NAAHP)

- Lisa Myers, Aquatic and Terrestrial Imports, CFIA

All CFIA Import requirements are listed in the Automated Import Reference System (AIRS) and specify whether a CFIA veterinary inspection, zoosanitary export certificate and import permit is required. **Currently, a CFIA veterinary inspection is required at the first port of entry in Canada for only live finfish listed on Schedule III and intended for aquaculture purposes.**

Link to AIRS:
http://www.inspection.gc.ca/animals/aquaticanimals/imports/airs/eng/1300127512994/1326599589537

A Canadian Food Inspection Agency (CFIA) import permit is required for the import of live finfish, crustacean and mollusc commodities listed on Schedule III of the Health of Animals Act for all end use unless otherwise exempted, AND for dead finfish, crustacean and mollusc (carcasses and offal) originating from species listed on Schedule III when the end use will be for:

(1) Bait
(2) Feed for Aquatic animals/Feeding to aquatic animals
(3) Research/Education
(4) Diagnosis and testing
(5) ANY END USE WHERE EFFLUENT OR OFFAL IS GENERATED (example: crustaceans on schedule III intended for further processing for human consumption)

Link to Schedule III *:
http://www.inspection.gc.ca/animals/aquaticanimals/diseases/susceptiblespecies/eng/1327162574928/1327162766981

* Finfish – Please note that aquatic animal species that are susceptible to only Epizootic Ulcerative Syndrome (EUS) do not require an import permit.

The enforcement of the Aquatic Import requirements listed above was enforced in three different phases based on intended end uses and became in effect as of the following dates: December 10, 2012, February 4, 2013 and April 8, 2013.

Import of live finfish listed on Schedule III intended for aquaculture requires an inspection at the Border upon entry into Canada.

- The importer must communicate in advance of the import with their Regional NAAHP veterinarian to plan and discuss expected dates and times of arrival and location of border crossing.
- Importer is responsible to verify with other municipal, provincial, territorial or Federal government authorities to ensure that all other conditions are met

Countries with negotiated Certificates with CFIA for export to Canada:

- USA - Live finfish for stocking and enhancement
  - Live aquatic animals and germplasm for culture and research and educational use
- Iceland - Salmonid germplasm (eyed eggs) for culture and research and educational use
- UK **-** Live aquatic animals and germplasm for culture

Submission of Application for an **Aquatic Import permit** sent to Moncton Area office:
Telephone: (506) 777-3968
Facsimile: (506) 777-3942
lisa.myers@inspection.gc.ca

Atlantic Regional NAAHP Veterinarians

Dr. Mike Trenholm, **New Brunswick**
Michael.Trenholm@inspection.gc.ca
(506) 851-7654

Dr. Shane Hood, **Nova Scotia**
Shane.Hood@inspection.gc.ca
(902) 679-5586

Dr. Tim McQuaid, **Prince Edward Island**
Timothy.McQuaid@inspection.gc.ca
(902) 566-7290 Ext 2025

Dr. Karla Furey, **Newfoundland**
Karla.Furey@inspection.gc.ca
(709) 772-4714

Information on the CFIA Aquatic Program can be obtained at the following link: www.inspection.gc.ca

See Attached Presentation

Lisa Myers
Lisa Myers has been employed with the Canadian Food Inspection Agency since 2007. She is currently responsible for Aquatic and Terrestrial Imports in the Atlantic. She received her Doctorate of Veterinary Medicine from the Atlantic Veterinary College in Charlottetown, PEI in 1996. Part of her current responsibilities include: Review of Import permit applications and Issue Aquatic Animal Import permits

MOVEMENT CONTROLS WITHIN CANADA FOR REPORTABLE ENZOOTIC AQUATIC ANIMAL DISEASES

***-** Dr. Wole Oguntona, Veterinary Program Specialist Aquatic Animal Health, CFIA*

The National Aquatic Animal Health Program (NAAHP) was developed to prevent the introduction and spread of federally regulated diseases in finfish, molluscs, and crustaceans in Canada. The Program also facilitates domestic and international market access for Canadian seafood with respect to infectious diseases of international and national concern.

The Domestic Movement Control Program within the NAAHP is under development but is intended to prevent the spread of diseases within Canada and, when complete, will encompass wild and cultured salmonids, bait fish, and American and Pacific cupped oyster.

Canada will be divided into geographic areas based on disease status and therefore certain movements of live aquatic animals, fresh dead and frozen aquatic animals, and equipment such as used fish graders from aquaculture facilities will require a CFIA permit. For each reportable disease, areas of Canada will be classified as a Free, Provisionally Free, Buffer Area or Infected Area and a permit will be required for any movement from an area of lower to higher health status:

- An Infected Area to Buffer Area, Provisionally Free Area or Free Area
- A Buffer Area to another Buffer Area, Provisionally Free or Free Area
- A Provisionally Free Area to a Free Area

Permits for movements may be issued by CFIA depending on the end use of the aquatic animal, carcass or thing, and the shipping destination / bio-containment capability or the disease free status and bio-containment procedures are appropriate to prevent the spread of the disease.

Examples of how areas have been defined for disease status and when permits may or may not be issued were reviewed.

See Attached Presentation

<u>Wole Oguntona</u>
Dr. Samson (Wole) Oguntona is the Area Program Specialist for CFIA out of Moncton. He has been working with CFIA since 2010.

HARMFUL ALGAL BLOOMS AND FINFISH AQUACULTURE

- Jennifer L. Martin, DFO, St. Andrews Biological Station

Harmful algal blooms (HABs) have occurred since biblical times. The common idea of HABs being referred to as "red tides" is not accurate; many harmful blooms are not red and in many cases, there is no water discolouration. Blooms may be harmful for a variety of reasons: through the production of toxins, clogging the gills of fish, asphyxiation or creating too much oxygen.

A phytoplankton study in Passamaquoddy Bay and the Bay of Fundy was carried out by Gran and Braarud in the early 1930s and acts as a reference source. The current phytoplankton monitoring program, which began in 1987, monitors the total phytoplankton community from five locations within the Bay of Fundy and acts as an early warning of HABs, identifies patterns/ trends, aids in prediction/hind-casting blooms and determines linkages to physical and chemical oceanography. There is large inter-annual variation in abundance and composition with weather and oceanography being important factors. We recognize that the present dataset is is not long enough to accurately identify changes and trends.

To date, two hundred and fifty-six species of phytoplankton (dinoflagellates, diatoms and others (Chrysophytes, Cyanophytes, silicoflagellates coccolithophores, ciliates, smaller zooplankton, etc)) have been identified in the Bay of Fundy; a list of those considered as harmful algal species was provided. Each species is unique and behaves differently. It was noted that, in recent years, the diatoms as a group appear now stay in the system throughout the summer whereas in earlier years there was a trend for there to be a spring diatom bloom followed by dinoflagellates and a return of the diatoms in late summer/early fall. Data from the years 2000 - 2010 shows a trend with the abundance of total organisms increasing and a decline observed in the last three years (2011-13). This decline may be associated with unusual weather patterns. For example, there were high winds in 2011, the warmest summer on record was in 2012 and heavy rainfall occurred in the summer of 2013. During the winter months, the phytoplankton abundances are very low with an increase in concentrations in the spring. In recent years, the spring blooms are occurring earlier and the blooms persisting later into the fall. Some species are now observed to be more abundant than in the past.

Alexandrium fundyense, the organism responsible for producing Paralytic Shellfish Poisoning (PSP) toxins was discussed. In addition to causing shellfish toxicity, *A. fundyense* was responsible for cultured Atlantic salmon mortalities in 2003, 2004 and 2007 and herring mortalities in 1976 and 1979.The species of *Alexandrium* found in the Bay of Fundy is the most toxic of all the species observed in the world and produces more than fifty different toxins. The highest number of overwintering *A. fundyense* cells (cysts) per unit area are found in the central Bay of Fundy. Our studies have shown that the higher biomass blooms tend to be linked to weather conditions associated with fog, little wind, moderate water temperatures, and although *A.fundyense* blooms occur every year, the intensity varies significantly and the cells are patchy in distribution. Records of PSP toxins in shellfish since 1943 show the highest levels of toxins were measured in 1944 indicating that blooms of *A. fundyense* and resulting PSP toxins in shellfish are not increasing.

There have been thirty-five new phytoplankton species identified within the Bay of Fundy since 1995; though not necessarily warm water species.

See Attached Presentation

<u>Jennifer Martin</u>
Jennifer Martin is a research scientist with Fisheries and Oceans Canada at the St. Andrews Biological Station and has been studying phytoplankton for more than 35 years. Much of her work has focused on toxic and harmful algal blooms (HABs) with emphasis on population trends and effects of HABs on fisheries. She has served as a Canadian representative on several national and international working groups on HABs. She is: past vice-president of the International Society for the Study of Harmful Algae, Chair of the International Harmful Algal Event committee, Canadian delegate and past chair of the International Council for the Exploration of the Sea / Intergovernmental Oceanographic Committee Working Group on Harmful Algal Bloom Dynamics, past chair of the Canadian Phycotoxin Working Group, and Canadian delegate to North Pacific Marine Science Organization.

THE FUNDY NATIONAL PARK INNER BAY OF FUNDY ATLANTIC SALMON RECOVERY PROGRAM - ASSESSING LIFE-LONG EFFECTS ON FITNESS OF TWO IBOF SALMON CAPTIVE REARING AND RELEASE STRATEGIES

- Corey Clarke, Resource Management Officer, Parks Canada / Fundy National Park

The history of the inner Bay of Fundy Atlantic salmon population was presented with details around the Live Gene Program (LGB) started in response to listing the salmon as endangered under SARA. Poor marine survival is considered to be most limiting population recovery.

On the Upper Salmon River (USR) the strategy was to annually release fry and parr into the river since 2006. Monitoring data showed that the fry releases were producing a larger smolt which would leave the river at 2 years, while the parr would leave the river at 1 year. However, since neither group were returning to the river after the marine phase a project was started with the Atlantic Canada Fish Farmers Association (ACFFA) to assess this portion of the life cycle.

In 2010, USR smolts, of fry and parr release origin, were transported to a marine cage site for a grow-out period of about eighteen months. From this group, 344 fry and parr-origin grilse were produced for release to the IBoF near Fundy National Park to monitor homing ability back to the USR. In addition, 100 fry and 100 parr-origin grilse were used in spawning experiments to monitor egg viability. The 2011 adult return monitoring in the USR found that only a handful of released fish returned but over 30 returned to the adjacent Point Wolfe River (which was closer to the release site). Notably, released salmon were detected in New Minas Basin, the Petticodiac River and at the Mactaquac Hatchery. Egg viability experiments, showed significantly higher survival for offspring of parents released into the river as fry. Smolts from releases of marine reared adults will migrate in spring of 2014 and 2015. However, 2011 adult releases returned well in 2012 to mark 20-year highs on both park rivers. Sampling these returns showed that fry release origin and marine reared adults returned more than those released as parr or reared in the hatchery.

Based on this and other recent studies of the effects of captive exposure, Fundy National Park (FNP) and other partners are considering options to increase the number of native adults released to their rivers. Smolts produced from adult releases are free from captive exposure which is predicted to improve marine survival. However, production of large amounts of adults for release has been logistically and financially prohibitive for many recovery programs.

FNP rivers were each likely home to upwards of 1000 returning adults and the entire IBoF around 40,000. Provided project partners can devise methods to reliably and safely capture wild smolts and grow-out at cage sites, innovative partnerships with conservation groups have many potential mutual benefits. Considering the aquacultures industry's capacity to produce salmon, the number of wild-origin adults released to spawn in participating rivers to produce smolts free of captive-exposure may be limited only to the number of smolts that can be collected for grow out.

See Attached Presentation

<u>Corey Clarke</u>
Corey leads Fundy National Park's salmon recovery program and has worked on IBoF Salmon recovery for Parks Canada in Fundy for over 10 years. He is currently wrapping up his MSc at MUN which developed an award winning partnership project with Parks Canada and the Aquaculture Industry. The project grew wild Fundy National Park smolts to maturity in sea pens which later contributed to 20 year-high salmon returns to Fundy National Park

MONITORING AQUACULTURE ECOSYSTEMS: PROGRESS AND EVOLUTION

- Jon Grant, Department of Oceanography, Dalhousie University

Marine ecosystems have natural variation in state/function over time and a range in ecological resilience to outside influences such as aquaculture. To ensure that an activity does not change the ecosystem and is therefore sustainable, environmental quality objectives and thresholds or acceptable limits must be established, as well as environmental monitoring around that activity.

Oxygen is generally accepted as a good indicator of environmental quality. Its proxy via the Pearson-Rosenberg model of benthic disturbance and succession was presented to show how organic input may lead to different fauna, elevated sulfides, reducing sediments (black color), and white sulfur bacteria in the environment under aquaculture cages.

Current environmental monitoring programs involve near-field monitoring for bio-deposition using sulphide as an indicator of benthic response. The questions posed: are the results of the near field monitoring programs helpful to predict potential far-field effects? The latter effects are seldom observed, regardless of the near field results - are we using the correct variables and approaches?

Since regulators and industry do not have appropriate alternatives at present, it is unrealistic to expect a move away from sulphide or toward far-field monitoring in the short term. Work to develop other options is being done and will be continually evaluated.

Mapping techniques have the capability for rapid turnover of data, can include multiple criteria and have the potential to observe far-field effects. The use of sediment profile imaging (SPI) for benthic community assessment was also discussed as was sampling to determine benthic faunal health of an ecosystem. Ecosystem models are predictive rather than reactive and may help farmers in terms of management strategies and farm siting while providing regulators with a tool for ecosystem-based management.

Marine spatial planning was presented as an overarching tool for developing a sustainability framework.

See Attached Presentation

<u>Jon Grant</u>
Jon Grant is a Killam Professor of Oceanography at Dalhousie University, Canada's premiere ocean institution. Trained as a benthic ecologist, he has a BSc from Duke University and PhD from the University of South Carolina. Jon has worked in aquaculture-environment interactions for more than 25 years, and authored well over 120 scientific papers. Working with both the shellfish and finfish farming industry, Jon has pioneered concepts and tools for assessing carrying capacity in field culture. Ecosystem models have been developed for coastal bays including explicit criteria for sustainability. This work has led to rigorous application of ecosystem-based management and marine spatial planning to aquaculture, including incorporation of remote sensing and GIS. With extensive experience in oceanographic instrumentation and environmental assessment, Jon has conducted aquaculture research worldwide. At present, his research involves close ties to industry for sustainable salmon farming in Atlantic Canada.

DEVELOPMENT OF A ROBUST METHODOLOGY FOR SULFIDE PROBE CALIBRATION

***–** Bob Sweeney, Sweeney International Marine Corp and Blythe Chang, Fisheries and Oceans Canada, St Andrews Biological Station*

Sulfide is the only indicator currently used to evaluate organic enrichment at New Brunswick and Nova Scotia fish farms when determining their classification relative to the marine quality objective (MQO) of maintaining oxic conditions. Government departments in NB, NS and BC have developed Standard Operating Procedures (SOPs) for sulfide monitoring at fish farms; however, there are some significant differences in the SOPs among the provinces. To ensure that the use of sulfide in environmental monitoring of the finfish aquaculture industry in Canada is as consistent, reliable and accurate as possible, it is essential to standardize procedures. This one-year ACRDP funded project has concentrated on laboratory techniques used in measuring sulfide concentrations. The initial goal is to develop a standard methodology for sulfide probe calibration and use. It is also hoped to examine other aspects of the monitoring procedures, including sample collection and storage, in a future project.

The research team includes L. Lewis-McCrea and S. Cameron (SIMCorp) and D. Wong, K. MacKeigan, and F. Page (SABS) and all experiments are being conducted at two labs: SIMCorp (SIMC) in Halifax and the St Andrews Biological Station (SABS). Identical trials are conducted at each lab, using the same methods, probe model (Thermo Orion silver/sulfide electrode model 9616), and meter model (Accumet AP125). The results presented are preliminary, as not all work has been completed.

1) *Comparison of probe filling solutions*

There are two probe filling solutions available: Solution A is recommended in BC, while Solution B is recommended in NB and NS. In this study, we compared sulfide results using the 2 solutions on standards of known concentration (250, 750, 2 500, and 7 500 µM). The results indicated that both solutions provided accurate results, but results using Solution A were slightly more accurate and less variable than using Solution B.

2) *Number of standards for calibration*

NB and BC recommend using 3 calibration standards: in NB, the 3 standards are 100, 1 000, and 10 000 µM; in BC, the 3 standards are 10, 100, and 1 000 µM, or 100, 1 000, and 10 000 µM (depending on the expected sulfide concentrations). NS recommends using 5 calibration standards: 100, 500, 1 000, 5 000, and 10 000 µM. The results at SIMC suggested that the 3-point calibration was more accurate than the 5-point, which is contrary to expectations. At SABS, there were no differences between the use of 3 and 5-point calibration. Additional trials are being conducted.

3) *Degradation of standards over time*

Previous information suggests that standards can be stored 2-5 days without significant change. The length of time that standards can be stored has implications for the practicality of conducting sulfide analyses in the lab vs. in the field. Sulfide concentrations were measured in standards ranging from 100–30 000 µM at 0, 24, 48, 72 & 96 h. Preliminary results indicate that there can be significant degradation within 24 h, regardless of the initial concentration. This suggests that it may not be advisable to conduct sulfide measurements in the field (as recommended in BC), using pre-prepared standards. Additional trials are in progress.

4) *Standardization of sodium sulfide*

Standards are prepared at known concentrations to calibrate sulfide probes. The concentrations of the standards can be derived in two ways:

- Non-standardized: from molarity calculations
- Standardized: verification via titration with lead perchlorate

The probe manual specifies that titration (i.e. standardized) should be used. Data from the SIMC lab indicated that results were more accurate using the standardized method; the non-standardized method resulted in overestimates of the actual concentrations. Partial results from SABS indicate no differences between the two methods: both methods appear to be accurate. One possible reason for the differences between the labs is that SIMC has been using crystalline sodium sulfide to prepare the standards, while SABS has been using granular sodium sulfide. Additional trials are being conducted.

5) *Other project components*

Other project components have just started or not yet begun:

- Effects of storage time of probes (post-calibration)
- Changes in calibrated probe accuracy during use (probe "drift")

A special session of the Aquaculture Canada 2014 conference in St. Andrews in June 2014 will be dedicated to environmental monitoring issues, including new methods.

<u>Bob Sweeney</u>
Bob is a graduate of Ontario's Algonquin College. He returned to his native province of New Brunswick in 1978 to pursue a career in land surveying and mapping. Four years later in 1982 he started what became a 14 year tenure with the Provincial Government first as a Project Manager in Crown lands with Department of Natural Resources working with coastal resource management where he was introduced to the aquaculture sector and then as an Aquaculture Development Officer with the Department of Fisheries and Aquaculture. After leaving the government in 1996 he held Senior Production and Management positions with Cooke Aquaculture Inc. and Deer Island Salmon Ltd. both of which had salmon farming operations in New Brunswick and Nova Scotia. In February 2002, Bob followed one of his lifelong ambitions of owning a business and started "*Sweeney International Marine Corp*" (SIMCorp). In 11 short years the business has grown to the point where SIMCorp now has a staff of 16 employees throughout Atlantic Canada. In December 2008 a subsidiary company, "*SIMCorp Marine Environmental Inc.*", was established in the community of Harbour Breton on the southcoast of Newfoundland with a third office and laboratory established late in 2011 in the National Research Council Institute for Marine Biosciences in Halifax. The SIMCorp teams of Marine Environmental Biologists provide environmental assessments and benthic monitoring for the aquaculture sectors in New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland. The companies have also worked on projects in Saskatchewan, Chile, Mexico and Croatia and most recently have formed a new affiliate, "*CaribeAqua Marine Environmental*", providing environmental expertise on marine based aquaculture projects in the Caribbean.

<u>Blythe Chang</u>
Blythe Chang (MSc) is a biologist in the Coastal Ocean Ecosystem Research Section (COERS) of the Department of Fisheries and Oceans at the St. Andrews Biological Station. He is a biologist with experience in biological oceanography, benthic ecology, habitat management, as well as fish health and environmental siting issues associated with finfish aquaculture. He has served on several aquaculture-related committees on subjects including: aquaculture siting, environmental interactions of aquaculture, fish health, and new species development.

OFFSHORE AQUACULTURE: TRUTH OR DARE

- Terry Drost, President, Four Links Marketing

Several truths about the earth were provided such as:

- Only **0.65%** of the Earth's water is found in Rivers, lakes, ground and air

- The coastal zone is the area - where the land meets the sea and includes land within 150 kms from the sea – is home to 44% of the world's population

Drost suggested that for the aquaculture industry to expand and avoid coastal conflicts it must look to the offshore. Case studies from Turkey with its production of bass and bream and Panama with its production of cobia were presented as examples of how aquaculture sites are being moved offshore to take advantage of deeper water with good currents. The Norwegian salmon aquaculture industry was also cited as an example where new sites are being located outside the fjords where the water can be 1000 feet deep and sites can experience 13 foot waves.

The dare for the industry is to re-envision / redesign aquaculture system components to meet the requirements of this environment. Mooring systems are being developed by the oil and gas industry that could be used for remote installations. New cage systems are being developed to take advantage of deep water sites (submergible) and harsher wind / wave environments. Feeding systems are being designed using very rugged barges, and new netting materials / net management systems are being developed with to reduce labour needs and health and safety concerns.

Comparing the basic statistics of Turkey and Canada, the obvious disparity between the amount of coastline and marine production in each country was presented. The suggestion was made that to meet the growing food needs of the world Canada needs to take advantage of its coastline.

See Attached Presentation

Terry Drost
Terry Drost has worked in the aquaculture industry for the last 27 years and has obtained a diverse background in both production and marketing of aquaculture products. He started his aquaculture career in feed manufacturing and nutrition of finfish and during the last 5 years has been involved in sales and marketing of aquaculture products. Developing sustainable production practices and growing aquaculture production in offshore conditions is a driving passion of Terry and his aquaculture sales and marketing consulting business, Four Links Marketing Ltd.

Thursday, November 7, 2013

ISA SURVEILLANCE AND CONTROL IN NEW BRUNSWICK

- *Michael Beattie, NB DAAF Chief Veterinarian*

The ISA (infectious salmon anemia) Surveillance Policy in New Brunswick was developed to minimize the overall economic impact of ISA on the aquaculture industry and legislated through the Province of New Brunswick's Aquaculture Act and Regulations. ISA was identified in New Brunswick in 1997, pre-dating the National Aquatic Animal Health Program and CFIA involvement. The NB Department worked with industry and all other stakeholders and regulators to develop the ISA program, sharing all monitoring data weekly. Beattie reviewed the nine critical components of the program with particular reference to the importance of early detection and depopulation of infected fish. The Department's ability to trace in-out within 48 hours and the establishment of a fallowing period which is two to three times the lifetime of the virus were also noted as important factors in ISA control.

Important changes in industry structure and protocols since 1997 were also a critical aspect to disease management. Aquaculture Bay Management Areas were developed requiring single year class entry based on odd / even year and progressed to a three year management system which utilized oceanographic information with mandatory site and area fallowing periods. Other policy changes included harvest vessel certification by the Province and biosecurity audits at sites and processing plants.

Surveillance for ISA in New Brunswick continues with NB DAAF fish health technicians assisting private company veterinarians in meeting the requirement monthly site visits and fish health reporting to NB DAA (*Monthly Fish Health Report)*. Data was presented for 2002-2009 indicating how many cages sampled per visit and, the number of fish tested monthly.

ISA genotyping began in 2005. Currently there are over twenty-five strain type variants identified for Atlantic Canada with HPR0 identified as an avirulent strain. There is debate whether HPR0 may mutate to become virulent, but evidence from the Faeroes, Iceland and New Brunswick seems to indicate that this is not the case. Information on HRP0 detection at the site level and by month from 2005 to 2010 was presented. It was noted that HRR0 used to show up only on the shoulder seasons but it is now found throughout the year, but once detected disappears within two weeks.

If virulent ISA is detected in New Brunswick, the steps that the company and DAAF must take immediately were described. These steps include the license holder submitting a "Marine Site – Control and Containment Agreement" to NB DAA veterinarian within 48 hours of receiving notification of an infected cage. Upon approval of the Agreement, all sites are notified of detailed depopulation plans within 24 hours. The site license holder must remove all fish from the infected cage within seven (7) days using a certified harvest vessel and as per the approved plan.

Management protocols are changing somewhat with the introduction of the NAAHP and CFIA involvement. It was noted also that salmon farmers may now qualify for federal compensation when orders for destruction are received. This is in line with all protein producers in Canada.

See Attached Presentation

Michael Beattie

Michael Beattie is the Chief NB DAAF Veterinarian. Michael received a BSc, (hon.) and MSc. in marine biology from the University of New Brunswick, a DVM degree from the AVC and a Marketing certification from the Norwegian School of Business. In 1997 he became a member of the Royal College of Veterinary Surgeons. Since 2003 he has served as the Chief Veterinarian for Aquaculture in the New Brunswick Department of Agriculture, Aquaculture and Fisheries. Prior to joining the Provincial government Mike was the North American Product Manager for the world's largest integrated aquaculture company, Nutreco. He was involved in uncovering new research, carrying out field trials and marketing new products.

UPDATE ON COLD WATER ULCER DISEASE IN CANADA

- *Allison MacKinnon, Head of Technical Aqua, Novartis Animal Health Canada Inc.*

A description of cold water ulcer disease and causative agent was provided. The bacteria *Moritella viscosa* is the pathogen involved with winter ulcers, which often appear during periods of cold water (most common below 10 degrees C) and high salinity. The disease is characterized by the formation of dermal and sub-dermal ulcers with the resulting scar tissue leading to a high number of downgraded fish at harvest. Response to oral antibiotics is generally poor as clinically infected fish tend to not eat and open wounds increases susceptibility to secondary infection. *Vibrio wodanis is* commonly isolated in association with the ulcers and may inhibit the growth of *M. viscosa*.

It was reported that cold water ulcer disease is one of the most frequently observed marine bacterial diseases in Norway with sixty-nine cases in 2011, and incidences are increasing in Scotland and Canada. On the Canada's west coast the prevalence is approximately 20%, while the prevalence in the Bay of Fundy is over 10%. In Canada it has been associated with falling or increasing water temperatures.

The suggested method for isolation of *Moritella viscosa* was presented along with information that genotyping / western blot assays suggests the presence of sub-groups within the species - an Eastern Atlantic group and Western Atlantic group although it is not clear whether the two identified groups of bacteria comprise ecologically distinct populations.

The known virulence factors for the bacteria were identified and graphs showed comparative mortality curve data on experiments conducted with the Bay of Fundy isolates in comparison with a reference Norwegian isolate. Work two with Canadian field isolates demonstrated low virulence, but this remains an emerging animal welfare concern.

Vaccines against *Moritella viscose* are available in Norway, but none are currently licensed for use in Canada although discussions with CFIA are being held on the potential registration of a Novartis product.

See Attached Presentation

Allison MacKinnon

Allison has worked for the past 22 years within the health management sector of the aquaculture industry. Allison is a graduate of the University of Guelph with a degree in Animal & Poultry Science with further specialization in the field of fish immunology & vaccinology. For the last 13 years he has been employed with Novartis Animal Health Aquaculture Division in such roles as Territory Manager, Technical Service Manager and most recently Head of Technical Services for the North American Aqua Division. During this period of field support, Allison has played an integral role in clinical trial testing and product support for the Aqua brand of vaccines. He has also worked closely with the Novartis Global Technical Support Team with both vaccines and pharmaceuticals and has also assisted with projects involving warm water species in Europe, Asia and the USA.

FISH FEEDS, YESTERDAY TODAY AND TOMORROW

- *Steve Backman, Manager Technical Services, Skretting*

The technological changes in fish feed production over the years was described. Fish feed technology evolved out of the early cold extrusion of trash fish carcasses producing high moisture low energy diets through to Steam Pelleting and modern day computer controlled extrusion. Each advancement was paralleled by improved nutritional characteristics and technical quality leading to improved growth, feed efficiency and food safety for the fish.

The Aquaculture Research Center, a division of Skretting, annually invests over ten million Euros ($15 million Cdn) in research directed by industry priorities. The Research center includes fish feed technology plant containing miniature versions of our production extruders allowing researchers to fine tune production techniques as well as product small run test diets used on the ongoing evaluations of ingredients and formulations in the land based aquaculture research farm.

Many potential fish feed ingredients have and are being evaluated with a focus on total gut health and the ability to modulate the balance of good and bad gut bacteria. Through the "labelling" of certain inflammatory cells histological changes can be seen in the gut as, for example, the temperature is raised from 12 degrees Celsius to 18 degrees. Then the secret ingredient can be added to the feed to determine if gut health returns.

In support of the research and food safety the Skretting ARC maintains an ISO 9000 9001 analytical laboratory accredited to ISO 17025. The lab has available quantitative histology, plasma biochemistry, electrophoretic assays, HPLC and NIR.

Current research at the ARC is focusing on the identification of functional nutrients to support health; identify sustainable ingredients which are commercially viable for incorporation into fish feeds; and improve overall feed efficiency through technical advancement of production techniques. This is accomplished through the hard work by over 80 scientists and technical staff from approximately 22 nationalities.

<u>Steve Backman</u>
Steve Backman has been the Manager of Technical Services for Skretting since 1988. He received his Diploma of Agricultural Science from Nova Scotia Agricultural College in 1982, attended the University of Guelph where he received his Doctor of Veterinary Medicine in 1987 and a Diploma in Anatomic Pathology in 1989. Steve has been a member of the NB Fish Health Technical Committee and the NB Fish Health Policy Committee since 1996. He was the founding president of the Canadian Association of Aquatic Veterinarians and Charter member of EAVA. He holds multiple veterinary licenses and memberships in a number of professional organizations, which includes being past President of the Canadian Association of Aquatic Veterinarians and member of the NAAHP steering committee. He is also the owner of Magellan Aqua Farms Inc.

BACTERIA - WHAT ARE THEY GOOD FOR?

- *Ben Forward, Head of the Food, Fisheries, & Aquaculture Dept., New Brunswick Research & Productivity Council (RPC)*

The workshop audience was reminded that not all bacteria are bad and that there are many bacteria that perform essential functions for people and the environment. Bacteria are found everywhere, from mild to extreme environments, with the Bay of Fundy being one of the most unique marine habitats. It is possible that it may contain bacteria with unique biosynthetic capacity and as bacteria are easily cultured; their production would also be sustainable.

An ACOA funded project started RPC on the path to develop new aquaculture products from marine bacteria with a particular focus on potential probiotics and antimicrobials. Every possible location was sampled with over 2,000 culturable isolates collected and stored (at -80 degree Celsius). To store and manage all the data, a bioinformatics library was created for all the isolate information – identity, origin and the associated biodata - DNA sequence, metabolic profile, antibiotic sensitivity. The library data can be used to run comparative analyses and screen large numbers of potential candidates.

The database produced a list of:

- Antibiotic producing bacteria
- Antiviral producing bacteria
- Probiotic bacteria
- PUFA producing bacteria
- Antifoulant producers
- Hydrolytic enzyme producers
- Anticancer agent producers

Work has followed on marine probiotics for cod, haddock and oyster, and anticancer products for humans. Valuable pigments have also been identified from some of the marine bacteria. Violacein is not only antibacterial, antiviral, anticancer, and antitrypanisomal, it can retail for $330 CAD per milligram.

Future work includes the pursuit of commercial opportunities and potential development of hydrolytic enzymes for industrial processes, bio-pesticides, and microbial fuel cells.

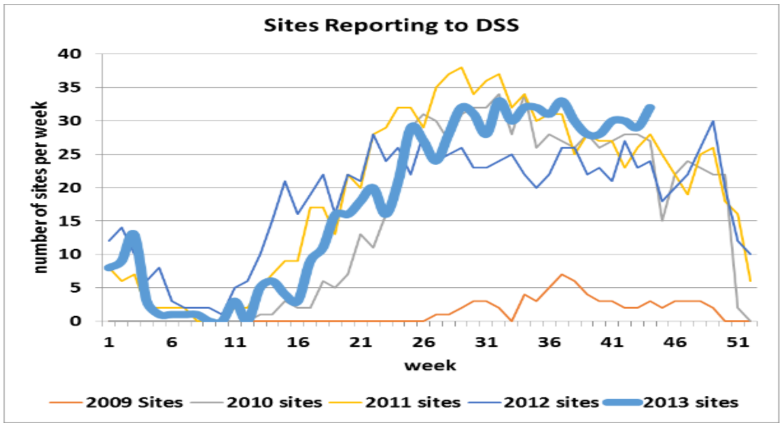
See Attached Presentation

<u>Ben Forward</u>
Dr. Forward is Head of the Food, Fisheries, & Aquaculture department at the New Brunswick Research & Productivity Council (RPC), in Fredericton, NB, Canada. He holds a PhD in Biochemistry from the University of Victoria and a BSc with honors in Biology from the University of New Brunswick. As Department Head he oversees three divisions providing R&D and diagnostic services in the areas of Fish Health, Microbiology, and Forensic Biology and has served as project lead on numerous applied molecular and microbiological R&D projects. He is an adjunct professor at UNBSJ, member of the Canadian Society of Forensic Science, Society for Wildlife Forensic Science, and Aquaculture Association of Canada.

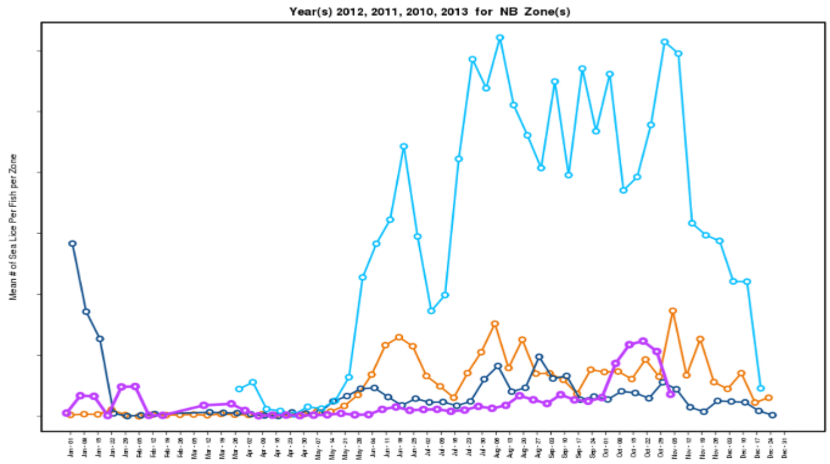
SEA LICE UPDATE – NEW BRUNSWICK INDUSTRY TRENDS, TRIALS, AND TRIBULATIONS

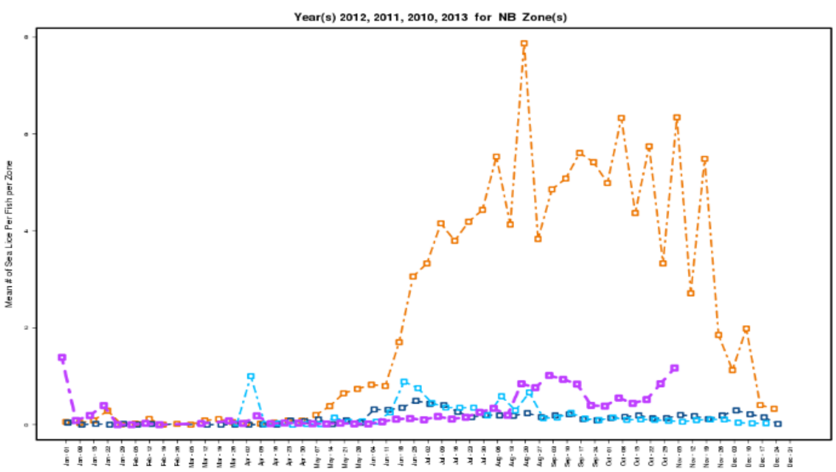
- Larry Hammell, Director, AVC Centre for Aquatic Health Sciences, UPEI

The Decision Support System (DSS) developed for the New Brunswick industry by AVC has been adapted for salmon farms in Nova Scotia and Newfoundland and Labrador with data input expected soon. Data is primarily inputted by industry and pre-agreed reports are automatically generated and sent to regulators for measures of site compliance with provincial policies. Graphs presented showed site reporting by week since 2009. Information was provided on training AVC has conducted since 2010 for industry personnel to ensure sea lice data is collected and reported correctly. Due to cutbacks in provincial funding, AVC is no longer conducting bioassays or site audits so only historical information could be presented.



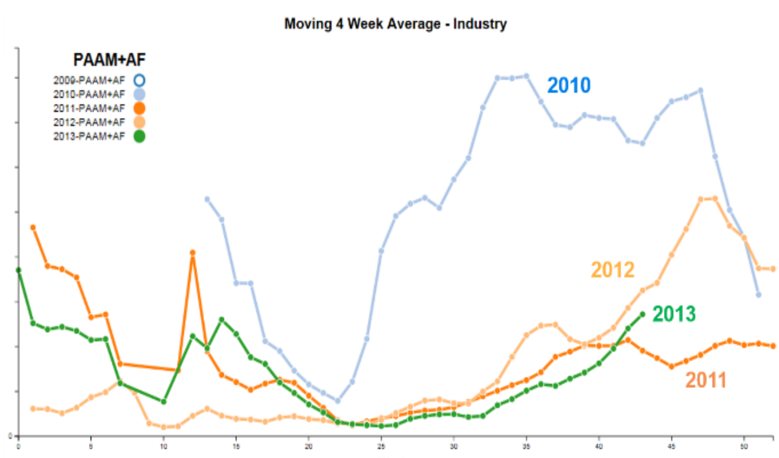
Data indicates the levels of Caligus (herring louse) being reported are low again for 2013, similar to 2010 and 2011 levels.



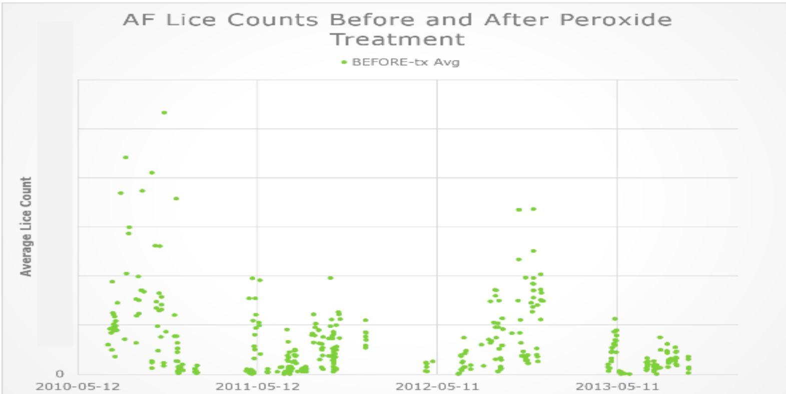


Average number chalimus per year since 2010 indicates that 2013 levels generally were the lowest recorded, remaining low until the last few weeks (i.e. starting in October) when numbers have been increasing.

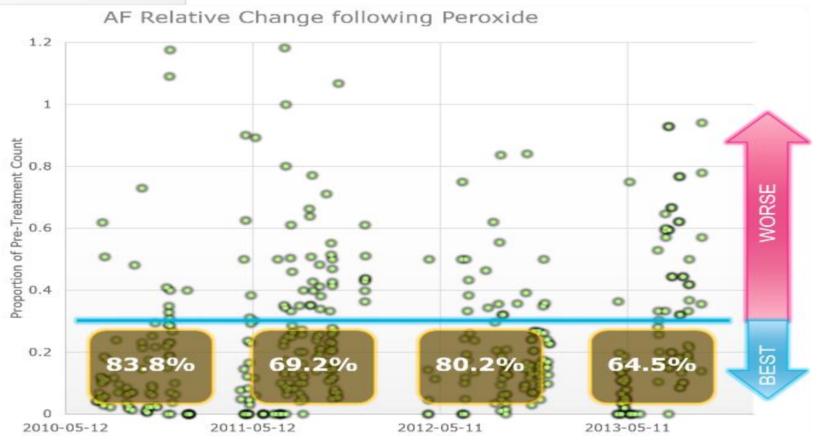
Trends for pre-adults / adult males (PAAM) and adult female (AF) lice were presented graphically, again reflecting, except for the very recent weeks, a very low year compared to the other three years recorded



Bath treatment summaries were presented for Interox Paramove and Salmosan. The total number of treatments with Interox to the start of November2013 was similar to the entire year in 2012.

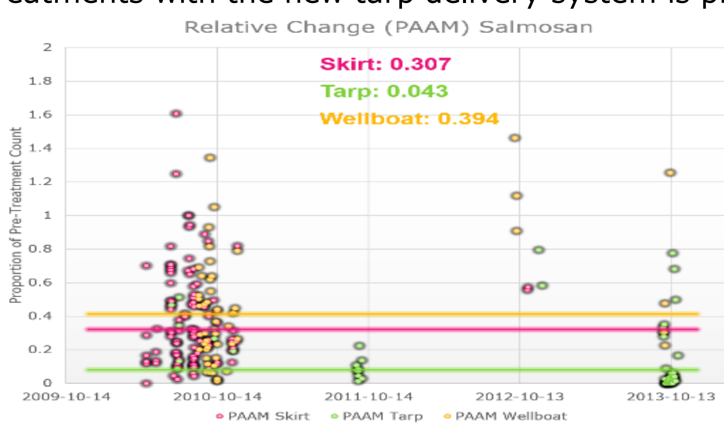


The industry appears to be initiating treatments at lower pre-count numbers.



However, treatments with more than 70% reduction in lice (i.e. considered successful treatment) are less frequent in 2013 than in 2012. Paramove was effective 65% of time for adult females and approximately 66% of time against PAAM in 2013.

A comparison of relative change in sea lice numbers over the last four years with Salmosan applied by various methods shows treatments with the new tarp delivery system is producing a good response for PAAM and AF.



<u>Larry Hammell</u>

Larry Hammell, DVM, MSc (Epidemiology), is Director of the AVC Centre for Aquatic Health Sciences and Professor in the Department of Health Management, Atlantic Veterinary College, UPEI. Dr. Hammell has been a faculty member in the Department of Health Management at AVC since 1992 and was Coordinator of Fish Health at AVC from 1996 to 2002. As a specialist in finfish health management, Dr. Hammell has a particular interest in applying epidemiology research tools to evidence-based management of aquaculture health issues, and has taught and worked with veterinarians and farmers in many parts of the world, including both coasts of Canada, Chile, Australia, Thailand, and the United States. As an epidemiologist, Dr. Hammell carries out both applied and clinical research in aquatic food production settings, including risk factor studies, clinical field trials, and the development and evaluation of surveillance programs.

TREAT - GENOMIC TOOLS TO RESOLVE ENVIRONMENTAL IMPACT AND TREATMENT RESISTANCE IN SEA LICE

- Sara Purcell, Research Technician, HOPLITE Research Lab, AVC.

The work presented had three objectives – to create a database for *Lepetherious salmonis*, profile sea lice response to drugs and to apply the knowledge to increase treatment efficacy.

To create a single nucleotide polymorphisms (SNP) or "mutation" database for *L. salmonis* a record of all SNPs would have to be created as each SNP represents a difference in a single DNA building block or nucleotide. The database will provide a tool to study the mutations (SNP chip), to genotype families and populations in Canada, and eventually predict resistance development. The second objective is to profile sea lice response to drugs across populations; current and future drugs. The final objective will be to take the information gathered and enhance salmon responses to lice by increasing the effectiveness of the immune system, vaccine prototyping, etc.

The SNP database is being established through work already conducted in BC and Norway which have large lice sequencing initiatives. To ascertain if the mutations identified are related to therapeutant resistance, a population study has been started by sample lice from throughout Eastern and Western Canada. To determine inheritance, work inbreeding lice from different Bay Management Areas (BMAs) in Eastern Canada has begun at AVC-UPEI. Preliminary data suggests that temperature, which influences the number of treatments used in a year will therefore, affect the rate that resistance evolves. How inheritance of particular mutations will affect this rate and how the process works for different drugs are questions yet to be answered.

To profile louse response to drugs across populations, samples of sea lice from Bay Management Areas 1, 2a and 2b in New Brunswick and lice from Newfoundland were compared through a sensitivity analysis of adult male and female sea lice populations exposed to emamectin benzoate (EMB) in a 24 hour bioassay. BMA 1 and 2a populations are considered resistant populations, while BMA 2b populations are considered sensitive to EMB. Within populations there is a difference in LC50 values between males and females, with females tending to be more sensitive to EMB; except in the case of NL and BMA 2b. Results of crosses between the populations indicate that resistance / sensitivity can be inherited.

The survival of sea lice from BMA 1 and 2b were compared when exposed to two dosages of EMB, azamethiphos and deltamethrin. Sea lice from BMA 1 had high survival when exposed to azamethiphos, but it was noted that farms in this area were treated with this product extensively in 2009 and 2010.

See Attached Presentation

<u>Sara Purcell</u>

After graduating from Mount Allison University in 1994 with a BSc, Sara headed west to the University of Manitoba to do an MSc in wetland ecology. She then moved back to the Maritimes in 1996 when she married a potato farmer from PEI. While working in the biology department at the University of Prince Edward Island, she started a PhD in the field of population genetics, using the tools of molecular biology to examine lobster populations around PEI and NS. She has completed two Postdoctoral Fellowships at UPEI. The first in the Department of Applied Human Sciences where she examined the relationship between bioactive components from marine algae and disease prevention within the human genome, and the second in the Department of Pathology and Microbiology where she tested antigens of the Koi Herpes Virus (KHV) to build a DNA-based vaccine. Since 2010 she has worked as a research technician with Dr. Mark Fast in the Host Parasite / Louse Interaction (HOPLITE) research lab at the Atlantic Veterinary College.

BEST PRACTICE: CLOSED TARPAULIN SEA LICE TREATMENTS

- Nils Steine, Technical and Sales Representative Canada and Norway, Pharmaq

A video on delousing best practice with large cages when using tarps was shown, that was developed in conjunction with many service and supply companies including Aqua Pharma, Storvik and AQS. The video "Best Practice" may be found at http://www.pharmaq.no/forms-manuals/training/ (available in English, Norwegian and Spanish).

Best practices identified for the use of tarps for sea lice treatments include:

- Activity must be well planned and coordinated, preferably through one person – an Operations Manager who ensures roles and responsibilities are understood by entire crew.
- Verify sea lice susceptibility to product and method of choice
- Ensure all equipment has been serviced, ready to use and secured properly to vessel
- Ensure oxygen system is in place and appropriate for the activity – producing microbubbles
- Ensure all health and safety equipment is in place
- Verify Fish health status prior to treatment.
- Fish should be starved for 15 degree days
- Water current should not be more than 35 cm/s
- Ensure distribution system releases product both vertically and horizontally
- Monitor water temperature, oxygen, behaviour constantly and in several locations
- Ensure weather forecast is favourable for the completion of the activity

Proper procedures for oxygen system, tarp and product distribution system deployment were reviewed, and product preparation.

<u>Nils Steine</u>
Nils Steine completed a MSc in aquaculture / fish health and so in Norway is called an Authorized Fish Health Biologist. Nils worked in a fish health service company in Northern Norway in the 90's and as the Fish Health Manager for the production company, Atlantic Salmon of Maine from 2000-2004. From 2005-2008 he worked as a fish health consultant in BC, with emphasis on physiology /smolting, vaccines and fish health services. He then moved with the family to Stavanger, Norway and has worked with PHARMAQ since that time, serving as a technical and sales representative for Canada and parts of Norway.

PROGRESS REPORT: TRAPPING TECHNOLOGY ON SALMON AQUACULTURE SITES

- Shawn Robinson, Biological Effects Section, Fisheries and Oceans – SABS

This presentation reported on the final stage in a series of projects conducted in association with Nathaniel Feindel from SABS and Keng Pee Ang from Cooke Aquaculture Inc, designed to develop and test biological and physical traps as a tool to help control sea lice. A second goal was to gain a better understanding of the early life history ecology of sea lice. Data was collected first in 2011 from lab and field observations, then from pilot scale field trials in 2012 and finally with full-scale trials in the summer/fall of 2013. Analysis of the data from this work has led to a number of interesting findings including:

- ➢ Larvae collected from sea lice trap deployments are distributed mostly near salmon farms in relatively low numbers compared to other zooplankton

- Larvae are readily attracted to light sources, particularly towards ones with blue wavelengths based on controlled lab experiments

- Larvae appear to have well-developed swimming abilities (up to 10 m/h over a 4 m track)

- Simple light traps capture a wide-range of zooplankton that are not normally seen in the water at the farm suggesting that conditions at night are different

- The results to-date from the trapping experiment suggest that the current configuration traps is not sufficient to remove enough larvae to reduce the parasitic load on the salmon, although there were some confounding factors during the study. Further work should be done to validate this conclusion.

Graphs and photographs highlighted the sampling process and data used to determine light trap electrical and trap performance. Power requirements of the pump and lights were shown to be at the capacity of the solar panels used which impacted their effectiveness on larger scales. Light penetration of the solar panel powered lights into the water column was low, so it is not expected to impact other species such as herring. While not all the data have been analyzed, it doesn't appear that the traps are significantly reducing the numbers of lice on the site, so if traps are to be effective they may need additional attractants specific to sea lice. There were also some confounding factors during the experiment such as sea lice treatments being carried out with possible cross-contamination between cages while the light experiment was underway. More work on this aspect is warranted.

Sea lice appear to be primarily associated with salmon aquaculture sites and are found at relatively low densities (1-8 /m^3) compared to other zooplankton (10,000 /m^3), so internal sea lice dynamics at the salmon farm sites may need a higher level of understanding in order to control these parasites. The larvae are found down to 20 m on a regular basis at all times of the day although there is little understanding on the intermediate depths to date and their relative movements.

Data from larval sea lice swimming capabilities was presented that demonstrated sea lice larvae are very proficient swimmers, reaching speeds up to 10 m/h over distances of 4 m. Morphometric observations suggest that oil droplets found in the larvae (e.g. larval fuel) will last approximately 10 to 12 days at 12°C (presumably a host must be found before that is depleted). Experiments indicated that hatching rate decreases with increasing sediment organic content likely due to the oxygen demand of the substrate and its associated organisms. Monitoring oxygen use over time in the laboratory indicated that sea lice eggs use less oxygen than juveniles and gravid females. All stages do not survive well in low oxygen environments.

See Attached Presentation

Shawn Robinson

Dr. Shawn Robinson has been working for the last 18 years as a research scientist with the Dept. Fisheries and Oceans at the Biological Station in St. Andrews, New Brunswick. He is also an adjunct professor at the University of New Brunswick and the Nova Scotia Agricultural College and is actively engaged in applied ecological research on marine shellfish species such as blue mussels, sea scallops, sea urchins and soft-shell clams. His research team is studying the natural processes by which these animals interact and utilise their environment so that better and more sustainable culture techniques can be developed. One example of this research is the study of an integrated multi-trophic aquaculture (IMTA) project (sometimes known as polyculture) where shellfish are grown in conjunction with other species to produce a more sustainable and productive system. Much of this work involves collaborative projects with industry and academic partners and takes a more holistic view of the aquaculture system combining biology, physics, economics, sociology, and government policy.

CUNNER AS CLEANER FISH AND CUNNER BREEDING PROGRAM

\- *Nell Halse for Keng Pee Ang, VP Research, Cooke Aquaculture*

Norway has known for over 20 years that wrasse could be used as cleaner fish for sea lice but only recently has interest in this country resurfaced as sea lice have become resistant to a number of treatment products. It is estimated that over 20% of Norwegian sites are using wrasse to combat sea lice. The local cunner fish is in the same family as wrasse and Cooke Aquaculture has been working with this fish since 2010 in the lab and field trials.

Preliminary tests placed wild cunner in tanks to determine that the cunner would indeed eat sea lice. Further testing at the Huntsman in 2011 considered whether various sizes of cunner would eat sea lice off salmon in the presence of other potential food sources such as natural biofouling, mussel meats, and salmon feed. Behavioural trials showed that the cunner had no interest in the salmon feed, but that nets had to be kept clean as they would eat biofouling organisms. Cunners also need shelters within tanks / cages.

Fishermen in Nova Scotia were trained by DFO personnel to catch and hold wild cunner. The health of the cunner were checked and then transported to New Brunswick for field trials. Field trials began in Back Bay in 2011; wild cunners were placed in 20 cages holding 40,000 salmon each and monitored weekly for sea lice. The cunner survived the winter water temperatures well and the number was topped up as needed to maintain the required inclusion rate.

To determine the appropriate level cages with 3%, 6% to 12% and a 9% inclusion rates were compared against control cages without cunner during 2012. While the data presented indicates that the cages with the cunner had lower sea lice numbers than the control cages, the salmon did require bath treatments during the 2012 season. During 2013 the cunner did control the number of gravid sea lice on the salmon.

A breeding program began in 2011 but the larvae did not survive beyond 21 days post hatch. Several issues were identified including swim bladder development. As of August 2013 fry had survived to 100 days post hatch.

See Attached Presentation

Keng Pee Ang

Dr. Keng Pee Ang was educated at Plymouth University in England, Stirling University in Scotland and received his Phd in Animal Behavior at the University of British Columbia in 1999. He began his career in Malaysia and has worked in the aquaculture industry in North America as a Technical Manager for both Feed and Production companies. He has held his current position of VP R&D, Feed and Nutrition with Cooke Aquaculture since 2006. In this role Keng is responsible for feed management, quality and trials as well as training of farm crews. He also oversees R&D and biotech projects and interacts with universities, government scientists and private labs on the company's behalf. During his career, Keng published extensively and accomplished a number of research milestones, including the invention of a patented enhanced feed pellet technology, establishment of novel laboratory procedures for studying fish response to pellet choice and the development of underwater technology for monitoring the feeding of fish in sea cages. This technology is now used widely in salmonid aquaculture worldwide.

OPTICAL SEA LICE TREATMENT

- Esben Beck & John A. Breivik, Stingray Marine Solutions AS

One of the major concerns for salmon farmers worldwide is to find effective, non-chemical solutions to fight sea lice infestations. The delousing method presented by Stingray Marine Solutions is to use camera vision, advanced software and laser to gently remove sea lice.

A history of the company and product development was presented as well as a description of the main components of the Stingray. The team has 15 years of experience as part of Beck Engineering AS, a company that has been involved in designing equipment for the oil and gas industry, offshore technology and medical applications. The successful proof-of-concept in lab was in 2011 followed by the development and production of test units in 2012-13. In 2014 further improvements in hardware and software are expected based on the field trials, with commercial units available by fall 2014.

The node is designed based on sub-sea units. Machine vision is used to detect and identify sea lice on salmon, then shoot the lice with a laser. It is a stereo camera - 3D imaging with lice recognition similar to face recognition used in I-phones and bottle inspections. The software identifies the distance disparity between pictures to predict where the lice will be and the laser aims for the exact location. It is currently effective for gravid females but work is on going to include pre-adults.

A video was shown from the ongoing field trials. The node was placed in a cage of salmon for a 24 hour period. The unit counted around 300,000 salmon passing by, with capasity to kill two to three lice per second. Data from controlled trials indicate that a considerable reduction in sea lice numbers can be expected. The node is meant to be permanently installed in cages for continuous sea lice management.

A comparison of the optical delousing method versus existing methods was provided to identify the advantages of the Stingray which included the fact that the unit will be:

- Fully automated so less labour intensive
- Not stressful to fish and increasingly effective / precise
- Collecting and providing Information 24/7 to farmer

See Attached Presentation

<u>John Arne Breivik</u>
Mr. John A. Breivik is Managing Director at Stingray Marine Solutions AS where he is responsible for company and project administration, operation and financing. He has also taken part in the initial phase of the optical delousing project. He has been involved in several successful start-ups and has a degree in finance from Norwegian School of Economics and also a Master of Management from Norwegian Business School.

<u>Esben Beck</u>
Mr. Esben Beck is the Development Manager of Stingray Marine Solutions AS. He has been the main person behind the idea and patent for the Stingray optical delousing unit. He has also been involved in a number of development projects from year 2000 and onwards, developing pipeline inspection vessel for gas pipelines, Ultra deep (3000 m) hydraulic ROV tooling, Helix Crawler, Water mains pipe scanner, automated robotic system for cutting, packing and ultrasonic sealing of canisters and more.

DEVELOPMENT OF A NEW BIOPESTICIDE AGAINST SEA LICE

- *Delphine Ditlecadet, Soricimed Biopharma Inc.*

Soricimed Biopharma Inc. is a private company established in 2005 following the discovery of a small paralytic peptide called soricidin, which was isolated from the short-tailed shrew saliva. Research and development work focuses on the use of non-paralytic soricidin derivatives in cancer treatment, with a clinical phase I trial being presently conducted. Other potential applications being investigated include the use of soricidin in pain treatment and in the development of a pesticide against sea lice.

Baculoviruses (BV) are highly specific to arthropods (insects, arachnids, crustaceans) and are ubiquitous in nature. The potential of baculoviruses as biopesticides is well known and documented as they have been used in the agriculture and forestry industries worldwide for decades. A table of current products, commodities and pests they are used for was presented. Five BVs are currently licensed in Canada's forestry industry and testing of a BV specific to the cabbage looper has been conducted. Baculoviruses pesticides are considered low-risk candidate microbial pest control agents in the UK under Regulation of Biological Control Agents (REBECA, 2007). After a review of the BV infection process, the lag time between infection and death of the target organism has been identified as a significant drawback. If used as a sea lice treatment, this lag time could result in continued damage to the fish and provide sea lice time to reproduce and potentially develop a resistance to the BV. The answer to this concern may be to couple the effects of soricidin and BV by inserting the gene encoding for soricidin in its genome. Infected sea lice would produce soricidin that would result in their paralysis while the viral infection proceeds. Thus there is both knock down and kill. This modification process has been tested in other systems. To date, 27 modified BV have been tested in several countries for different pests / food products. The use of arthropods toxins (mostly from scorpion and spider) to modify BV has shown a significant decrease in the knockdown time and increases effectiveness compared to wild BV in wide-spread field tests. Costs were significantly reduced compared to chemical treatment with the added bonus of no chemical pesticide being used on the fields.

Tasks to be completed prior to proof of concept were listed and discussed. The first, to determine if soricidin paralyzes sea lice, has been completed. Sea lice injected with the peptide were paralyzed within 15 to 20 minutes for up to 24h, while sea lice injected with saline were not affected over the same period of time. Paralysis symptoms included complete disability to adhere to the substrate, unresponsiveness when touched, and inability to return to the upright position when turned on their backs. All sea lice treated where alive after the 24h experiment.

See Attached Presentation

Delphine Ditlecadet

Delphine Ditlecadet arrived from France a decade ago to pursue a master degree on the determinants of growth rate variability in Arctic char at the University of Québec in Rimouski. She then moved to Newfoundland to conduct her PhD research on cold adaptations in rainbow smelt under the supervision of Dr. William Driedzic. She is presently conducting her postdoctoral research at Soricimed Biopharma Inc.

OFFSPRING DNA TRACEABILITY SYSTEM

- Ben Forward, Head of the Food, Fisheries, & Aquaculture Dept., New Brunswick Research & Productivity Council (RPC)

The need and uses of DNA traceability within an aquaculture operation are many and include whole food chain traceability for food safety and building consumer confidence, family assignment of parental fish for breeding, government compliance, and building a competitive edge. There are current examples of in-store traceability where a code from a fish product label can be entered into a specific website and provide consumers with information about the product. "This Fish" was used as an example of how this concept works with the commercial wild capture fishery. Entry of a simple product code can elicit information on the species, where it was caught, the fisherman who caught it as well as who processed the product. The unique quality with using DNA for traceability is that DNA will follow the product essentially throughout its entire life, from egg to plate and there are no physical tags to fall off or get lost when the product is processed.

Offspring™ DNA Traceability System is integrated across multiple areas of the production chain, from spawning and breeding, to the growth and production phase, to processing and the retail chain. Offspring™ has a unique set of components to deal with each part of the production cycle. The Offspring™ DNA Traceability System for Cooke Aquaculture begins with the genotyping of all parental fish with a powerful set of marker panels designed for salmon that have a combined discriminatory power that exceeds that currently used worldwide in human criminal investigations. A unique breeding strategy used by the Company, helps to increase the precision of the DNA traceability system and is facilitated by a custom-designed software package that can choose genetically unique mating pairs while incorporating breeding values and familial relationships. Tracking the movement of fish throughout the production cycle is facilitated by a custom designed whole chain traceability software package that can track fish movements, feed consumption, and environmental parameters. The Offspring™ parentage assignment software completes the loop by tracking all offspring back to their parents. A quality assurance / quality control (QA/QC) program rounds out the traceability system to allow constant testing, facilitating error tracking and identify areas of process improvement in data management and workflow.

Together these components create a powerful traceability system that enables the tracking of fish from egg all the way to the consumer's plate. As the project concludes the focus will include marketing considerations and how can this system be leveraged to add value to the existing products and create a competitive edge in the marketplace.

See Attached Presentation

<u>Ben Forward</u>

Dr. Forward is Head of the Food, Fisheries, & Aquaculture department at the New Brunswick Research & Productivity Council (RPC), in Fredericton, NB, Canada. He holds a PhD in Biochemistry from the University of Victoria and a BSc with honors in Biology from the University of New Brunswick. As Department Head he oversees three divisions providing R&D and diagnostic services in the areas of Fish Health, Microbiology, and Forensic Biology and has served as project lead on numerous applied molecular and microbiological R&D projects. He is an adjunct professor at UNBSJ, member of the Canadian Society of Forensic Science, Society for Wildlife Forensic Science, and Aquaculture Association of Canada.

Participants

Last Name	First Name	Company
Abbott	Matthew	Fundy Baykeeper
Alward	Nelson	New Brunswick Community College
Antworth	John	New Brunswick Environment
Armstrong	Ian	Aqua Pharma Inc
Armstrong-Chadwick	Travis	NBCC Student
Beattie	Mike	Dept of Agriculture, Aquaculture and Fisheries
Backman	Steve	Skretting
Bacon	Bev	RDI Strategies Inc
Beck	Esben	Stringray Marine Solutions AS
Benfey	Tillmann	University of New Brunswick
Bennett	Aaron	Silk Stevens Limited
Blanchard	Clarence	Future Nets & Supplies Ltd
Boerlage	Annette	Atlantic Veterinary College, UPEI
Borthwick	Gwen	Sweeney International Marine Corp
Bosien	Bryan	Snow Island Salmon
Bourque	Christy	Mitchell McConnell Insurance
Breivik	John A.	Stingray Marine Solutions AS
Bridger	Chris	Huntsman Marine Science Centre
Carney	Rod	NBCC Instructor
Carpenter	Erin	Kelly Cove Salmon
Chang	Blythe	Fisheries and Oceans Canada
Cheung	Leo	Research and Productivity Council (RPC)
Chopin	Thierry	University of New Brunswick - CIMTAN
Clarke	Corey	Parks Canada
Cleghorn	Kathy	Dept of Agriculture, Aquaculture and Fisheries
Cline	Jeff	Fisheries and Oceans Canada
Collins	Jason	Fish Vet Group
Cook	Sarah	Skretting
Coombs	Karen	Dept of Agriculture, Aquaculture and Fisheries
Cooper	Lara	Fisheries and Oceans Canada
Cox	Kasha	Merck Animal Health
Craig	Aaron	Northern Harvest Sea Farms
Cronk	Duncan	Cooke Aquaculture
Curtis	Donna	University of New Brunswick - PhD Student
Daggett	Tara	Sweeney International Marine Corp
Daigle	Amanda	Sweeney International Marine Corp
Dalton	Kathy	Dept of Agriculture, Aquaculture and Fisheries
Ditlecadet	Delphine	Soricimed Biopharma Inc
Donkin	Alan	Northeast Nutrition Inc
Drost	Terry	Four Links Marketing Ltd
Fielding	Stacy	Kelly Cove Salmon

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Frisch	Kathleen	Mainstream Canada
Francis	Joshua	Kelly Cove Salmon
Garber	Amber	Hunstsman Marine Science Centre
George	Sheldon	Kelly Cove Salmon
Gilbert	Eric	Fisheries and Oceans Canada
Glebe	Brian	Non affiliated
Graham	Caroline	NBCC Instructor
Grant	Jon	Dalhousie University
Green	Darrell	Newfoundland Aquaculture Industry Assoc.
Halse	Nell	Cooke Aquaculture
Hammell	Larry	Atlantic Veterinary College, UPEI
Hoare	James	Fish Vet Group
House	Betty	ACFFA
Hutchin	Lynn	Dept of Agriculture, Aquaculture and Fisheries
Ingalls	Larry	Northern Harvest Sea Farms
Jackson	Tim	NRC-IRAP
James	Sean	Cooke Aquaculture
Jones	Ginny	Novartis Animal Health
Kaufield	Kathy	ACFFA
Kesselring	Mark	Northern Harvest Sea Farms
King	Shelley	Genome Atlantic
Larsen	Johannes	National Research Council
Leadbeater	Steven	Saint Andrews Biological Station
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Lyons	Troy	Dept of Environment and Local Government
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Martell	John	Fisheries and Oceans Canada
Martin	Jennifer	Fisheries and Oceans Canada
Matheson	Tamara	NBCC Student
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McGee	Doni	ACFFA
McGrattan	Jason	Novartis Animal Health
McKinnon	Allison	Novartis Animal Health
McLean	Alicia	Novartis Animal Health
McNeillie	Alastair	Solvay Chemicals Inc
Miller	Matthew	Northeast Nutrition Inc
Mitchell	Hugh	Aqua Tactics Fish Health
Moore	Christine	Intrinsik Environmental Sciences Inc
Muzzerall	Robin	Gray Aqua Farms
Myers	Lisa	Canadian Food Inspection Agency
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Ogilvie	Thomas	Dept of Agriculture, Aquaculture and Fisheries

Oguntona	Wole	Canadian Food Inspection Agency
O'Halloran	John	Aqua Vet Services
O'Neil	Rodney	Cooke Aquaculture
Parker	Pamela	ACFFA
Pizarro	Hernan	Fish Vet Group
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Price	Derek	Atlantic Veterinary College, UPEI
Primus	Alex	Novartis Animal Health
Purcell	Sara	Atlantic Veterinary College, UPEI
Quaiattini	Gord	Maple Leaf Strategies
Rainnie	Don	Non affiliated
Recchia	Maria	Fundy North Fishermens Association
Reid	Gregor K.	Canadian IMTA Network (CIMTAN) / UNB
Robinson	Shawn	St. Andrews Biological Station
Rodriguez	Jose	Novartis Animal Health
Salazar	Fernando	Ulnooweg Development Group Inc
Salmon	Ruth	Canadian Aquaculture Industry Alliance
Savoie-Swan	Victoria	Aquaculture Association of Nova Scotia
Scattolon	Faith	Fisheries and Oceans Canada
Smith	Amanda	Sweeney International Marine Corp
Smith	Arianna	Kelly Cove Salmon
Smith	Jamey	Huntsman Marine Science Centre
Smith	Steve	Kelly Cove Salmon
Smith	Sybil	ACFFA
Snyder	Anthony	NS Dept of Fisheries and Aquaculture (NSDFA)
Stanley	Trevor	Skretting
Steine	Nils	Pharmaq
Stevens	Dave	Silk Stevens
St. Hilaire	Sophie	Atlantic Veterinary College, UPEI
Sweeney	Bob	Sweeney International Marine Corp
Szemerda	Mike	Cooke Aquaculture
Taylor	Gary	Skretting
Taylor	Tom	Northeast Nutrition Inc
Thompson	Shawna	NBCC Student
Thorpe	Bruce	Dept of Agriculture, Aquaculture and Fisheries
Thorne	Elliott	NBCC Student
Tippett	Colin	Cooke Aquaculture
Totten	Stephanie	NBCC Student
Trenholm	Mike	Canadian Food Inspection Agency
Vanderstichel	Raphael	Atlantic Veterinary College, UPEI
Walker	Scott	Atlantic Canada Opportunities Agency
Wallace	Shawna	Atlantic Salmon Federation
Watson	Kimberly	Dept of Agriculture, Aquaculture and Fisheries
Weaire	Ted	GMG Fish Services
White	Brian	Northeast Nutrition Inc
Williams	Brian	NBCC Student

Worth	Ann	PEI Aquaculture Alliance
Young	Tina	Sweeney International Marine Corp

DFO NHQ Work-plan Priorities for Aquaculture in Canada

Presentation to the Atlantic Canada Fish Farmers Association

November 2013

Objective

- To provide a high-level overview of organizational changes within Fisheries and Oceans Canada (DFO) and work-plan priorities.
  – Overall, DFO's aquaculture agenda will continue to be busy, driven by the need to take best economic advantage of the opportunities available in a suatainable way for rural, coastal, and Aboriginal communities.

DFO Reorganization

- Budget 2013 announced further efforts to constrain direct program spending including targeted savings at DFO of $33 million per year by 2015–16.
- The budget reduction is driving the organizational changes at DFO HQ and regions.
- Areas of interest: reduced overhead; reduced areas of duplication; and improved decision-making processes.
- One of the major change: Program Policy and Ecosystems and Fisheries Management sectors have been merged into one sector. This means integration of Aquaculture Policy and Operations within one Directorate.

Aquaculture Management

- DG, Aquaculture Management — Éric Gilbert
  - Director, Policy and Regulatory Initiatives — John Campbell
    - Manager, Fisheries & Aquaculture Management — TBD
      - Senior Fisheries & Aquaculture Management Officer — Dean Medeiros
      - Policy Advisor — Terry Johnston
      - Policy Advisor — Hung-Minh Lam
      - Policy Analyst — Jill Aitken
      - Fisheries & Aquac Mgmt Officer — Guillaume Dagenais
    - Mgr Pol & Prog — David Whorley
      - Senior Policy Advisor — Abdou Chalabi
      - Policy Advisor — Ellen Campbell
      - Policy Advisor — Stephen Asamoah
      - Policy Analyst — Lee Harber
      - Policy Analyst — Julian Labrin
  - Director, Aquaculture Operations — TBD
    - Mgr, Fisheries & Aquacult Mgmt — TBD
      - Sr. Fisheries & Aqua Mgmt Officer — Keith Were
      - Sr. Fisheries & Aqua Mgmt Officer — Amanda Mielke
      - Sr. Fisheries & Aqua Mgmt Officer — Michael Leonard
      - Fisheries&Aquac Mgmt Officer — David Boulet
      - Program Administration Officer — Joanne Lavictoire
    - Manager Aquaculture Governance & Sustainability Reporting — Anne Dufresne
      - Senior Policy Advisor — Vacant
      - Policy Advisor — Rashed Nabi
      - Policy Advisor — Jennifer Adams
      - Sr. Fisheries & Aqua Mgmt Officer — Lauren Lavigne
      - Fisheries & Aquac Mgmt Officer — Mireille Anderson
    - Mgr Pol. & Prog — Ed Porter
    - Manager, Fisheries & Aquaculture Management (CSSP) — Grace Mellano

Canada

Sustainable Aquaculture Program Renewal

- The Sustainable Aquaculture Program (SAP) underwent sunset review in 2013 --- Budget 2013 announced program renewal at $57.5 million/5 years.

- Program pillars (3) and key activities:

  – **Regulatory Reform**: e.g. *Aquaculture Activity Regulations*; updating the *Management of Contaminated Fisheries Regulations*; amending the *Fishery (General) Regulations* for new I&T Code and NAAHP full implementation; developing a National Fish Health Governance Framework; and improving the *Pacific Aquaculture Regulations*.

  – **Regulatory Science**: e.g. implementation of a scientific risk assessment framework; targeted regulatory research;

  – **Regulatory and Sustainability Reporting**: e.g. development of a national aquaculture information management system; ongoing aquaculture regulatory and sustainability reporting.

Broader Regulatory Reform Under SAP

- Recently, Parliament has demonstrated interest in aquaculture:
  - The Commons Committee on Fisheries and Oceans recommended: that the "Government of Canada develop a national policy and regulatory framework for aquaculture including an aquaculture act."
  - During the previous parliamentary session, the Senate Committee on Fisheries and Oceans held initial meetings on the regulation of aquaculture in Canada and future prospects for the industry.
  - It is unclear whether the Senate committee will reinitiate work in this area in the new parliamentary session.
  - DFO will support Parliament's efforts as needed.
  - DFO is significantly engaged in CAIA's industry-governments WG

Post-Cohen Business Resumption in British Columbia

- In deference to the work of the Cohen Commission, DFO postponed decisions on applications for new salmon aquaculture licences and for significant licence amendments until it had a chance to review the Commission's findings.
- Industry has now been informed that restrictions have been lifted in BC, except in the Discovery Islands area, enabling industry development following years of stagnation.
- User fees and service standards for aquaculture licensing are being developed. Expected implementation for the 2014 licence year, following consultations.
- Consideration is being given to multi-year licences to improve business certainty.

Canadian Shellfish Sanitation Program

- Delivered by CFIA, EC and DFO the Canadian Shellfish Sanitation Program (CSSP) is a strong food safety program that helps protect the reputation of the shellfish industry and enables access to international markets.
- National coordination is now under AMD

Program highlights for this year:

- **2013 US FDA audit of CSSP on East and West coasts completed**
  - Audit report to come.
  - No significant deficiencies reported; CSSP was considered to have adequately followed up on the 2009 USFDA audit findings.
- **CSSP Evolution**
  - integrate regional data into a national geospatial database to allow industry/public web access to real-time maps where bivalve shellfish can be safely harvested.
  - Economic opportunities to be taken into account in program resource priorities.

Aboriginal Aquaculture in Canada Initiative (AACI)

- An increasing number of Aboriginal communities have expressed interest in the economic development opportunities available in the aquaculture sector.

- $3.15 M over 3 years funded through the Strategic Partnerships Initiative (SPI) of Aboriginal Affairs and Northern Development Canada, providing Aboriginal proponents with:

  - Access to technical expertise for developing business plans;
  - Support to address economic development policy issues;
  - The ability to do feasibility studies or other supportive work.

- 30-35 viable proposals to be prepared through the AACI will attract investment to develop Aboriginal aquaculture business ventures.

Conclusions

- We recognise the opportunity for substantial growth in the Canadian aquaculture sector due to consistently increasing demand for fish and seafood.
- We also recognise that DFO's role and actions pertaining to the aquaculture sector can have an impact on the investment climate.
- The Sustainable Aquaculture Program will strive for continued improvements to the federal aquaculture regime in support of sustainability and investment growth.

Thank you

Questions/comments

Overview of Developments on CAIA's National Strategy

ACFFA Workshop
November 6, 2013

First: Who Are We?

Fundamental starting point -- we are farmers:

"Aquaculture is the **farming** of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. **Farming** implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. **Farming** also implies individual or corporate ownership of the stock being cultivated. "

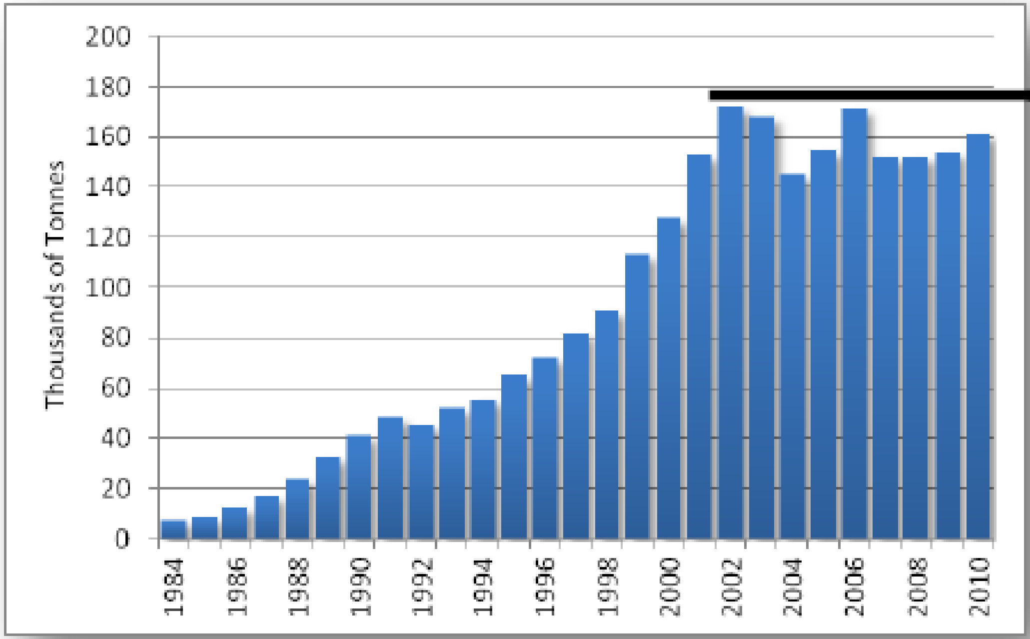
Aquaculture Development – FAO Technical Guidelines for Responsible Fisheries #5. Food and Agriculture Organization of the United Nations, 1997

Aquaculture in Canada today

- ✓ **$2.1 billion industry**
- ✓ **14,500** workers
- ✓ **Every province** and the Yukon
- ✓ **1/3** of the total value of Canada's fisheries production

13 years of stagnated growth

Aquaculture Production in Canada (1984 to 2010)

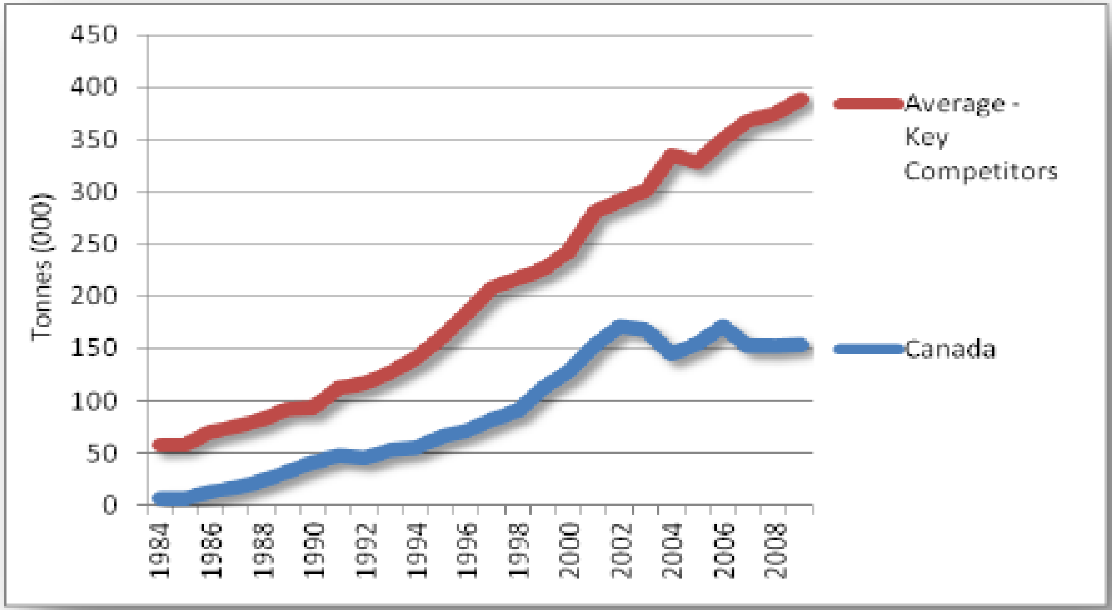


Aquaculture production has stagnated over the past 12 years

Source: FAO Statistics

Context: Falling behind key competitors

Aquaculture Production – Canada vs. Key Competitors (1984-2009)



Source: FAO Statistics Key competitors = U.S., Australia, Norway, Chile, New Zealand, Scotland, Ireland

(Scotland 220,000 tonnes by 2020; Norway currently 1.2M tonnes moving to 2.7M tonnes by 2025)

Context: Losing Investment to Other Countries

- A number of CAIA members invest in aquaculture on a global scale
- Recent investments of **more than $500+ million** worldwide
- **Less than 7%** of this new investment has come to Canada

Why have we flat lined?

1. Regulatory system that is overly complex, uncertain and confusing
2. Federal & provincial overlap and duplication
3. Patchwork quilt of statutes created decades ago to guide a wild fishery

The Solution: Implementation of a National Strategy

Focus on Key Issues:

- Establishment of an Industry Government Working Group (AAFC and DFO)

- Develop a **Modern Legal and Regulatory Framework** for Aquaculture which involves working toward a new Aquaculture Act and improving the regulatory system

- Implement **Policy and Program Reforms** in a variety of areas including a renewed focus on research and development, improved market access strategies and more active engagement of the farmed seafood sector in policy development

Tangible Benefits of the Strategy

Achieving real results on our National Strategy could lead to:

1. Increased production, jobs and economic activity:

	Within 5 Years	Within 10 years	Within 15 years
Total production*	200,000 tonnes	400,000 tonnes	600,000 tonnes
Total employment**	16,200 jobs	32,500 jobs	48,500 jobs
Economic activity**	$2.8 billion	$5.6 billion	$8.4 billion

* These are preliminary, conservative estimates that will continue to be refined by CAIA members
** Total employment (direct, indirect and induced employment) and economic activity impacts have been calculated based on input-output estimates prepared for DFO by Gardner-Pinfold

2. Expanded opportunities for First Nations & rural coastal communities

3. Capitalize on opportunities like Canada EU Trade Agreement

Key Issues Identified and Prioritized

- Rigorous process of ranking legislative, regulatory, policy and program priorities by CAIA's Technical Committee based on following criteria:

1. Urgency	2. Direct costs	3. Indirect impacts
• Safety threat (human and/or crop) • Threat to current crop • Interferes with immediate production schedule • Interferes with long range planning	• Profit loss on current crop • Increased production costs • Increased regulatory burden	• Investment loss • Market risk/loss • Loss in international competitiveness • Inability to expand/grow business • Social license and community costs • Reduced ability to attract/retain employees

Evidence-Based Discussion Documents

- From the priority issues identified, CAIA is preparing evidence-based documents to facilitate discussion, recommendations and actions

- <u>Prepared to date:</u>

✓Regulatory Cost, Economic Impacts and Overall Social Welfare Benefits of the Aquaculture Sector in Canada (May 2013)
✓Predictable Tenure/Lease/License Framework (March 2013)
✓Overview/Broad Elements of a new Aquaculture Act (March 2013) and Legal Elements of an Aquaculture Act (May 2013)
✓Improved Access to Feed & Fish Health Products (May 2013)
✓Farmed Seafood and Canadian Health (November 2013)
✓Industry Subsidy Report (Spring 2013)

Preliminary Results of CAIA's Industry Survey

	Finfish ($M)	Shellfish ($M)	Annual Total ($M)	Long Term Impacts* ($M)
Regulatory Costs				
Direct Compliance Costs	$9.9	$0.2	$10.1	$71
Indirect Compliance Costs	$80.3	$4.7	$85.1	$597
Total costs	$90.2	$4.9	$95.1	$668
Economic Impacts				
Lost Sales	$300	$20	$320	$2,260
Lost Economic Activity	$740	$45	$785	$5,500
Lost Jobs	4,300	250	4,550	32,000

* Present value impacts @ 7% discount rate over 10-year period

Subsidies to Industry

In recent years, subsidies to the aquaculture sector in Canada have been raised from time to time in the media - and this information has at times been based on little reliable data or opaque methodology.

The purpose of this brief was to provide CAIA with a more informed perspective of where the aquaculture industry in Canada sits in regard to subsidies and in comparison to other sectors.

Subsidies to Industry

According to Statistics Canada data, aquaculture is much less subsidized than

- animal and crop production
- forestry and logging
- mining

and was about as subsidized as fishing, hunting and trapping in Canada.

Seafood Saves Lives

- 5,800 lives could be saved per year, if Canadians increased their consumption of fish to the recommended levels.
- Increasing levels of fish beyond the minimum recommended servings could save about 7,000 lives per year.
- Based on the Treasury Board of Canada's recommended value of life saved (VSL), 5,800 to 7,000 lives saved represent **a potential benefit to Canadian society of between $42 and $50 billion per year.**
- These estimated benefits are based only on the value to Canadian society of **reduced number of coronary-related deaths per year, and do not include potential reductions in Canadian health care costs.**
- Clearly, there are significant potential benefits to Canadian society of changing fish consumption habits
- To achieve these benefits, the aquaculture industry in Canada will have to be able to grow to meet increased demand. Aquaculture is the only way to address increased demand for fresh, local, sustainably produced fish.

Evidence-Based Discussion Documents

- From the priority issues identified, CAIA is preparing evidence-based documents to facilitate discussion, recommendations and actions

<u>Under development:</u>

Regulatory Reform (November 2013)

Policy and Program Reform (February 2014)

Additional Policy Papers :

✓Social Licence and the Aquaculture Industry in Canada (draft Nov. 2013)

✓Building an Effective BRM Model for Canadian Aquaculture Based on Worldwide Best Practices

What have we accomplished?

- Strong support from PMO for National Strategy
- Mention of aquaculture in the Federal Budget
- DM commitments (in writing) to make progress on our priority issues
- Minister Shea supportive of National Strategy; wants to see growth brought back to the sector
- Strong support from Conservative Rural Caucus, who want to take on aquaculture as a priority project in fall
- Development of credible position papers and regulatory technical papers

Completed / Immediate Priorities

- BC Business Resumption Plan – signed and implemented
- Multi-Year Licenses in BC – with new fee structure
- MUMS Funding – developing proposal
- Clarification of Salmon as Medium/High Risk in Atlantic Canada (DFO letter in response to CAIA letter is in draft)
- Meeting with Reg Review Panel for Nova Scotia

Near Term Priorities

- Engage in AAR Consultation (November 18)
- Formalize Rural Caucus Working Group on Aquaculture
- Build on Communications / Food Narrative:
  - "Seafood could save 5000 Canadian Lives Each Year" – release during AGM
  - UN FAO presentation on global food demand and role of aquaculture (AGM)
- Continue outreach to politicians

Climate Change Implications for Aquaculture

G.K. Reid[1,2], S Leadbeater[2], N Feindel[2]

[1]Canadian Integrated Multi-Trophic Aquaculture Network, University of New Brunswick, Saint John, NB, Canada, E2L 4L5

[2]Fisheries and Oceans Canada, St. Andrews Biological Station, St. Andrews, NB, Canada, E5B 2L9

acffa Atlantic Canada Fish Farmers Association

Annual Workshop and Research Review
November 6, 2013

UNB Saint John

NSERC Canadian Integrated Multi-Trophic Aquaculture Network
Réseau canadien d'aquaculture multitrophique intégrée du CRSNG

Fisheries and Oceans Canada
Pêches et Océans Canada

Introduction

- Literature on climate change is “exploding”, with dedicated journals on the subject
- It’s encouraging that research is being done, but difficult to keep up…huge diverse field
- What is applicable to aquaculture?
- Research, specific to aquaculture and climate change is relatively new
- This presentation aims to explore this area as a means to encourage discussion, using a combination of peer-reviewed, anecdotal and industry reports

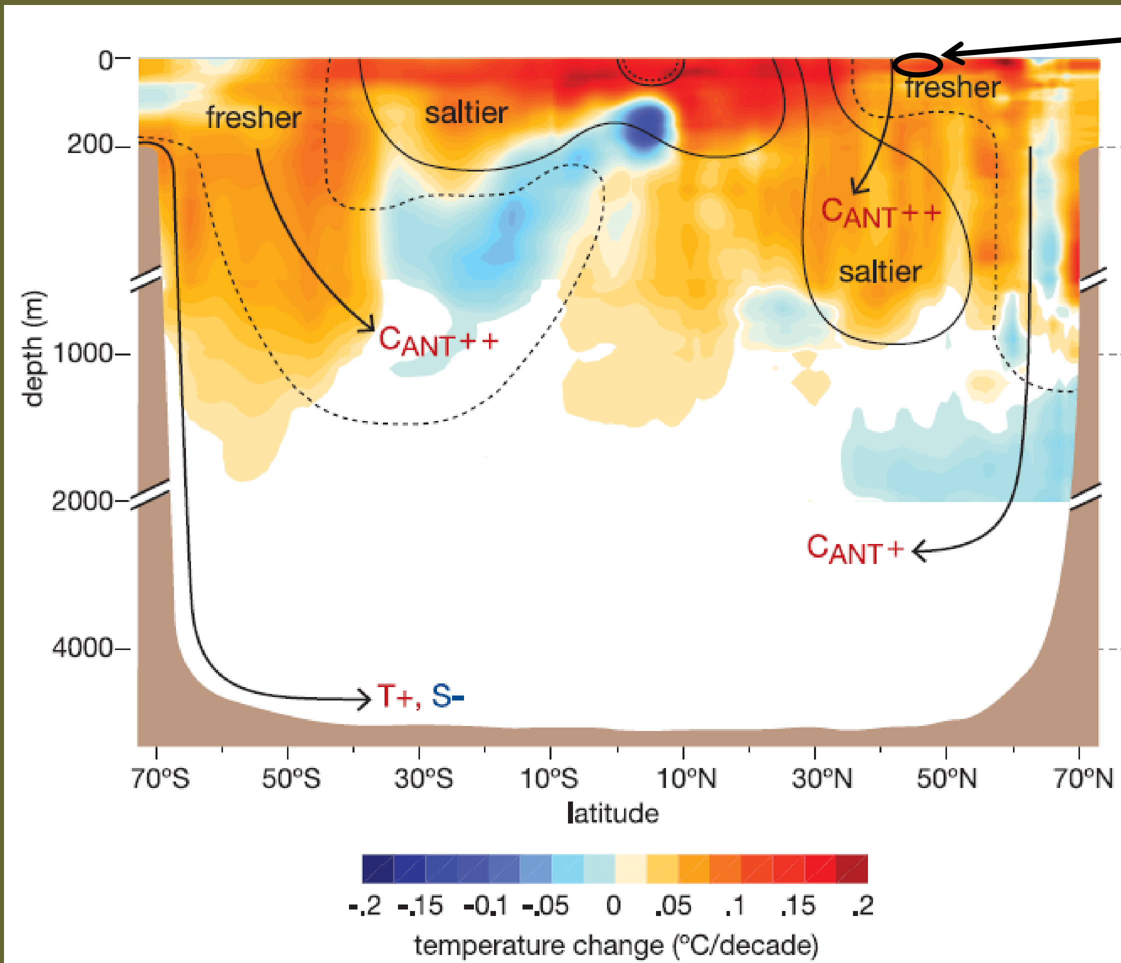
IPCC Assessment Report

- The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change and was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO)
- The main activity of the IPCC is to provide at regular intervals (every 6-7 years) Assessment Reports of the state of knowledge on Climate Change
- Last month (October 2013) the IPCC released its 5th Assessment Report (AR5)
- Produced by over 600 contributing authors from 32 countries

IPCC (AR5) summary of oceans, highly simplified

- The oceans have become a sink for 93% of the earth's additional energy inventory (between 1971-2010)
- Sea level rise: thermal expansion of seawater and glacier melting are considered the dominant contributors (mean 0.19m increase in mean sea level since 1901 to 2010)
- Evidence of increased stratification, size of oxygen minima zones and wave heights
- More precipitation projected in some areas (e.g. Poles, North America), less in others (e.g. Southern Europe, central America), changes to hurricanes uncertain
- Anthropogenic CO_2 has caused a gradual decrease in pH, by 0.1 (≈ 26%) since the beginning of the industrial era

IPCC (WR5) summary of oceans



Atlantic Canada location and aquaculture depth

Summary of observed changes in zonal averages of global ocean properties.

Temperature trends (°C per decade) are indicated in color (red = warming, blue = cooling); salinity trends are indicated by contour lines (dashed = fresher; solid = saltier) for the upper 2000 m of the water column (50-year trends from data set of Durack and Wijffels (2010); trends significant at >90% confidence are shown).

Concerns for aquaculture

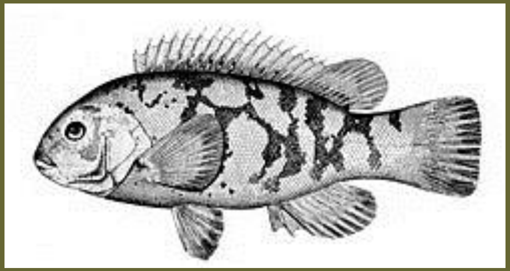
Temperature

- Increases in mean temperature within thermal tolerances will accelerate growth rates (assuming food availability), while exceeding optimal temperature ranges will cause stress, impaired immune functionality and increased susceptibility to disease

- There are also temperature considerations for bioenergetic expenditures, such as diet digestibility and assimilation, respiration rate (oxygen consumption), enzymatic functionality, osmoregulation as well as reproductive cues and expenditures

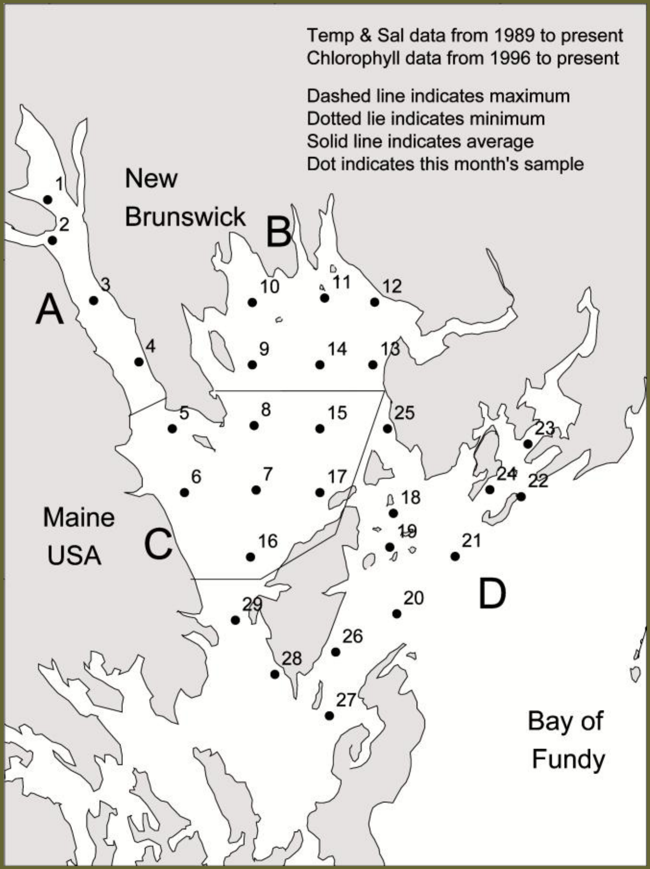
Temperature continued

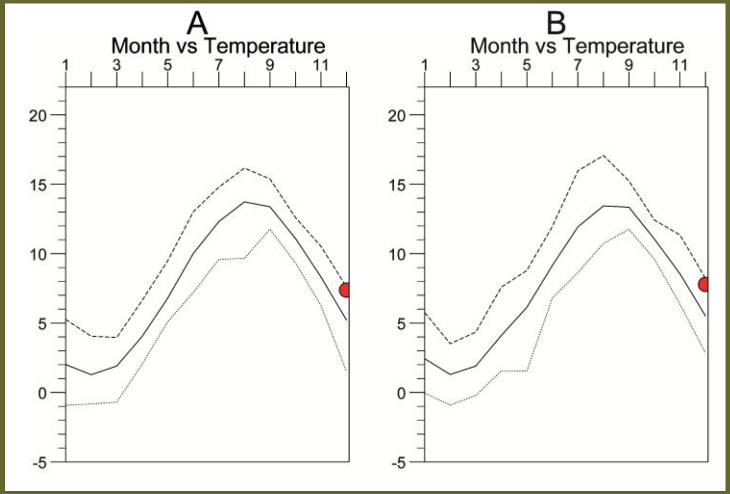
- Range distribution change of species, either as a direct or indirect response to temperature, is well-documented
- This effect has the potential to introduce new regional predators and pathogens; or the reverse, where regional prevalence is reduced
- Local example: first time sightings this year by a whale watching/sport fishing company out of St. Andrews (Island Quest), sighting Black fish (*Tauyoga ontis*) and Black sea bass (*Centropristis striata)*

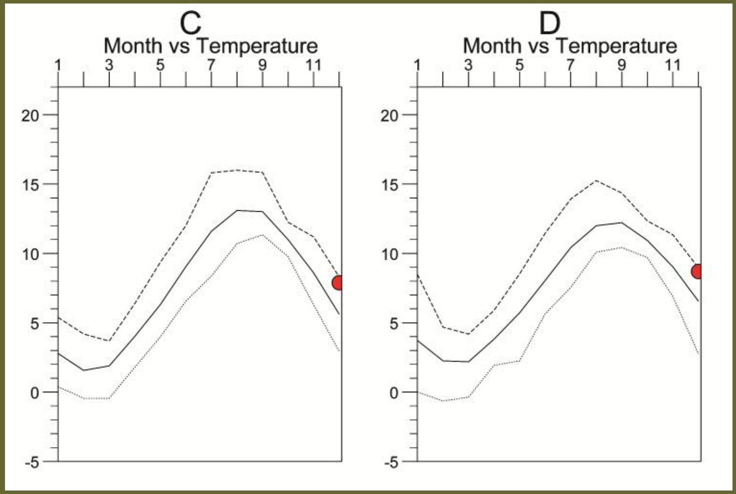


Images from Wikipedia.org

Local temperatures in 2012







2012 December example: at upper historic maxima

Lander and Robinson (2012)
Fisheries and Oceans Canada

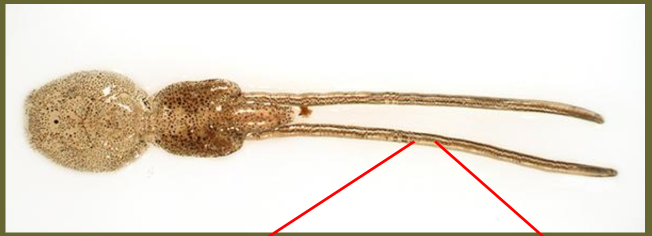
Concerns for aquaculture: temperature and sea lice

- Sea lice eggs can hatch and develop between 2°C and 10°C but probably need ≥4°C to complete their lifecycle (Boxaspen and Naess 2000)

- Cooler waters in the winter months have a lower incidence of infection, but as waters warm, infestation potential on farms can increase, as well as expand the geographical distribution of hosts and parasites (Heuch et al. 2002; Rikardsen 2004)

- Overall, temperature increases will reduce the time to complete the entire life-cycle of the sea louse, increasing their productivity, with potential negative impacts on salmon aquaculture (Stien et al. 2005)

Adult with egg strings



Eggs

Day 2

Day 7

Other temperatures effects

Off-flavor a recurring problem for US catfish farmers

BY ERICH LUENING

TEXAS – Despite continuing efforts by southern catfish farmers, the problem of off-flavor product seems to be difficult to eliminate.

Problems with inconsistent flavor occur in all food industries, but are especially noteworthy in aquaculture where products are often more expensive than other sources of animal protein. To capture and maintain market share, aquaculture products must be of consistent, superior quality, according to a Southern Regional Aquaculture Center paper on the issue.

Flavor quality is particularly important in farm-raised catfish because this species is not a customary part of the diet for consumers outside the southeastern United States. If off-flavored catfish is sold to first-time buyers they may be reluctant to make future purchases and instead favor more familiar foods such as poultry, pork, beef or seafood from capture fisheries.

"Off-flavor is a big problem in the catfish and hybrid striped bass and redfish aquaculture industries," said Granvil Treece, of Texas Sea Grant. "Most of the folks that I am aware of treat with Diuron or Copper sulfate to try to eliminate the blue-greens creating the problem."

Common off-flavors in pond raised catfish are grouped together on the basis of suspected origin. Three common off-flavors are based on their known or suspected origin as metabolites produced by blue-green algae, which are plant-like bacteria common in the blooms of many fish ponds. Two off-flavors in this category – 2-methylisoborneol and geosmin – are known to be caused by blue-green algae.

The third off-flavor, called "woody," is commonly included in this category although there is only weak evidence that it is caused by blue-green algae.

The most common cause of flavor problems in catfish raised in northwest Mississippi, southeast Arkansas, and northeast Louisiana is caused by 2-methylisoborneol (MIB). The chemical causes a unique musty-medicinal off-flavor that can be quite intense and disagreeable.

In catfish ponds, MIB is nearly always produced by the microscopic blue-green algae, *Oscillatoria perornata*, although in other environments MIB can be produced by several other species of blue-green algae, as well as by actinomycete bacteria. *O. perornata* grows slowly when water temperatures are below about 70°F (20°C), so is usually present only during the warmer months. The organism probably overwinters in the pond bottom muds and then begins to grow when water temperatures rise above 60 to 70°F (15 to 20°C) in the spring.

Off-flavors caused by MIB can develop rapidly, but they dissipate slowly. Fish exposed to MIB become noticeably off-flavor within minutes or hours. Fish purge the chemical naturally when exposure ceases, but days or weeks may be needed for the off-flavor to completely dissipate. The rate at which the off-flavor disappears is related primarily to water temperature and the size and fat content of the fish.

A different approach

In El Campo, Texas, southwest of Houston, JK Farms owner Jeffrey Koehn takes a different approach to fighting the off-flavor issue in his catfish ponds.

In the past he tried using a little Diuron, but never used copper sulfate. Now he uses a microbial-based product called Pro-Act Aqua Treatment, a Pro-Act Biotech solution.

"I've been using these microbes for a couple years now," said Koehn. "I am still not 100% convinced about the microbes and off-flavor, but I have had one pond tested out of 10 this year that was off-flavor when I had harvest size fish in the pond."

He said he is using the "microbes" on a regular basis.

The Rhode Island-based Pro-Act Biotech also sells its microbial treatments to hog, cow and chicken farmers, as well as oil spill treatment companies too.

"We are big in animal waste and lake and pond treatments," said Pro-Act president Bill Campion. "We like the aquaculture sector because we find it works so well. Our microbes dine on carbon and ammonia. The microbes are protein so in the end act as food for the fish."

Pro-Act Biotech calls its treatment a bioaugmentation product that feeds on animal waste and treats the water and cuts down on off-flavor product. In 2009, Pro-Act expanded its aquaculture division.

"When they use up the ammonia and sequester the phosphorous it keeps the blue-green algae down," Campion explained.

Dr. Chuzhao Lin, of Pro-Act agreed that they haven't done a lot of research on how the microbial treatment works, but said the customer feedback is enough, for now, to go on.

"As far as I know, none of the catfish folks pump water, so this compounds the off-flavor problem; whereas the hybrid striped bass and redfish farmers do pump water and can try to flush the algae out," said Treece.

Chilling the harvested animal may suppress the volatility of the compounds so that it is less detectable, but it does not get rid of the compounds, according to experts who also note that when the animal is warmed up or cooked, the off-flavor will return.

"The only solution is to get rid of the algae (if that is the source of the compounds producing the off-flavor) or move the animals to water that doesn't contain the compounds," said Treece. "Getting rid of all the algae usually isn't feasible, and moving the animals is difficult."

Water exchange may help, but not usually in ponds unless it's a massive and efficient exchange, he explained. Chemical applications to thin the algae bloom is the method most often used in the catfish and HSB industry (copper sulphate or diuron).

Off-flavors are difficult to manage in pond aquaculture, in large part because "off-flavor" describes a variety of problems, each with a unique (and often unknown) origin. It is, therefore, impossible to eliminate off-flavors with a single management strategy.

(ANA 2012)

- Off-flavour linked to blue-green algae that proliferate rapidly above 20°C (warmer months)

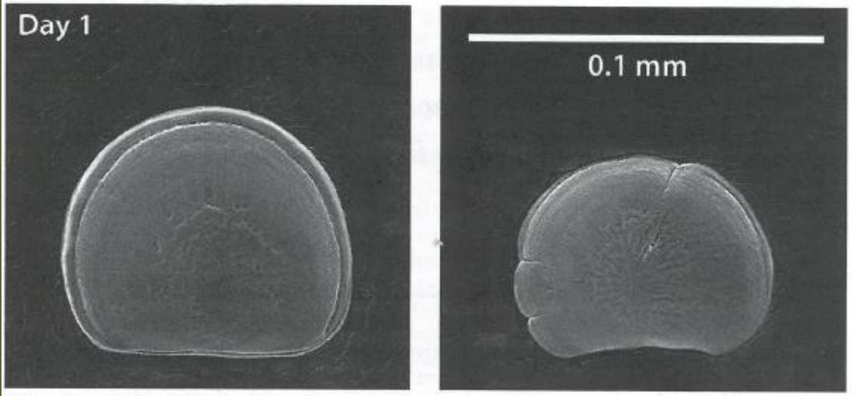
- HABs? (see Jennifer Martin talk)

Ocean acidification

- Increased CO_2 in conjunction with the resultant increase in acidity is of particular concern for hatching success, larval survival and early-rearing of shellfish and some finfish

- Ocean acidity decreases the saturation of aragonite (a crystalline form of calcium carbonate) which in general results in a reduction of calcification ability during shell formation; although this relationship can be quit complex

- In Washington State, natural oyster beds were reportedly failing and hatchery problems were first identified in 2005; one hatchery seeing a progressive reduction in oyster larval production to %80 by 2009 (PNS 2011, ANA 2012)



This image shows 1-day old Pacific oyster larvae from the same parents, raised by the Taylor's Shellfish Hatchery in natural waters of Dabob Bay, Wash. The larvae on the left were reared in favorable carbonate chemistry; the ones on the right in unfavorable chemistry. The waters were not manipulated and differences in the chemistry were accounted for by shallow and deep water intake pipes at the hatchery. The 0.1 mm scale bar is about the diameter of a human hair. *(image courtesy of George Waldbusser and Elizabeth Brunner, Oregon State University)*

(ANA 2013)

Ocean acidification continued

- Increasingly unproductive clam flats in Maine have prompted volunteer pH monitoring where they report productive clam flats only occurring at a pH of 7.8 or higher (ANA 2012)
- Industry collaborative research with the USDA has identified 100s of acres of unproductive clam flats at a pH of 7.0, prompting efforts to buffer flats with additional calcium carbonate as crushed shells, with some success (ANA 2012)
- At least one hatchery in Maine (USA), has observed a delay in settling of larval clams accompanied with difficulties culturing microalgae and have consequently teamed up with researchers to confirm if acidification is the problem (ANA 2012)

SPECIAL REPORT OCEAN ACIDIFICATION

Researchers explore ways to help clams survive *continued from cover*

hatcheries and Maine's multi-million dollar clam industry. In recent years, clam harvest has been reduced by the appearance of non-productive flats in previously productive areas, even when seeded, causing clam diggers in some areas to look for other work.

POSSIBLE SOLUTION

But Green has a possible solution – buffering clam flats with calcium carbonate. He has applied for a $750,000 grant from the USDA to fund a large buffering, seeding and educational project in Maine with the aim of restoring unproductive flats and supporting natural recruitment.

Acidification along the coast is exacerbated by several factors: runoff from rivers, which in Maine are naturally more acidic than ocean water owing to their forested headwaters and the plentitude of granite along their banks; combined sewage overflows during the heavy rains that have been more frequent during the past 10 years; and eutrophication, which occurs when nitrogen runoff from rivers and non-point sources, along with sewage overflows, feed algal

Photo: Fred Field, St. Joseph's College

Mark Green in the field (Broad Cove, Casco Bay, Maine) with students from St. Joseph's College, Standish, Maine.

that an acidic plume of water from the Kennebec River, which enters the ocean at the eastern edge of Casco Bay, is carried into the bay by wind and currents. This plume is strongest during spring runoff, when clams are spawning

AQUACULTURE NORTH AMERICA

SPECIAL REPORT OCEAN ACIDIFICATION

Warning signs at a Maine shellfish hatchery

BY MURIEL L. HENDRIX

Acidification is a significant concern for shellfish hatcheries in Maine. Bill Mook, whose hatchery is located on the Damariscotta River, says he has been acutely aware of problems with shellfish survival caused by low pH water along the West Coast. He first suspected something might be amiss at his location when larval clams were swarming near the bottom of their tank and delayed setting, and when certain types of microalgae were not as easy to culture as they had been.

Mook has been working with Mark Green and Joseph Salisbury to determine the best ways to monitor pH levels at the hatchery and methods to mitigate the effects of lowered pH. A portion of a grant Green has applied for with the USDA is set aside to purchase a monitoring instrument for Mook's hatchery that would provide continuous measurements of sea water entering the tanks. If Mook observes abnormal behavior in the hatchery, he could then correlate it with water measurements, including levels of pH.

"I'm basically nervous," Mook says. "My whole attitude is we need to be setting up monitoring programs to look at all these questions now before the situation becomes critical as it did on the West Coast where hatcheries have been badly impacted."

Bill Mook's hatchery on the Damariscotta River, Maine.

ANA

Acidity, cultured fish and other issues

- Some peer review studies of CO_2 / acidity affecting finfish larval (*Menidia beryllina*) hatching / survival (Baumann et al. 2012) and potential interference with neurotransmitter function (Nilssson et al. 2012)
- Few industry reports of finfish problems with acidity so far, but there are some: Wolf eels hatch at 7.6 but not 7.3 (ANA 2011)
- No apparent reports of issues with oxygen, sea-leave rise or salinity

AQUACULTURE NORTH AMERICA

NEWS

Ocean acidification may also be adversely affecting the hatching success of various marine species such as wolf eel (pictured).

Ocean acidification impacting both shellfish and finfish aquaculture says industry veteran

Escalating levels of carbon dioxide in the atmosphere are leading to growing problems of acidification in the ocean according to scientists, aquaculturists and other observers around the world.

On the west coast of Canada, BC scallop hatchery operator Rob Saunders recently made a presentation to local shellfish famers saying that he believes ocean acidification poses more problems than have yet been realized.

Rob Saunders, President Island Scallops Ltd.

And Saunders added that he's convinced that for at least some shellfish-farming areas, the problem is closely tied to a possible change in the density of the upper layers of the ocean.

That has led, he said, to the increased density of the upper layers as shown by periods of greatly-increased levels of ocean carbon sometimes double and even triple the normal level. That goes up , he suggests, as the ocean layers turn over and the ocean "burps" acid-bearing water to the surface.

He also said he's finding growing numbers of ocean-acidification incidents that indicate to him that the problem is not just an issue for shellfish farmers, but for finfish producers as well.

For a few years, Saunders has been involved in a research study on wolf eel with the Vancouver Aquarium. He said that some months ago he received a worried phone call from the aquarium to say they were having problems getting a batch of the tiny eggs to hatch.

According to Saunders, over time researchers have worked out an extremely accurate time-and-temperature formula that allows them to almost "set their watches" for when the fertilized wolf eel eggs will hatch. The tiny juveniles should have hatched as much as a week before, but they hadn't.

Saunders said he had been speaking to one or two people in Europe about their experiences with ocean acidification, so he asked what the pH of the water was.

"He said it was 7.3, so I said, that's your problem." And sure enough it was. When hatchery personnel gradually raised the pH to 7.6, they had what Saunders refers to as "an explosive hatching" of somewhere between 12,000 and 15,000 wolf eel within just five minutes.

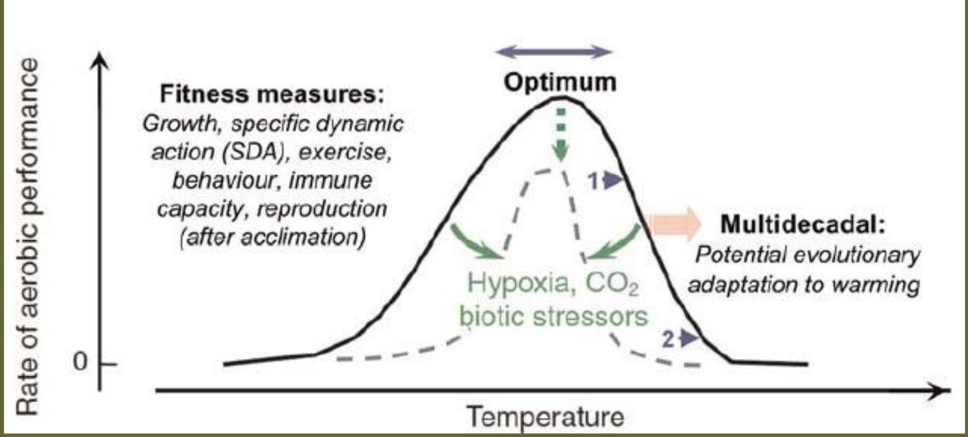
Saunders, who operates Island Scallops in British Columbia, said that numbers of shellfish hatcheries and producers in the province and in the US's Pacific Northwest have had serious problems with shellfish juvenile die-off's, owing to ocean acidification, and upwelling, acid-bearing water.

They've been able to overcome the problem by keeping a close eye on the water and ocean conditions in conjunction with wind direction, Saunders said, but that doesn't change the ocean-acidification situation. He's now part of a multidisciplinary research project that involves several institutions and companies, as well as Canada's Department of Fisheries and Oceans, which he said is very concerned about the still-escalating problem as identified in so-called "hot spots" around the world.

- Quentin Dodd

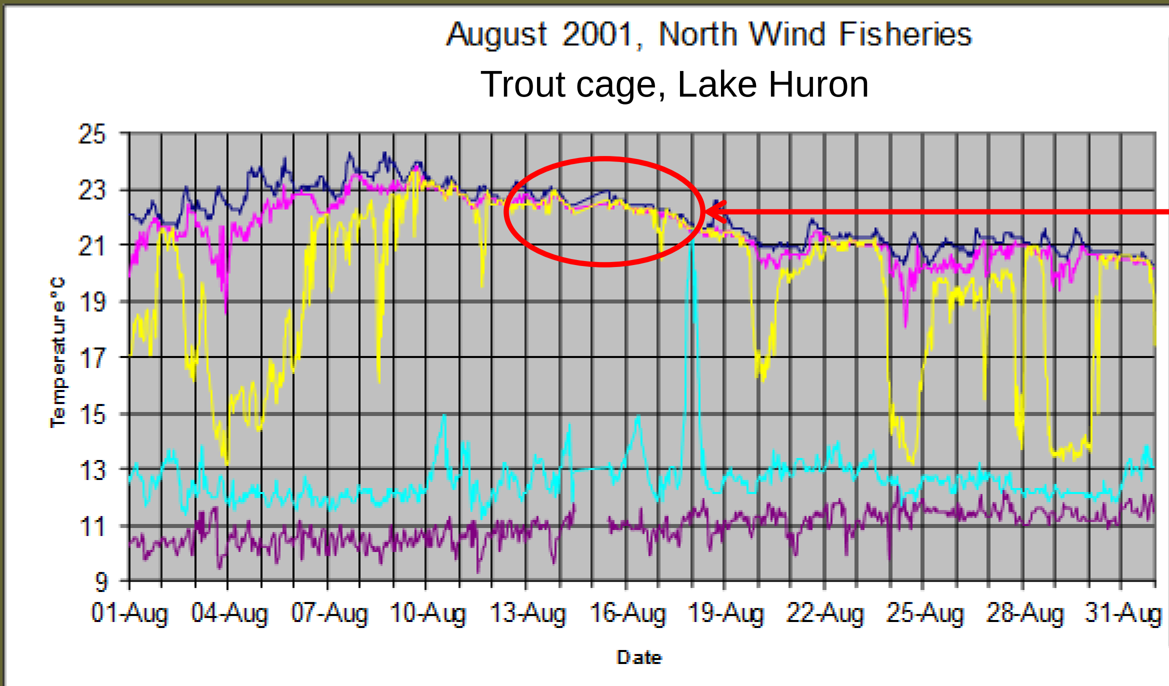
Negative and positive feedback

- Some cultured species will be simultaneously exposed to increased water temperature, decreased oxygen saturation, increased CO_2 and increased acidity, creating potential negative synergies
- Other effects may be offset
- Phytoplankton may decrease in some areas due to increased thermal stratification, reducing mixing of nutrients from deeper water, but wind induced up-welling has increased in some areas (e.g. California coast) and appears to be countering the effects of increased stratification potential (Doney et al. 2011)



Animal physiology and climate change: presenting "fitness" of marine animals as a function of ambient temperature, for various fitness measures (solid line) (Denman et al. 2011)

Conflicting outcomes of temperature



(Reid 2004)

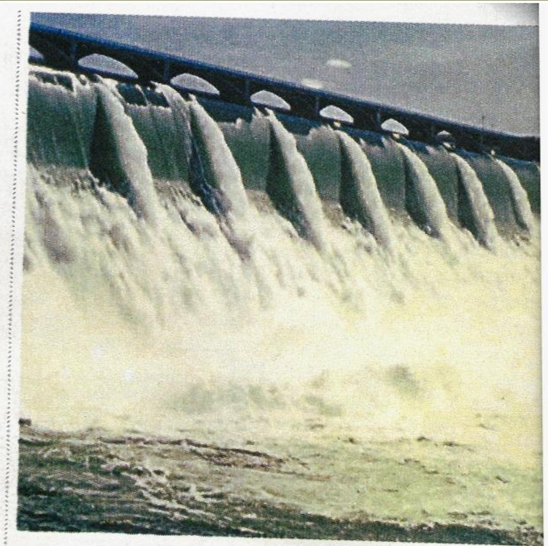
No thermocline, within the cage and at temperatures above 19 °C, fish would stop feeding

- Over the past 20 years, increased periods of high sub-optimal trout temperatures in summer and less ice in Lake Huron
- However, the overall effect still increased harvest weight by 10-20%, reported at one farm

(ANA 2013)

Industry reports suggest climate influence on freshwater user conflict

- Water for irrigation and trout farms had been supplied by Idaho's magic valley aquifer, which over the last decade, showed signs of drawn-down without refilling between irrigation seasons (ANA 2010)
- The resultant prolonged water-usage conflict between agriculture and aquaculture cost five state groundwater districts, 30 million ($US) to purchase the trout facilities with water rights, which will take 20 years to pay off (ANA 2013)
- In 2011, as a response to high perception and run-off from an excessive winter snow-pack, the US Army Corps of Engineers released vast amount of water from the Grand Coulee dam in Washington State (USA), reportedly causing a fish farm to lose large quantities of fish from over-saturation of gases, caused by the release (ANA 2011)



Fish farm losses blamed on dam run-off

The operators of a fish farm downstream of the Grand Coulee Dam in Washington state recently found themselves in trouble when the Army Corps of Engineers who operate the dam released vast quantities of water to reduce levels in preparation for run-off from an excessive winter snow-pack in the area.

Pacific Aquaculture Inc was quoted as saying the company was losing significant quantities of fish owing to the water releases over saturating the river with gases toxic to the animals.

Company management first sent a letter to the Northwest congressional delegation asking for an immediate stop to the spillage and later decided to take the matter to court to try to get an injunction against the Corps – all unsuccessfully.

Severe weather event examples and aquaculture

Lanesboro fish hatchery scrambles to recover from flooding

Story | Comments | Image (2) | Print | Font Size:

0 | Tweet | +1 0 | Pin it 0 | Share 3

Previous | Next

Posted: Wednesday, June 26, 2013 9:37 am |
Updated: 10:14 am, Wed Jun 26, 2013.

Marion Renault, mrenault@postbulletin.com

Its crew is tearing out carpeting and cleaning mud from its offices, but the Lanesboro State Fish Hatchery has bigger fish to fry.

At 6 a.m. Sunday, workers got a call from hatchery supervisor Pat Schmidt saying that the water had risen 40 inches after Saturday's flooding.

Scott Jacobson / sjacobson@postbulletin.com

Lanesboro State Fish Hatchery in Lanesboro, Minnesota, June 2013 (postbulletin)

Bellvue-Watson Fish Hatchery Colorado , September 2013 (fox31 Denver)

Belize, Hurricane Richard, October 2010 (ANA 2012)

Oak Bay hatchery, New Brunswick, December 2010 (St. Croix Courier)

Bow habitat Station fish Hatchery, June 2013 Alberta (worldpress)

White River National Fish Hatchery, Vermont (Hurricane Irene) August 2011 (flickr)

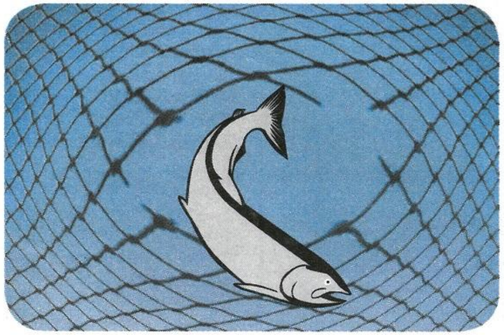
Industry reports: severe weather events

- Severe weather events have long been associated with escaped fish, and both the industry and ENGO’s have acknowledged the seriousness of this issue (Tang 2013)
- There is some industry awareness that cage-design should account for increasing severe weather events, particularly in already storm-prone regions such as coastal Vietnam, where HDPE floating cages have failed (Can and Tuan 2012)
- It is not just the storm damage proper that is problematic. Industry reports inaccessibility to damaged cages due to ongoing weather severity (ANA 2011), suggesting even small containment breaches may facilitate large escapes given a prolonged time until repair

AQUACULTURE NORTH AMERICA

NEWS

Storms and seals trigger salmon escapes in New Brunswick



It’s not been a good winter for salmon farms in New Brunswick. Pam Parker, Executive Director of the Atlantic Canada Fish Farmers Association, said that for five years New Brunswick went without any escapes of farmed-salmon. Then came the past few months.

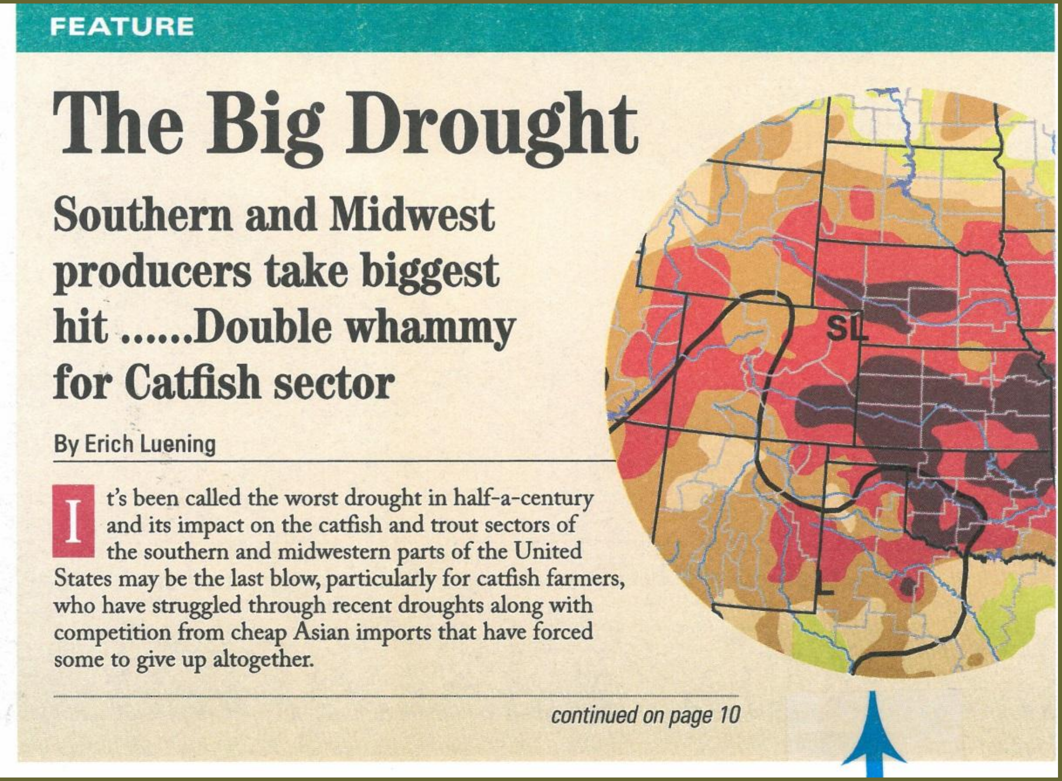
Parker said that fish had escaped from an Admiral Fish Farms site after a seal made a hole in one of the nets. Then, more escaped when a submerged stake from a herring weir tore a hole in a pen at a Northern Harvest site.

Later, says a statement from Admiral president Glen Brown, about 138,000 juvenile salmon escaped when high winds resulted in “a breach of containment” at two company-owned salmon cages.. Workers first noticed the breach on December 26, but were unable to do anything for another four days. The breach occurred on two new cages located south of Pumpkin Island, Grand Manan, when part of the anchoring system chafed the nets.

“Heavy winds… prevented workers from being able to recapture any of the fish, but survival of such young fish in the wild is very unlikely,” says the company statement. Brown is quoted as saying that the company wasn’t planning to re-stock this type of cage until the design issues have been resolved.

- Quentin Dodd

Drought and aquaculture



FEATURE

The Big Drought

Southern and Midwest producers take biggest hit ......Double whammy for Catfish sector

By Erich Luening

It's been called the worst drought in half-a-century and its impact on the catfish and trout sectors of the southern and midwestern parts of the United States may be the last blow, particularly for catfish farmers, who have struggled through recent droughts along with competition from cheap Asian imports that have forced some to give up altogether.

continued on page 10

- Freshwater aquaculture particularly susceptible to drought
- Less than 10% America fish production is mariculture
- What about terrestrial feed production?

(ANA 2012)

Alternative feed ingredients: Need to pay attention to terrestrial production

AQUACULTURE NORTH AMERICA MARCH/APRIL 2012 >> 5

COMMENTARY

By Brad Hicks

Fish meal and fish oil no longer a limiting factor for aquaculture

A recent FAO publication, Demand and supply of feed ingredients for farmed fish and crustaceans, trends and prospects, by Tacon, Hasan and Metian (www.fao.org/docrep/015/ba0002e/ba0002e.pdf) reviews the current use of a variety of ingredients available for the production of fish feeds. This review leads me to the conclusion that limited supplies of fish meal and fish oil are no longer limiting factors for the growth of aquaculture.

ONGOING DEBATE

For many years there has been an ongoing debate about limitations on aquaculture growth owing to the limited amount of fish meal and fish oil available for making fish feeds. Globally, the annual production of fish meal is limited at approximately 6 to 7 million tonnes per year and the production of fish oil is limited at approximately 1 million tonnes per year.

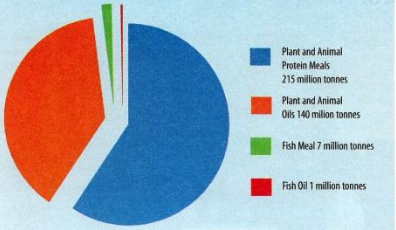
Historically, fish meal was used for a variety of applications, ranging from fertilizer to a feed ingredient for domestic livestock and to a lesser extent for the production of fish feeds. Now, approximately 70% of fish meal produced is used for the production of fish feeds.

ALTERNATE PROTEINS

The development of alternate protein sources for fish feeds, including animal by-product meals and vegetable by-product meals, has recently reversed this trend and less fish meal is now being used for the production of fish feeds than it was five years ago. Fish meal is quickly becoming just one of many ingredients used as a suitable protein source for fish feeds.

Fish oil was initially used for fuel and industrial purposes and to lesser extent for the production of margarine. Now, the majority of fish oil, approximately 80%, is used in the production of fish feeds. The use of fish oil in fish feeds continues to increase owing to the unique nature of fish oil which has large quantities of long-chain polyunsaturated fatty acids (omega 3 and omega 6 fatty acids). Alternate sources of these special fatty acids are limited and very expensive. However, fish can grow well on other oil sources such as animal by-product oils and vegetable oils, but if these alternative oils were the only source of oils the fish would lose some of the health-promoting properties attributed to the high omega 3 and omega 6 content. This problem can be solved by growing fish on non-fish oil diets until they are close to harvesting and then feeding a finishing diet high in fish oil content. This will in effect free up fish production from the relatively limited supply of fish oil while still maintaining the health-promoting attributes of eating fish.

Relative supply of plant and animal proteins and oils compared with the much more limited supply of fish meal and fish oil. The use of alternate protein and oil sources for fish feeds means that there is less reliance on fish meal and oil.



Proteins from plant and animals sources which are suitable for fish diets are available in large quantities. Global production of plant and animal protein meals are about 215 million tonnes compared with only 6 to 7 million tonnes of fishmeal. Global production of plant and animal oils are about 140 million tonnes compared with only about 1 million tonnes of fish oil. What's more, the past 30 years of research into the use of alternate sources of proteins and oils for fish diets have been very successful. Fish feed production is no longer limited by the relatively meagre availability of fish meal and fish oil.

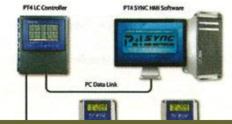
ROLE REVERSAL

Fish meal, and to a lesser extent fish oil, are now returning to their place as just another alternative source of protein and oil in the ingredient suite available for fish feed producers. This is reflected in the pricing of these ingredients. For a while fish meal was priced at a significant premium to other protein sources because we had not yet learned how to use other protein sources for fish feed. However, in the last five years this has changed dramatically and now the price ratio between fish meal and soy bean meal has returned to its historical ratio indicating that fish meal and soy bean meal are being used interchangeably in diet formulations.

However, the pricing of fish oil is a little more complicated. The price of fish oil is confounded by the specific demand for fish oil which has been created by the recognition that the long-chain polyunsaturated fatty acids uniquely contained in fish oil have strong health-promoting properties. These unique properties mean that fish oil is priced higher than other oils and it is expected that this price differential will remain in place until these very special fatty acids become available from other sources such as the commercial production of algae. However, this does not mean that fish oil is a limiting factor for the production of fish feeds. It only means that we will have to be more judicious in our use of fish oils. Fish grow well on alternate oils. They will just need to be fed finishing diets using fish oils so that the health promoting-properties of fish oils will continue to be transferred to people.

Aquaculture is entering a new phase in its evolution. Fish production is now on a more equal footing with other animal food production industries as it can now compete using the same less expensive raw materials.

Brad Hicks worked for many years as a veterinary pathologist. He has operated fish farms in Canada, the United States, Chile and is currently partner and vice president of Taplow Feeds in Vancouver, Canada.



World's animal feed production continues to rise

Chicken is largest, but aquaculture the fastest growing

The world's production of feed (all animals) has reached an estimated 873 million metric tons, according to a global survey commissioned by Lexington-based Alltech. Conducted through Alltech's regional managers, the survey assessed the tonnage of 132 countries and all species.

"This new global estimate is quite significant, especially when compared to the 2010 WATT report, which indicated 717.6 million metric tons," said Aidan Connolly, vice president of corporate accounts at Alltech. "Feed production is an increasingly global phenomenon and this survey is the broadest in its reach and, therefore, also complete in terms of its review of the state of play in the world feed industry."

Asia has secured a role as the number one feed producing region with a tonnage of 305 million, and China is the leading country with a total tonnage of 175.4 million. Europe follows Asia with 200 million. North America, Latin America and the Middle East/Africa round out the listing with 185 million, 125 million and 47 million respectively.

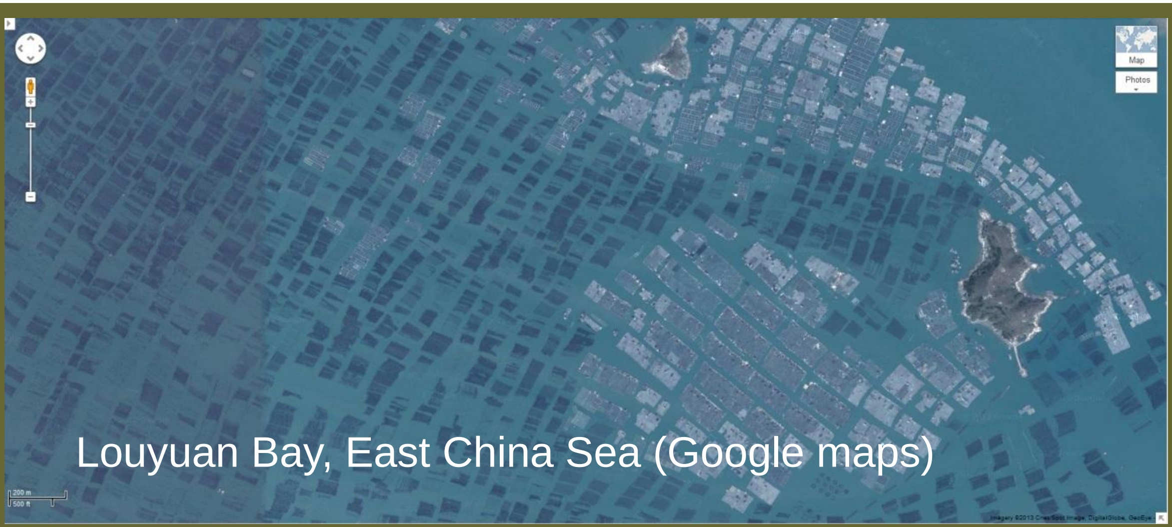
In terms of species, poultry feed now represents 44% of world feed production. Pig, equine and pet feeds have not changed significantly, but aquaculture is the fastest growing feed sector, now totaling nearly 30 million tons.

(ANA 2012)

Discussions on potential response and adaptations?

- Relocation
- Sourcing alternative feed ingredients
- Diversification (e.g. multiple species, IMTA)
- Changes to husbandry and time to market
- Engineering solutions (mitigate flood impacts, cage re-design)
- Emergency response plans
- Investigate genetic adaption potential (temperature, pH, etc.)
- Finfish producers should observe the response of the shellfish industry to climate change
- Regional mitigation solutions (next slide example)

Different problems, different regions



Louyuan Bay, East China Sea (Google maps)

Back Bay, NB, at same scale

- Maps are the same scale
- Multiple species culture in Louyuan Bay
- Enough culture diversity if one type of crop fails?
- Multiple culture structures dampen wave effects from severe storms
- Need to focus on region specific solutions

Aquaculture and Climate Change Research on the East Coast

- DFO received $16.5 million (2011) through the Federal Aquatic Climate Change Adaptation Services Program (ACCASP), over five years to implement science-based climate change programs, including aquaculture
    - DFO Research:
        - SABS (e.g. Ed Trippel, Shawn Robinson)
        - BIO (e.g. Kumiko Azetsu-Scott)
- Some academic research related to aquaculture and ocean acidification (e.g. Heather Hunt, UNB; Mark Green, St. Josephs College, US)
- Many of these studies are in early stages
- Some incidental aquaculture and climate research in NSERC database, but little

Aquaculture and Climate Change Research on the East Coast

- Need to establish baseline and historical conditions
  - pH data absence in Bay of Fundy
- Need to tie aquaculture development with regional projections (storm frequency, severity, rainfall, etc.)
- Prioritize issues for finfish culture
- What are research priorities for industry?
- Is it time to have a workshop?

Thank you!

Questions?

Author correspondence

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Helping The Fisheries and Aquaculture Sectors Leverage the Power of Genomics

Shelley King
VP, Research and Business Development

Atlantic Canada Fish Famers Association AGM

Nov 6/7, 2013

GenomeAtlantic
Life Sciences. Life Solutions.

What is Genomics

Genomics is the powerful combination of biology, genetics and computer science.

It helps us understand the role of genes in the function and health of all living organisms.

It is relevant to all sectors.

Genomics in Fisheries and Aquaculture

- **Production**: genomics can help address production issues through selective breeding programs disease management, diet optimization and hatchery effectiveness

- **Fish Health**: genomics can help in the development of therapeutics and vaccines; understanding of infectious diseases and parasites; and interactions between farmed and wild fish

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Genomics in Fisheries and Aquaculture

- **Conservation and Population Genomics**: genomics can help us monitor wild fish migration; understand differences in wild and farmed stocks; population health and species abundance

- **Ecosystem Integrity:** genomics can help us ensure species survival and genetic variation, as well as the sustainability of coastal and inland water ecosystems

Projects

Pleurogene – a $4.1M partnership with Scotian Halibut and Genome Espana to map the Senagal sole and halibut genomes

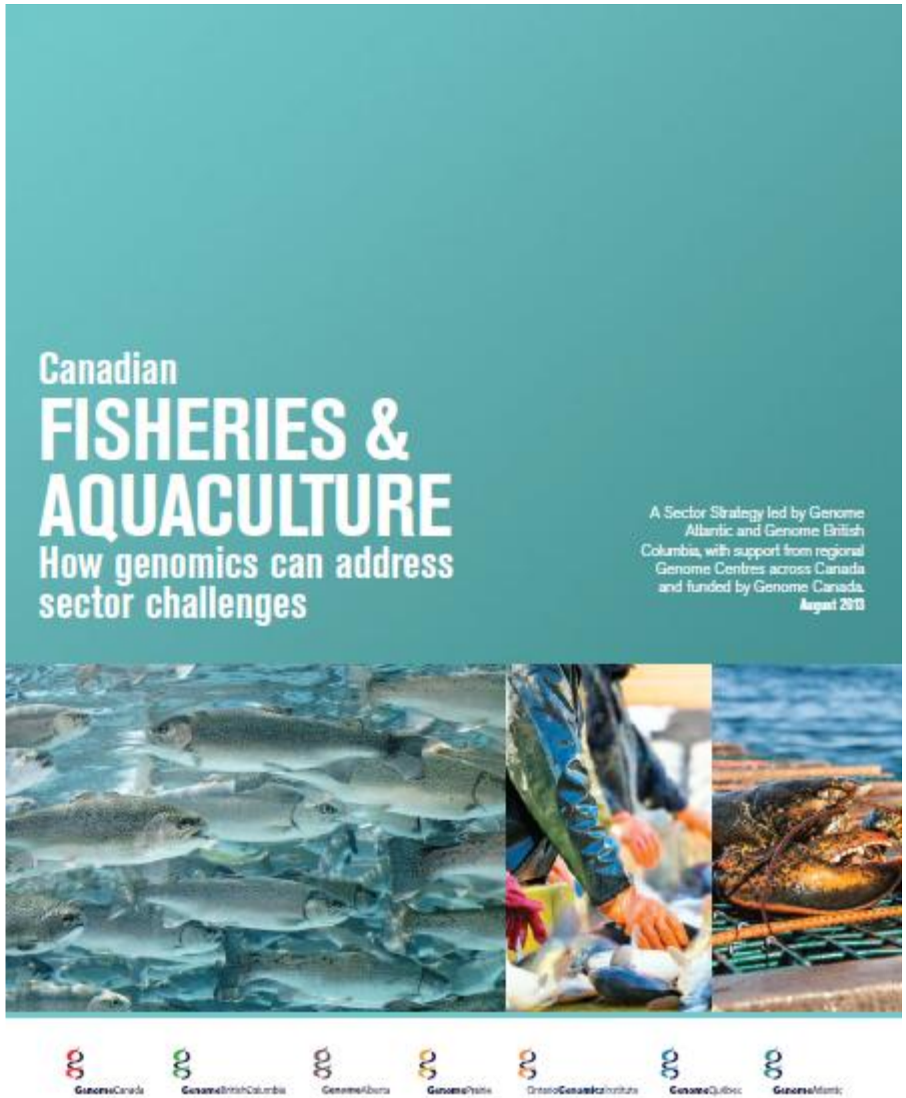
Projects

The Atlantic Cod Genomics and Broodstock Development Project – $18.2M project , including Cooke Aquaculture and Northern Cod Broodstock Company, to develop an elite broodstock

Projects

Developing Camelina as the Next Canadian Oilseed - $6.2M – an alternative replacement to fishmeal and oil in aquaculture feeds

Genomics in Fisheries and Aquaculture



Key Opportunities

- Genomics tools
- Health and nutrition
- Species sustainability
- Breeding programs
- Species-specific research

What is Genome Atlantic

- NFP incorporated in 2000.
- Developed to help implement the Atlantic Canadian portion of Genome Canada’s agenda

Increase Canada’s Ability To Benefit From Genomics Research And Development

The Genome Canada Enterprise

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Life Sciences. Life Solutions.

Genome Canada Programs and Resources

Genome Canada Genomics Application Partnership Program (GAPP)

- $30M available from GC
- $100K - $2M investment by GC (maximum 1/3 of budget)
- Total project size: $300K - $6M
- Project duration: 6 mths – 3 years
- Rolling intake
- Jointly led by industry- research institution
- Designed to move technology into hands of companies

Genome Canada Programs and Resources

Genome Canada Large Scale Applied Research Project (LSARP)

- 3-year projects, ~$2-6M
- Next one focused on food: Spring 2014
- Focused on industry/end user need
- Earlier stage than GAPP
- Industry's/End User role is vital, but does not require co-lead

Genome Canada Programs and Resources

Genome Canada Large Scale Applied Research Project (LSARP)

- Include research on societal (GE^{3}LS) aspects of the genomics work
    - Ethical
    - Economic
    - Environmental
    - Legal
    - Social

Genome Atlantic Services

Regional Pursuit of Genome Canada Funds

Genomics Opportunity Review Program

Genome Atlantic Services

Genomics Opportunity Review Program

- **Identify** industry need
- **Connect** industry need with genomics expertise
- **Shape** research parameters
- **Define** budget and help procure funding
- **Manage** R&D projects
- **Direct** integration/commercialization

Thank You

NBCC
COLLEGEWORKS

Aquaculture Technician Program

35 years and Counting

Program Origins

- First offered in 1978 with a seat capacity of 12 students
- Originally in support of the provincial river restocking program
- Dept. of Fisheries investigating Norwegian industry and setting up first cage trials on Deer Island

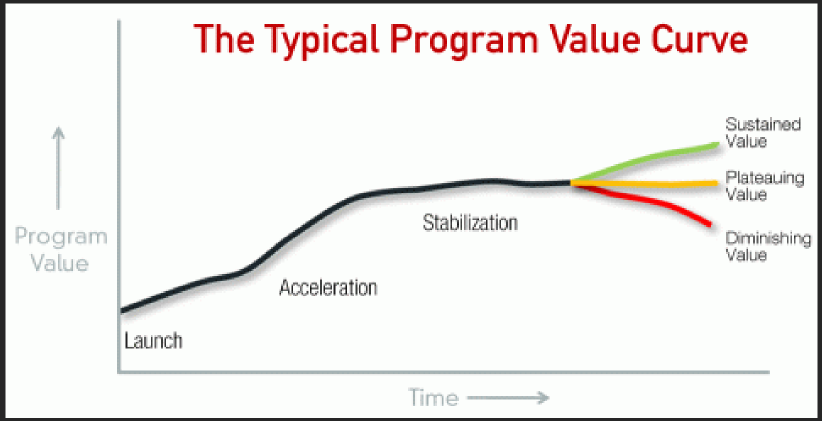
NBCC

Program Gains Popularity

- By mid to late 80’s the local industry is catching on
- 10 hatcheries and 20 marine sites = lots of jobs
- Program capacity upgraded to 23 seats
- Waiting list for program entry

Program Reaches Maturity

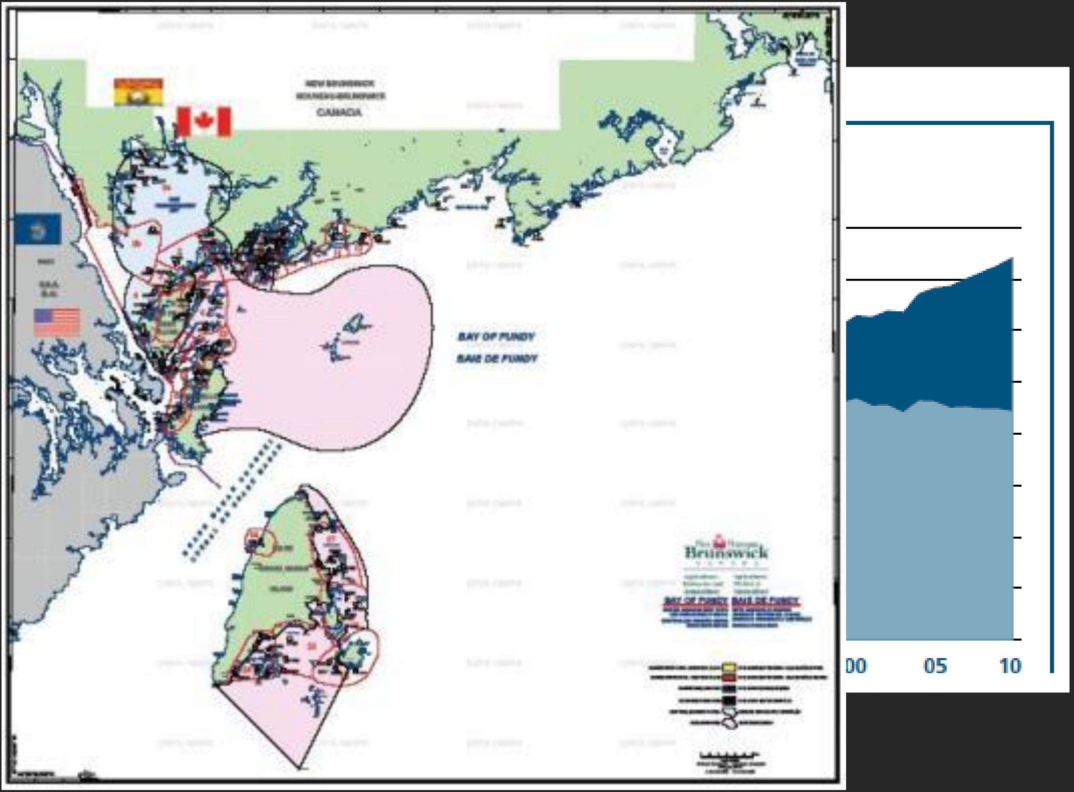
- By mid 90's the local industry growth is reaching saturation
- 20 hatcheries and nearly 100 marine sites (40 companies)
- Program capacity maintained at 23 seats
- No longer a waiting list but still lots of jobs



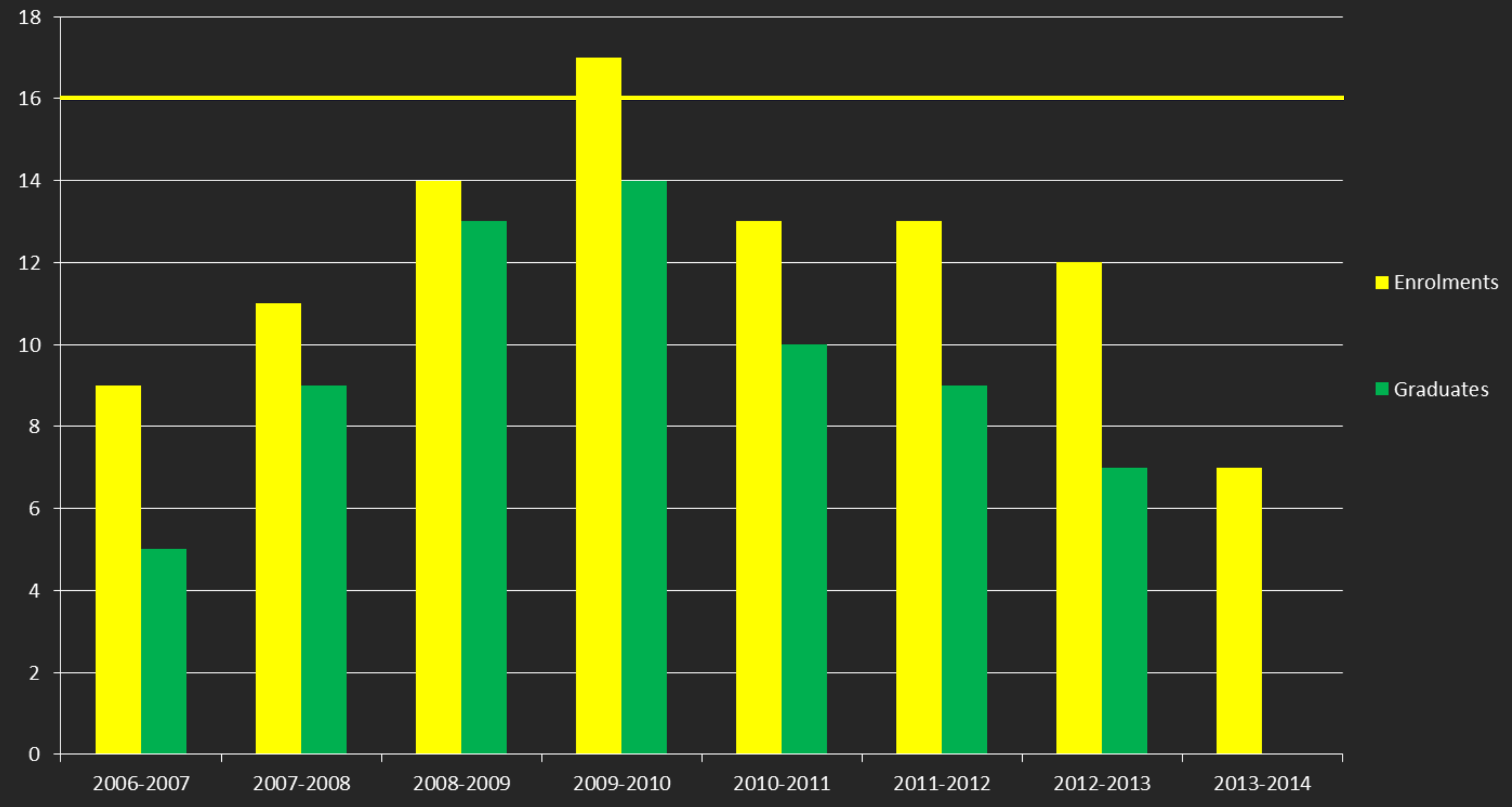
NBCC

Program Popularity Wanes

- By mid 2000's, industry growth in NB has slowed
- 40 marine companies are amalgamating
- Program enrolment at NBCC starting to decline
- Program capacity reduced to 16 seats



Last Eight Years Enrolment Statistics



What Makes This Program Unique

- Only 1-year program of its kind in Canada
- Located in the heart of the aquaculture industry in South West NB
- Excellent support from industry and allies
- Gateway to multiple career possibilities

Program Studies

- Intro to Aquaculture
- Biology of Fish
- Handling Fish
- Water Treatment
- Hatchery Culture
- Sea Cage Culture
- Fish Health
- Aquaculture Equipment
- Alternate Species
- Research Project
- Communications and Computers
- Marine Emergency Duties
- Workplace Safety

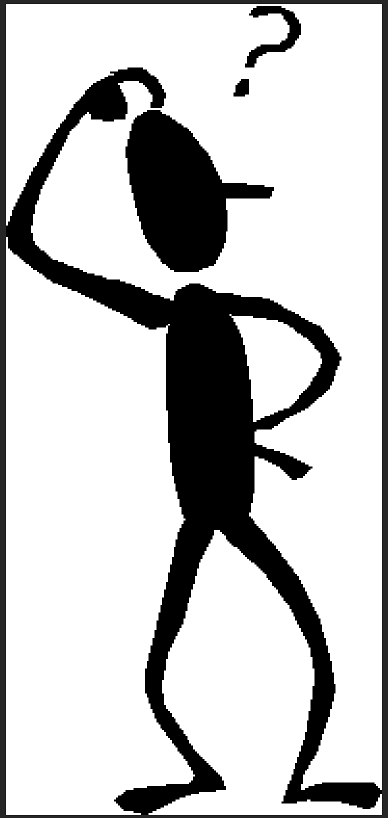
NBCC

Other Options

- Applied Research
- Innovation
- Articulations with Universities
- International Travel
- Entrepreneurial Aspects

NBCC

So, What's the Problem?



- Is it an awareness issue?
- Is it a negative industry image?
- Are young people not "career" minded today?
- Or do they think it's too dangerous?
- Is it St. Andrews?
- Has the student market changed?

NBCC

What Can We Do? (brainstorming session)

Thank You

NBCC
COLLEGEWORKS

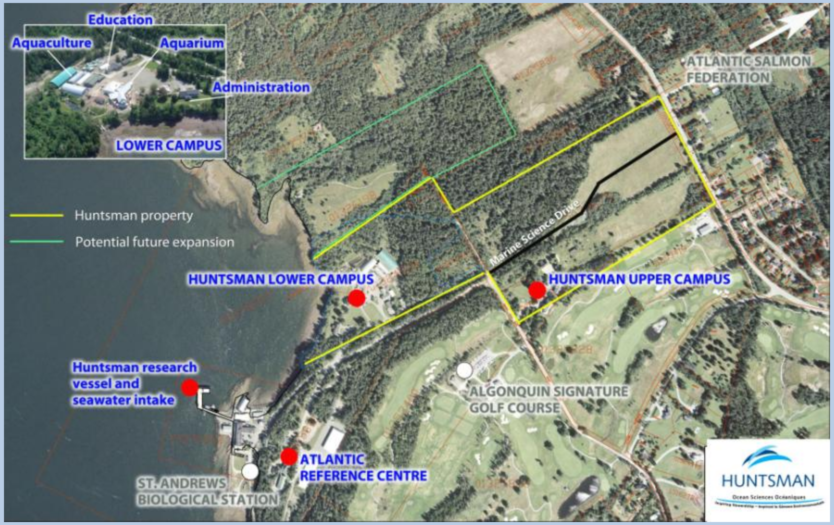
Call or visit us online for more information: **1-888-796-NBCC** | **nbcc.ca**

HUNTSMAN
Ocean Sciences Océaniques
Inspiring Stewardship – Inspirant la Gérance Environnementale

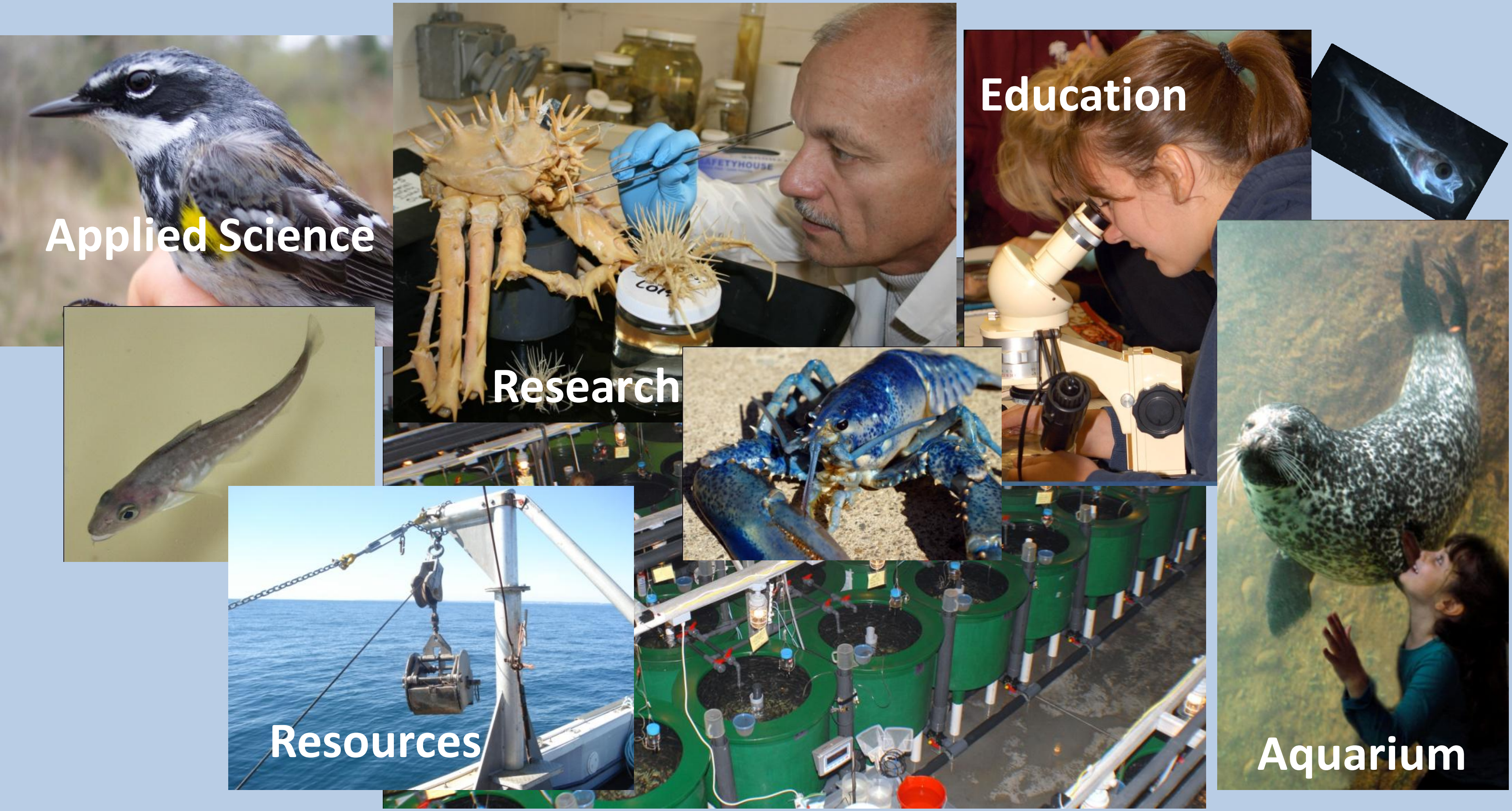
Huntsman Marine Science Centre
St. Andrews, New Brunswick

Exploring Opportunities to Engage the Expertise in Research, Development, Innovation, and Education of New Brunswick Southwest

Jamey Smith
Executive Director
Huntsman Marine Science Centre



Overview of the Huntsman Marine Science Centre



Huntsman Departments

HUNTSMAN
Ocean Sciences Océaniques
Inspiring Stewardship – Inspirant la Gérance Environnementale

- ✓ Aquaculture Department – broad array of fish husbandry facilities, capabilities and expertise. Also manage Atlantic salmon broodstock program giving access to individually tagged, family-based fish for R&D activities.
- ✓ Atlantic Reference Centre – expertise in biodiversity, ecological monitoring and environmental impact.
- ✓ Research Vessels – Transport Canada certified; used for field studies often associated with lab/tank studies.
- ✓ Fundy Discovery Aquarium – public outreach opportunities associated with innovative R&D efforts.
- ✓ Public Education & Academic – training opportunities of Highly Qualified Personnel through Huntsman and associated member universities.
- ✓ Residences & Other Rentals – Executive suites and meeting facilities available for workshops, retreats etc.

Collaborative Centre by Nature

✓ Shared Infrastructure

- Share saltwater intake system with DFO SABS to supply clean natural saltwater
- Huntsman has representation on DFO Animal Care Committee & also to meet our own Canadian Council on Animal Care (CCAC) requirements.
- Co-ownership of ARC biodiversity collection with DFO
- Access to numerous off-site facilities

✓ Personnel Collaboration

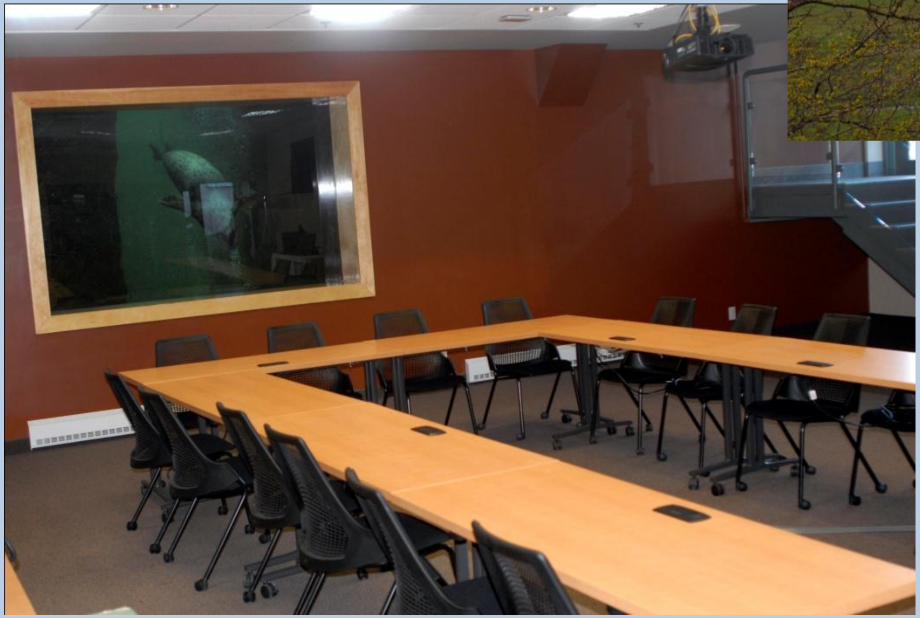
- Huntsman staff having federal clearance to conduct collaborative research at DFO SABS
- NB DAAF Chief Fish Veterinarian serves as Huntsman attending vet and work with their Level 2+ biosecure lab certified by Health Canada and Agriculture Canada.
- Project lead past and present involving a network of other institutions (e.g., RPC, NB DAAF, DFO SABS).

✓ Governance Structure

- Board of Directors represented by Industry, Province of NB, DFO, Universities

Meeting Rooms and Accomodations

- ✓ Dunn Science Theatre
  - 218 seats
  - Translation booth
  - Projector and smart board
  - Wheel chair access
- ✓ Paturel Board Room
- ✓ Test kitchen



- ✓ 20 Executive style suites with en suite bathrooms
- ✓ Wireless internet
- ✓ Wheelchair access
- ✓ Dining area and food service available

The Opportunity

Coastal regions…

✓ Most heavily populated

✓ Significant areas of food production – aquaculture and fisheries……with demand continuing to rise

✓ Location of many other industries that must sustainably integrate

WE HAVE A WORLD CLASS CLUSTER OF EXPERTISE AND INFRASTRUCTURE AVAILABLE IN THIS AREA TO TACKLE ISSUES

……..LOCAL, REGIONAL, AND INTERNATIONAL

New Brunswick Southwest Aquaculture Expertise

HUNTSMAN
Ocean Sciences Océaniques
Inspiring Stewardship – Inspirant la Gérance Environnementale

- ✓ Industry – farming, feed, fish health, environmental, analytical, policy
- ✓ Huntsman – R&D, incubation, education, public outreach, vessels, meetings, residences
- ✓ RPC – fish health, environmental, food, engineering
- ✓ Federal government – DFO, CFIA, NRC/IRAP
- ✓ Provincial government – DAAF, DENV
- ✓ Universities – UNB, several others working at Huntsman and/or in the region
- ✓ Colleges and Schools – NBCC, SJDA, Fundy High, St Stephen

……. AND BEYOND AQUACULTURE – fisheries, transport, energy…..

……. AND THIS IS JUST IN SWNB…….

HUNTSMAN

Ocean Sciences Océaniques

Inspiring Stewardship – Inspirant la Gérance Environnementale

Why Now

- ✓ There is a need and a demand - We have the expertise and infrastructure
- ✓ Provincial and federal governments have recognized the opportunity
  - ✓ Bioscience listed as one of six PNB priority areas
  - ✓ DFO re-committed to the SAP and other programs
  - ✓ Provincial and federal programming available – focus on commercial development needs

But haven't we looked at this before? Aren't we already doing this?

Yes, and with many successes that support the potential

…..but the demand is stronger and collaborative effort needs to be energized

THERE IS COMPETITION

Coastal Economy Interdisciplinary Research and Education

- ✓ UNB and Huntsman initiative – with support of President Campbell, VPR Burns, VPSJ McKinnon, Chopin, Benfey, Stephenson, Huntsman BoD and Research Committee

- ✓ Address practical research and education needs for environmental, economic, social sustainability of coastal industries

- ✓ NSERC workshop to discuss scope – January 2014 – invitation to be extended to member and regional universities, colleges, industries

Aquaculture Development – Possibilities

- ✓ Build on strengths of the SWNB cluster – aquaculture development, breeding, nutrition, fish health
  - We were the first and the best….and we still are

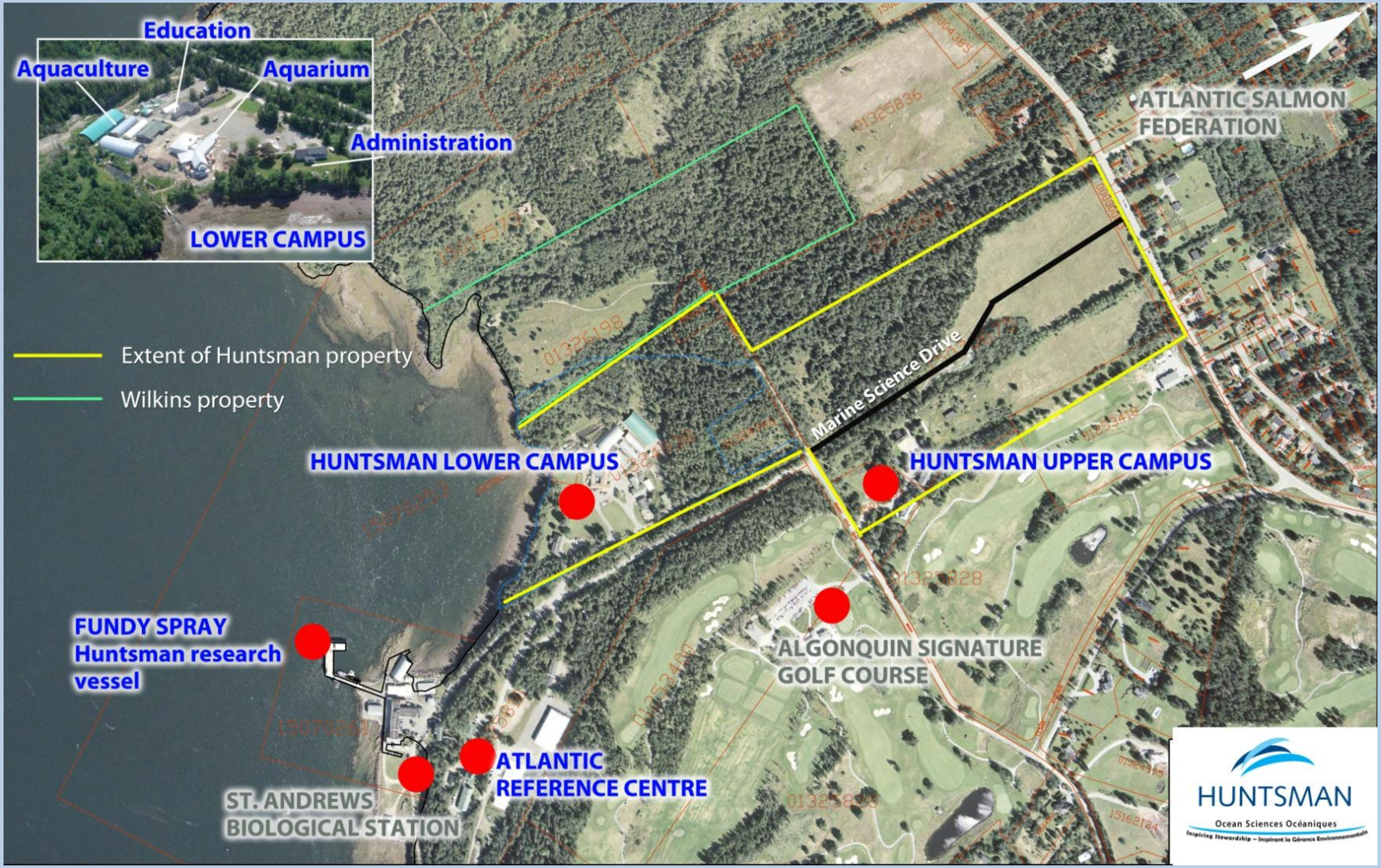
- ✓ Solidify existing infrastructure and human resources

- ✓ Develop new research, development, incubation, and education facilities

- ✓ Establish research chair in area of highest need

- ✓ Act on SCOFO recommendation?

Huntsman Marine Science Centre
St. Andrews, New Brunswick



Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Canadian Food Inspection Agency

Our vision:
To excel as a science-based regulator, trusted and respected by Canadians and the international community.

Our mission:
Dedicated to safeguarding food, animals and plants, which enhances the health and well-being of Canada's people, environment and economy.

Aquatic Imports

November 6, 2013
Lisa Myers

Canada

NAAHP Components

- International Trade
  - **Import**
  - Export

- Domestic Disease Control

  Mandatory Disease Notification

  Domestic Movement Control

  Disease Response

- Active Surveillance
  - Wild and cultured aquatic animals

Aquatic Import Program

- Prevent introduction into and spread within Canada of aquatic animal diseases
- Ensure healthy and sustainable aquatic resources

Aquatic Import

- **Schedule III in *Health of Animals Regulations***
- ***PART XVI AQUATIC ANIMALS***
- ***191 No person shall import an aquatic animal listed in Schedule III except in accordance with a permit issued under section 160***

- Regulated by scientific name

- Aquatic Animal = finfish, mollusc and crustacean

Where to Find CFIA Import Requirements

CFIA’s Automated Import Reference System (AIRS)

http://www.inspection.gc.ca/english/imp/airse.shtml

CFIA Automated Import Reference System

- Searchable database that uses a question and answer approach
- Database for importers, brokers, Canadian Border Service Agency (CBSA), Import Service Centre (ISC), CFIA
- Can search by Harmonized System (HS) Code or scientific name
- HS codes – 6 digit number used worldwide for classifying traded commodities

Automated Import Reference system (AIRS)

HS Description : 030199

03Fish and crustaceans, molluscs and other aquatic invertebrates 01Live fish 99Other live fish: Other

OGD Extension : 787147

7871Taxonomic names starting with Sa (cont.) 47Salmo salar - TSN 161996 - Atlantic salmon (germplasm)

Origin : UME

End Use : 106

106 Culture

Recommendations to CBSA/Documentation and Registration Requirements

Refer to CFIA-NISC(must be accompanied by the following:

documents\registrations): Zoosanitary Export Certificate and Aquatic Animal Health Import Permit

What Requires an Aquatic Import Permit

- All **live** aquatic animals on Schedule III
- Dead aquatic commodities with end use:

(1) Bait

(2) Feeding aquatic animals to aquatic animals

(3) Research and educational use

(4) Diagnostic testing

(5) Any end use where effluent or offal is generated

- Unless exempted

Import Permit **IS** Required

commodities intended for human consumption:

- Finfish that are whole round and uneviscerated
- Head on eviscerated salmonids
- Molluscs with whole shell intact
- Crustaceans with head on and shell on

Exemptions – Import Permit NOT required

Commodities intended for human consumption:

- Eviscerated non-salmonid finfish (all internal organs removed, excluding brain and gills)
- Head-off eviscerated salmonids
- Crustaceans with head off and shell on or off
- Molluscs shucked or in half shell
- Any products that are processed and packaged as ready to eat (ex. cooked, pickled, powdered)

Exemption – Import Permit <u>not</u> required

- Pet fish (specified species only) accompanied by the owner

- Importer's Declaration of Ownership - Pet Aquatic Animals Form

Personal Use

- Present animals and declare as for personal use

- Must be accompanied by owner

- Receipt

Quantity limited to:

- 4 crustaceans
- 3kgs of molluscs
- 10 finfish not eviscerated

Submission of Application for an Aquatic Import permit

Atlantic Area Office

Operations – Animal Health

5th floor, 1081 Main Street

Moncton, New Brunswick

E1C 8R2

Telephone: (506) 777-3968

Facsimile: (506) 777-3942

lisa.myers@inspection.gc.ca

Service standard: processing of permits within 5 business days

CFIA Fees associated with Import

Import permit

- single entry ($35)
- multiple entry ($60)

Border inspection

- Document review ($17.50)
- Inspection of animals ($35)
- Overtime fees if applicable

Important to coordinate ahead of time with Regional NAAHP vet if inspection required

Aquatic Import

- Regulations or prohibitions from other municipal, provincial, territorial and federal authorities may apply
- Importer is responsible to verify with other government authorities to ensure that all other conditions are met

Atlantic Regional NAAHP Veterinarians

Important to communicate/coordinate with your regional NAAHP vet in your regions

Dr. Mike Trenholm, New Brunswick

Michael.Trenholm@inspection.gc.ca

(506) 851-7654

Dr. Shane Hood, Nova Scotia

Shane.Hood@inspection.gc.ca

(902) 679-5586

Atlantic Regional NAAHP Veterinarians

Dr. Tim McQuaid, Prince Edward Island

Timothy.McQuaid@inspection.gc.ca

(902) 566-7290 Ext 2025

Dr. Karla Furey, Newfoundland

Karla.Furey@inspection.gc.ca

(709) 772-4714

Electronic Data Interchange(EDI)

- Canadian Border Service Agency(CBSA) System
- Allows broker/importer to submit import/export data electronically
- Reviewed by CBSA and CFIA at National Import Service Centre (NISC)
- Import documentation can be submitted several days/weeks prior to import

Border Clearance

Live finfish intended for aquaculture requires

- CFIA Veterinary Inspection at border
- Document submission to CFIA National Import Service Centre (NISC) for review

  - Can be submitted several days ahead of import depending on import requirements

Import Document review

Import permit

- Valid
- Original - if single entry
- Copy - if multiple entry

Export certificate issued by competent authority

- Original
- Tombstone info on certificate, import permit and invoice same
- Correct reference number of import permit

Import Document Review

- Conducted by CFIA National Import Service Centre for end use: aquaculture (live animals and germplasm), bait, research and educational use

- Information on import document (export certificate, invoice) must be the same as information on permit:
  - Description of the commodity
  - Name of importer
  - Name of exporter
  - Quantity (if indicated on permit)
  - End use

- Shipment may be refused entry if discrepancies

Export Certificate

- Export certificate is appropriate for the commodity
- mandatory fields have all been completed
- original negotiated certificate presented
- competent authority of the exporting country has endorsed

Exporting Countries with negotiated Certificates

- **USA**
  - Live finfish for stocking and enhancement
  - Live aquatic animals and germplasm for culture and research and educational use
- **Iceland**
  - Salmonid germplasm (eyed eggs) for culture and research and educational use
- **UK – includes Guernsey, Jersey, Isle of Man**
- Live aquatic animals and germplasm for culture

Exporting Countries with ongoing Negotiation

- **Denmark** (in negotiation)

Salmonid germplasm for culture and research and educational use

- **Netherlands** (in negotiation)

Live aquatic animals and germplasm for culture and research and educational use

National Import Service Centre

- Centre in Montreal and Ontario
- Hours of operation – 7 am to 3 am (Eastern time)
- Telephone 1-800-835-4486 (Canada or USA)
- Fax 1-613-773-9999

National Import Service Centre

- Processes import request sent electronically or by fax
- Return decision of the shipment to importer or broker
- Submits release package to the Canadian Border Service Agency(CBSA)
- Handle telephone inquiries of all commodities regulated by CFIA
- Coordinate inspections if required

Canadian Food Inspection Agency
Government of Canada

Agence canadienne d'inspection des aliments
Gouvernement du Canada

Import permit # (on export certificate, EDI)

Permit No./N° de permis:

ORIGINAL
2013/11/01
year/mo/day
année/mois/jour

IMPORT PERMIT PERMIS D'IMPORTATION

THIS PERMIT IS ISSUED PURSUANT TO:/CE PERMIS EST DÉLIVRÉ CONFORMÉMENT A:

THE HEALTH OF ANIMALS ACT AND REGULATIONS/LOI ET RÈGLEMENT SUR LA SANTÉ DES ANIMAUX

Importer/Importateur	Exporter/Exportateur
TEST TEST MONCTON, NEW BRUNSWICK A1A1A1 Applicant Name: ABC LAST Phone: 506-123-4567 Fax: 506-234-5689 Email: GH@HOTMAIL.COM	TEST SUBJECT 55 TEST LANE UNITED STATES
Quarantine/Destination/Quarantaine VARIOUS DESTINATIONS WITHIN ATLANTIC CANADA	**Producer/Producteur** TEST SUBJECT 55 TEST LANE UNITED STATES
Valid/Valide **from/du** 2013/11/01 year/month/day année/mois/jour **to/au** 2013/11/01 year/month/day année/mois/jour	**Country of Origin/ Pays d'Origine** UNITED STATES (ARKANSAS)

For the entry of/ Pour l'entrée de: _____ Single shipment/Chargement simple __XX__ Multiple shipments/Chargements multiples

Place of entry into Canada/Lieu d'entrée au Canada:
ALL REGULATED PORTS

FOR THE IMPORTATION OF:/POUR L'IMPORTATION DE:
(Description of things(s)/Description de la ou des choses)
1. Salmo salar - TSN 161996 - Atlantic salmon (live)
Description: SALMO SALAR (ATLANTIC SALMON)
END USE: CULTURE

Species: FINFISH
Life Stage: ADULT

A PERSON WHO IMPORTS A THING UNDER THIS PERMIT SHALL COMPLY WITH ALL THE CONDITIONS SET OUT HEREIN/TOUTE PERSONNE QUI IMPORTE UNE CHOSE EN VERTU DE CE PERMIS DEVRA RESPECTER TOUTES LES CONDITIONS DÉCRITES CI-DESSOUS

Import of live finfish intended for aquaculture

- Inspection required
- Plan and communicate well in advance of the import with the District office in your region
- Inform District office of expected dates, times and location of border crossing
- Transport equipment must be safe and in good working order for CFIA to conduct an inspection

Transportation of live Aquatic species

Import Inspection

Overall fish Assessment:

Body condition

Breathing (gasping, open-mouth)

Obvious lesions (masses, ulcers, wounds)

Changes in color, shape, or locomotion

Mortality

Clinical signs

Import Inspection

- Document review and inspection completed by CFIA veterinarian
- CFIA certifies that the animals are eligible or not eligible for entry into Canada
- Shipment released by CFIA Import Service Centre in the system if documents and inspection in order

Canada

Canadian Food Inspection Agency Agence canadienne d'inspection des aliments

Canadian Food Inspection Agency

National Aquatic Animal Health Program

Our vision:
To excel as a science-based regulator, trusted and respected by Canadians and the international community.

Our mission:
Dedicated to safeguarding food, animals and plants, which enhances the health and well-being of Canada's people, environment and economy.

MOVEMENT CONTROLS WITHIN CANADA FOR REPORTABLE ENZOOTIC AQUATIC ANIMAL DISEASES

ACCFA Workshop 2013.

BY: DR. WOLE OGUNTONA

Canada

Presentation Outline

1. Overview of the National Aquatic Animal Health Program (NAAHP) and the Proposed Domestic Movement Control Programs
2. Description of the Program
   a) Authority
   b) Administration
   c) Enforcement
3. Scenarios
4. Next Steps

Purpose of this presentation

- Provide Aquaculture industry stakeholders with additional opportunity to learn about the proposed Domestic Movement Control Programs for both wild and cultured salmonids, bait fish and American and Pacific cupped oyster

- Identify the areas of the proposed Domestic Movement Control Programs that have the potential to impact on aquaculture industry stakeholders activities

National Aquatic Animal Health Program (NAAHP)

- The NAAHP is about the prevention of the introduction and spreading of federally regulated diseases in finfish, molluscs, and crustaceans in Canada. Also, facilitates domestic and international market access for Canadian fish and seafood with respect to serious infectious diseases of international and national concern
- The NAAHP is concerned with infectious diseases that are listed in regulations under the Health of Animals Act
  - Another division of the CFIA, the Fish, Seafood and Production Division, is responsible for food safety
- The aquatic animal diseases covered under the NAAHP pose no risk to human health. Eating fish with these aquatic diseases does not affect humans

Note: Under federal legislation, it is Fisheries and Oceans Canada's role to regulate aquaculture as a fishery in BC and PEI

NAAHP Components

1. International Trade (Import and Export certification)
2. Disease Surveillance

2. Domestic Disease Control

   a. Mandatory Disease Notification

      Disease Response

   b. Domestic Movement Control

Proposed Domestic Movement Control Programs for the NAAHP

Purpose:

- Prevent the spread of diseases which are enzootic in specific parts of Canada to parts where they are not known to exist

Current focus:

- Wild & cultured salmonids (Pink/Chum/Sockeye/Atlantic Salmon, Cuttroat/Rainbow/Brown/Bull/Brook/Lake trout, Arctic char, Lake whitefish, Lake herring, Arctic grayling)
- Wild & cultured bait fish (for example, Pacific herring and Emerald shiners)
- Wild & cultured American oysters and Pacific cupped oysters

Proposed Domestic Movement Control Programs (within Canada) - continuation

Benefits:

- Protects wild & cultured aquatic animal resources in Canada
- Approach that is consistent with international standards – hence, supports international trade
- One federal requirement for control of aquatic animal diseases that is nationally consistent and risk-based:
  - *Fish Health Protection Regulations* - to be rescinded
  - *Fisheries (General) Regulations* – requirement for 56(b) is removed for aquatic animals

Proposed Domestic Movement Control Programs – Anticipated Impact

- Impacted parties will be finfish aquaculturists and processors; bait processors and dealers; and oyster aquaculturists and processors

- These control programs will not affect access to aquatic animals in the wild

Domestic Movement Control Program Elements of the Program

1. Dividing the country into areas of differing disease status and issuing permits for certain movements of live aquatic animals, fresh dead and frozen aquatic animals and certain things, such as used fish graders from aquaculture facilities

2. Within an Infected or Buffer Area, implementing a compartmentalization program where that facility is recognized as free of one or more diseases because of their ability to put in biosecurity measures that keep the disease out = Free Area

1. Legislative Authority

- *Health of Animals Regulations* sections 196 to 198
- Provinces/territories and the territorial seas are each established as an “Eradication Area”
- An Eradication Area or part of it can be declared as:
  - Infected Area
  - Buffer Area
  - Provisionally Free Area
  - Free Area
- This is done through a declaration posted on the CFIA web site which shall include for each disease to be controlled:
  - Description of the areas
  - List of species of aquatic animal, carcasses or parts of carcasses susceptible to the disease
  - List of things that may be contaminated with the disease

1.1. Legislative Authority (continuation)

- Prohibitions on movements of aquatic animals and things from an eradication area or part of it except with a permit
  - Section 199 (1) (2) (3) of the *Health of Animals Regulations*
  - Regulate movement of aquatic animals and things between areas of different health status: prohibition applies to movement from areas of a lower health status to areas of a higher health status

- Authority to issue permits
  - Section 160 of the *Health of Animals Regulations*
  - Issue permit for movement of aquatic animals/things
  - Set conditions on permit
  - Permit holder must comply with the permit conditions

1.2. Criteria Used to Define Different Areas

- Infected Area: the reportable disease agent has been identified in wild aquatic animals
  - CFIA's case definitions for a positive animal, population of animals, watershed
    - Historical evidence
    - Surveillance programs
    - Input of Aquatic Animal Health Committee members
  - Does not mean that every aquatic animal is infected
- Buffer Area: no disease/agent detected but the area is at risk of becoming infected because of epidemiological relationship with an Infected Area
  - e.g. historical movements of animals and things, hydrological links

1.2. Criteria Used to Define Different Areas (continuation)

- Free Area can be declared based on one or more of:
  - Disease detection activities sufficient to detect the disease
  - Evaluation of all suspected outbreaks – the disease is not present
  - Measures that prevent introduction of disease and ability to enforce
  - Physical barriers to spread
  - Successful eradication of disease if it was introduced
  - Time since the disease was last identified
  - Other relevant scientific information
  - Separation from an infected area by a buffer area
  - Accepted by the CFIA as a 'disease-free compartment'

  - And disease detection activities are in place

- Provisionally Free Area: if the area is not any of the above

Compartment as a Free Area

- Premises located in an Infected or Buffer Area
- Will satisfy the following conditions under s198(2)(a)(iv) and (v) and 198(2)(b) of the *Health of Animals Regulations*
  - Submission of a Biosecurity Plan (prevent introduction of diseases of concern)
    - Meets national standards (developed by the CFIA)
    - Documented: procedures, records
  - Inspection and sample collection for testing (conducted by the CFIA or under the oversight of the CFIA; testing conducted by DFO NAAHLS or an approved network laboratory)
    - Frequency depends on analyzed introduction risk
      - Inspection at least once a year
      - Sampling: 0 to 3 times a year depending on the assessed introduction risk

1.3. Permit Administration

- Declaration of the areas, describing the Infected, Provisionally Free, Buffer and Free Areas in each Eradication Area
- CFIA will notify regulated parties of the areas and of new permit requirements
- Proposing a web-based system that will outline;
  - When a permit is required and provide an application
    - Certain species, certain end uses
  - Movements that are prohibited, ie. permit conditions cannot mitigate risk of disease spread or there are federal/provincial prohibitions (usually relate to a species, life stage, use)
  - Permit conditions
- One permit may be issued for multiple movements to the same area.

Declaration for Diseases of Finfish

Eradication Area	Declarations for Diseases of Finfish							
	C. shasta	IPNV	ISAV HPR0	ISAV Pathogenic	IHNV	VHSV IVa	VHSV IVb	VHSV IVc
Pacific Ocean			Free Area	Free Area	Infected Area	Infected Area	Free Area	Free Area
BC*	Infected Area & Free Area	Free Area & Infected Area	Free Area	Free Area	Infected Area & Free Area	Infected Area & Free Area	Free Area	Free Area

Table 1: Declaration of Canadian provinces, territories, and territorial seas (including the contiguous zones) as infected areas, buffer areas, provisionally free areas and/or free areas for ceratomyxosis (infection with Ceratomyxa shasta), Infectious Pancreatic Necrosis Virus (IPNV), HPR0 or pathogenic strains of Infectious Salmon Anaemia Virus (ISAV), Infectious Haematopoietic Necrosis Virus (IHNV), Viral Haemorrhagic Septicaemia Virus genotypes IVa, IVb and IVc (VHSV IVa, VHSV IVb, VHSV IVc) as per section 198 of the Health of Animals Regulations.

Areas for *Ceratomyxa shasta*, infectious haematopoietic necrosis and viral haemorrhagic septicaemia IVa in B.C.

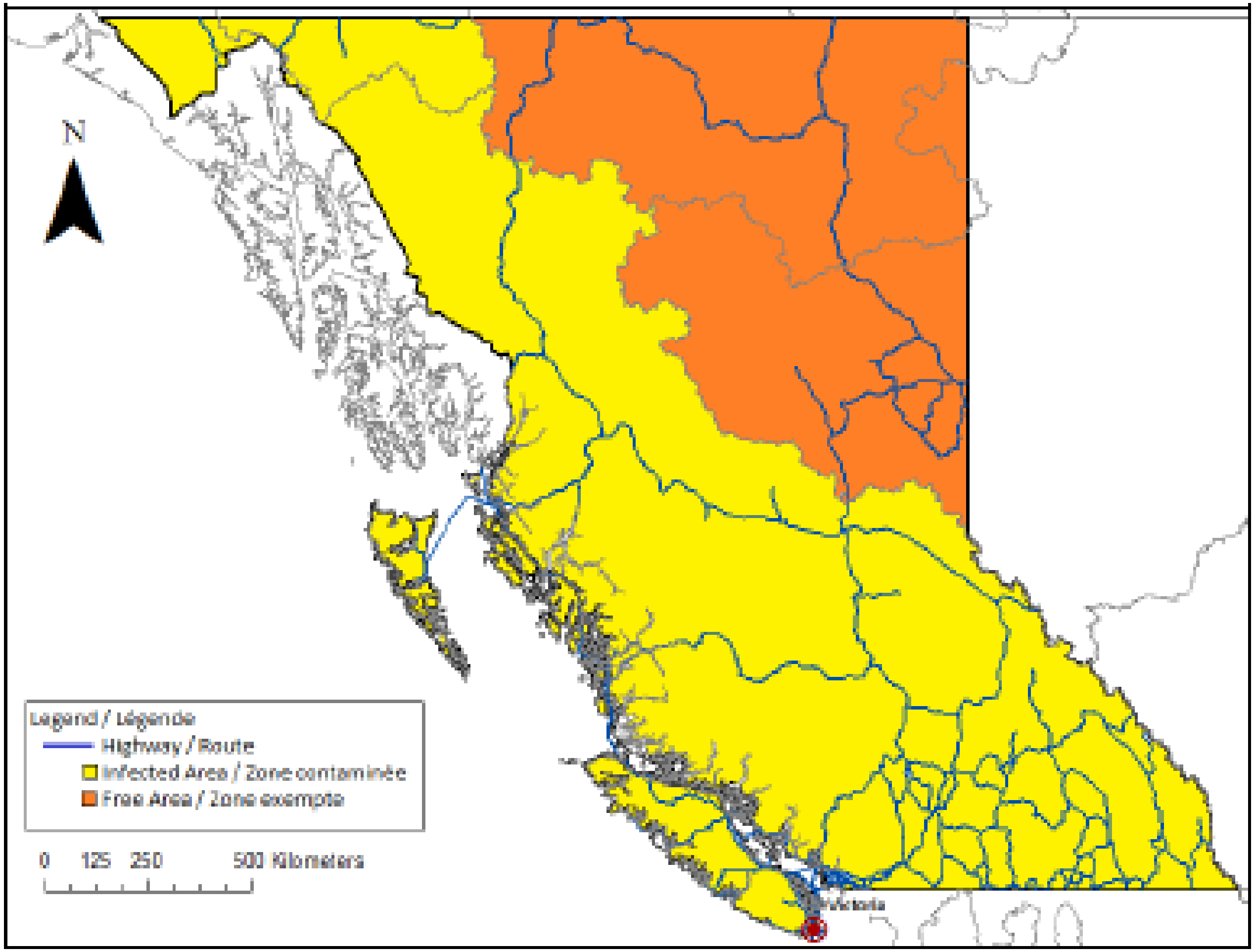


Figure 3: A map of British Columbia showing areas declared as infected areas and free areas for *Ceratomyxa Shasta*, infectious haematopoietic necrosis and viral haemorrhagic septicaemia IVa as per section 198 of the *Health of Animals Regulations*.

Areas for infectious pancreatic necrosis for B.C.

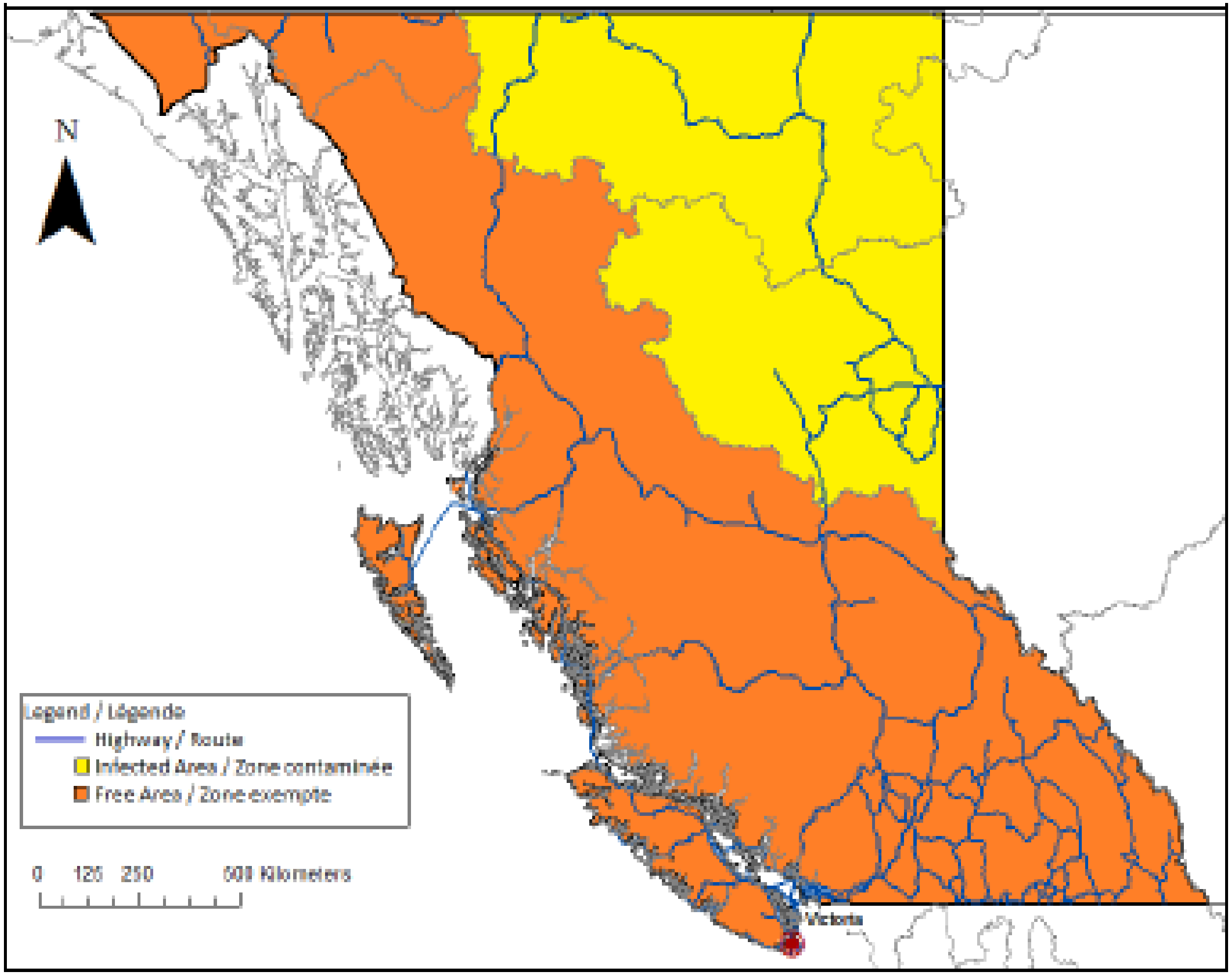


Figure 4: A map of British Columbia showing areas declared as infected areas and free areas for infectious pancreatic necrosis as per section 198 of the *Health of Animals Regulations*.

1.4. When a permit is required

- Species is listed on the declaration: applies to live animals and commodities (fresh or frozen whole round carcasses, offal)
- Thing is listed on the declaration
- End use is listed on the declaration
- Difference in health status between the areas of origin and destination
  - Movement from an area of lower to higher health status:
    - An Infected Area to Buffer Area, Provisionally Free Area or Free Area
    - A Buffer Area to another Buffer Area, Provisionally Free or Free Area
    - A Provisionally Free Area to a Free Area
- Movements within an Area do not require permits

1.5. Determining the Permit Conditions

- Conditions EITHER describe testing for freedom and preventing introduction of the disease thereafter OR shipping potentially infected animals to a facility where those shipped goods (animals, water, containers) are dealt with so that spread is prevented
- End use of the aquatic animal, carcass or thing usually determines the option chosen
  - Culture
  - Introduction into Natural Waterways
    - Bait, enhancement, stocking, restoration, relay/salting up, depuration
  - Processing
    - Effluent is discharged directly into natural waterways
  - Feed for aquatic animals
  - Research
  - Diagnostic or other testing

1.6. Permit Enforcement

- Verifying compliance with requirement to get a permit:
  - Knowledge of federal and provincial legislation and enforcement
  - Knowledge of movements and the risk they pose related to:
    - aquaculturists & operations, including government, government-private partnerships
      - service providers
    - recreational fisheries & operations
    - commercial fisheries & operations, including for bait
    - processors and manufacturers (federal and provincially registered; non-registered) & operations, including rendering facilities and feed manufacturers
    - research, testing, display
- Verifying compliance with permit conditions:
  - Inspection of premises: animals, documents, sampling
  - Inspection of shipments
  - Notifications and disease investigations
  - Surveillance

Case Scenario #1 – *Haplosporidium nelsoni* (MSX) in Nova Scotia/British Columbia

- MSX Infected Areas:
  - Cultured and wild American oysters (*Crassostrea virginica*) in Cape Breton area of NS have tested positive for MSX
  - The rest of Nova Scotia can be considered a Free Area for MSX. There have been no positive detections of MSX in New Brunswick, PEI or NL
  - Cultured and wild Pacific cupped oysters (*Crassostrea gigas*) in Pacific Ocean, British Columbia have tested positive for MSX

- Permit with “conditions” can be issued to allow safe movements of aquatic animals/things to minimize the risk of spread of MSX outside of defined areas

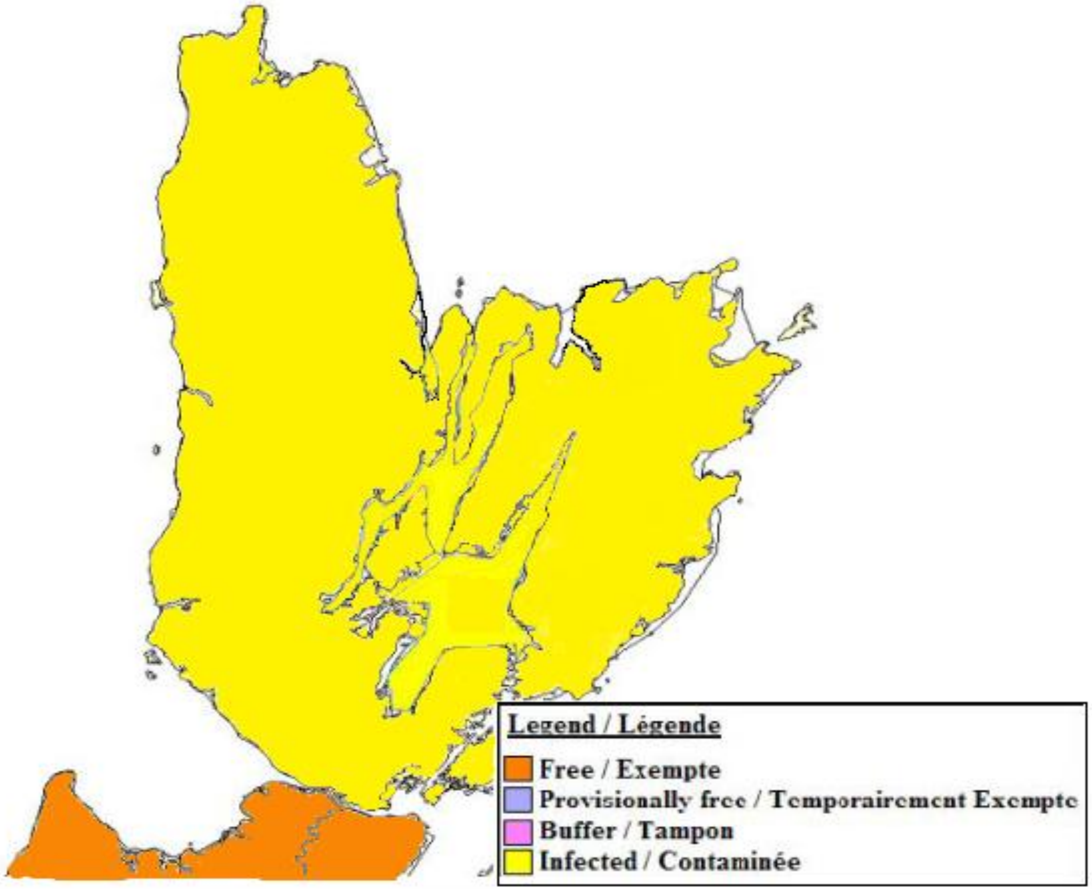
Case Scenario #1 - *Haplosporidium nelsoni*

Live oysters leaving the Infected Area and going for culture (including off-lease maintenance), introduction into natural waterways (relay, depuration, stocking) and processing for human consumption (shucking, cleaning).

No permit will be issued for these movements unless testing for disease freedom can be accomplished and the tested animals will not be exposed to the disease prior to the shipment

- oysters to be shipped are kept separate from oysters not to be shipped
- water is not contaminated
- equipment, materials are not contaminated

Haplosporidium nelsoni



Case Scenario # 2 – Viral Haemorrhagic Septicaemia Virus

- VHSV Infected Areas include:
  - Pacific Ocean and BC (Pacific Ocean watershed) (VHSV IVa), ON (Great Lakes watersheds) (VHSV IVb), NB, NS and the Atlantic Ocean (VHSV IVc)
  - Culture, Introduction into Natural Waterways, Bait, Diagnostic Testing, Feed for Aquatic Animals, Other Testing, Processing, Research
- Permit with “conditions” can be issued to allow movements of animals/things to minimize the risk of spread of VHSV outside of defined areas
- E.g. fresh or frozen Pacific herring outside of the Pacific Ocean watershed for bait may not be allowed because of s12 of the *Health of Animals Act*

Case Scenario #2 continued

E.g. Rainbow trout fingerlings from a hatchery near Kitchener, ON going to MB for further rearing at another aquaculture site

- fingerlings to be shipped are kept separate from fingerlings not to be shipped
  - tested for disease freedom
  - other conditions
    - no unexplained outbreaks in previous 3 months in the premises
    - no signs of disease at time of shipment, during shipment or at arrival
- water is not contaminated: rearing and shipping
- equipment, conveyances, materials are not contaminated: rearing and shipping

Next Steps

- Complete regional engagement
- Publish Aboriginal Peoples consultation report on the CFIA website
- Finalize the Domestic Movement Control Programs
  - Analyze feedback and accommodate as much as possible in the Program, if required
- Implementation of the Domestic Movement Control Programs
- Follow up activities, as required, including updating policies on disease response within the declared Areas

HARMFUL ALGAL BLOOMS AND FINFISH AQUACULTURE

Jennifer L. Martin and Murielle M. LeGresley

St. Andrews Biological Station

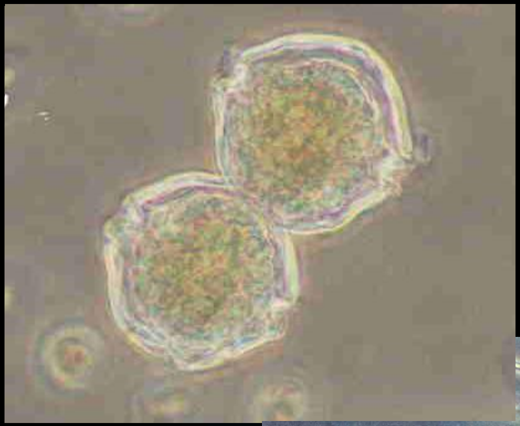
"And Moses and Aaron did so, as the Lord commanded; and he lifted up the rod, and smote the waters that were in the river, in the sight of Pharaoh, and in the sight of his servants; and all the waters that were in the river turned to blood.

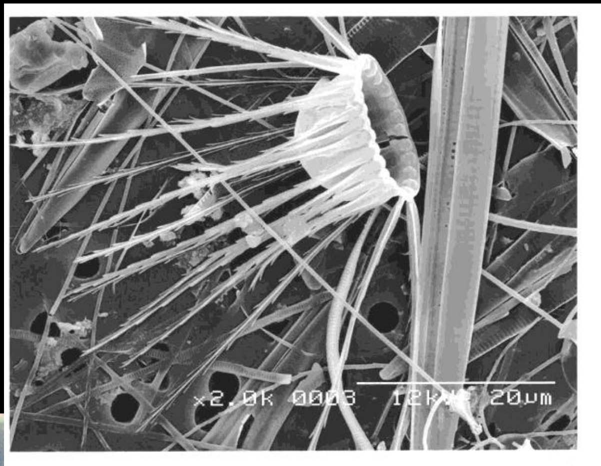
And the fish that were in the river died; and the river stank and the Egyptians could not drink of the water of the river; and there was blood throughout all the land of Egypt."

Exodus 7: 20-21

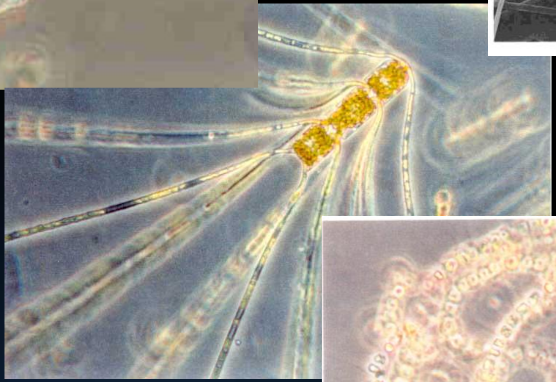
- Phytoplankton/ finfish - modes of action
- Sampling, long term datasets
- Harmful species
- 25 years - spatial and temporal trends
- New species

- Toxins





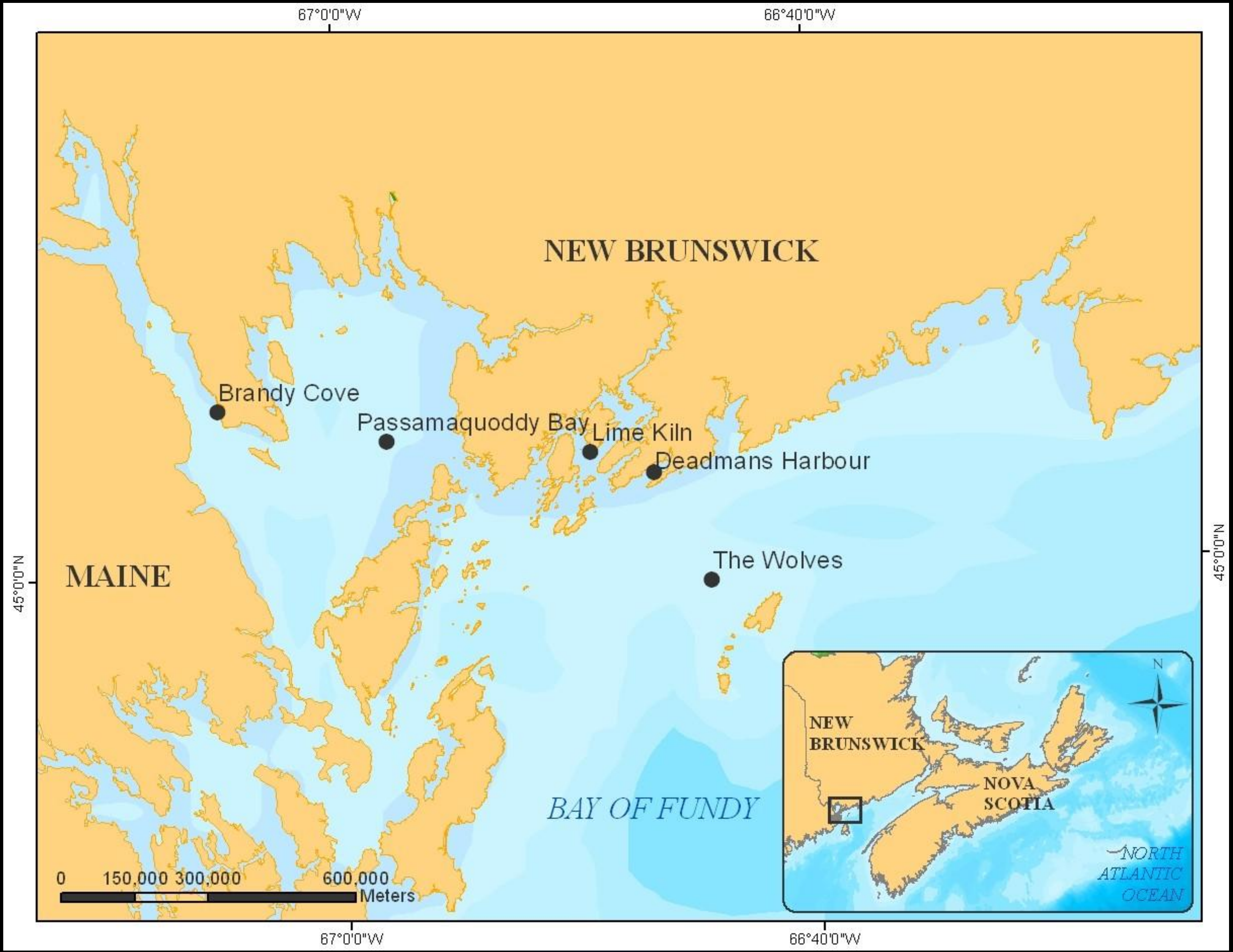
- Gill clogging



- Asphyxiation/Net clogging

- Excess oxygen

PHYTOPLANKTON MONITORING PROGRAMME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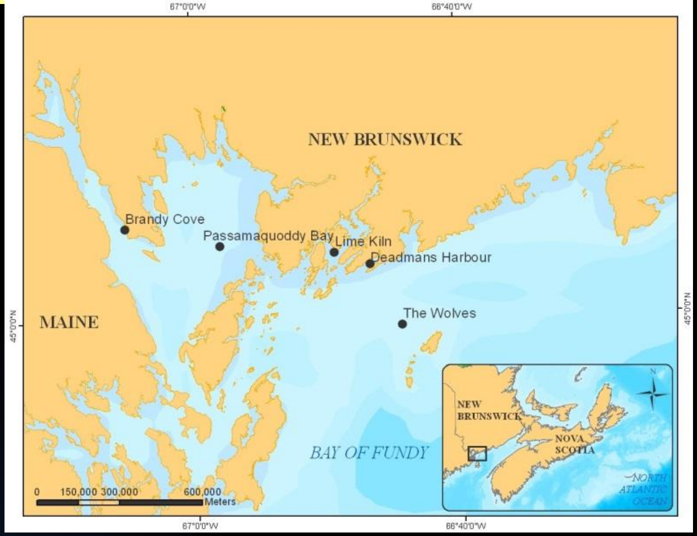
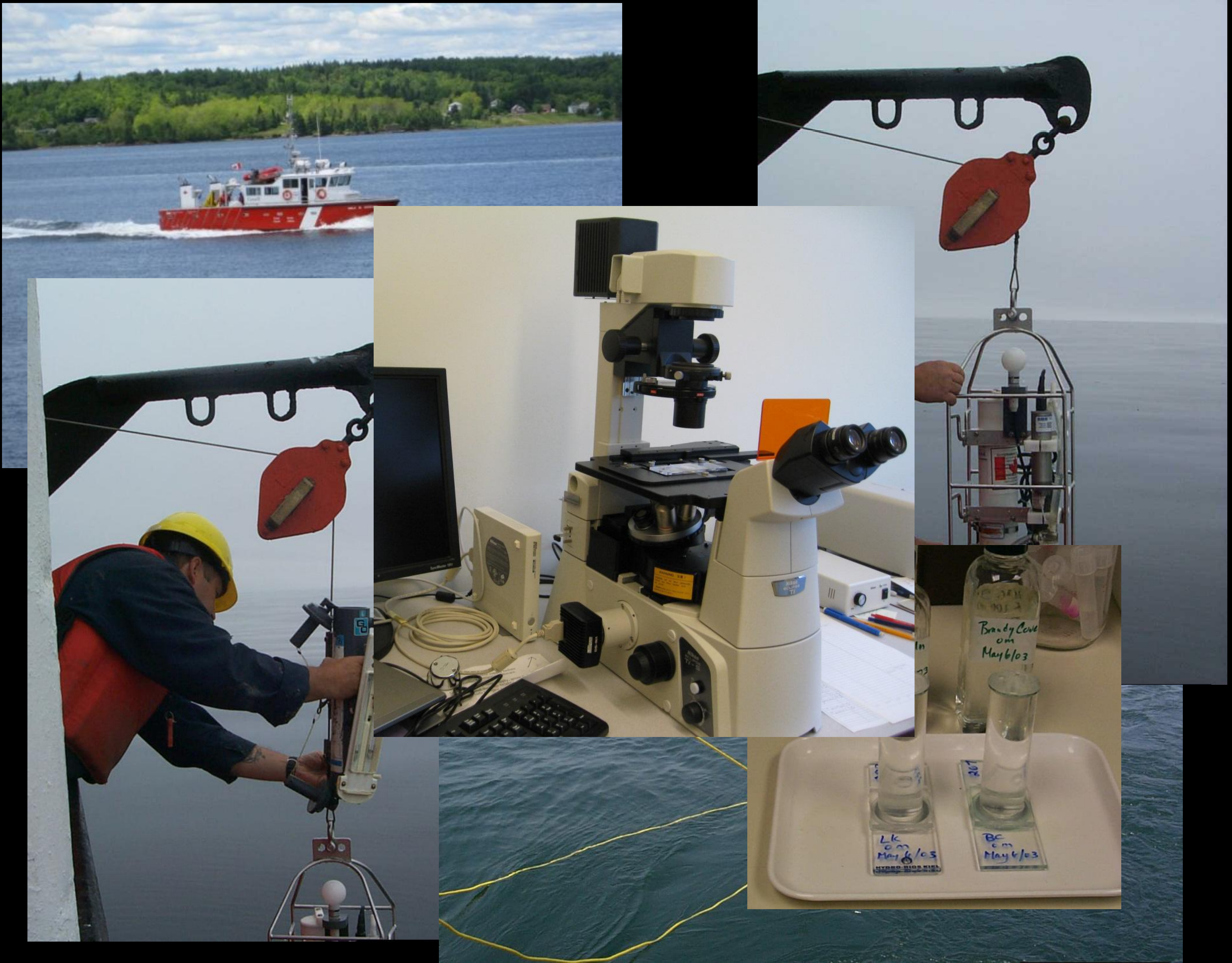
NEW BRUNSWICK
MAINE
Brandy Cove
Passamaquoddy Bay
Lime Kiln
Deadmans Harbour
The Wolves
BAY OF FUNDY
NEW BRUNSWICK
NOVA SCOTIA
NORTH ATLANTIC OCEAN
N
0 150,000 300,000 600,000
Meters

- baseline data
- early warning of HABs
- Patterns/ trends
- prediction/hind-casting
- linkages with physical and chemical oceanography

SAMPLING DAYS (1987-2013)

- ~683 sample days
- ~31 samplings/year

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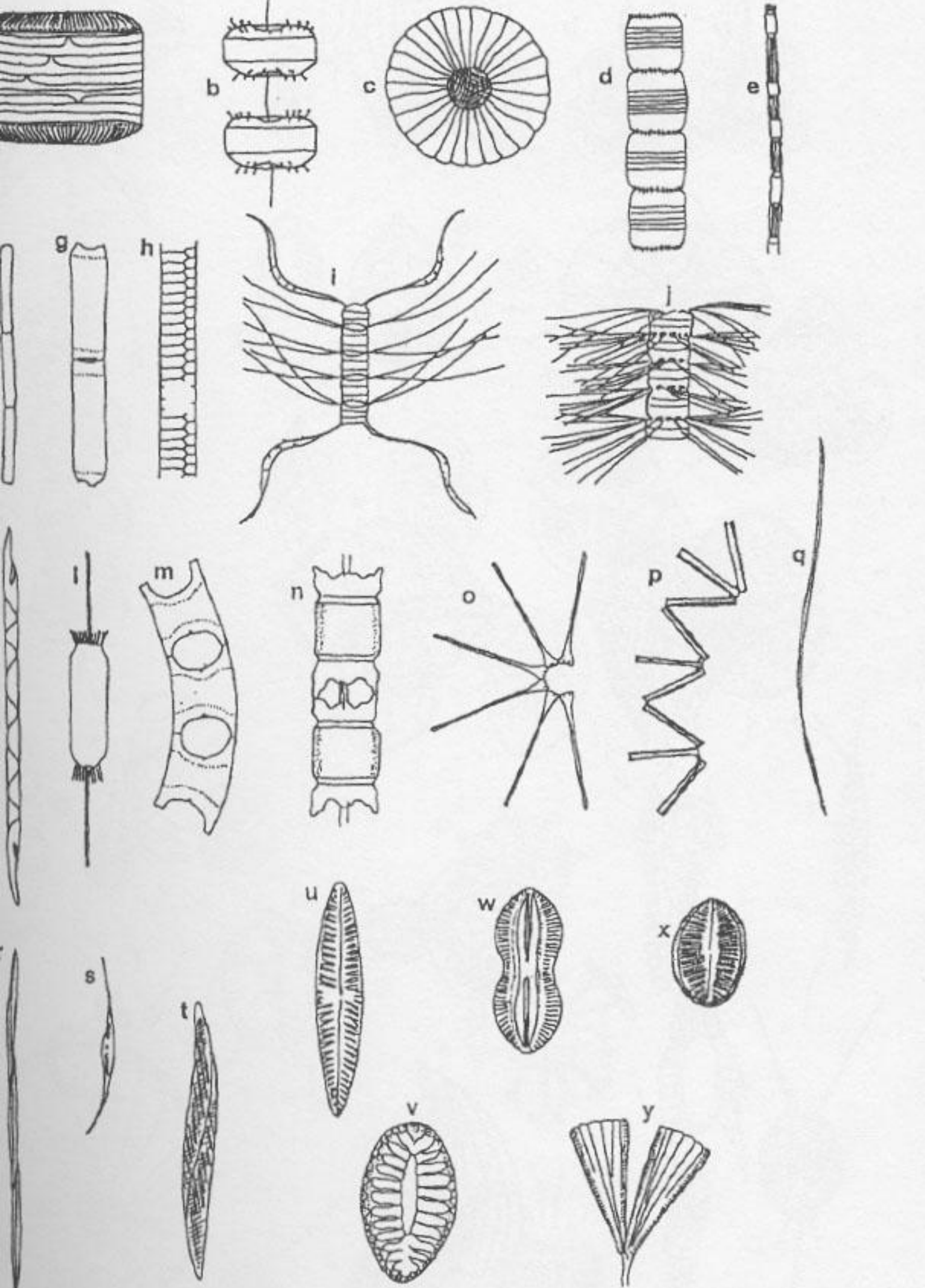
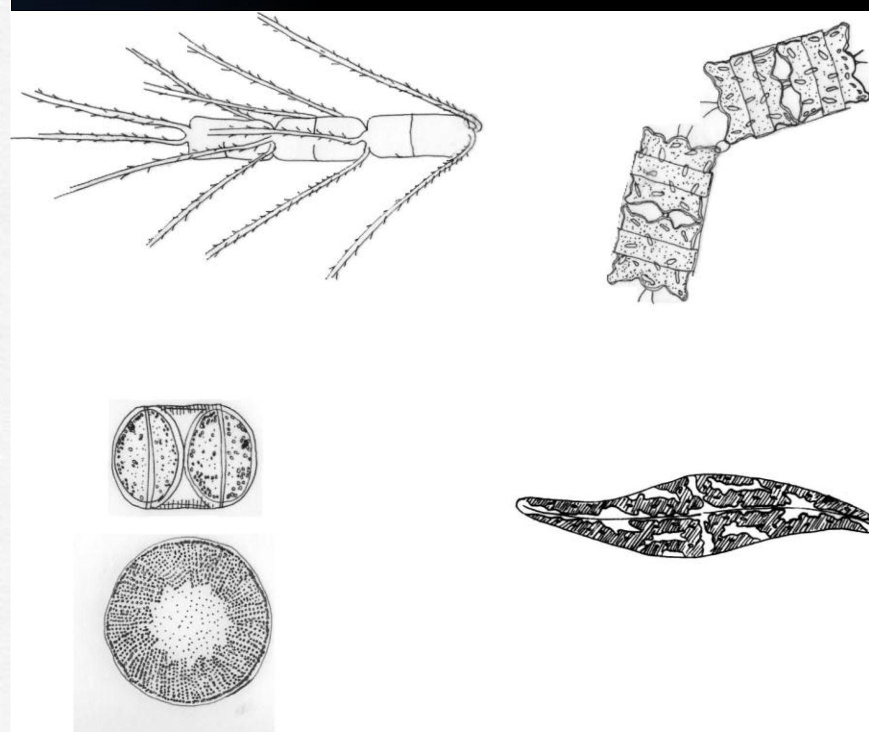
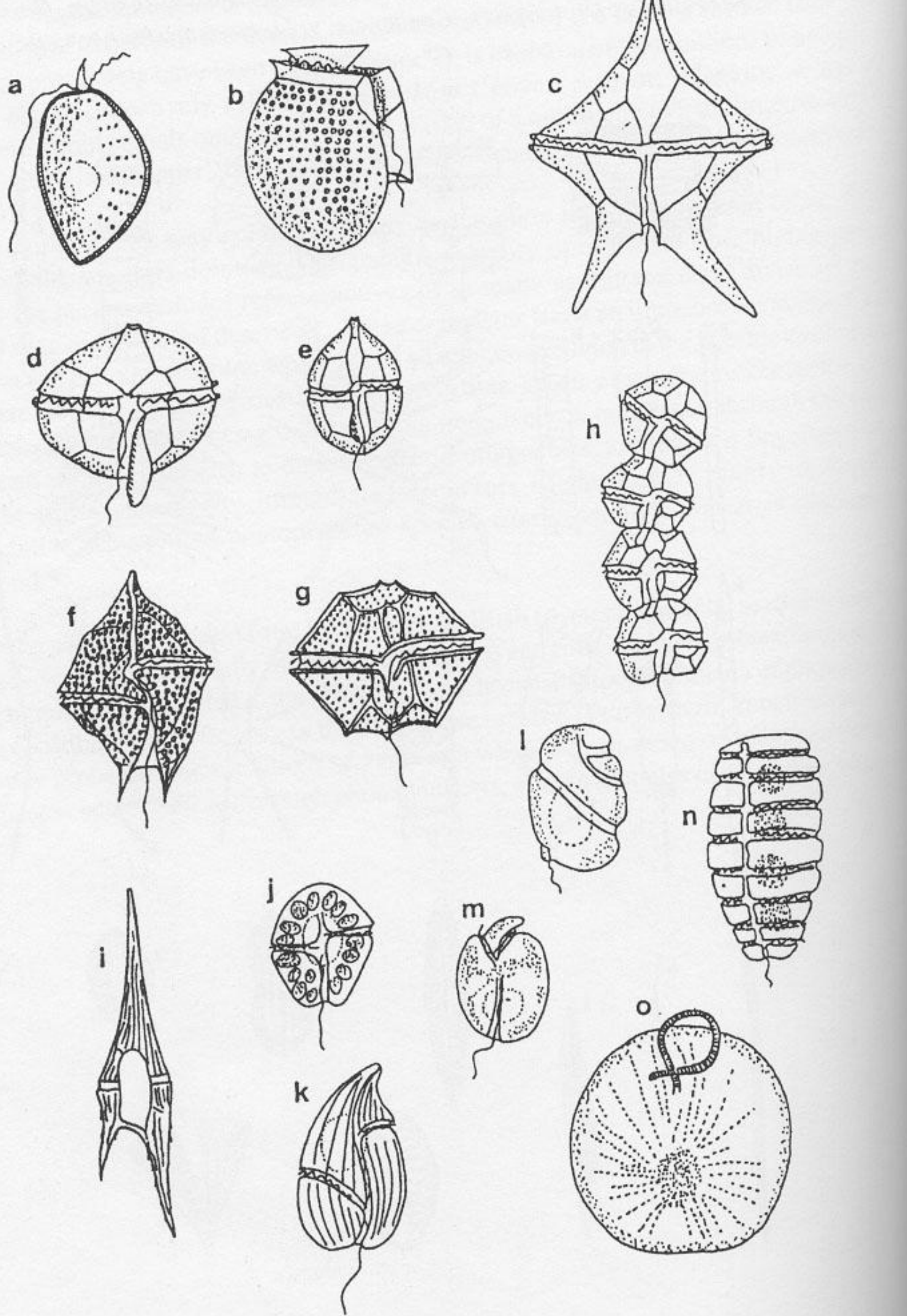
May 6/03



DIATOMS

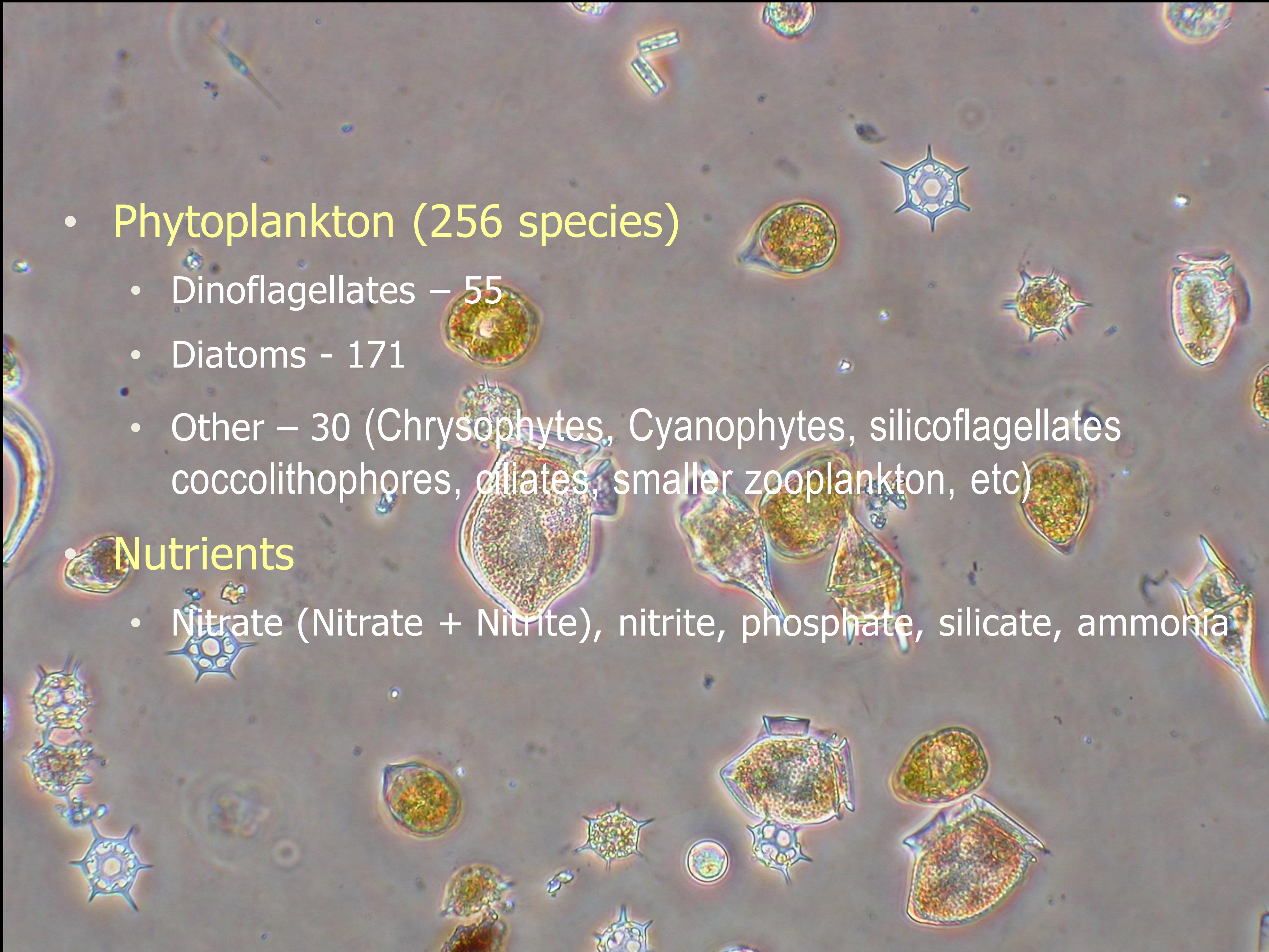
- SILICA WALL
- MOVE BY WATER CURRENTS





DINOFLAGELLATES

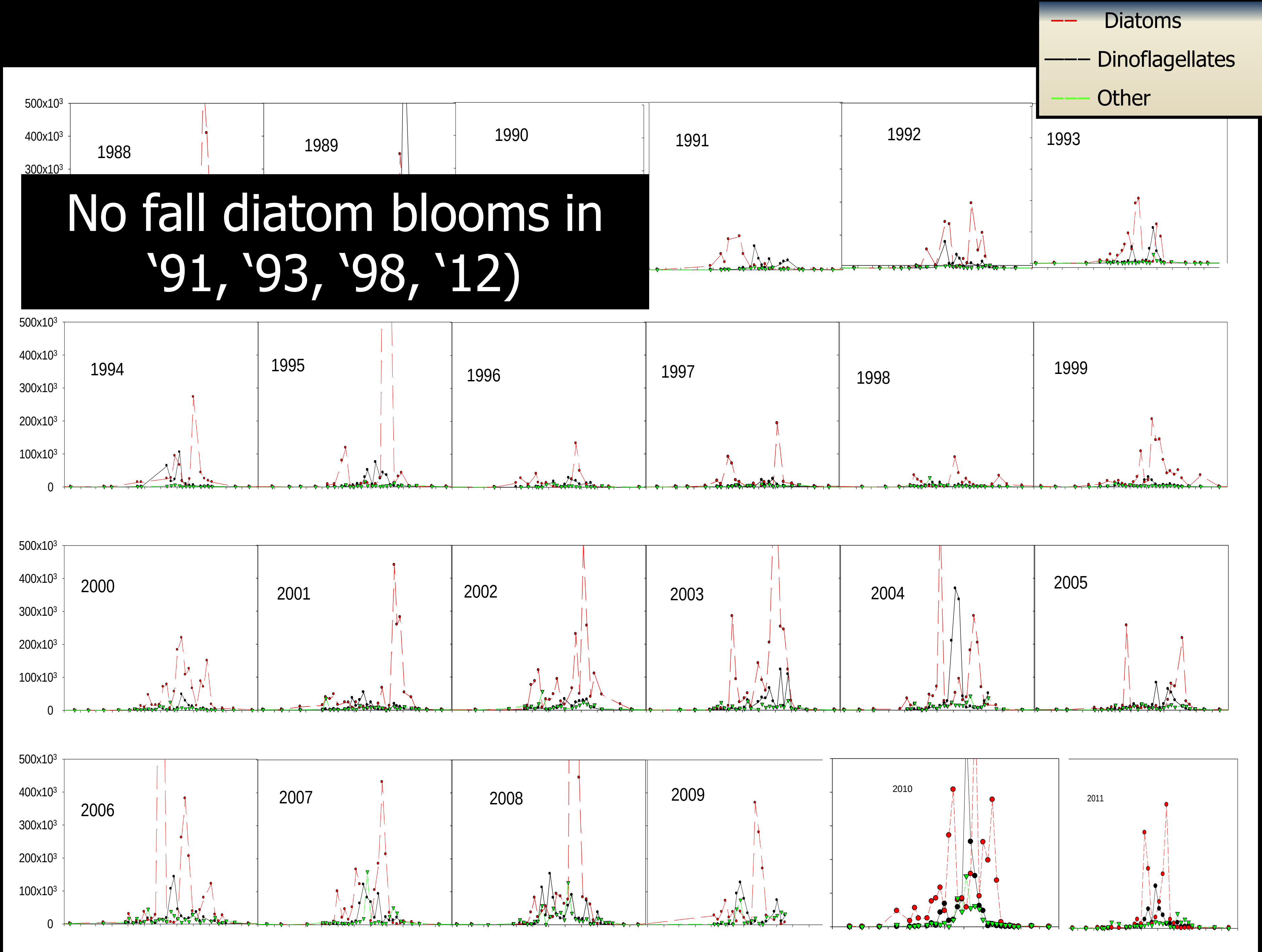
-FLAGELLA FOR MOBILITY



- Phytoplankton (256 species)
  - Dinoflagellates – 55
  - Diatoms - 171
  - Other – 30 (Chrysophytes, Cyanophytes, silicoflagellates coccolithophores, ciliates, smaller zooplankton, etc)
- Nutrients
  - Nitrate (Nitrate + Nitrite), nitrite, phosphate, silicate, ammonia

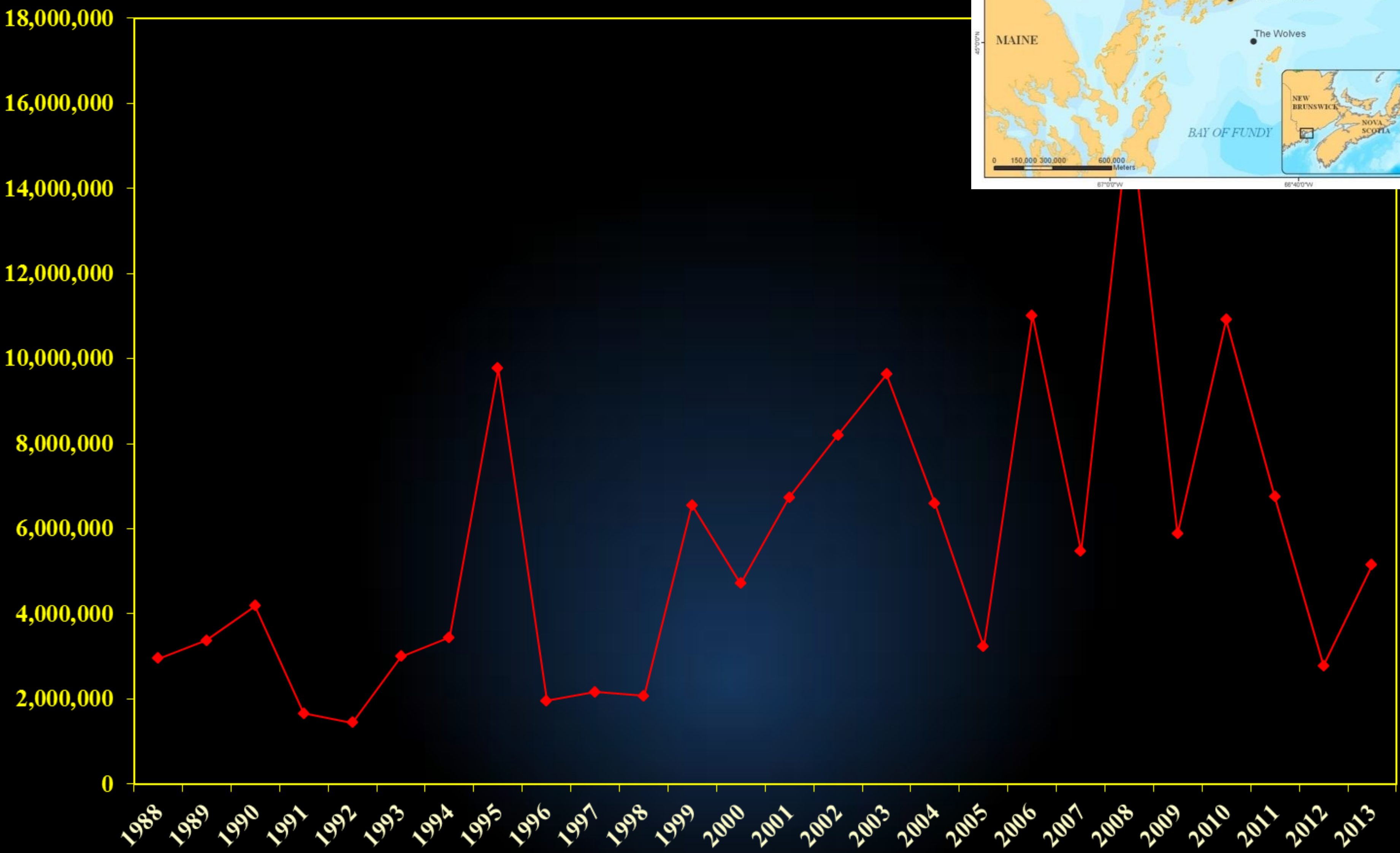
HARMFUL ALGAL SPECIES (BAY OF FUNDY)

- *Alexandrium fundyense***
- *Pseudo-nitzschia pseudodelicatissima*
- *Dinophysis* spp.
- *Mesodinium rubrum***
- *Eucampia zodiacus**
- *Chaetoceros socialis**
- *Prorocentrum minimum*
- *Gyrodinium aureolum*
- *Chaetoceros convolutus*
- *Chaetoceros wailesii*
- *Ditylum* spp.*
- *Leptocylindrus danicus*



No fall diatom blooms in ‘91, ‘93, ‘98, ‘12)

Diatoms



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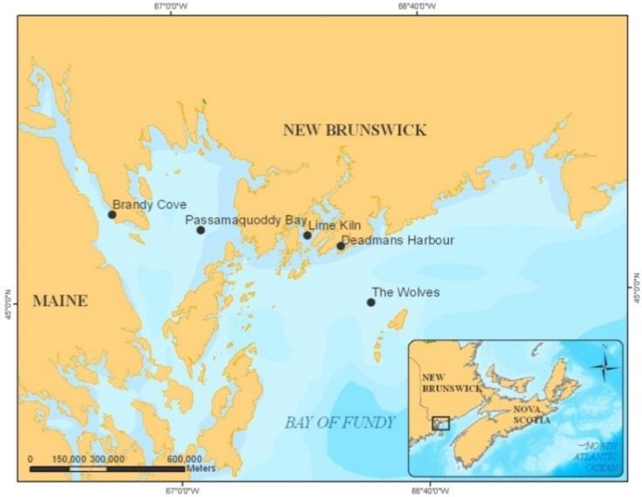
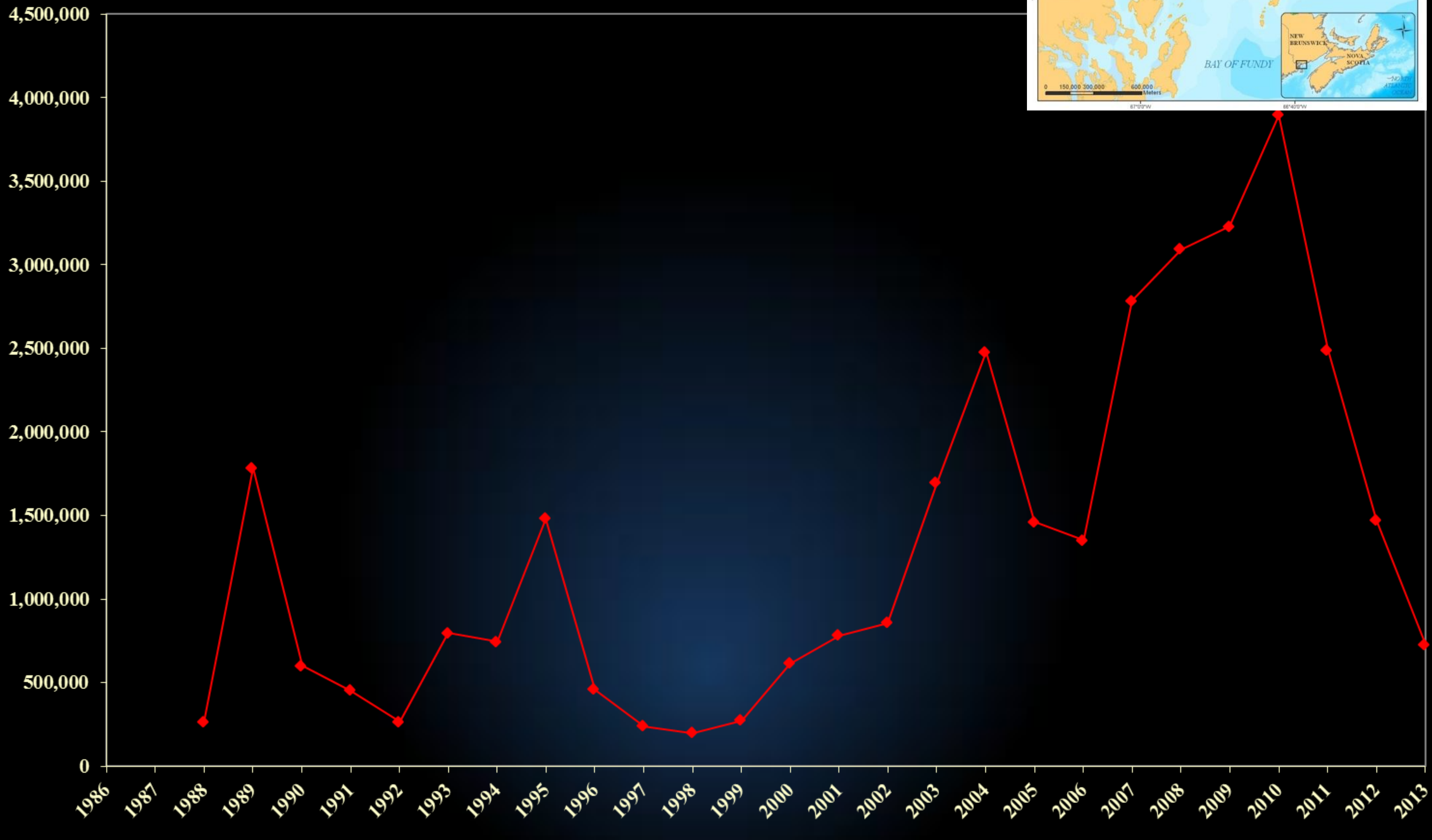
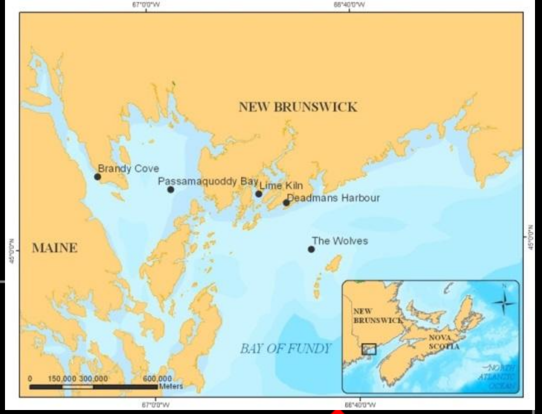


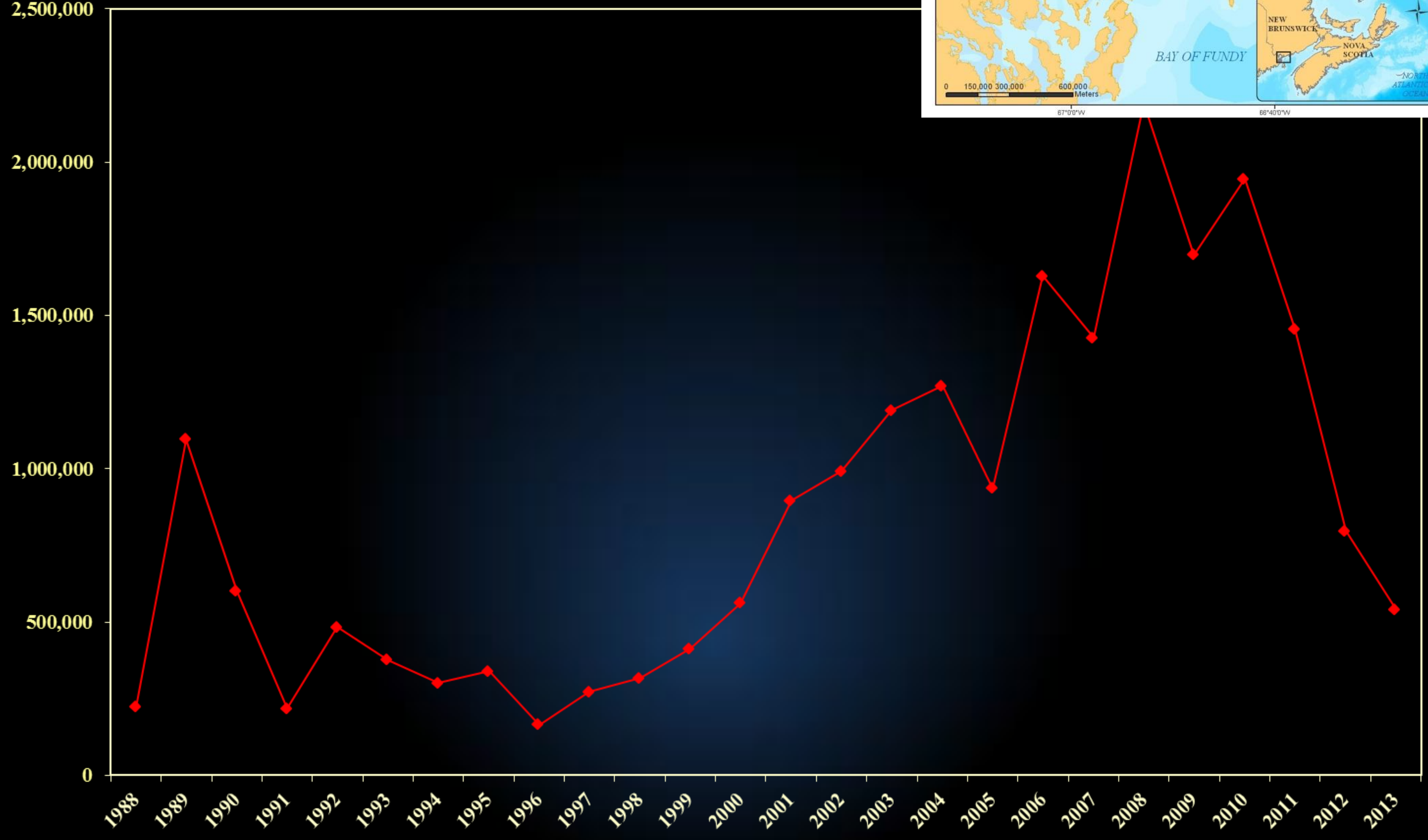
NEW BRUNSWICK
MAINE
Brandy Cove
Passamaquoddy Bay
Lime Kiln
Deadmans Harbour
The Wolves
BAY OF FUNDY
NEW BRUNSWICK
NOVA SCOTIA

TOTAL DINOFLAGELLATES

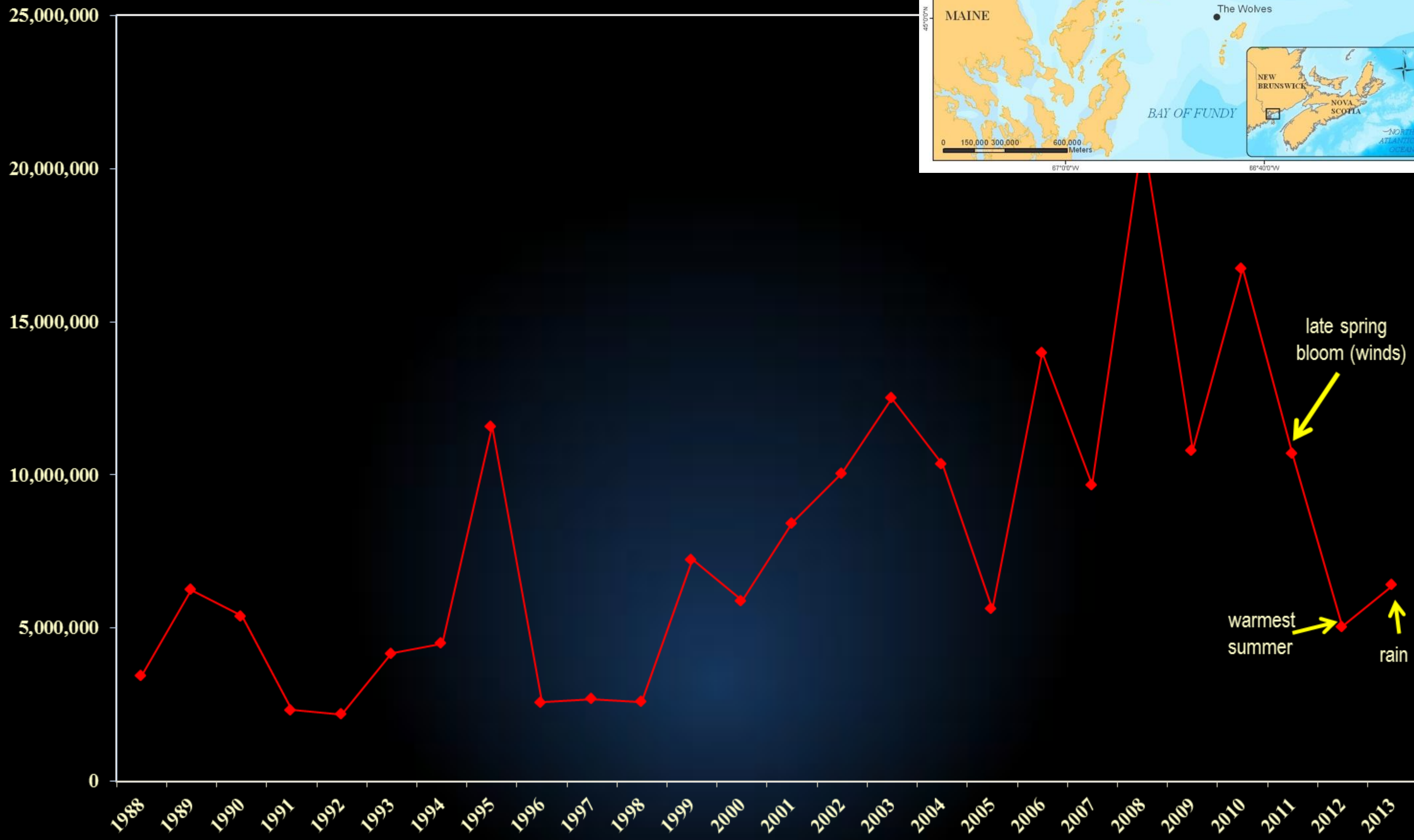




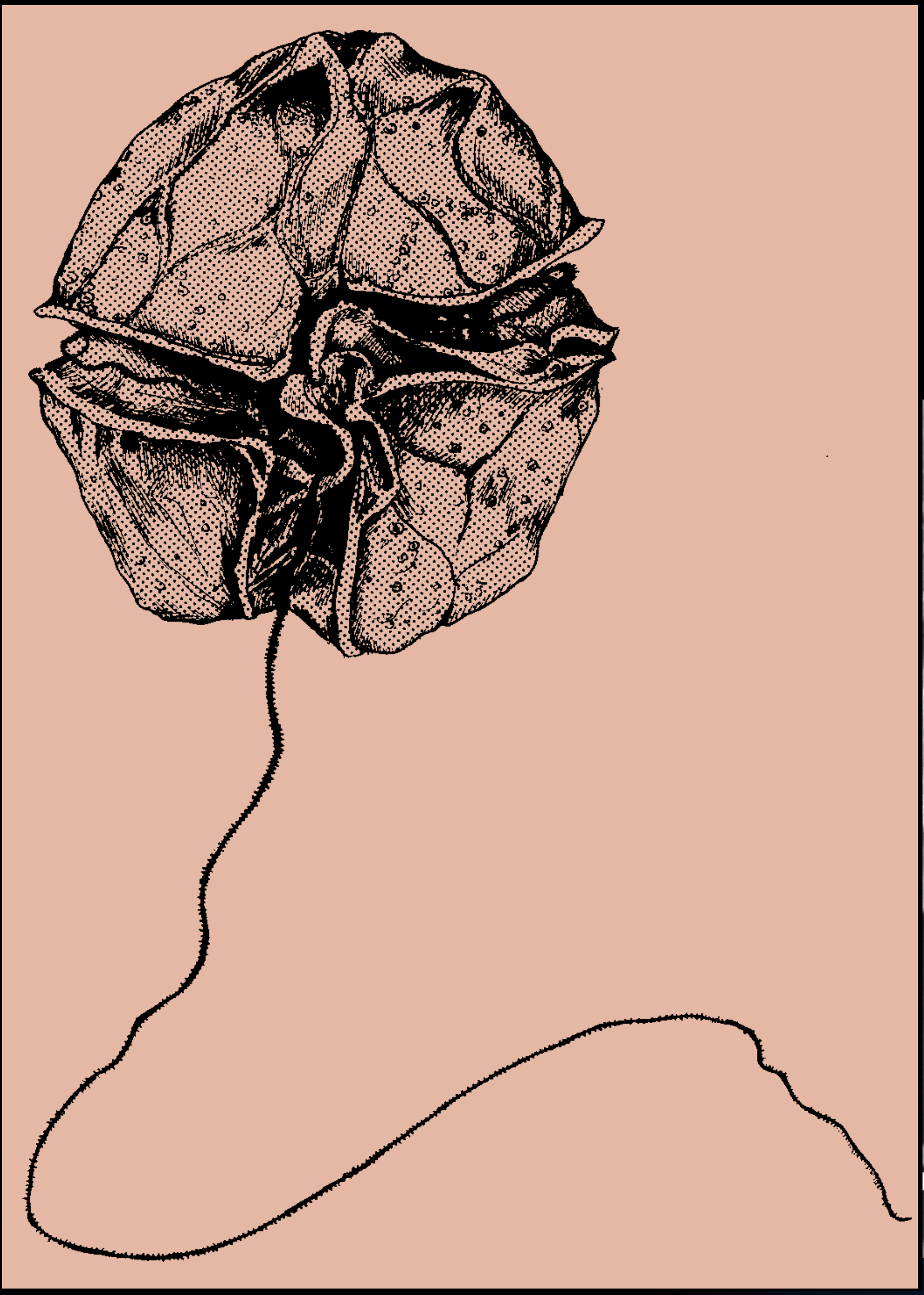
TOTAL "OTHER" ORGANISMS



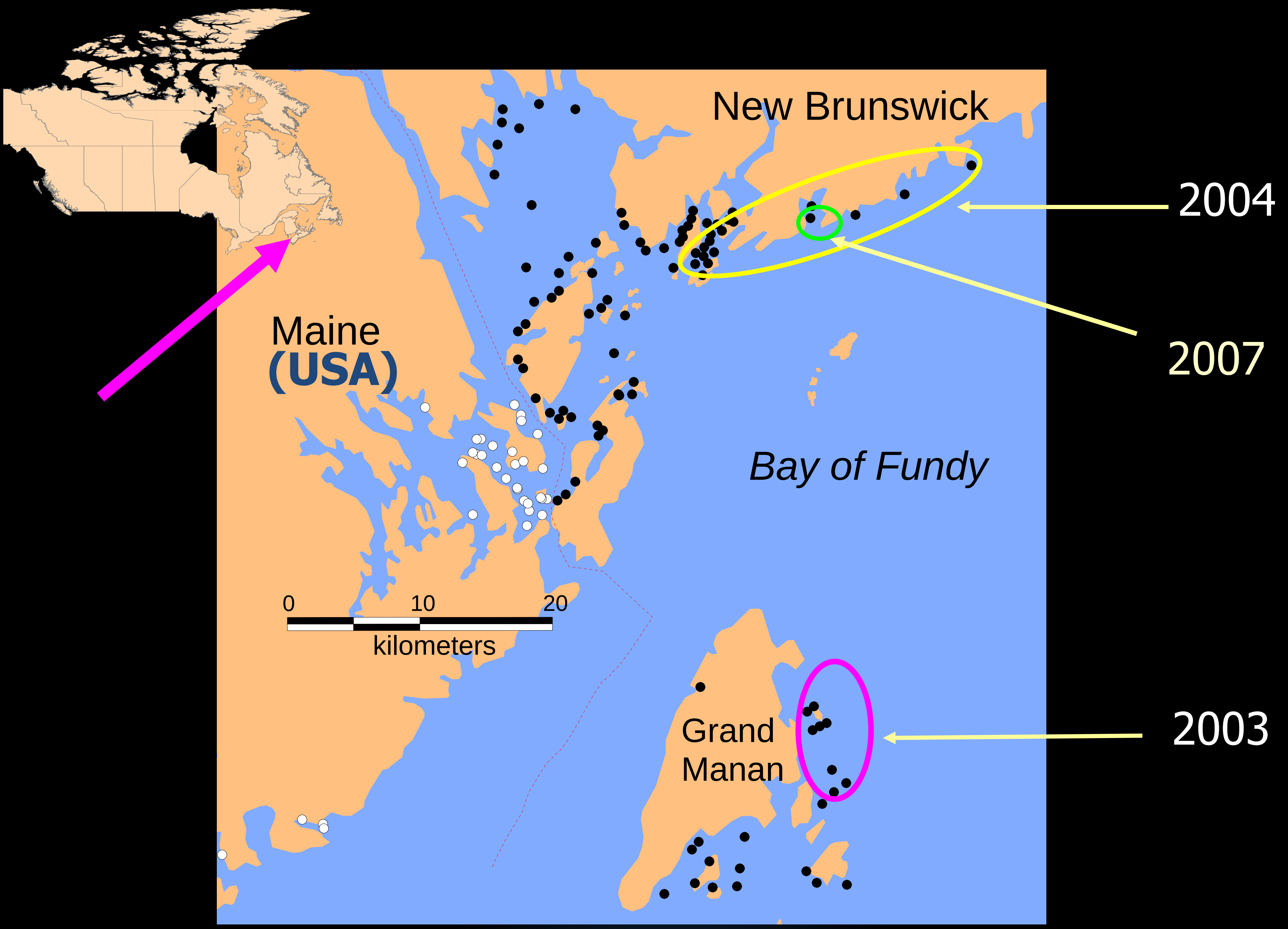
TOTAL ORGANISMS



PARALYTIC SHELLFISH POISONING (PSP)

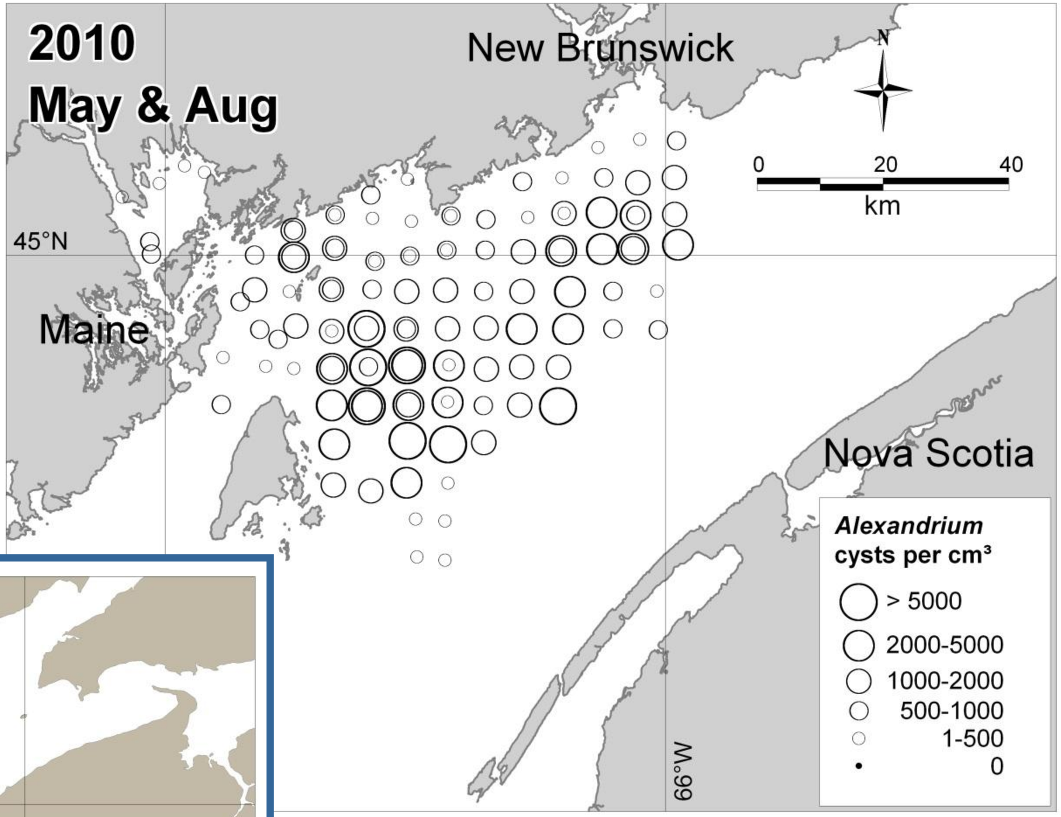


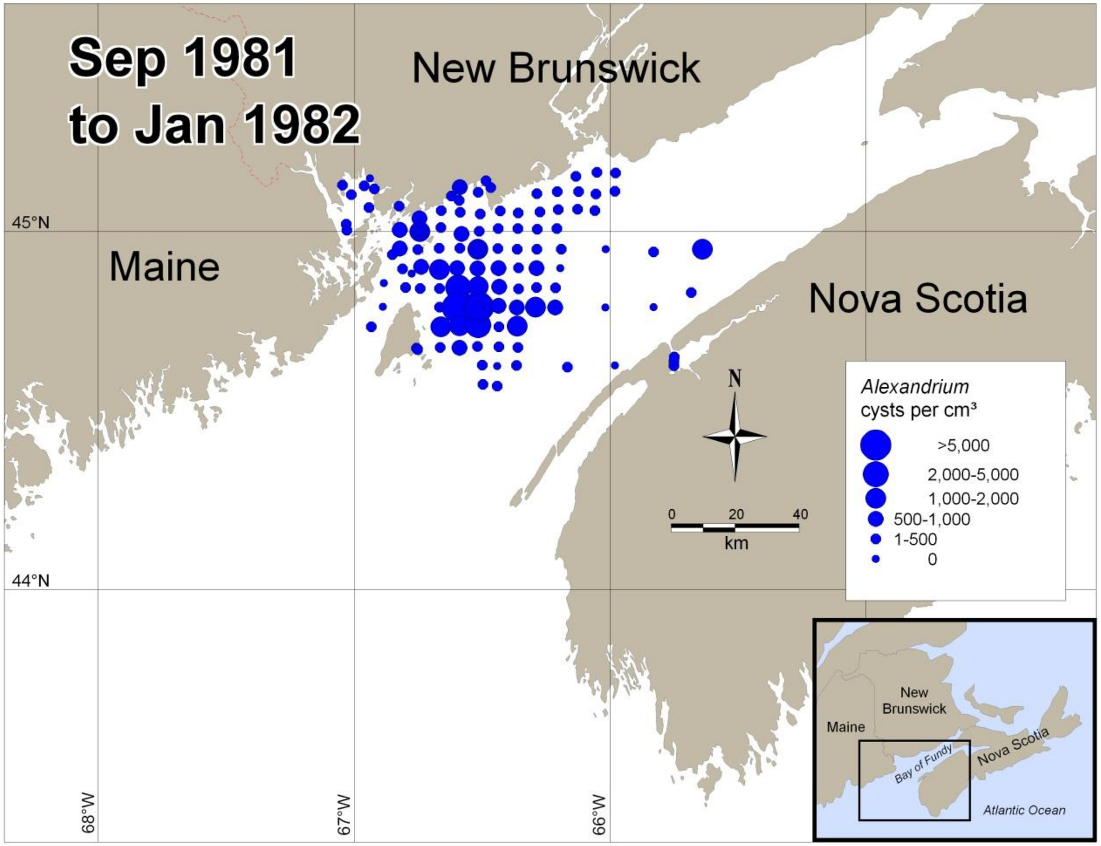
ALEXANDRIUM FUNDYENSE

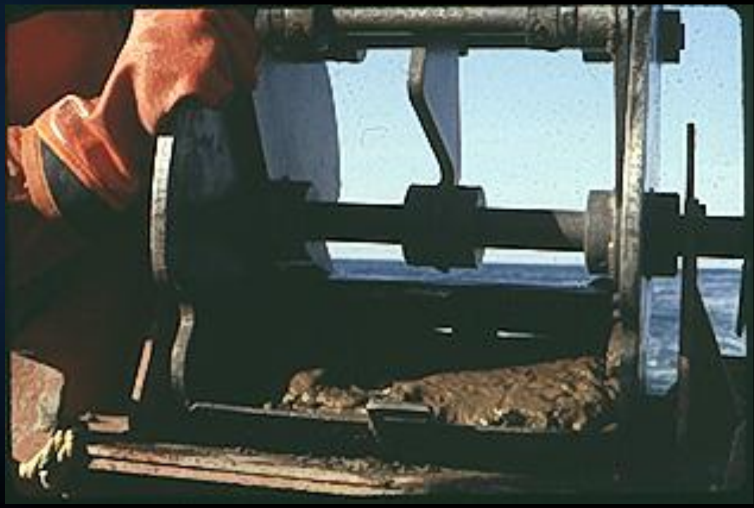


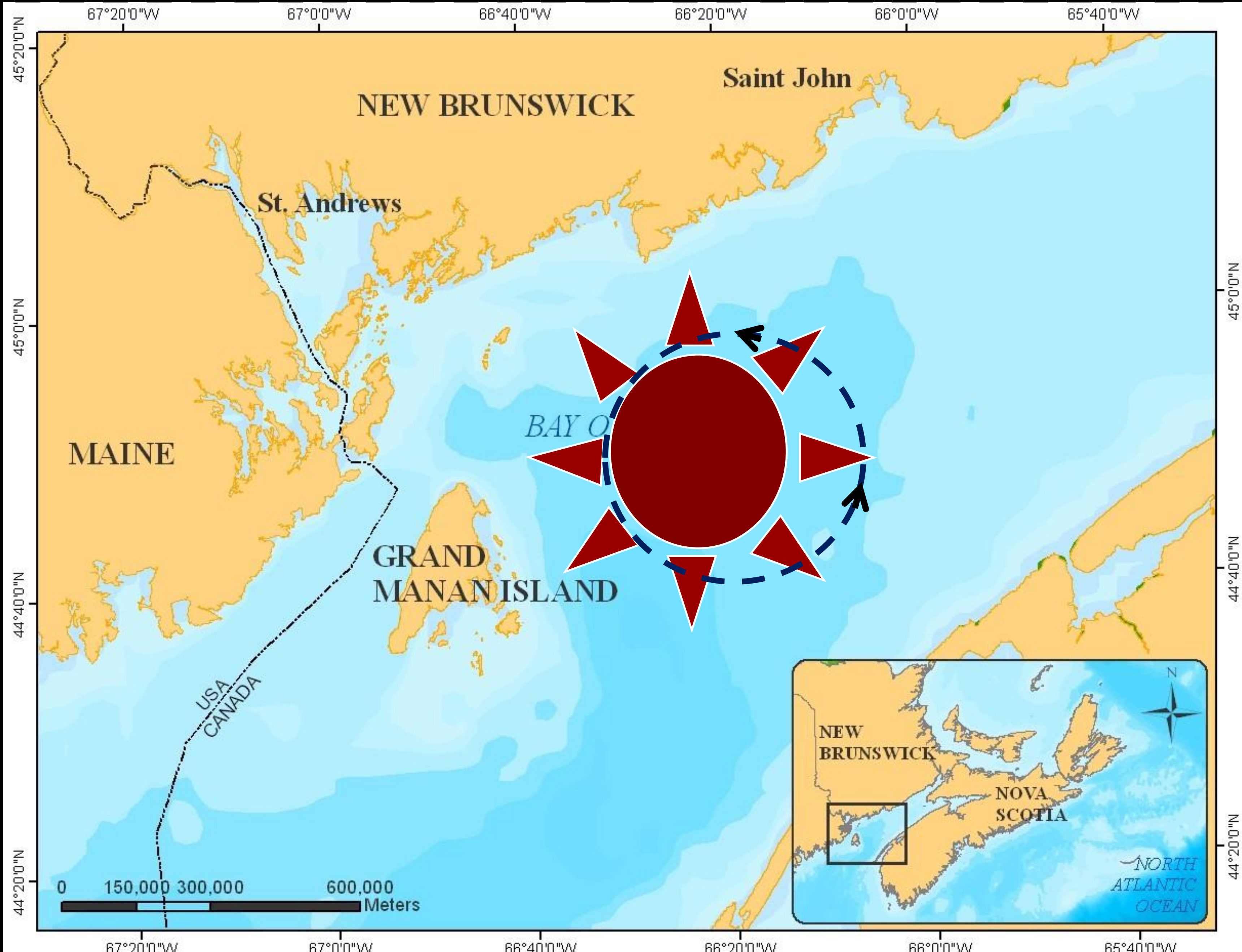
New Brunswick
Maine
(USA)
Bay of Fundy
Grand
Manan
0
10
20
kilometers
2004
2007
2003

WINTER CYSTS

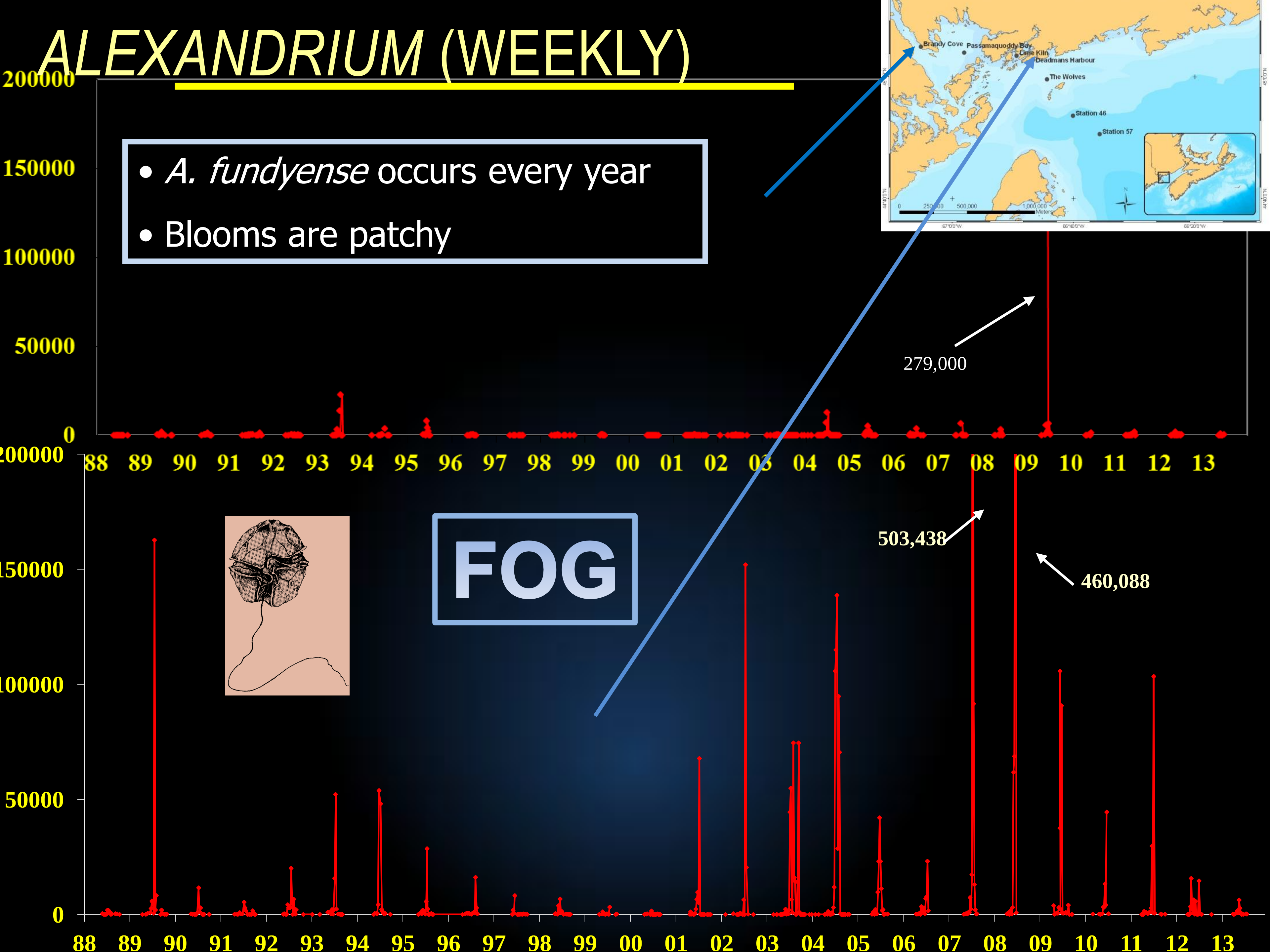




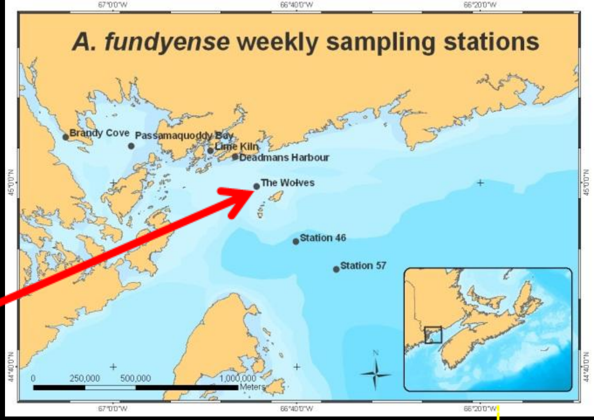


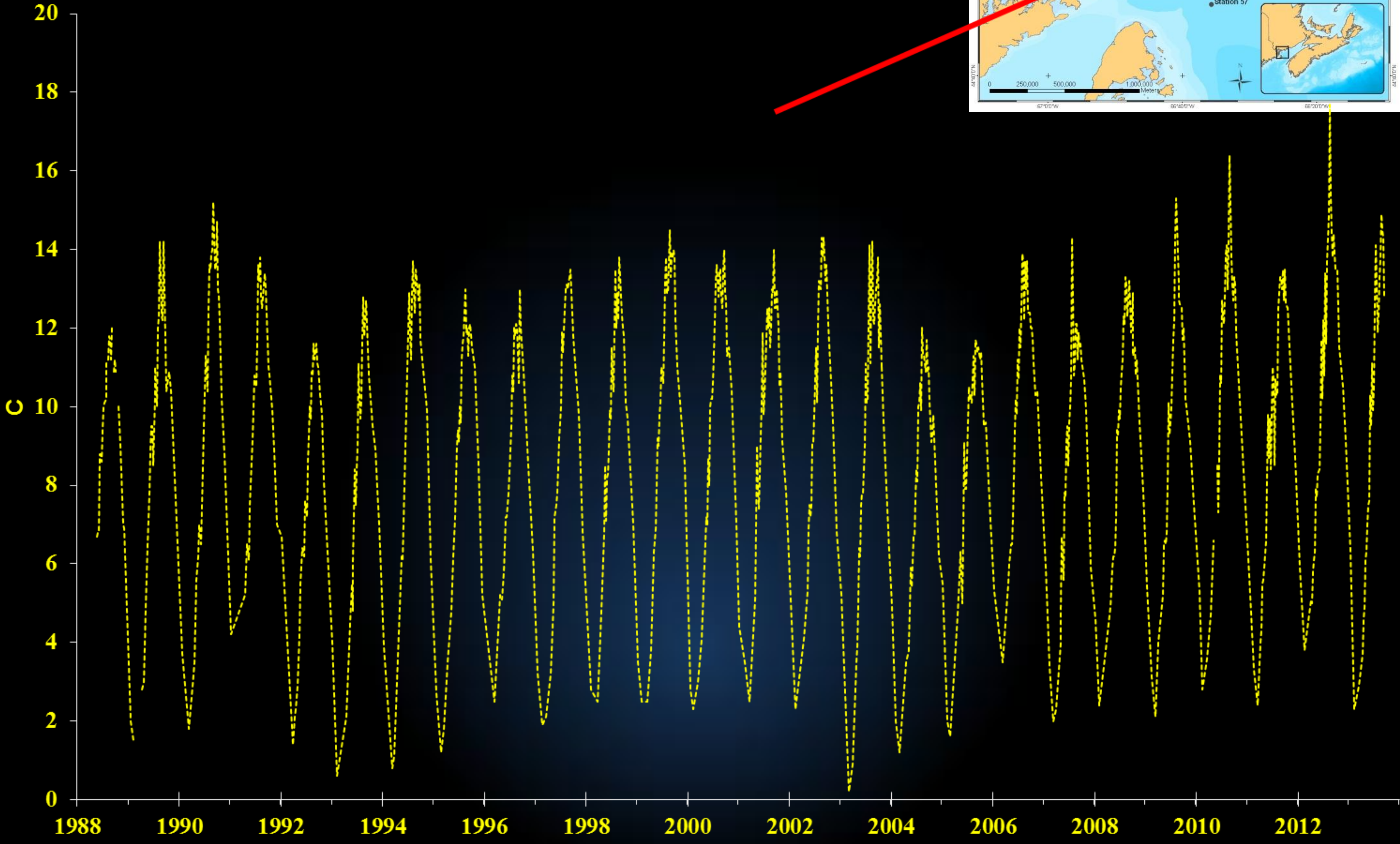


67°20'0"W
67°0'0"W
66°40'0"W
66°20'0"W
66°0'0"W
65°40'0"W
45°20'0"N
45°0'0"N
44°40'0"N
44°20'0"N
NEW BRUNSWICK
Saint John
St. Andrews
MAINE
BAY O
GRAND
MANAN ISLAND
USA
CANADA
0
150,000
300,000
600,000
Meters
NEW
BRUNSWICK
NOVA
SCOTIA
NORTH
ATLANTIC
OCEAN
N

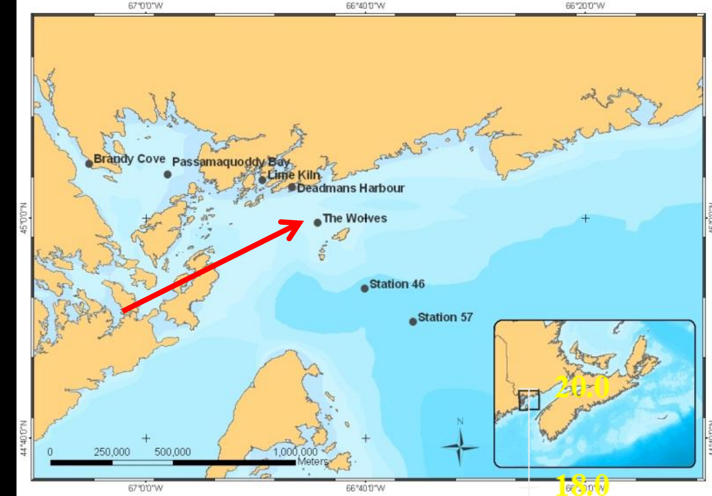

ALEXANDRIUM (WEEKLY)
• A. fundyense occurs every year
• Blooms are patchy
FOG
279,000
503,438
460,088
200000
150000
100000
50000
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13
Brandy Cove
Passamaquoddy Bay
Lime Kiln
Deadmans Harbour
The Wolves
Station 46
Station 57

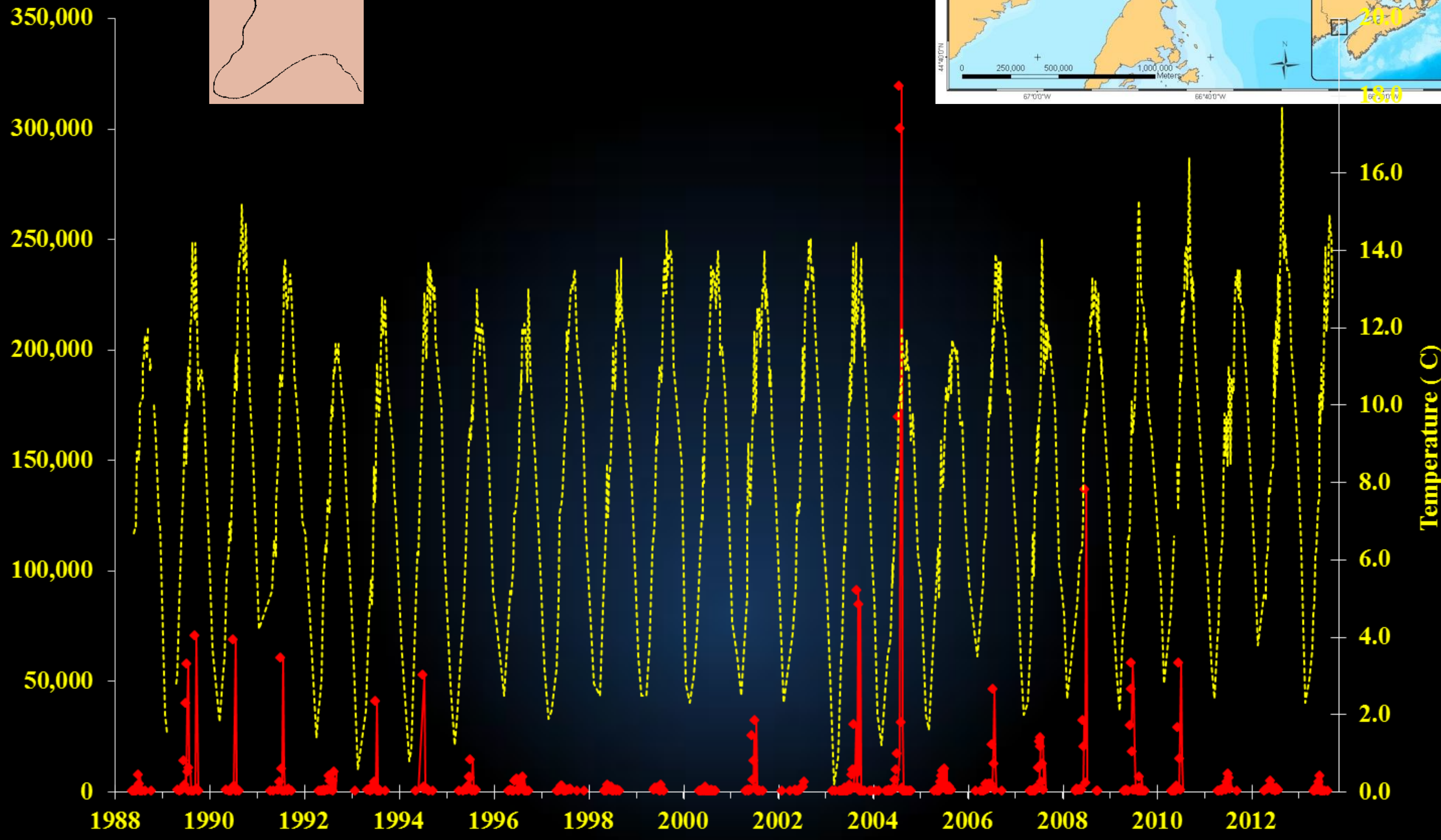
SURFACE WATER TEMPERATURE



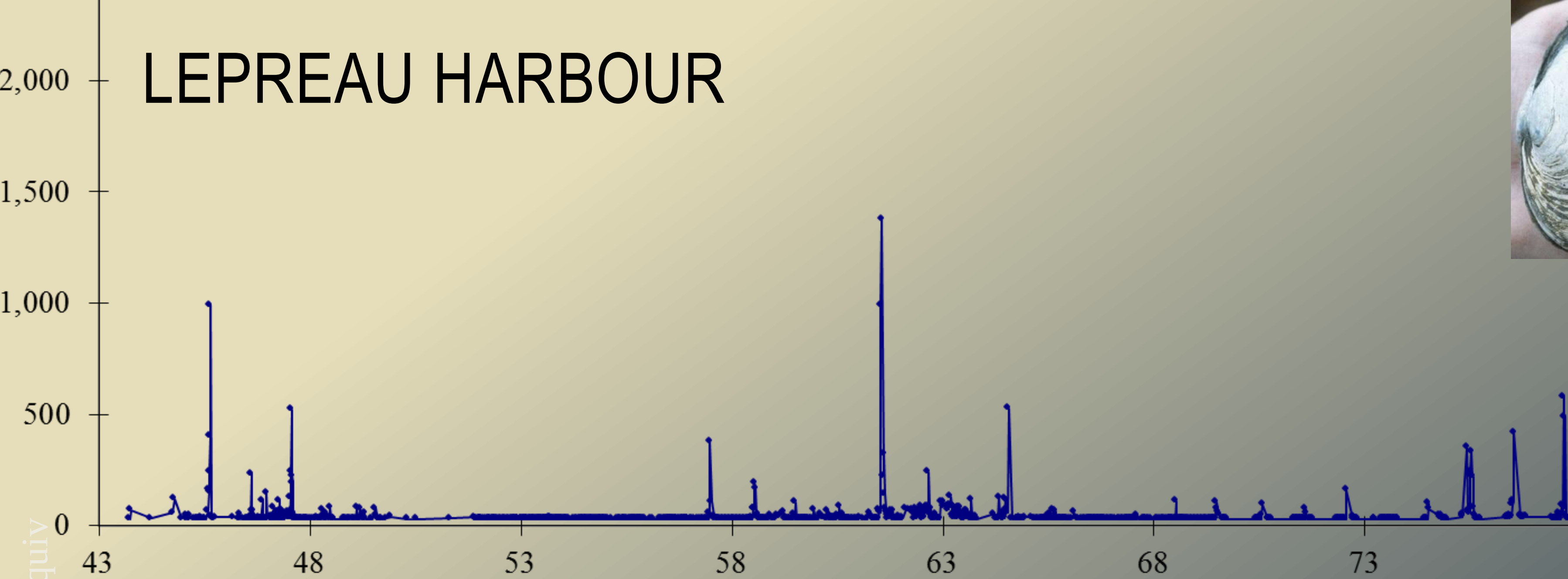


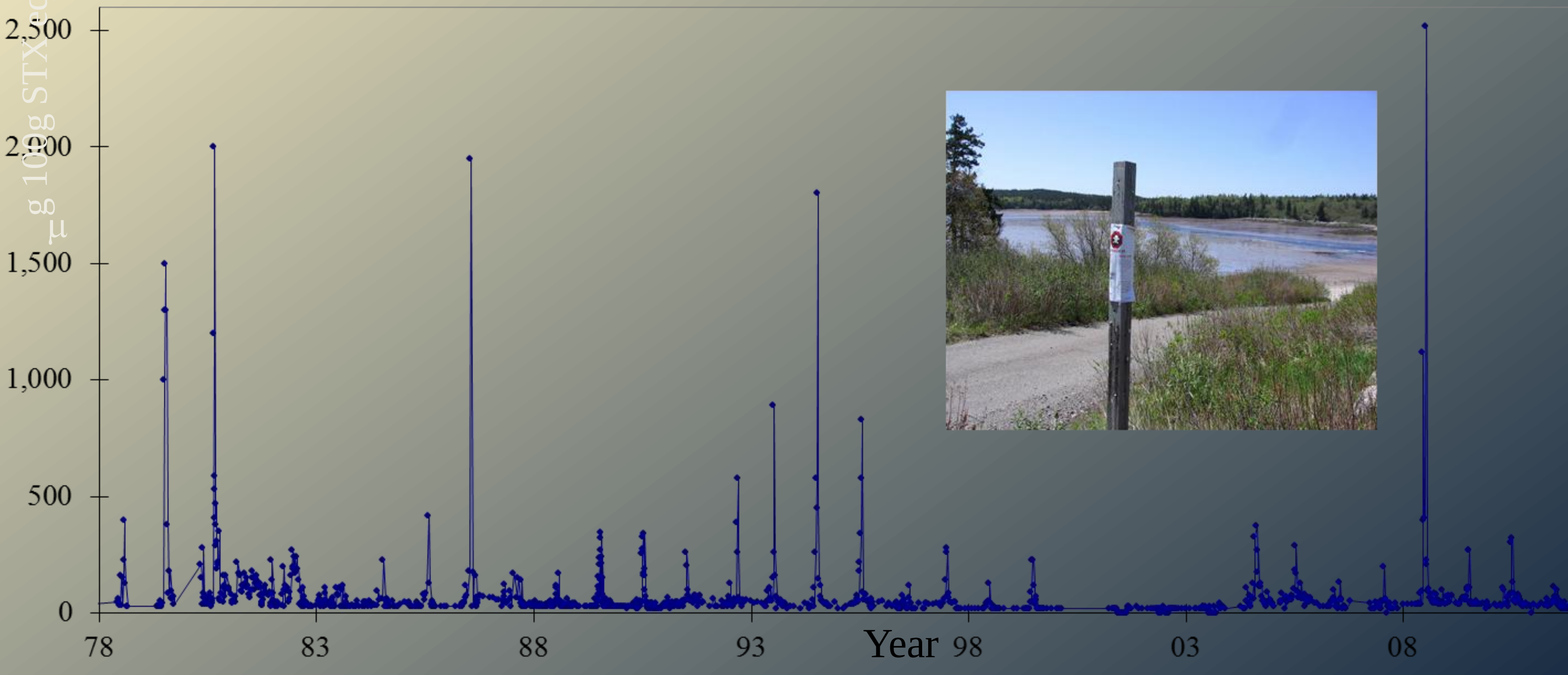
ALEXANDRIUM/TEMPERATURE





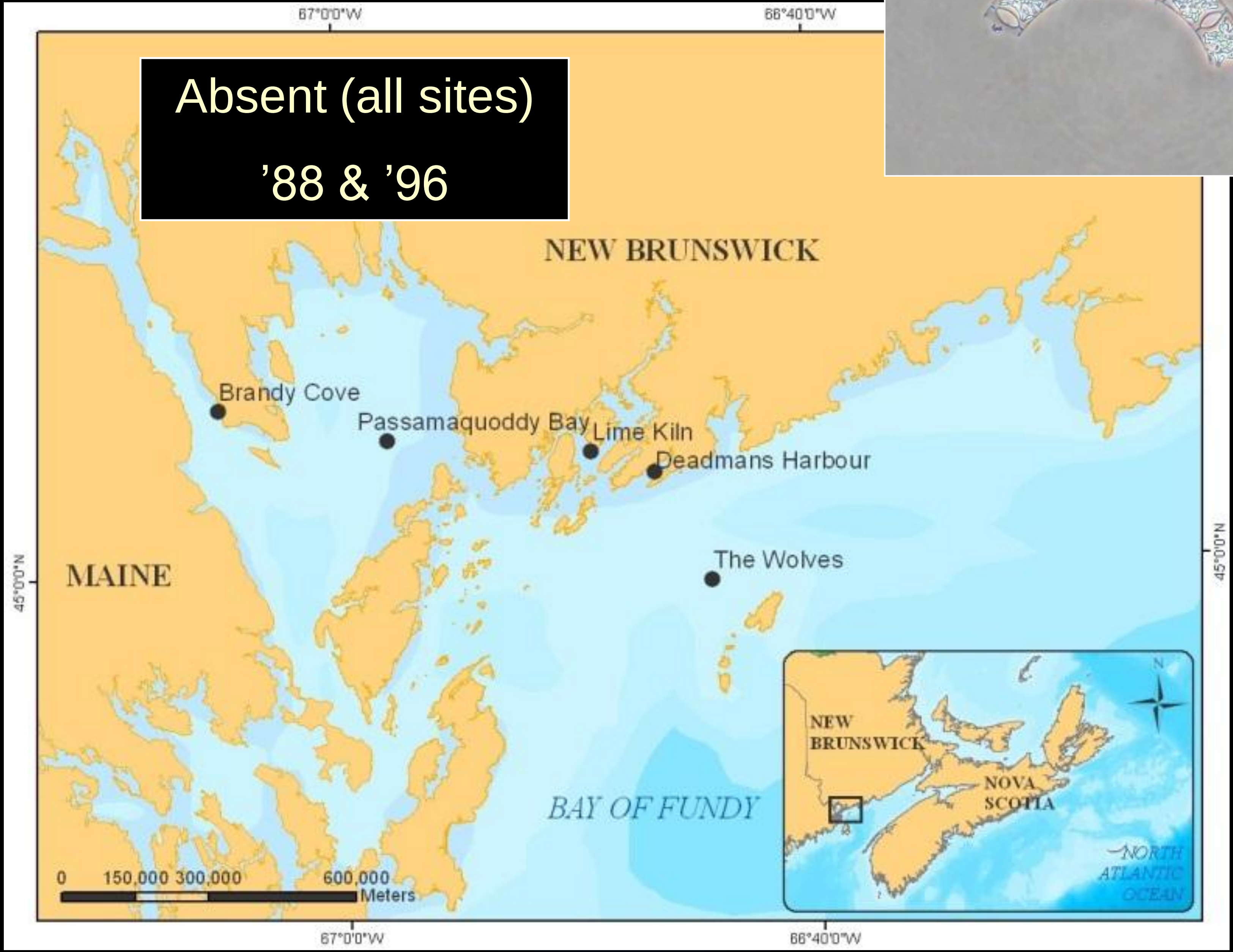
LEPREAU HARBOUR



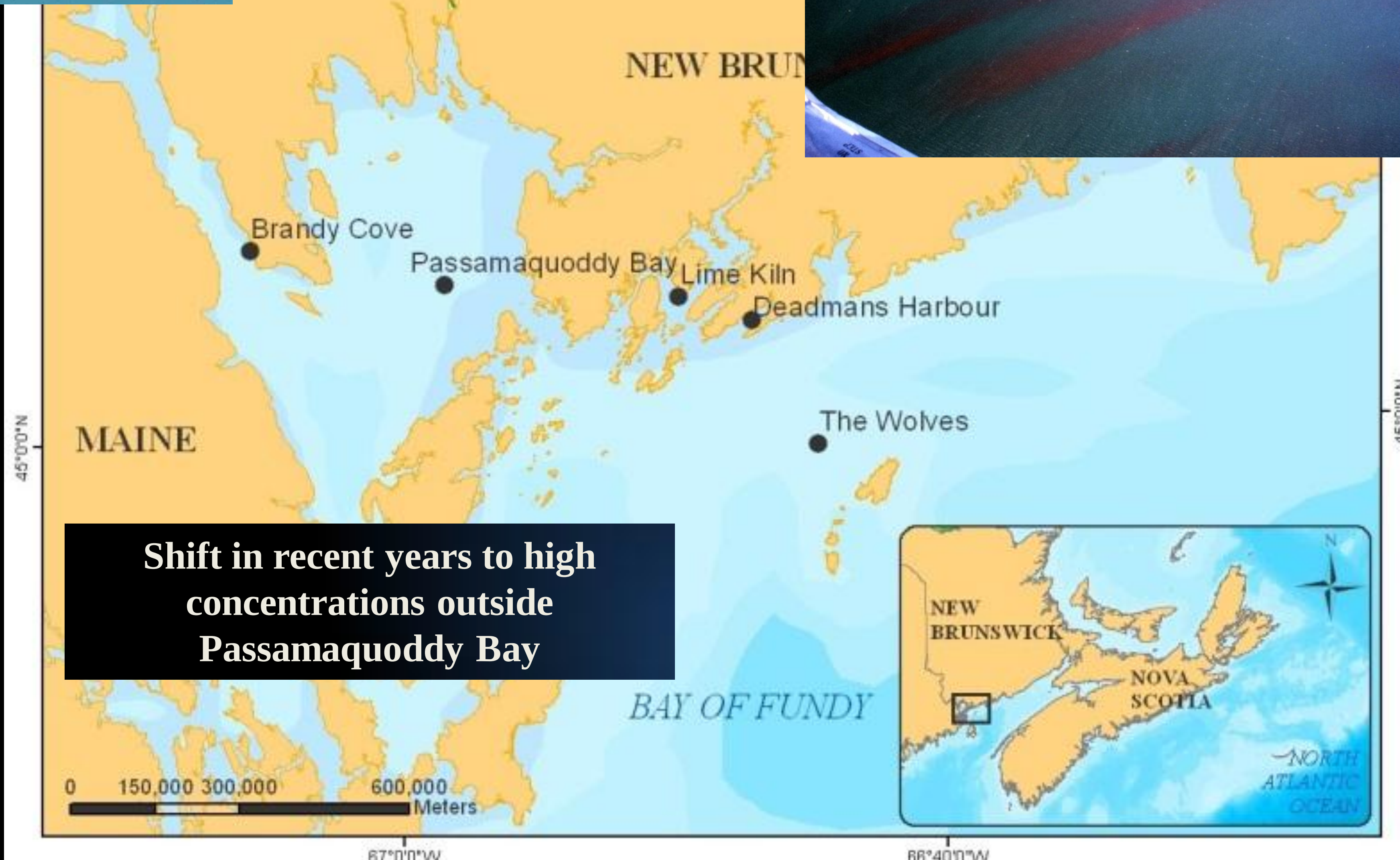


Absent (all sites)

’88 & ’96

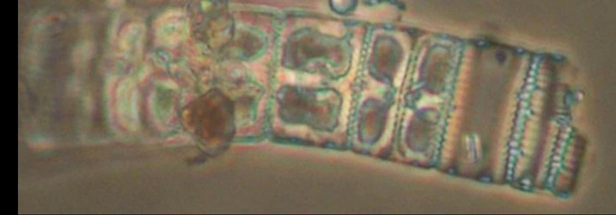


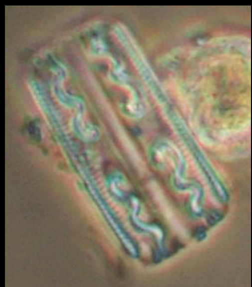
Mesodinium rubrum

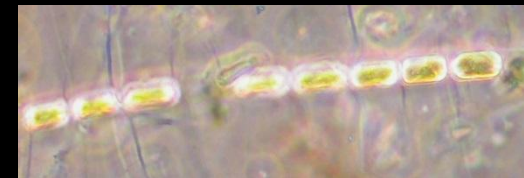


Shift in recent years to high concentrations outside Passamaquoddy Bay

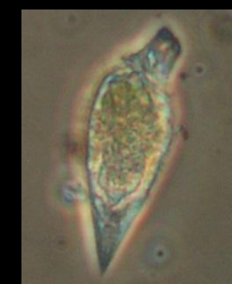
NEW PHYTOPLANKTON (35)

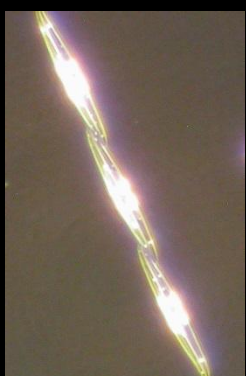


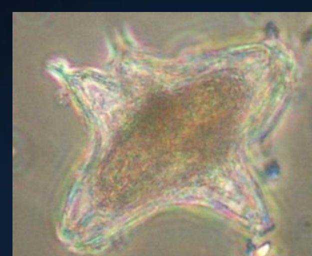


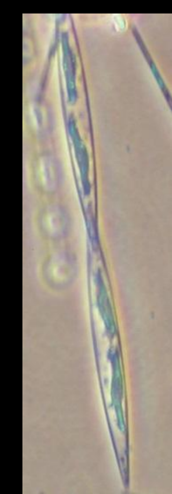


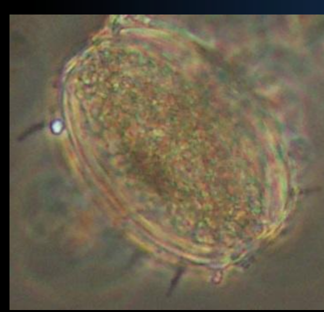
- Diatoms - 9
- Dinoflagellates - 11
- ‘Other’ - 5



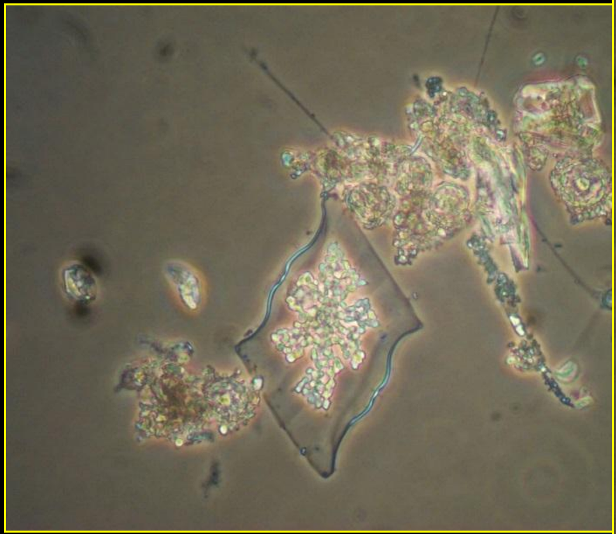






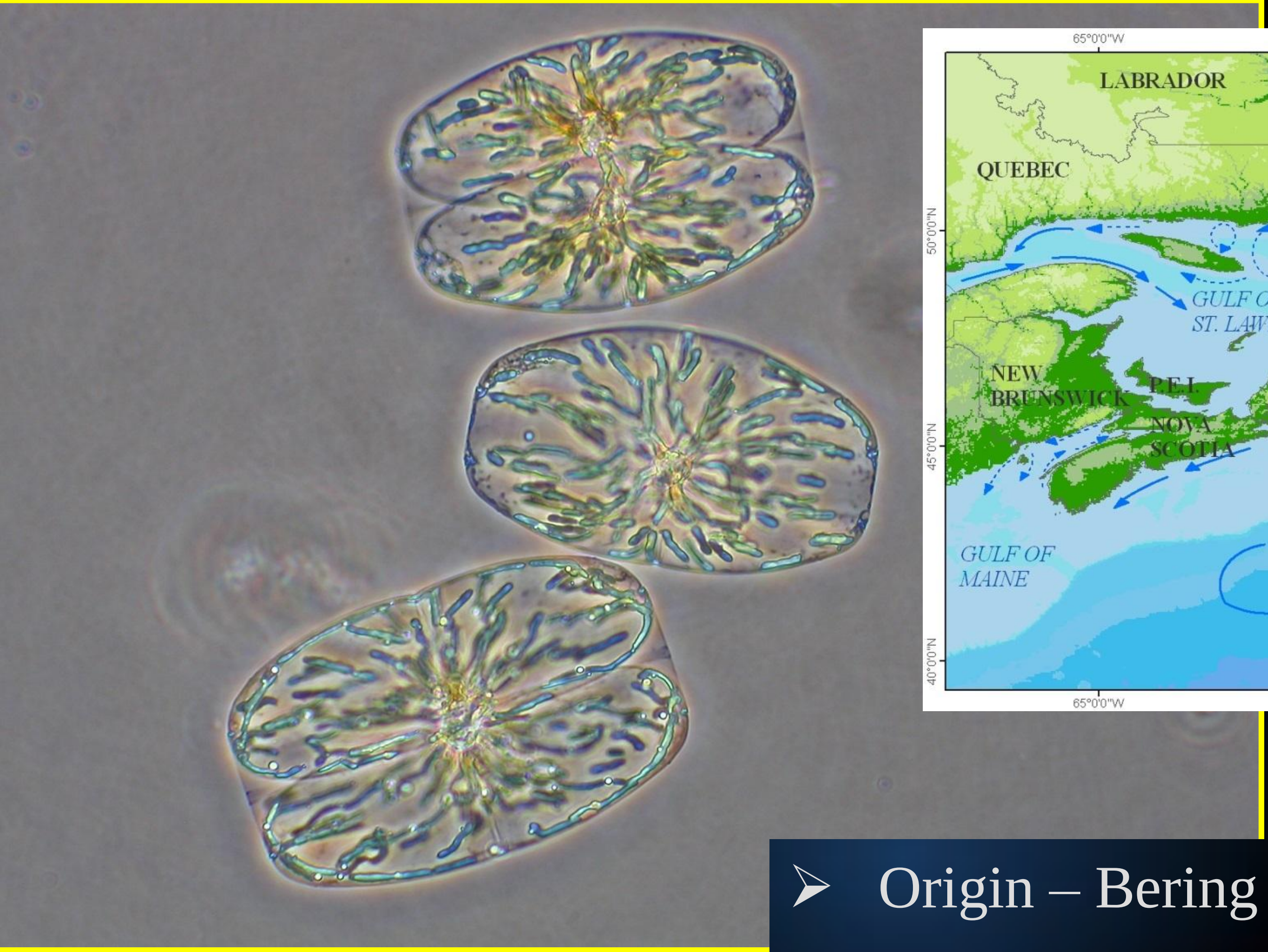


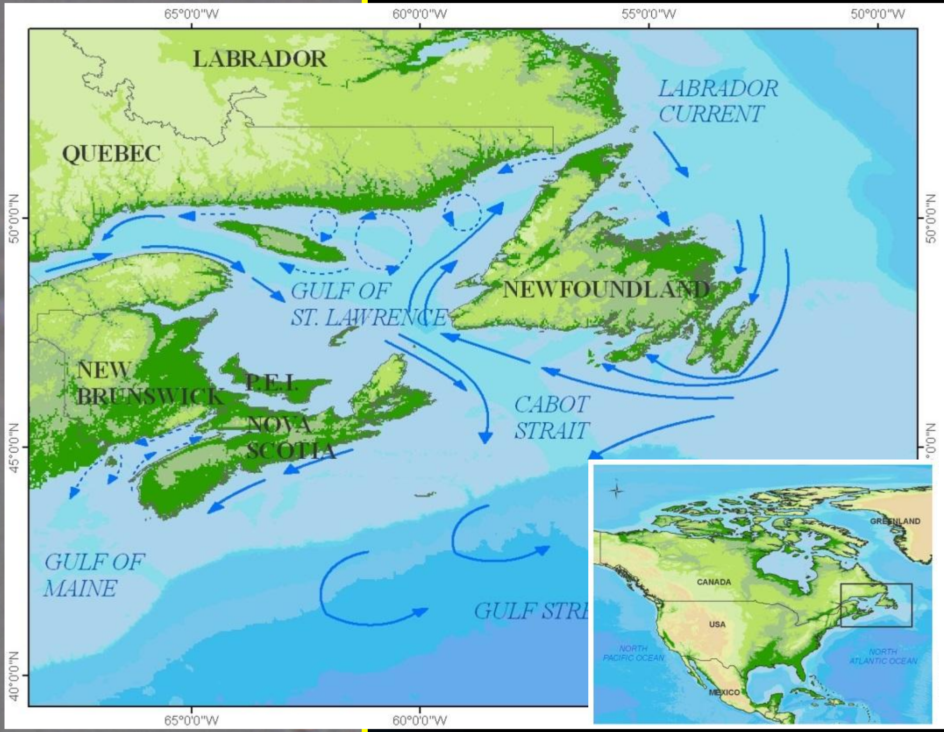
MEDIOPYXIS HELYSIA (2002)



- First record North Sea (2001)
- New – Gulf of Maine, Bay of Fundy, German Bight

MEMBRANEIS CHALLENGERI (2001)





- Origin – Bering Sea, north Pacific
- (?) Possible transport to Bay of Fundy from Labrador currents/Arctic

- Phytoplankton/ finfish - modes of action
- Sampling, long term datasets
- Harmful species
- 25 years - spatial and temporal trends
- New species

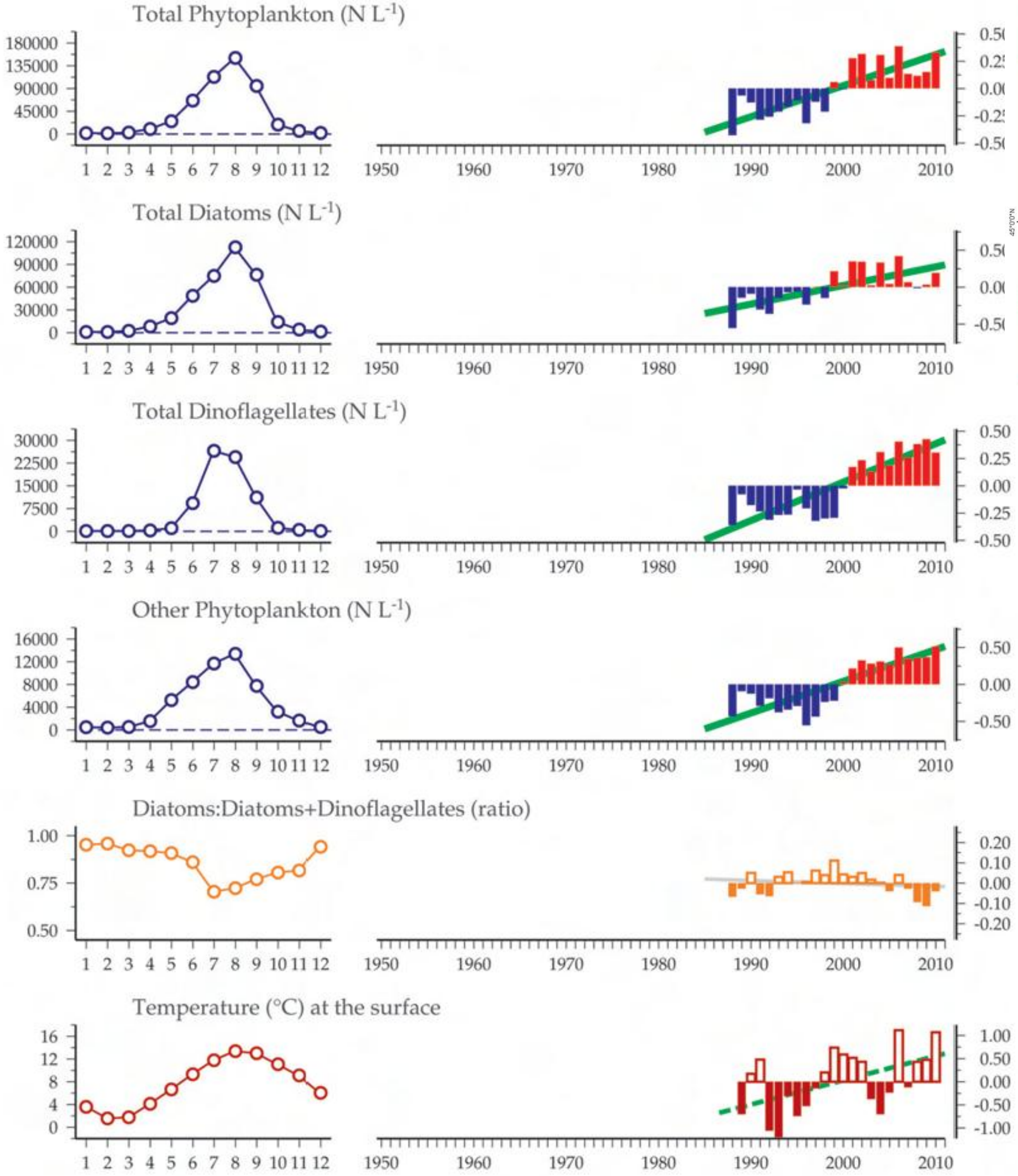
SUMMARY

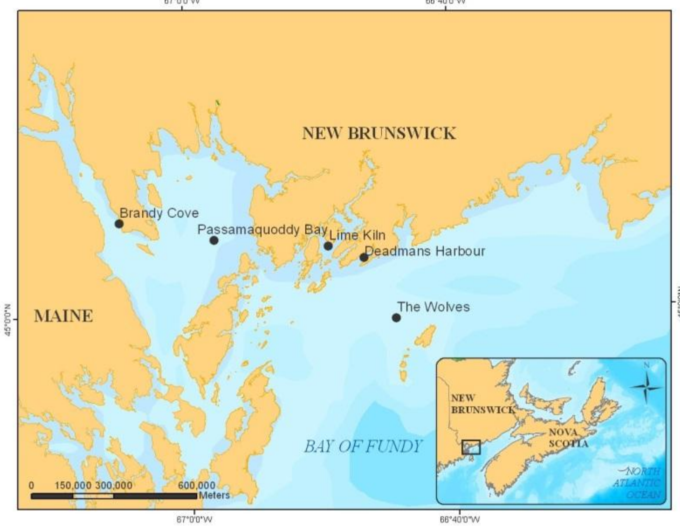
- Each species behaves differently
- Large inter-annual variability
- Long-term datasets valuable – need 50-100 yr
- New species (35) continue to thrive and be observed
  - too early to tell if any species have disappeared
- Blooms now tend to begin earlier and persist later into the fall
- Some species are more abundant than in the past
- Environment factors important – weather (wind, rain, fog), oceanography
  - Warmer summer temperatures in recent years (2012 warmest), Intense precipitation (2013) affected phytoplankton blooms

ACKNOWLEDGEMENTS

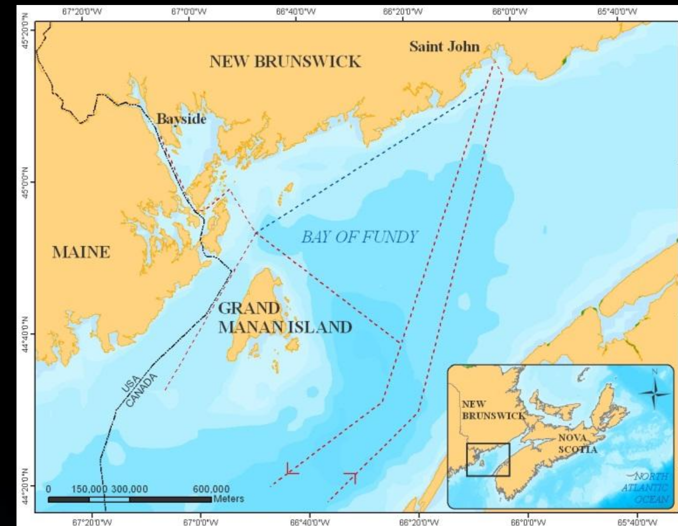
- Captain and crews of *Pandalus* and *Viola M. Davidson*
- Canadian Food Inspection Agency
- L. Burridge
- B. Chang
- S. Corey
- E. Doon
- J. Fife
- E. Gao
- M. Gidney
- J. Fife
- G. Forbes
- A. Hanke
- A. Hamer
- M. LeGresley
- R. Losier
- K. Mackenzie
- P. McCurdy
- F. Page
- M. Ringuette
- S. Robinson
- A. Saulnier
- D. Scott
- A. Wilson

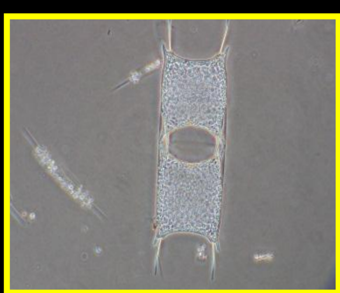
Bay of Fundy


Total Phytoplankton (N L-1)
Total Diatoms (N L-1)
Total Dinoflagellates (N L-1)
Other Phytoplankton (N L-1)
Diatoms:Diatoms+Dinoflagellates (ratio)
Temperature (°C) at the surface
1950
1960
1970
1980
1990
2000
2010


NEW BRUNSWICK
MAINE
Brandy Cove
Passamaquoddy Bay
Lime Kiln
Deadmans Harbour
The Wolves
BAY OF FUNDY
NOVA SCOTIA
NORTH ATLANTIC OCEAN
0 150,000 300,000 600,000 Meters


EO


67°20'0"W
67°0'0"W
66°40'0"W
66°20'0"W
66°0'0"W
65°40'0"W
45°20'0"N
45°0'0"N
44°40'0"N
44°20'0"N
NEW BRUNSWICK
Saint John
Bayside
MAINE
BAY OF FUNDY
GRAND MANAN ISLAND
USA
CANADA
NEW BRUNSWICK
NOVA SCOTIA
NORTH ATLANTIC OCEAN
0 150,000 300,000 600,000 Meters




EO

Threshold studies

- 150-380 g Atlantic Salmon
- LC50 - 650,000 *Alexandrium* cells/L

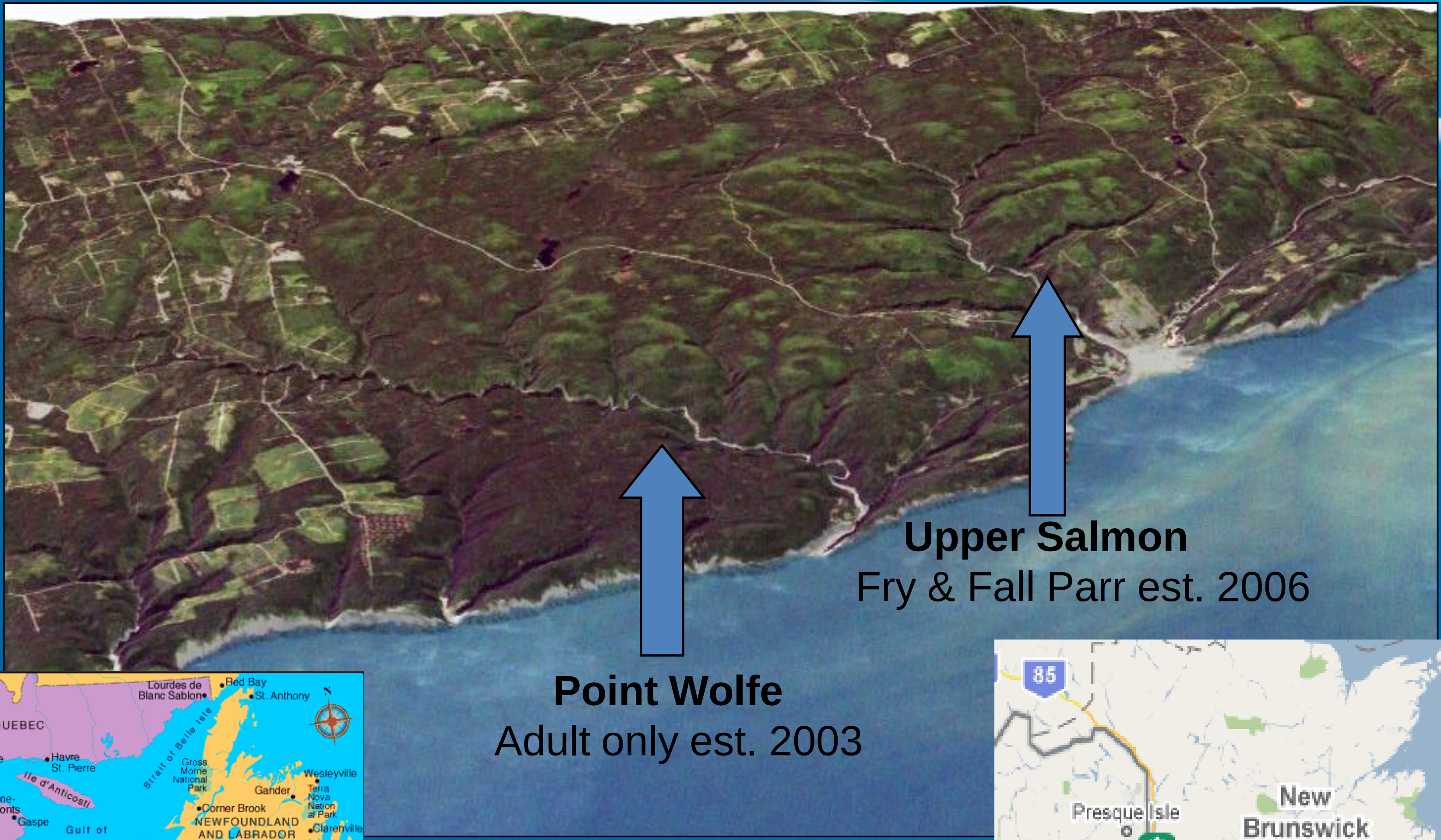
The Fundy National Park Inner Bay of Fundy Atlantic Salmon recovery program:

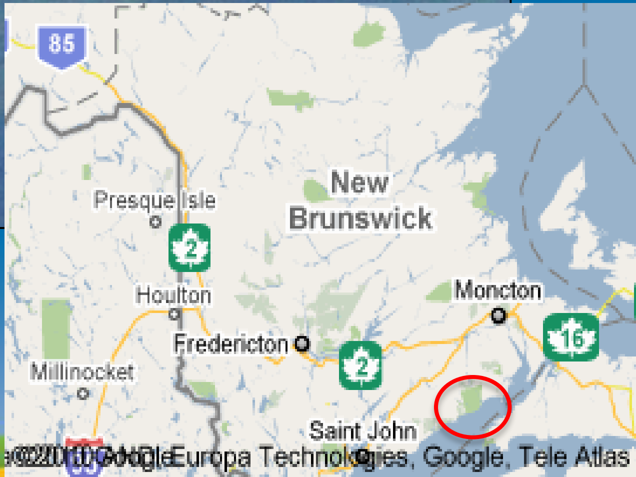
- Assessing life-long effects on fitness of two IBoF Salmon captive rearing and release strategies.

Clarke, C., [(1)] Purchase C.F. [(2)], Fraser D.J.[(3)], Mazerolle D.F.[(1)]

[1] Parks Canada, Fundy National Park, Alma NB
[2] Department of Biology, Memorial University of Newfoundland, St. John's NL
[3] Department of Biology, Concordia University, Montreal PQ

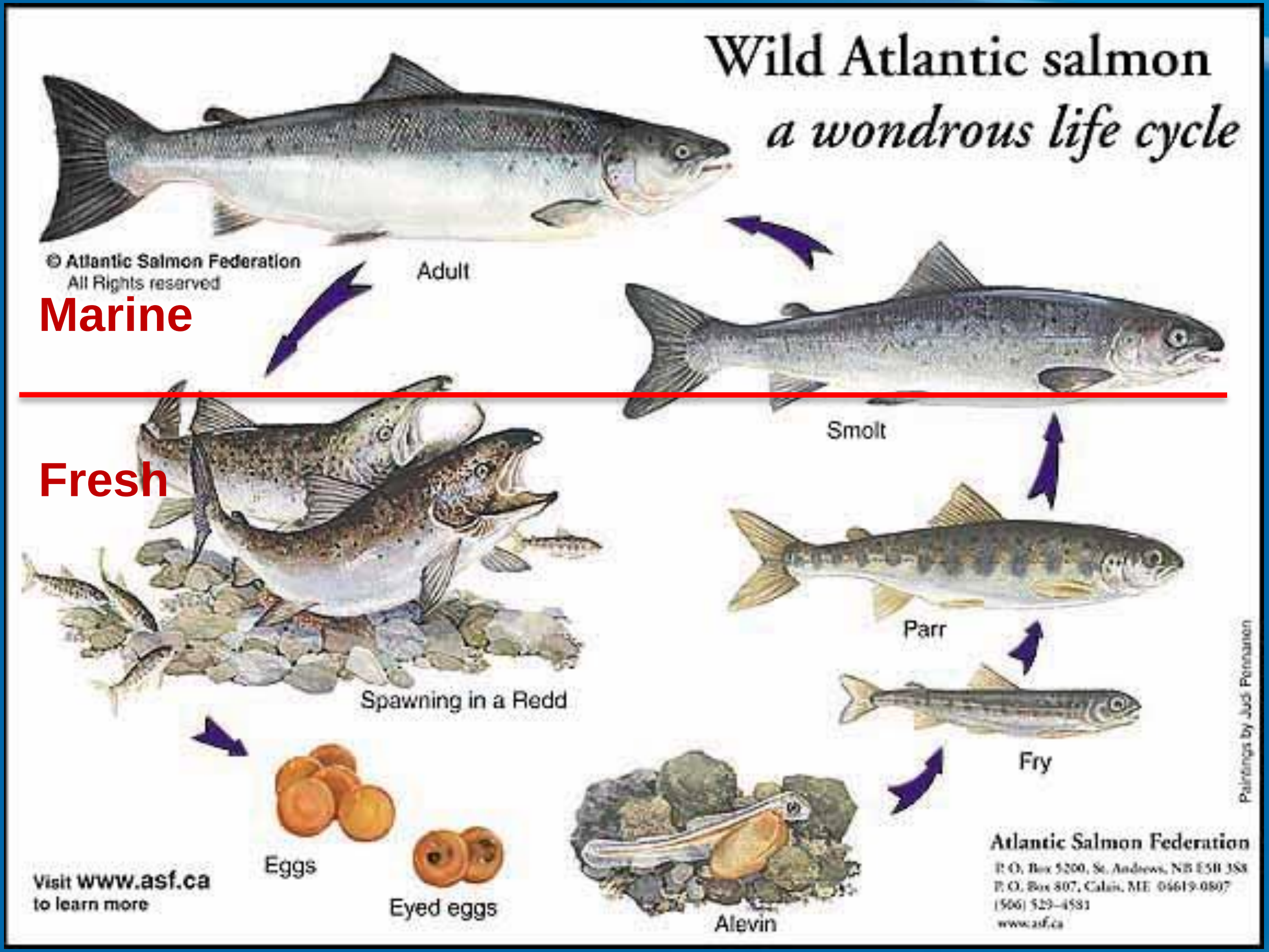
Atl. Canada – NB - FNP Rivers





Bringing you Canada's natural and historic treasures

Why are IboF Salmon Endangered?



- Historic returns of more than 40,000 have been reduced to as few as 250

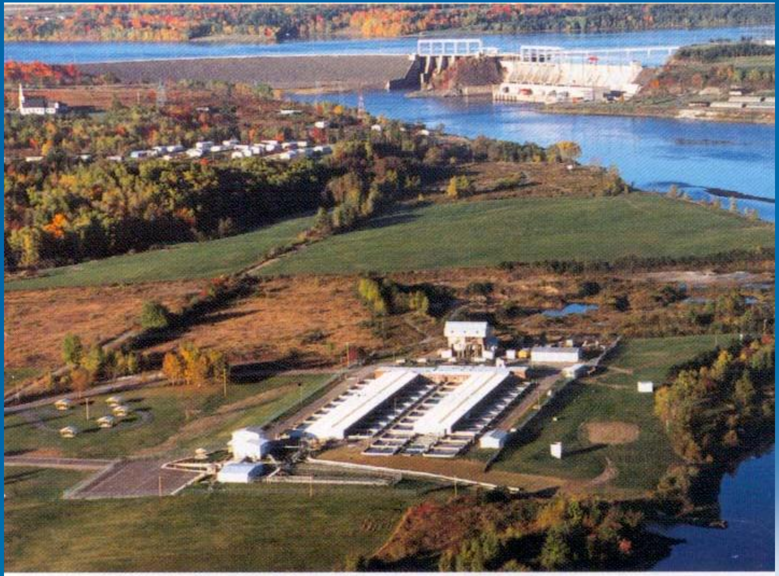
Marine survival considered to be most limiting recovery.

Assessed as Endangered by COSEWIC in 2001

2001- 2003 assessment of FNP stocks

Conclusions from ‘01-’03 Assessment of FNP rivers:
- **Juv. density declining**
- **Insufficient returns to recover**
- **Genetic diversity concern**

ACTION:
Capture remnant families,
Live Gene Bank (LGB),
release @ various stages



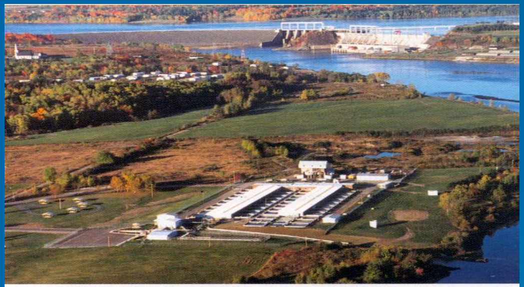
DFO MACTAQUAC “LGB”

Adaptive program in ‘re-circ’ by 2006

Collect As Smolt

Adult or Juvenile Releases

Captive Rear



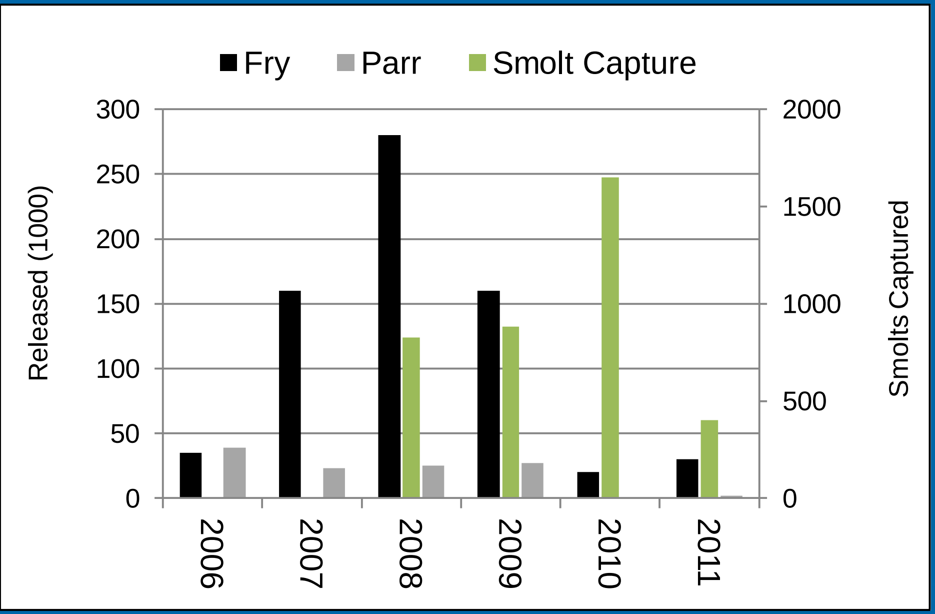
DFO LGB

Release & Smolt capture History

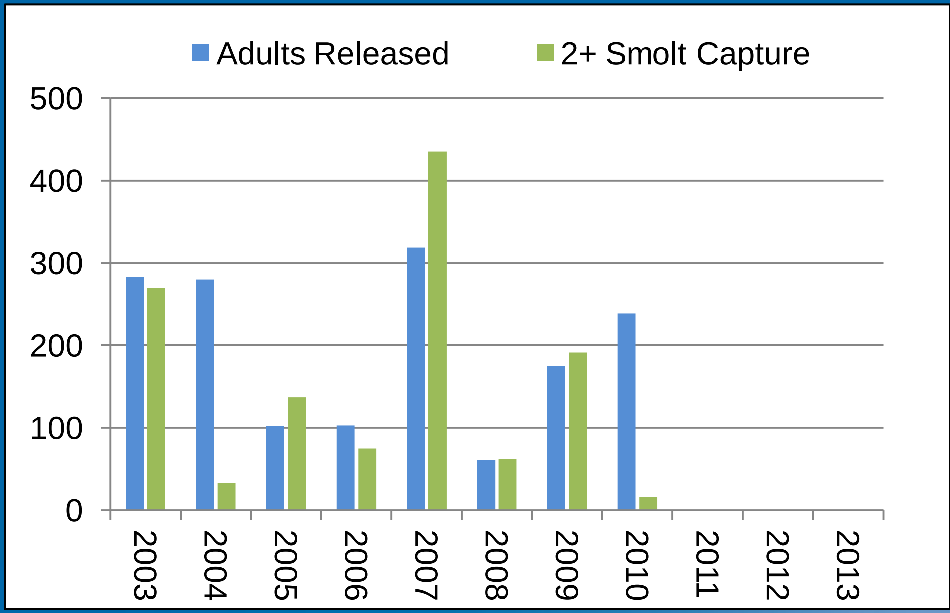
- 2,562 adults released since 2003 (Avg.=256/yr)
- 791,000 fry and 132,000 parr released since 2006 (113k & 19k/yr)

Smolt migrations tracked previous releases reasonably

Upper Salmon River

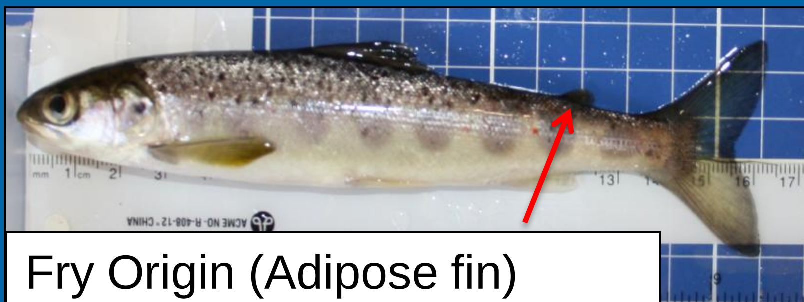


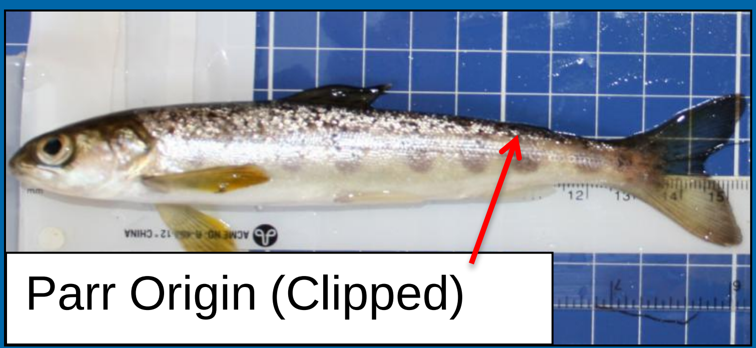
Point Wolfe River

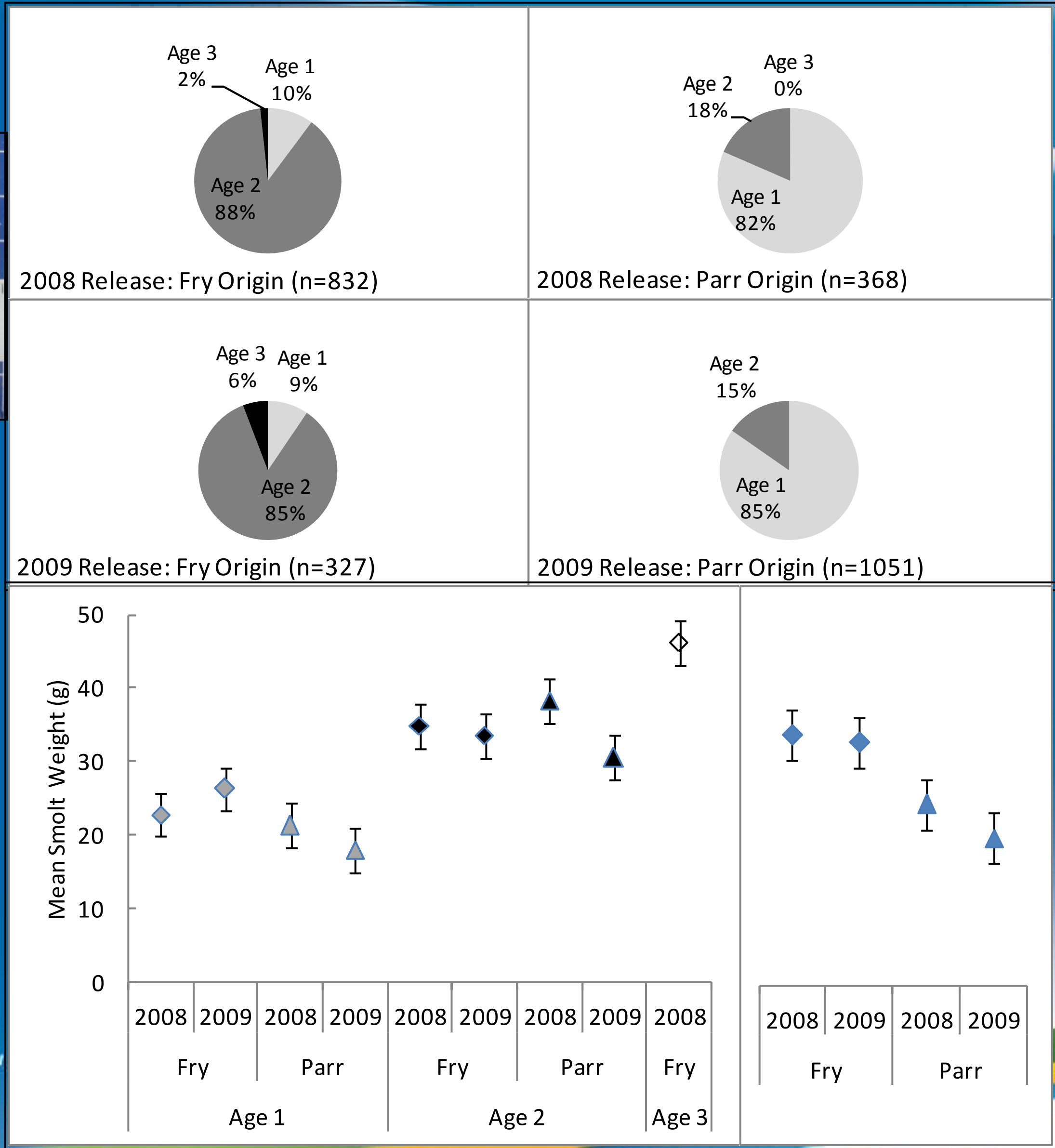


USR strategies produced different smolts:

Did that matter later in life or in next generation?



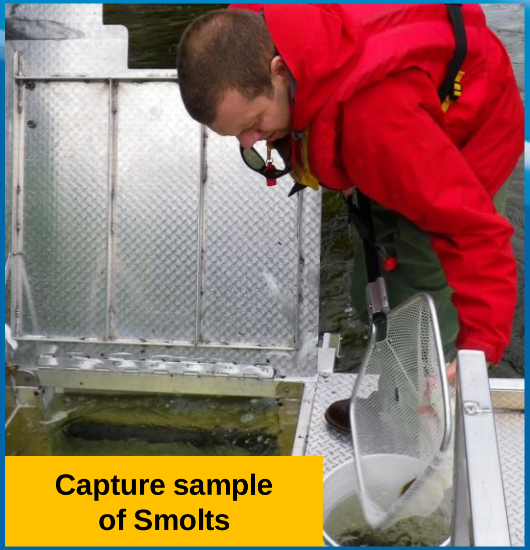




If smolts were different, which were best?


Release: Fry & Parr

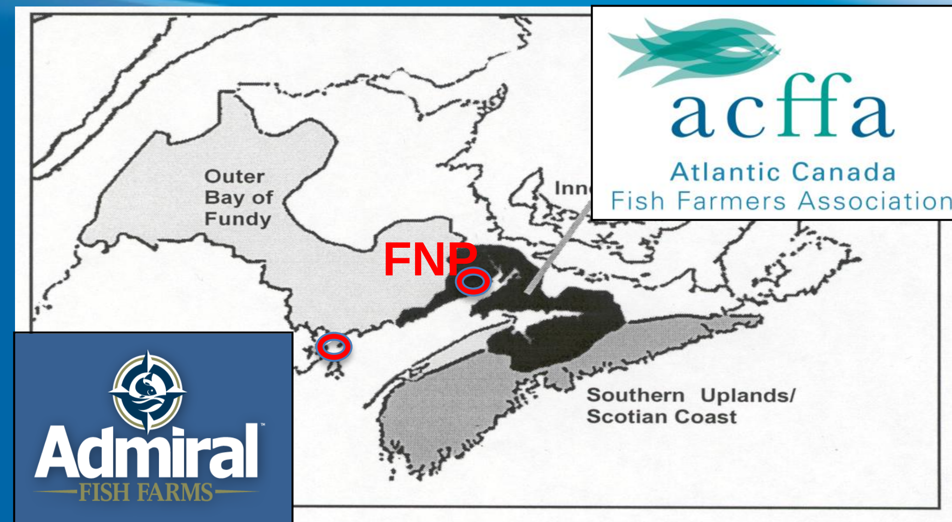
1-4yrs later


Capture sample of Smolts


~0 return from sea

Similar survival in hatchery

Rearing smolts in Bay of Fundy



-To gain contrast under current conditions, a proxy marine environment was needed.

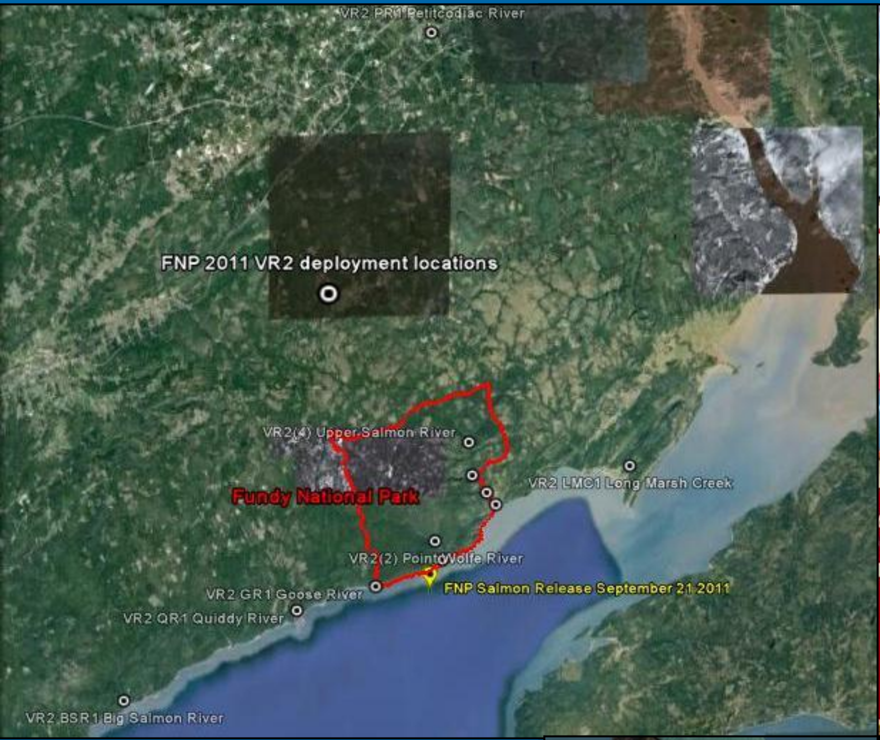
- 2010 USR smolts were reared in BoF sea cages during marine life phase.

18 Months later, at the grilse stage, fish were used in 2 experiments*

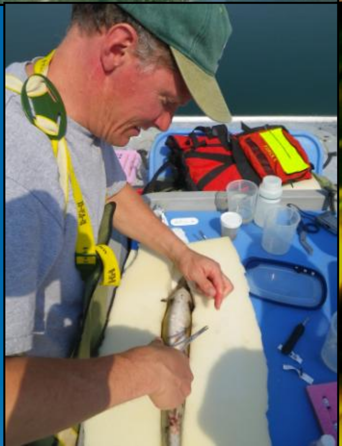
*including only cage reared fish

- 344 fry and parr-origin were tagged and released to IBoF to monitor homing ability
- 100 fry and 100 parr used in spawning experiments to monitor egg viability

Released cage fish to IBoF, 2011
(15km from USR)



- **All Tagged externally**
- **44 Acoustic Tagged**



parkscanada.gc.ca

2011 Adult Return Monitoring

Upper Salmon (Smolt Origin):
Diver Observations
- **5** fish observed
- 4 (5%) Fry & 1 (0.3%) Parr

Acoustic Detections (1st pool & up)
- **6** fish detected
- 3 (14%) Fry & 3 (14%) Parr

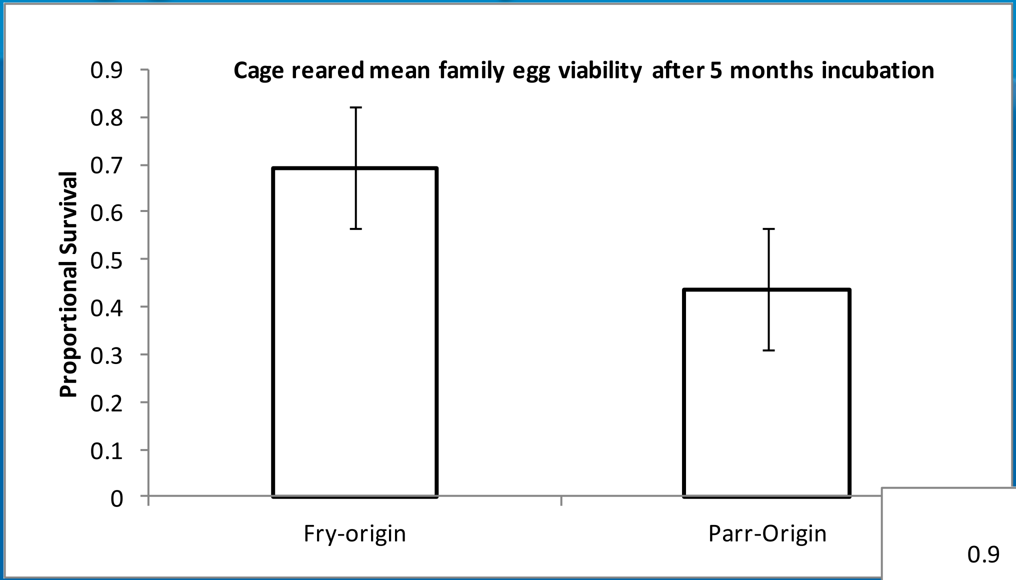
Overall Tracking Observations
- Divers observed:
  - 13 (16%) of the fry
  - 24 (9%) of the parr in 3 rivers
- 10 acoustic stations around BoF detected:
  - 17 acoustic tags from Fry (38%)
  - 16 acoustic tags from Parr (36%)
- Notable 2011 detections included:
  - New Minas Basin
  - Petticodiac River
  - Mactaquac Hatchery

Spawning Fry & Parr – origin parents

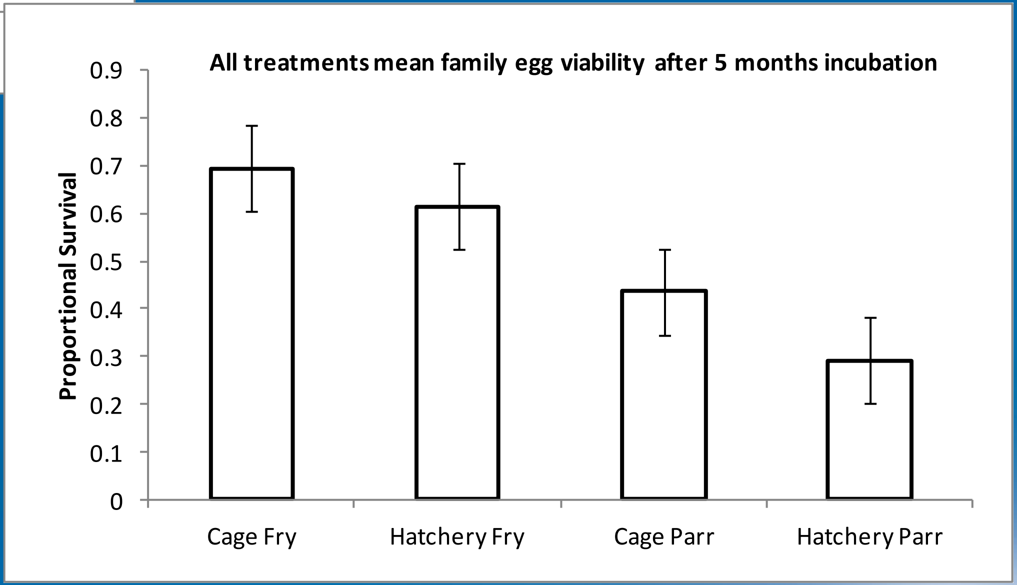
14 crosses of Fry parents
9 crosses of Parr parents

Viability recorded weekly for 5 months

Egg Viability Results:



Fry releases produced more viable offspring after 5 month incubation



Note:
Comparing hatchery reared post smolts suggests brief change in early conditions had greater effect on viability than 18 mo. post-smolt phase.

Low number of crosses and comparable parents in hatchery group

In addition to valuable data

- Parks Canada CEO Award for excellence in engaging partners
- Featured in:
  - Newspapers (cover of TJ Sept ‘12)
  - Specialty TV channels
  - ASF Journal Article (Spring ’13)
  - TV news
  - PCA communication products

Spawning experiment fish released to USR in fall 2011

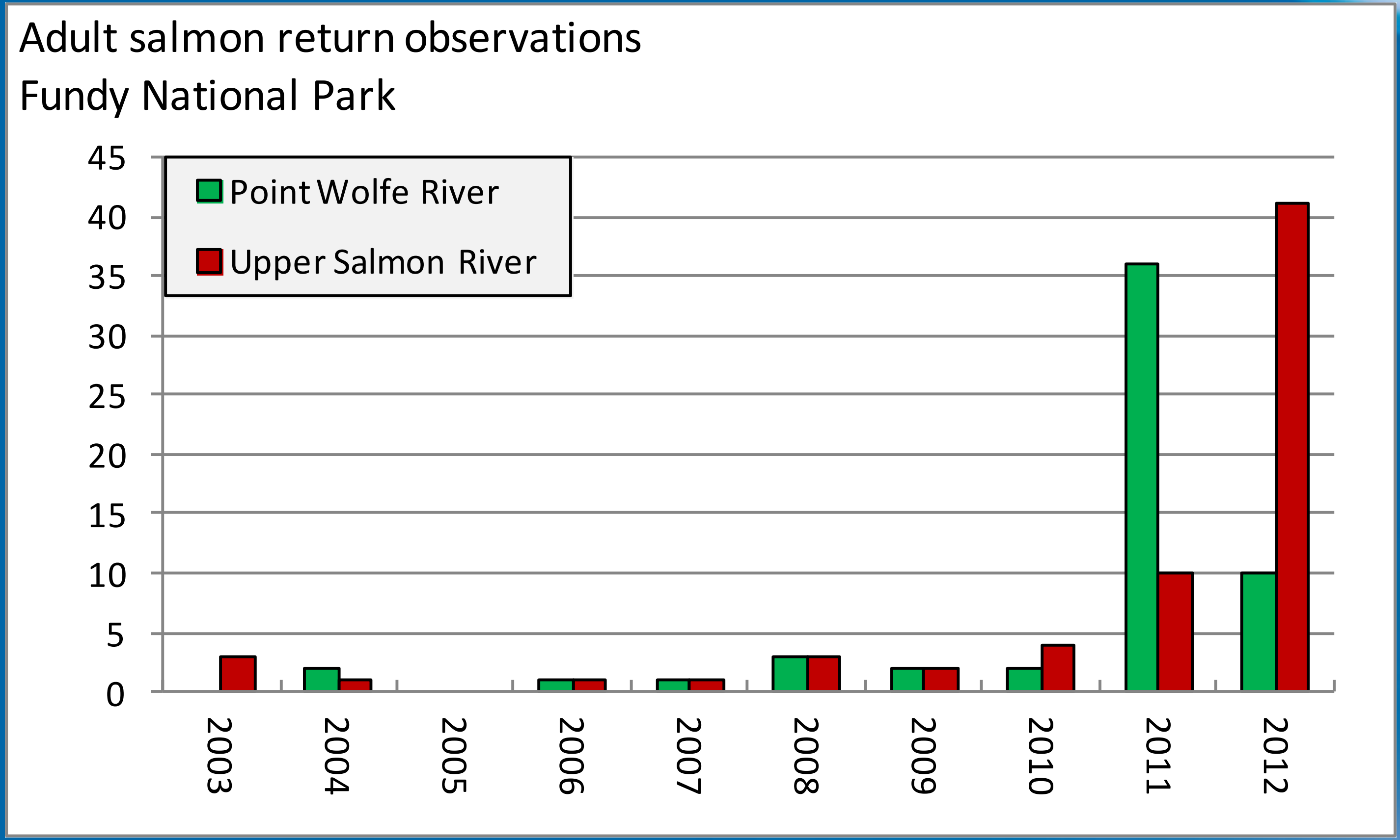
Slide pool on USR in 2012

2012 USR Returns, a >20yr high!

42 observed returns.
Of 188 Cage and 70 Hatchery rel:
-11% of Cage (13% Fry, 9% Parr)
-4% of Hatchery (7% Fry, 2% Parr)

Adult Returns to FNP…

…hopefully more than a flicker



Recovery program design considerations…

- Consider..
  - ..effects on population vary with life stage (early time ≠ later time)
  - ...adult releases produce smolt with ONLY wild exposure from natural mating pairs
  - ..naturalizing captive environments seems worthwhile
  - ..release volumes near natural levels for most realistic response

IF
the marine phase is limiting recovery,
AND
exposure during early life has significant effects on lifetime fitness,
THEN
perhaps an ideal program would intervene only during marine stages

parkscanada.gc.ca

Partners/Collaborators have been key to program achievements

acffa
Atlantic Canada Fish Farmers Association

Admiral
FISH FARMS

Fisheries and Oceans Canada | Pêches et Océans Canada

MEMORIAL UNIVERSITY

Atlantic Salmon Federation
Fédération du Saumon Atlantique

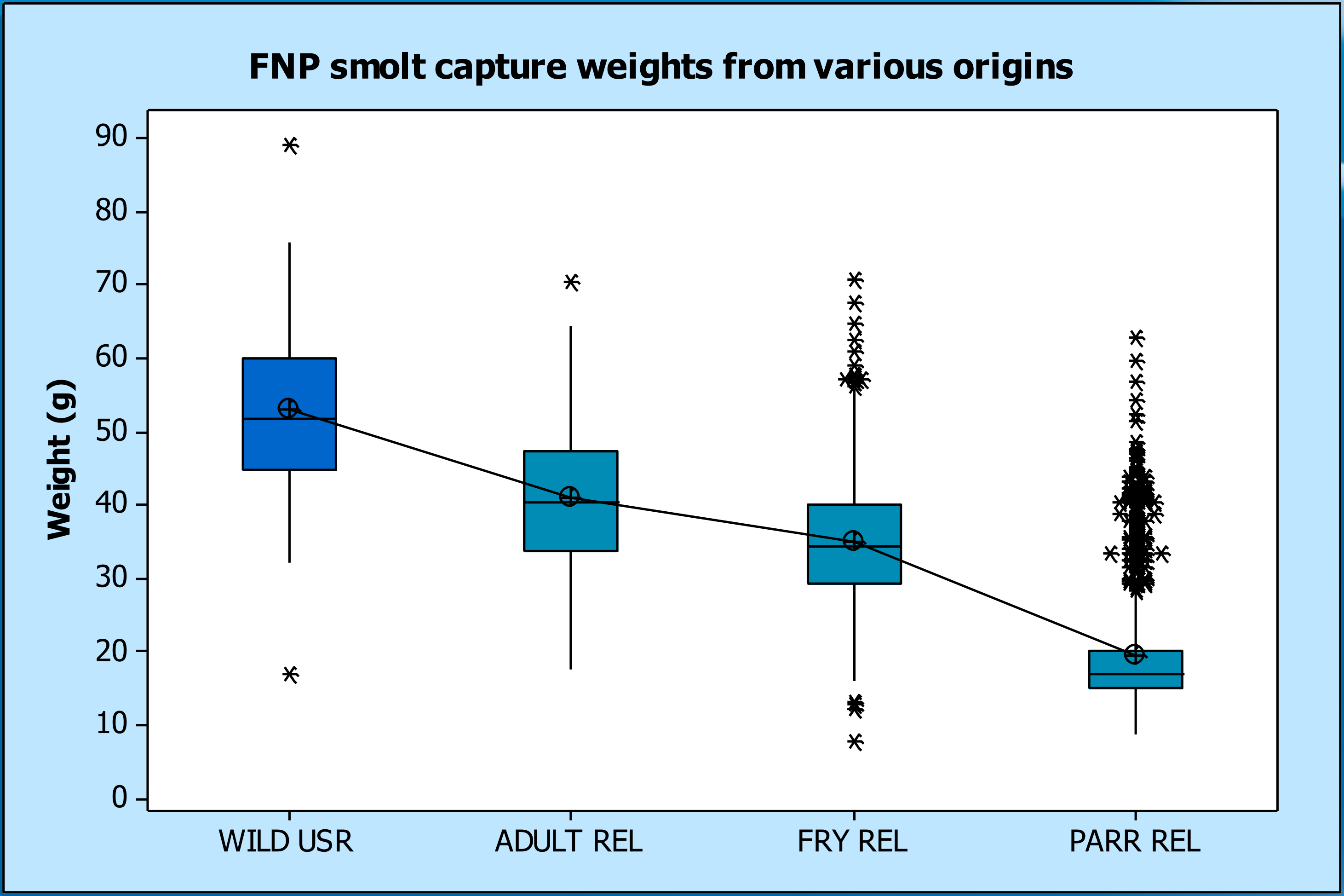
UNIVERSITÉ Concordia UNIVERSITY

Inner Bay of Fundy Atlantic Salmon
Fort Folly Habitat Recovery

OCEAN
TRACKING NETWORK
Headquartered at Dalhousie University, Canada


NB
Inner Bay of Fundy
NS

Smolt size declines with captive exposure?

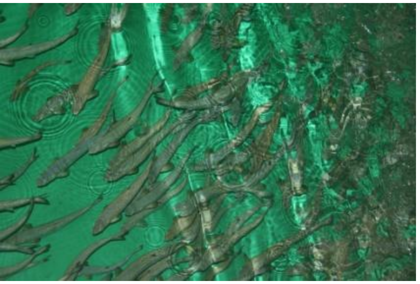


Additional considerations

- Until Population Collapse
  - 1 Adult =
    - 20 smolts (@ 5% survival at sea)
    - 1000 fry (@ 2% survival to smolt)
- After Collapse:
  - 1 Adult =
    - 1000 smolts
    - 50,000 fry (@ 2% survival to smolt)

As smolt, fry-origin have double survival of parr but 1/5 that of wild

Current FRY Program Output Examined



- Average output 100k fry (2k smolt /yr)
- Production equivalent to ~30 spawnings
- 30 Spawning = <10% of natural levels (600+ rtns)
- 30 spawnings require ~30-females + X males.

In 2012, We had 30 females and 8 males return to the USR by August from adult releases.

parkscanada.gc.ca

“Naturalized” Exposure??

QUESTIONS or COMMENTS?

DALHOUSIE UNIVERSITY
Inspiring Minds

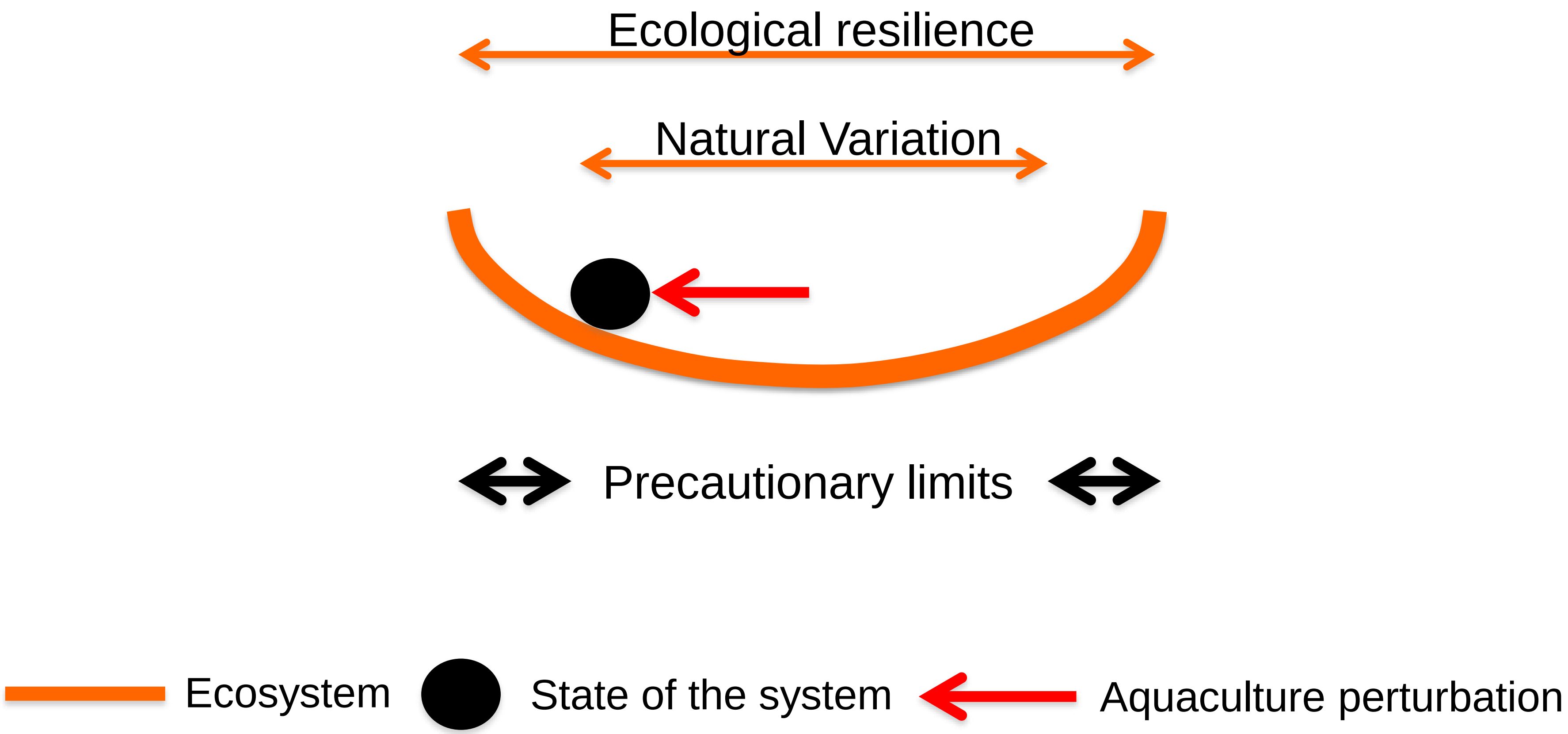
Monitoring aquaculture ecosystems: progress and evolution

Jon Grant
Department of Oceanography
jon.grant@dal.ca

Resilience in the context of Aquaculture

Culture capacity criterion

alteration of ecosystem functioning
within the bounds of natural variation
Grant and Filgueira 2011



Sustainability

Activity does not change the ecosystem
(easier said than measured)

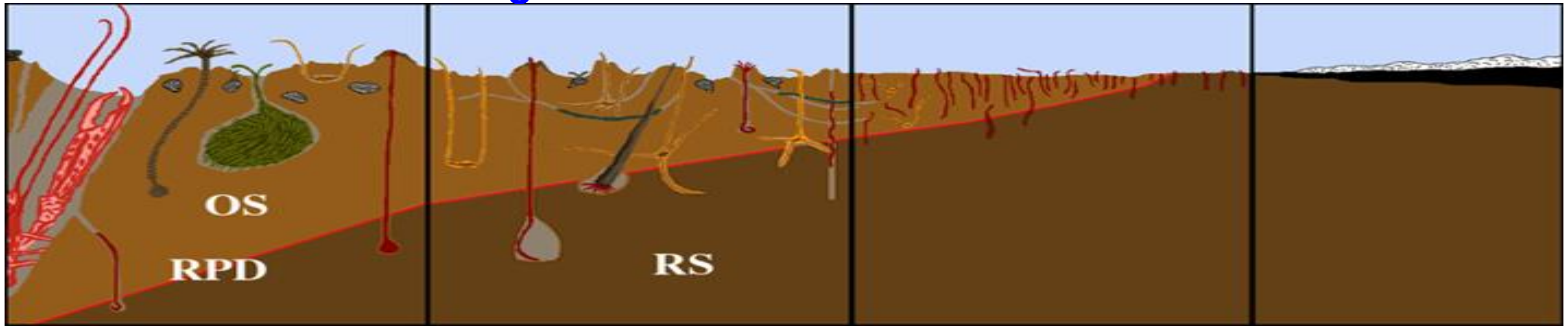
Need 2 things:

- Environmental quality objective

- Thresholds = acceptable limits

Universal: oxygen is good

Pearson-Rosenberg model of benthic disturbance & succession

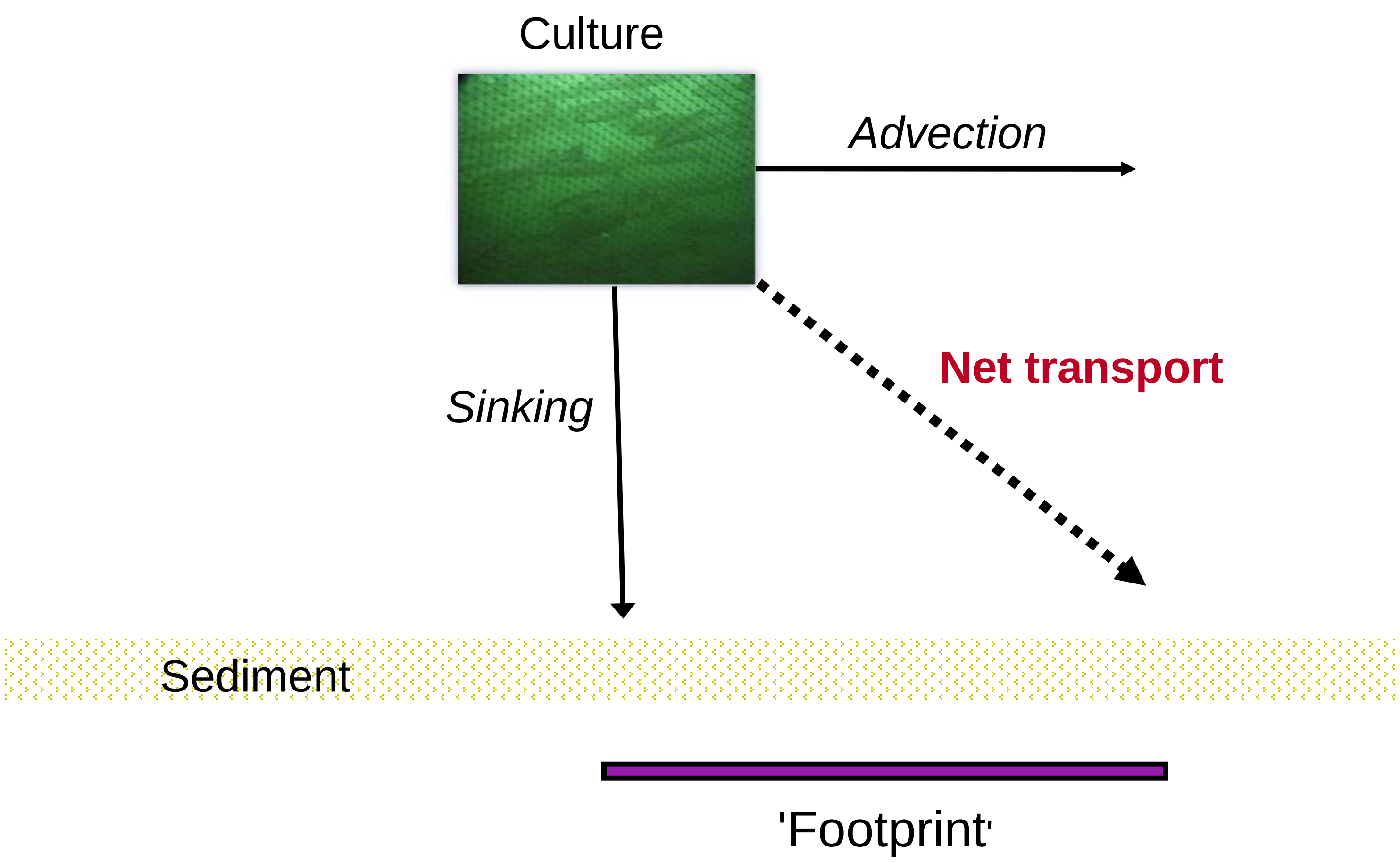


Organic input stimulates oxygen consumption, exceeding oxygen renewal, leading to anoxic conditions

<u>4 Effects:</u>
Different fauna
Elevated sulfides
Reducing sediments (black color)
White sulfur bacteria

Near-field and far-field locations

Near-field monitoring: biodeposition

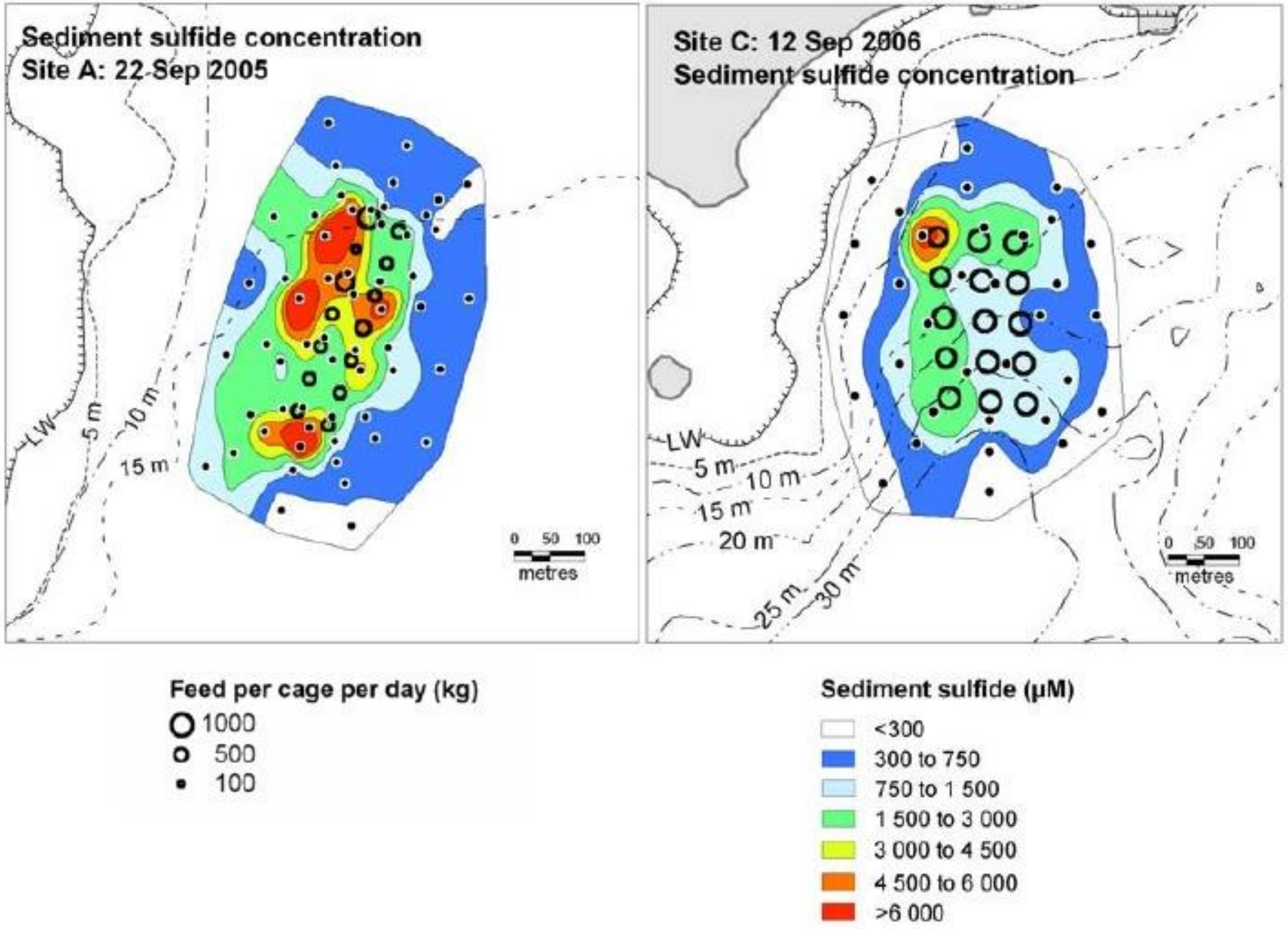


Status quo:

Near-field monitoring
Variables such as sulfides
Regulatory (sustainability?) criteria

Conundrum:

Far-field criteria unlikely to ‘fail’ due to lack of ecosystem-level effects
Therefore if near-field fails, are there ecosystem implications?
Are we using the right variables?



Sulfide can't travel

Figure 4. Contour plots of sediment sulfide concentrations on the seafloor under 2 salmon aquaculture sites (A and C). Black circles represent cages, with circle sizes representing the feed rate.

DFO CSAS Rep. 2012/042

GESAMP (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP Joint Group of Experts on Scientific Aspects of Marine Environmental Protection) 2008. Assessment and communication of environmental risks in coastal aquaculture. Rome, FAO. *Reports and Studies GESAMP* No. 76: 198 pp.

Risk Categories for Aquaculture

Catastrophic:	- irreversible change to ecosystems performance at the faunal-province level or - the extinction of a species or rare habitat.
High:	- high mortality for an affected species or significant changes in the function of an ecosystem. - effects would be expected to occur at the level of a single coastal or oceanic water body. - effects would be felt for a prolonged period after the culture activities stop (greater than the period during which the new species was cultured or three generations of the wild species, whichever is the lesser time period). - changes would not be amenable to control or mitigation.
Moderate:	- changes in ecosystem performance or species performance at a regional or subpopulation level, but they would not be expected to affect whole ecosystems. - changes associated with these risks would be reversible. - change that has a moderately protracted consequence. - changes may be amenable to control or mitigation at a significant cost or their effects may be temporary.
Low:	- changes are expected to affect the environment and species at a local level but would be expected to have a negligible effect at the regional or ecosystem level. - changes that would be amenable to control or mitigation. - effects would be of a temporary nature.
Negligible:	- changes expected to be localised to the production site and to be of a transitory nature. - changes are readily amenable to control or mitigation.

Should we abandon near-field monitoring?
No, alternatives not developed

Should we move away from sulfide?
Probably; data not meaningful away from sites

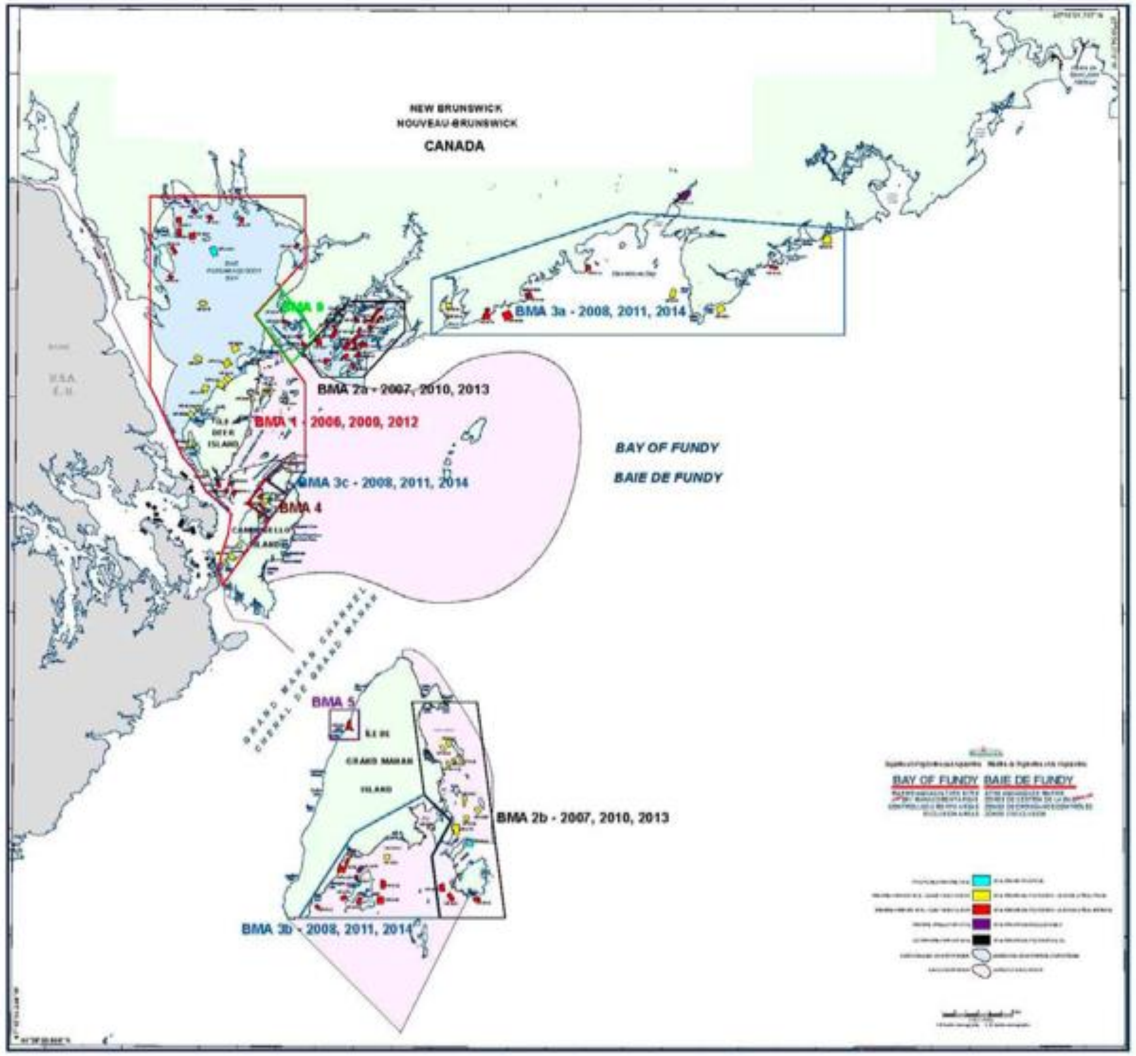
Prefer mapping technique with fewer analytical issues
Rapid turnover of data
Include multiple criteria
Potential to map far field

Alternative far-field approach
Ecosystem models
Predictive rather than reactive

Sediment profile imaging: benthic community assessment

15 cm

Bay management areas SWNB



Ecological modelling in aquaculture sites. Why?

Scenario building, prediction and optimization

How can science help farmers?

<u>Management strategies</u>

Growth predictions

Disease transmission

<u>Farm location</u>

Where and how big?

Culture density

How can science help regulators?

<u>Ecosystem-based management</u>

Impacts in the far- and near-field

Mitigation alternatives

Decision support systems

Marine spatial planning

Management and regulatory targets for fish farming

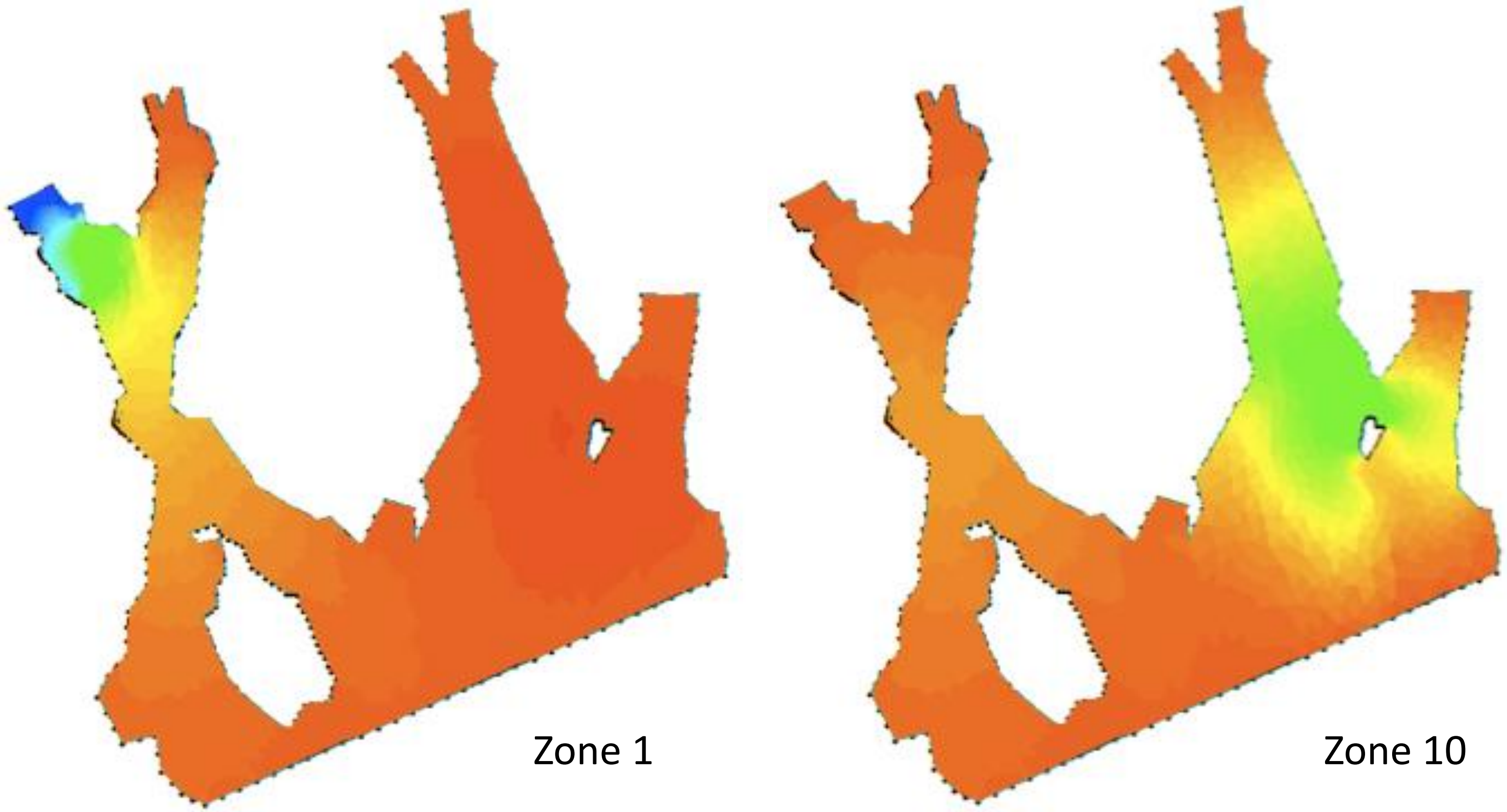
Benthic impacts

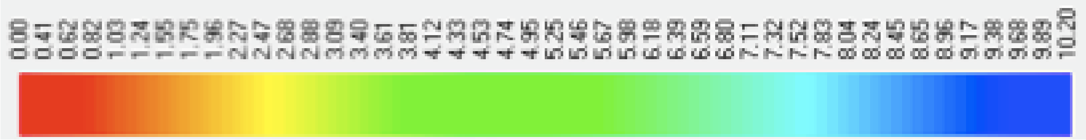
Disease

Nutrification (ammonia)

Habitat overlap with fisheries etc.

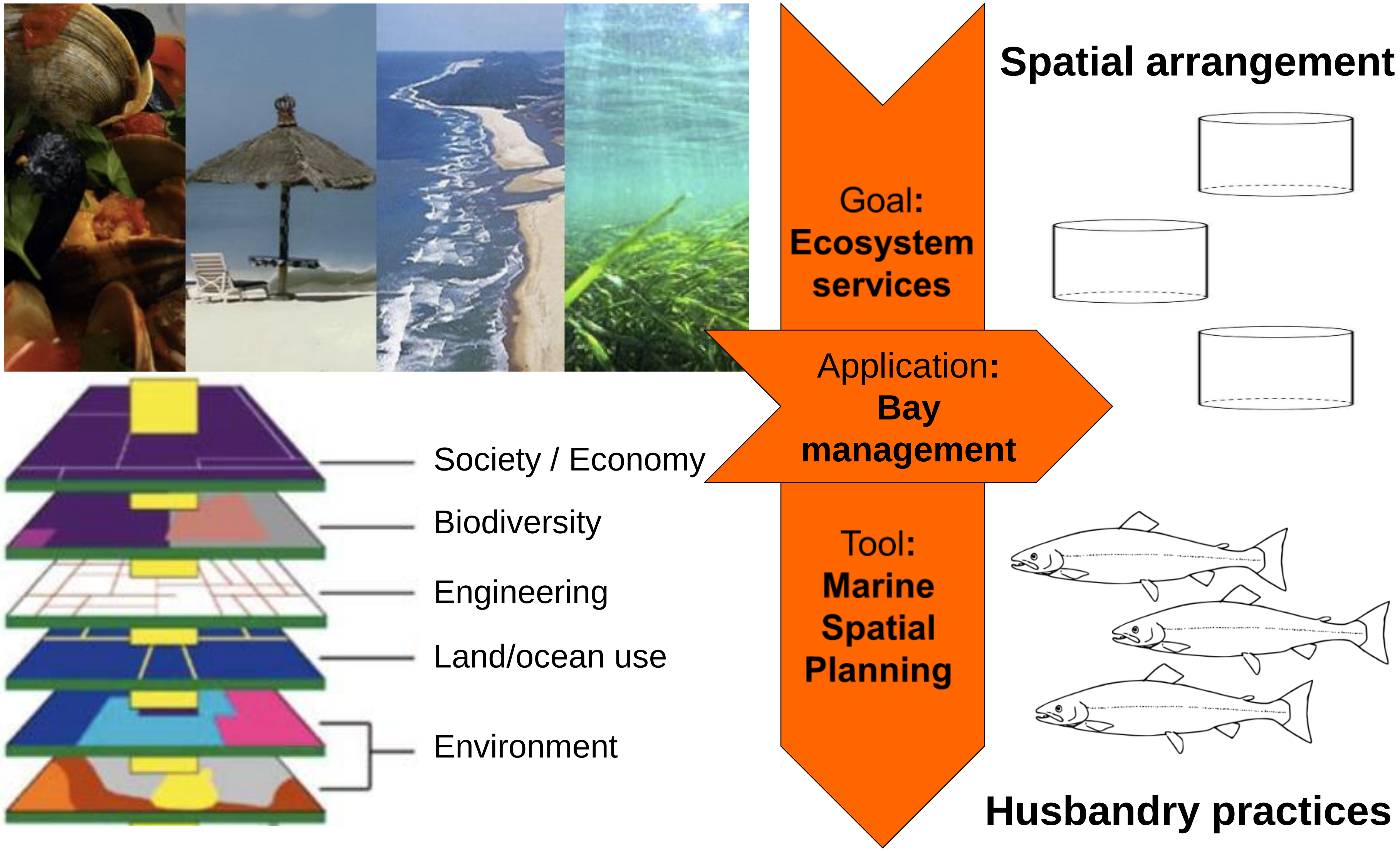
Conservative tracer results





Conservative Tracer Concentration

Sustainability framework



Offshore Aquaculture: Truth or Dare

Terry Drost

ACFFA Annual Workshop and Research Review

November 6, 2013

Huntsman Marine Science Center

St. Andrews, NB

www.4links.ca

four links MARKETING

Truth

- **72%** of the Earth's surface is covered by saltwater
- **97.2%** of the Earth's water is saltwater
- Only **0.65%** of the Earth's water is found in Rivers, lakes, ground and air

Truth

Truth

- The coastal zone is the area where the land meets the sea
- The coastal zone includes land within 150 kms from the sea
- 44% of the world's population lives within the coastal zone

Truth

- Water quality, both freshwater and saltwater, crucial to survival, growth and health
- Industrial Activity
- Human Activity
- Global changes in weather patterns

Case #1: Turkey

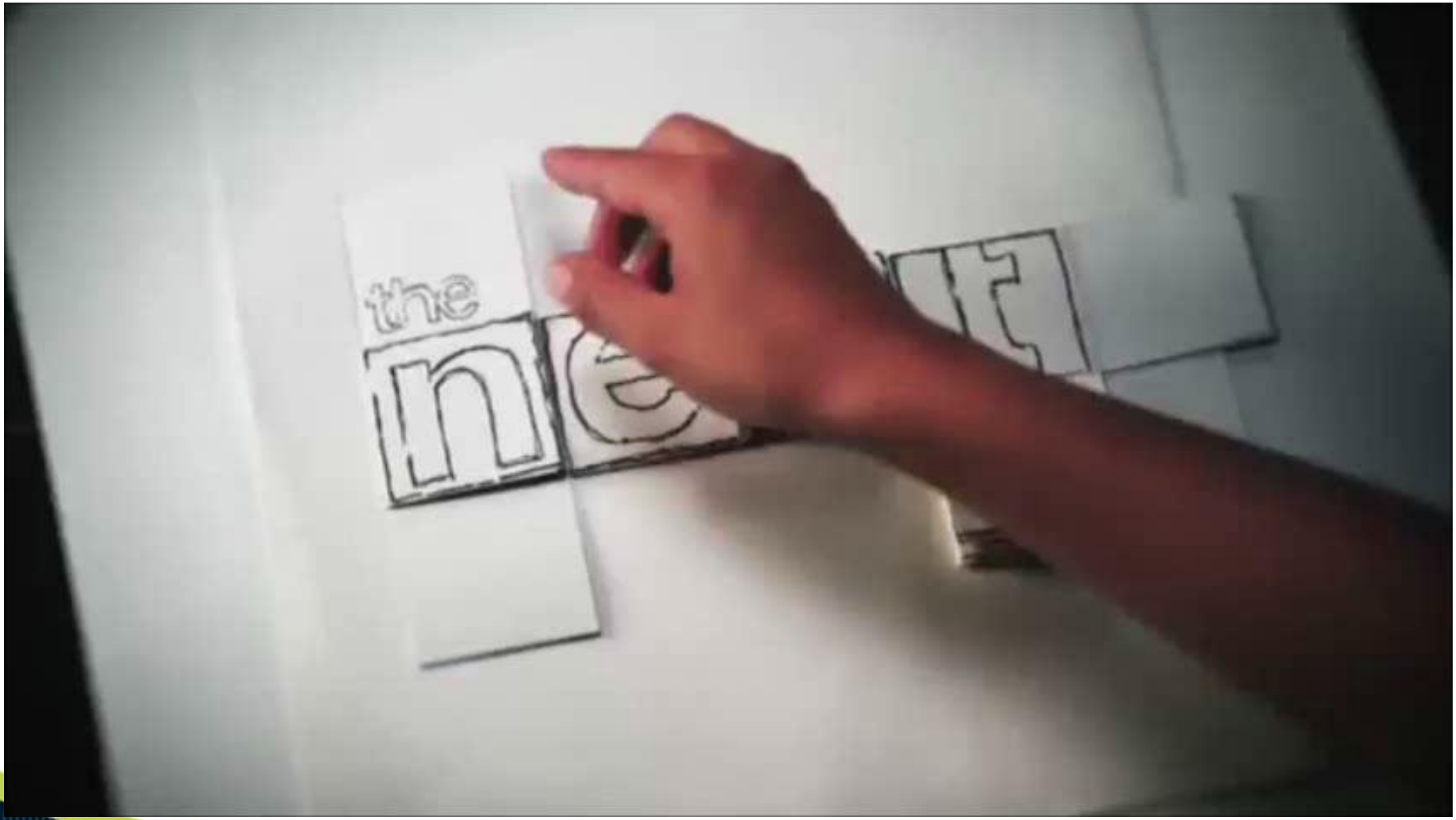
four links
MARKETING

Old World

four links
MARKETING

Offshore Aquaculture

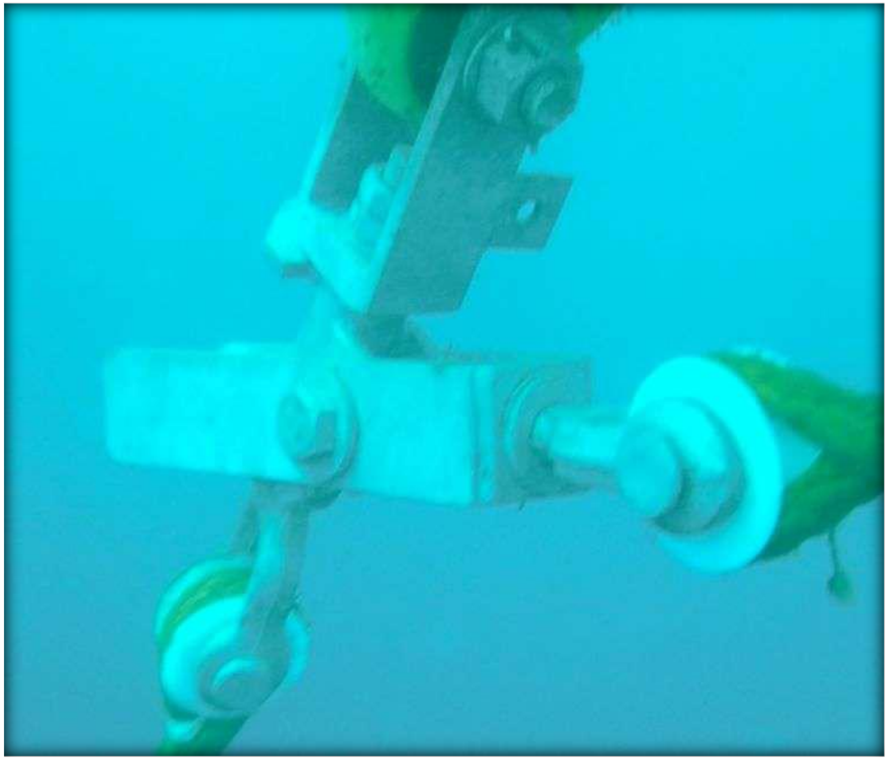
Case #2 Cobia in Panama



Case #3 Atlantic Salmon

four links MARKETING

Dare: Moorings



four links MARKETING

Dare: Cages

four links MARKETING

Dare: Cages

four links MARKETING

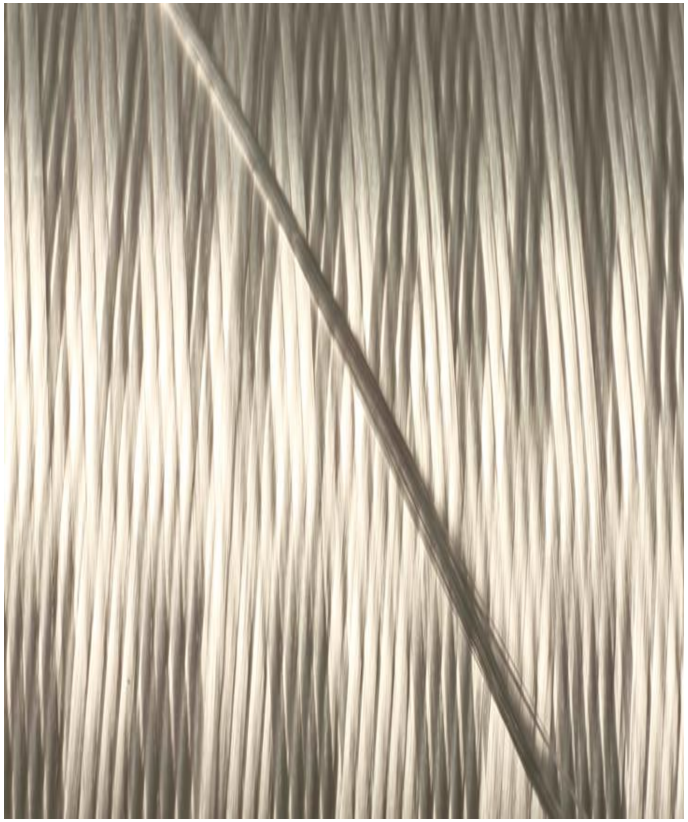
Cages

Dare: Feeding Equipment

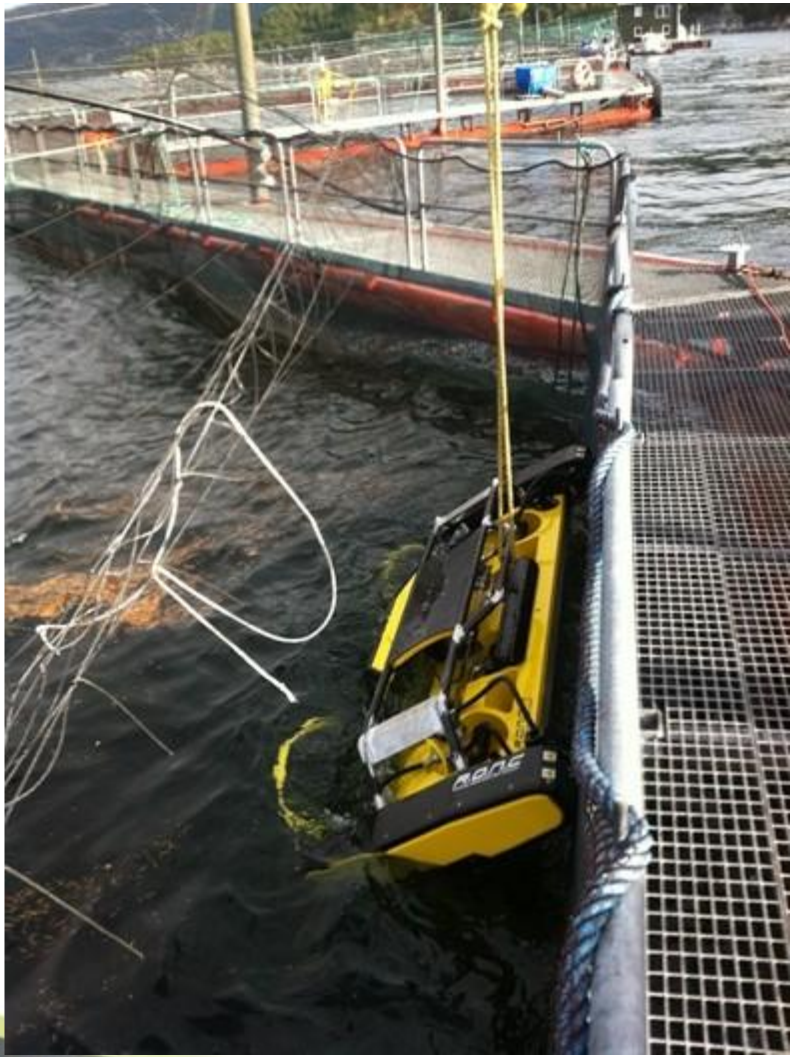
four links
MARKETING

Dare: Feeding Equipment

Dare: Net Management



Dare: Net Management



New World

four links MARKETING

Statistics

Turkey	Canada
780,000 sq km	10,000,000 sq km
75 million people	33 million people
1.3% Freshwater	8.9% Freshwater
79,000 MTs Freshwater Prod.	7,400 MTs Freshwater Prod.
8,000 Km Coastline	243,000 Km Coastline
89,000 MTs Marine Prod.	101,000 MTs Marine Prod.

four links MARKETING

The Future of Food

- 9 billion people by 2050
- Blue Revolution
- Where will it happen?

Thank You

ISA SURVEILLANCE AND CONTROL IN NEW BRUNSWICK

ACFFA WORKSHOP, NOV 2013

Larry Hammell
Professor, Dept of Health Management
Director, AVC Centre for Aquatic Health Sciences

Atlantic Veterinary College,
University of Prince Edward Island
Charlottetown, PE, Canada

Michael Beattie
NBDAAF Chief Veterinarian

Co-Director, OIE Collaborating Centre
Epidemiology & Risk Assessment for
Aquatic Animal Diseases

ISA Surveillance Policy (NB)

- Objective: *minimize the overall economic impact of ISA on the New Brunswick aquaculture industry*
- Legislation is provincial: Province of New Brunswick's ***Aquaculture Act and Regulations***
- Provincial vs Federal: ISA pre-dates National Aquatic Animal Health Program and CFIA involvement

Critical Program Components

- Monitoring and Surveillance Requirements
- Determination of Disease Status
- Reporting and Communication
- Trace in-out within 48 hrs
- Early Detection and Depopulation of Infected Stock
- Compensation for Mandatory Depopulation ?
- Cleaning and Disinfection Guidelines
- Fallowing Requirements
- Technical Expertise and Direction

Critical Changes to Industry Structure since 1997

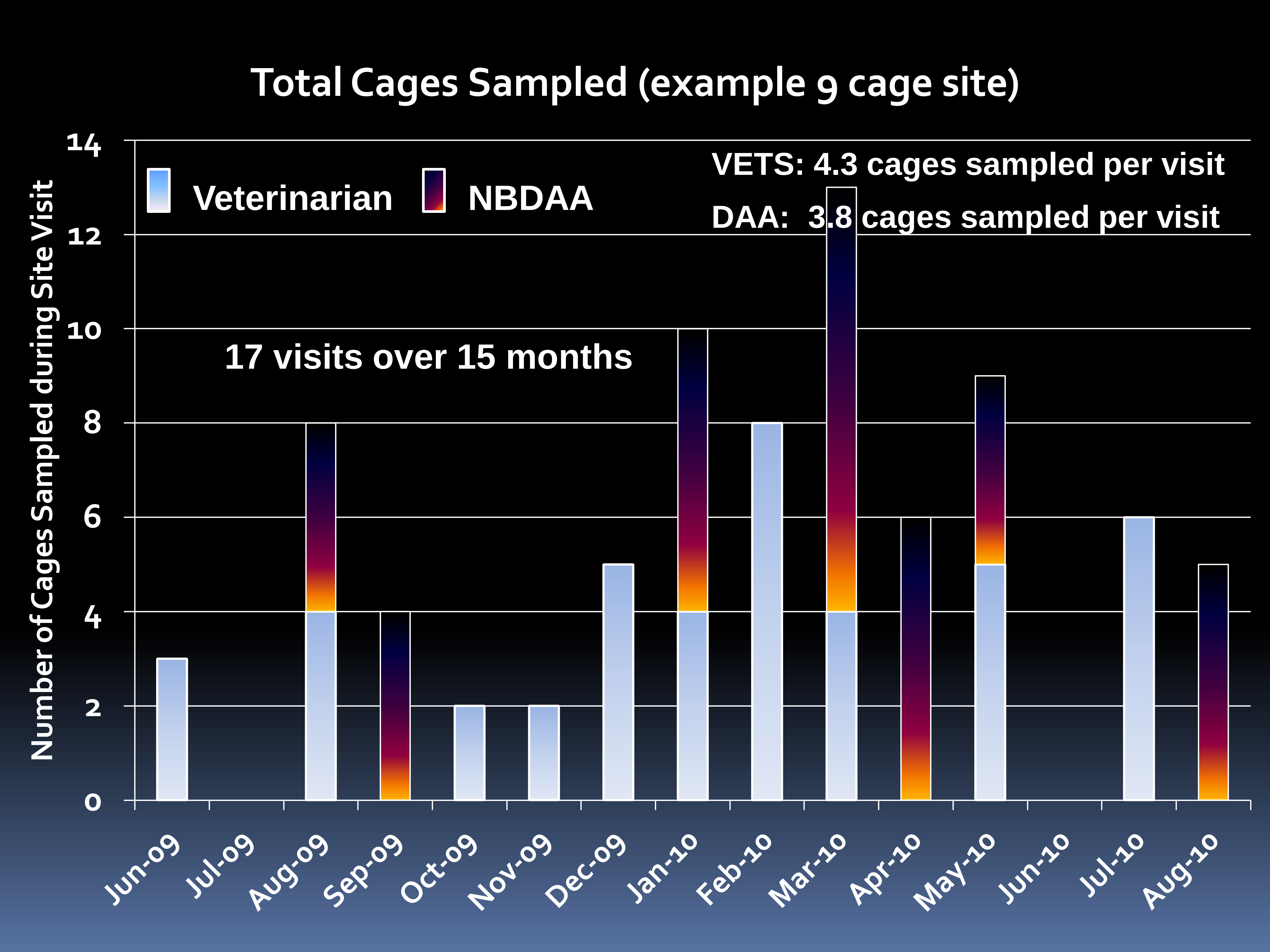
- Overhaul of year class structure within sites and Bay Management Areas
  - Single year class areas with no provision of holdovers
  - year class entry every third calendar year
  - minimum site fallow of four months
  - synchronized bay wide fallow of two months

Critical Changes to Industry Structure since 1997

- Harvest Vessel Certification (annual)
- Hydrographic information utilized
- Equipment Transfer permits
- Site bio-security audits
- Processing plant audits
- Controlled aquaculture areas designation

ISA Surveillance Frequency

- Policy: minimum of once per month visits by private veterinarian
  - Practice is that NBDAA fish health techs also visit sites to relieve timing pressure
  - Actual frequency is 2-6 weeks depending on weather and other constraints
- site operator and private veterinarian must jointly submit a monthly fish health report to NB DAA (*Monthly Fish Health Report*).

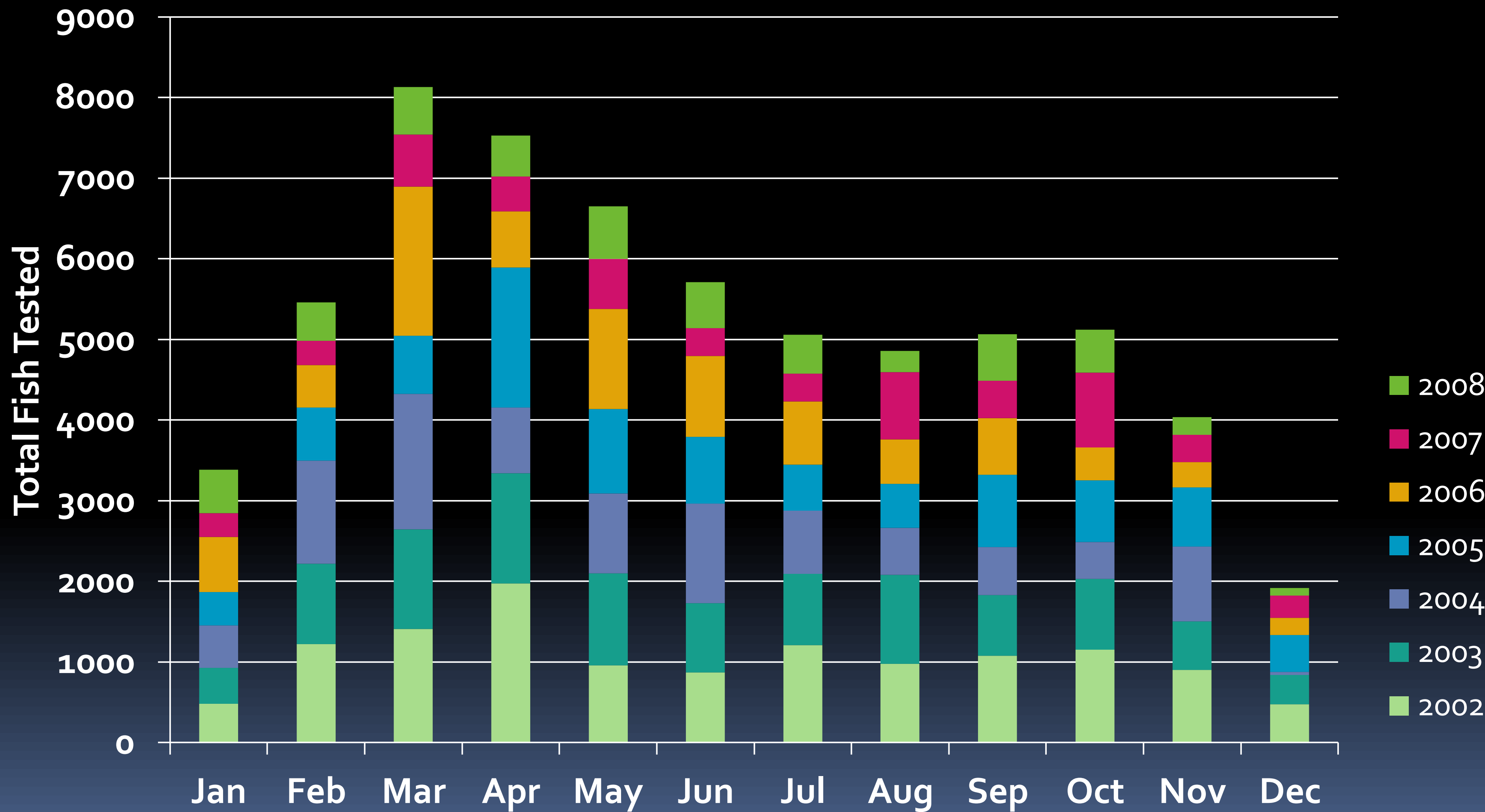


Total Cages Sampled (example 9 cage site)
Veterinarian
NBDAA
VETS: 4.3 cages sampled per visit
DAA: 3.8 cages sampled per visit
17 visits over 15 months
Number of Cages Sampled during Site Visit
0
2
4
6
8
10
12
14
Jun-09
Jul-09
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10

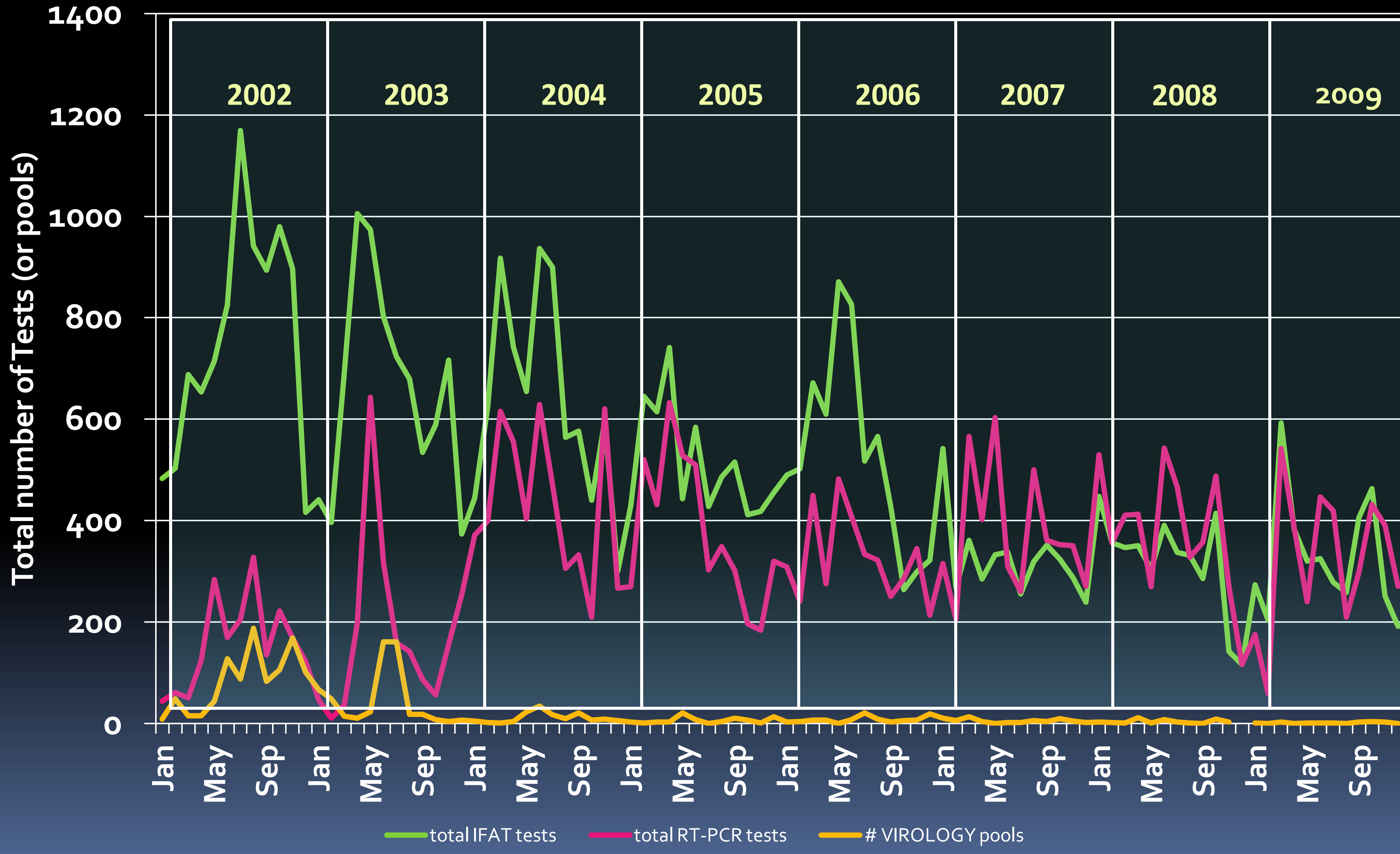
ISA Surveillance - Sampling

- minimum of five (5) moribund or suitable dead fish to a maximum of twenty (20) collected and submitted from each site once every calendar month
- private veterinarian conducts gross post mortem exam on all fish that are sampled
  - If 5 fish sample cannot be achieved, additional sampling may be required at discretion of NB DAA veterinarian

Total Fish Tested, by month
2002-2008, NBDAA, Canada



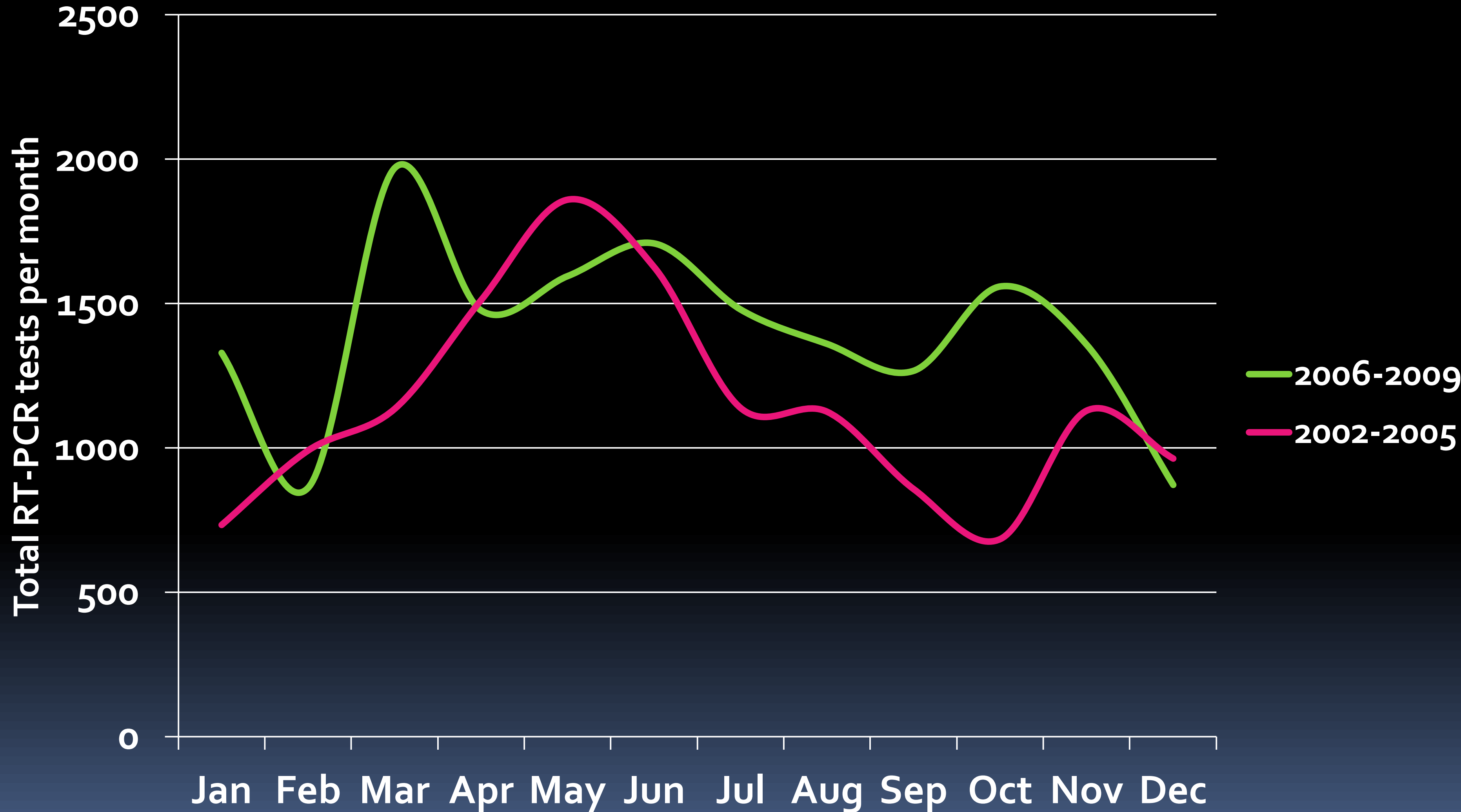
Total Number of Surveillance Tests
2002-2009, NBDAA, Canada



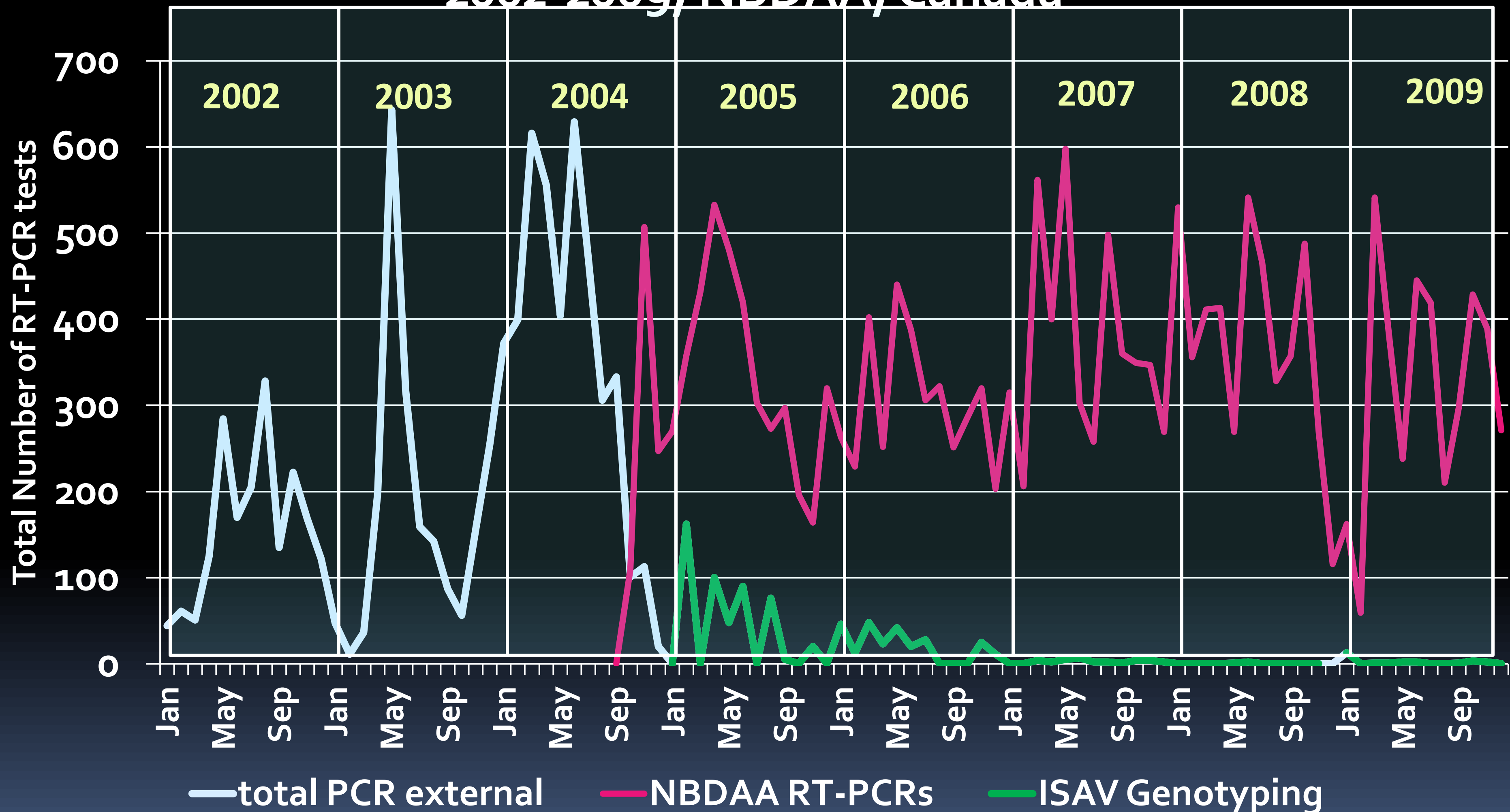
Tests used for ISA surveillance

- Samples routinely screened by both IFAT and PCR (unless otherwise directed by the NB DAA veterinarian)
- Virology (using -80 frozen samples) is done only on suspect cases
- Genotyping is done on all suspect cases

Average Monthly RT-PCR surveillance tests NBDAA, Canada



RT-PCR surveillance (gov vs external) 2002-2009, NBDAA, Canada

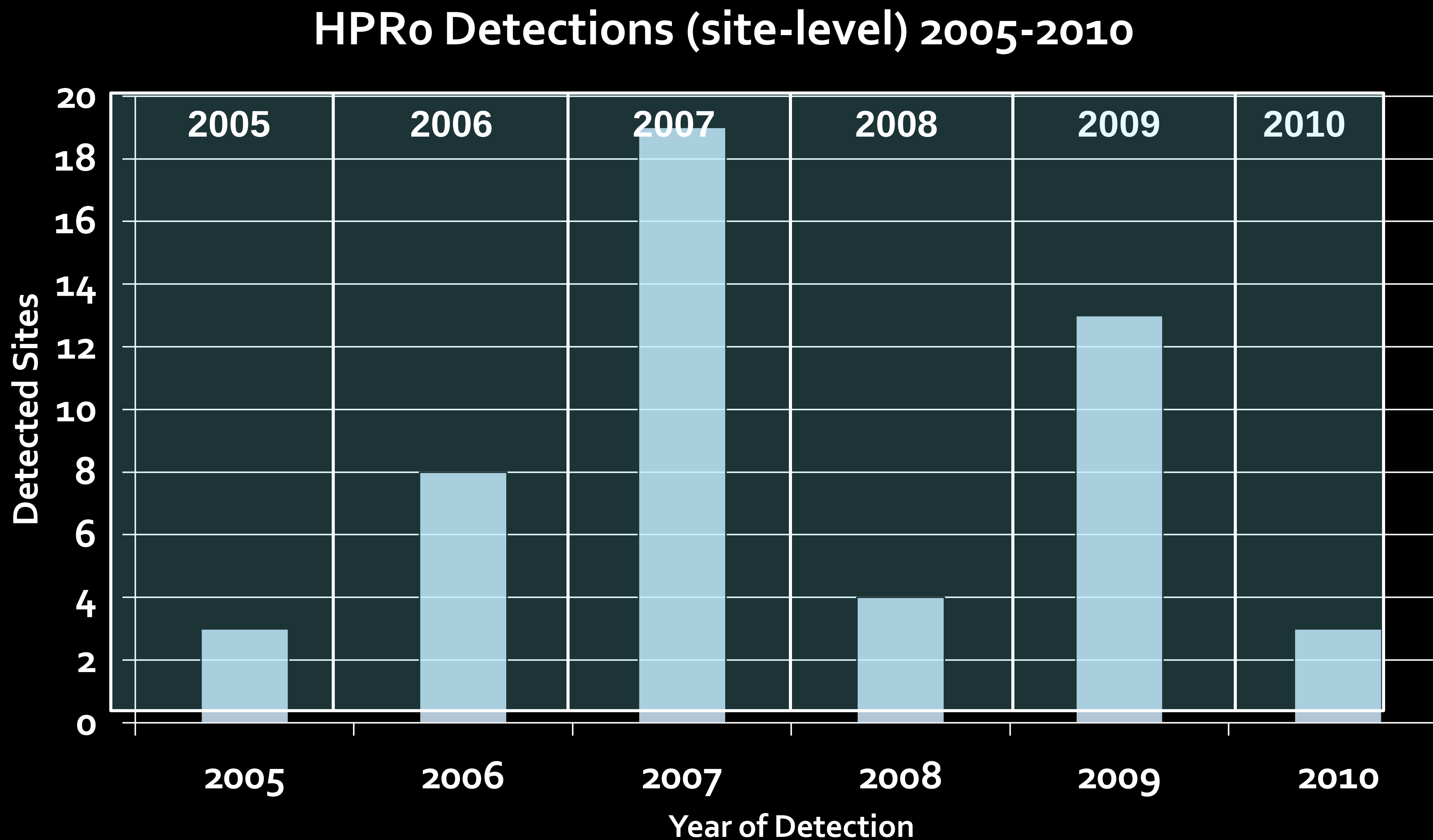


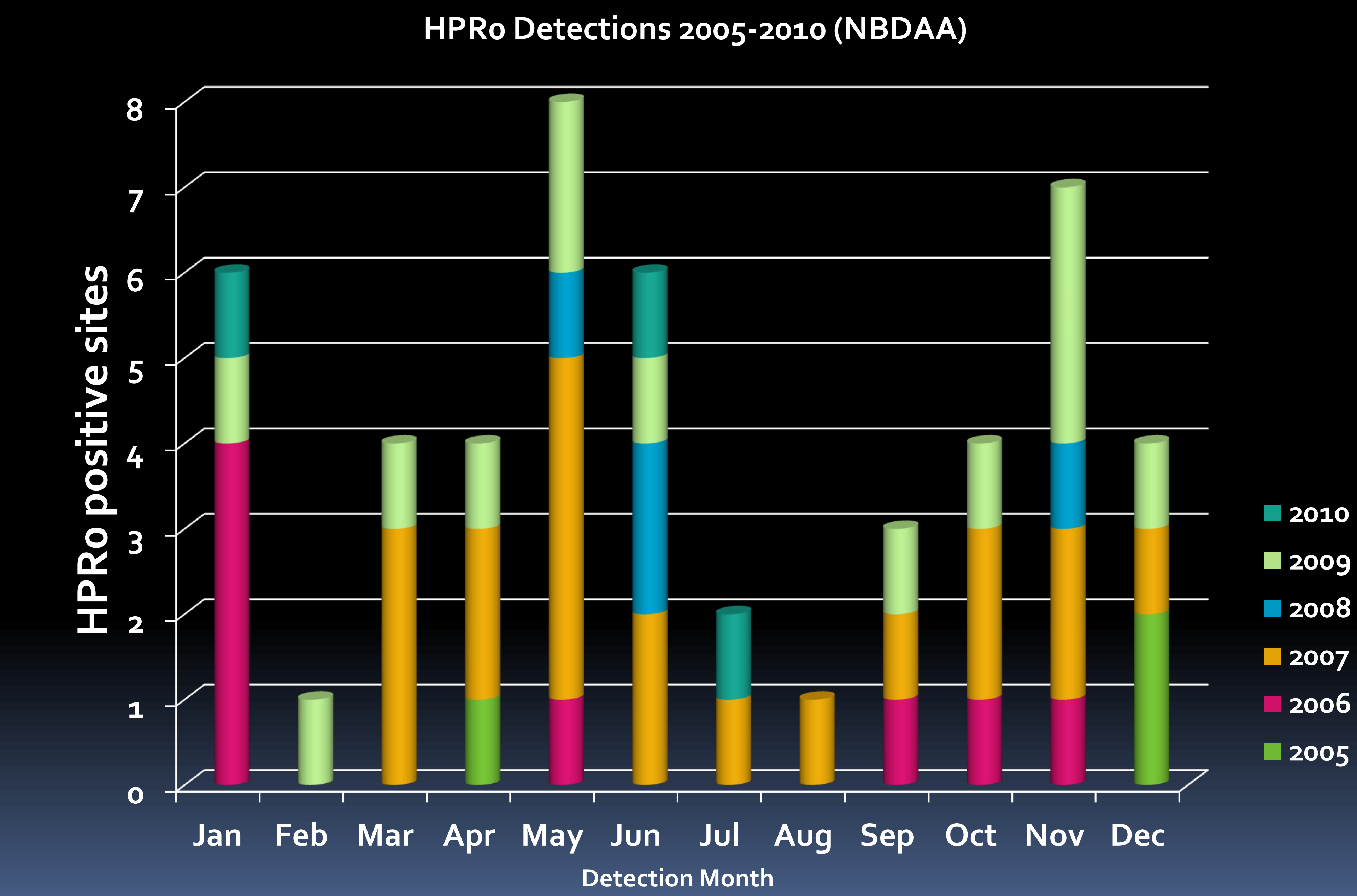
ISAv Review

- 8 single stranded RNA segments in an enveloped virus
  - Seg 6 HPR receptor binding = virulence
  - > 25 strain type variants for Atlantic Canada
    - If fully subscribed = HPRO = avirulence
  - Seg 8 NA vs Euro origin
  - Seg 5 fusion site = virus entry
    - R266 insertion vs no insertion

HPRO Debate

- Evolutionary vs Norwegian theory
  - Norway deletions lead to virulence
  - Steven J Gould additions lead to avirulence
- Faroes 2010   8.1% (35k samples)
- Iceland 2009
- NB 2007


HPRo Detections (site-level) 2005-2010
20
18
16
14
12
10
8
6
4
2
0
Detected Sites
2005
2006
2007
2008
2009
2010
Year of Detection


HPRo Detections 2005-2010 (NBDAA)
HPRo positive sites
0
1
2
3
4
5
6
7
8
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Detection Month
2010
2009
2008
2007
2006
2005

Communication for *infected* ISA pos

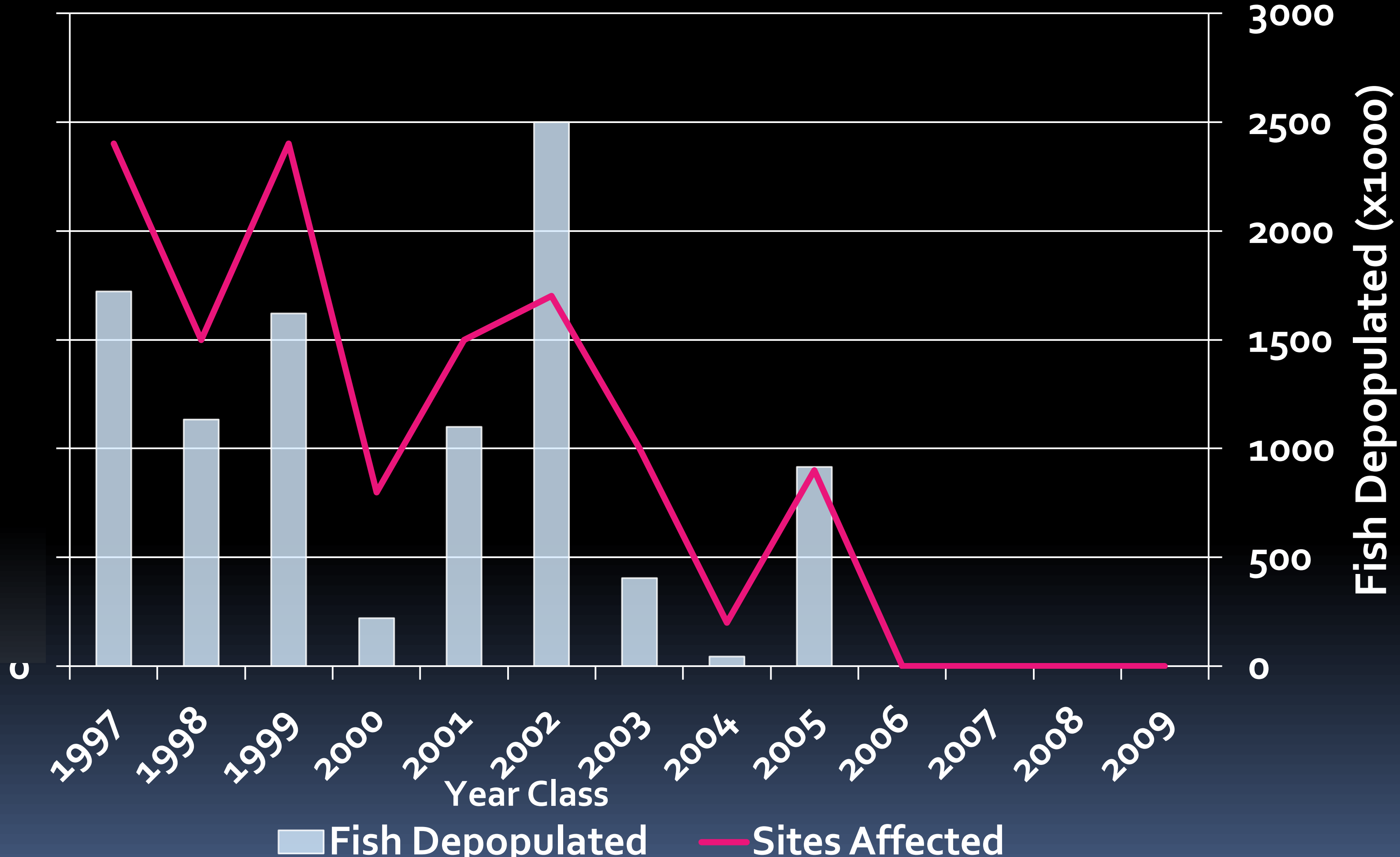
- Within 48 hours of identifying cage as *infected* with ISAv
  - Indicating site and cage that is *infected* and the control actions, including depopulation
- Within 48 hours of receiving notification of an *infected* cage, license holder submits *"Marine Site – Control and Containment Agreement"* to NB DAA veterinarian
- Within 24 hours, all sites notified of detailed depopulation plans

Depopulation of infected cages

- license holder must remove all fish from the cage within seven (7) days

- Harvesting depopulation in a biosecure fashion in accordance with guidelines as set out in the site’s Control and Containment Plan
  - using certified harvest vessel (based on audits)

ISA Positive Sites and Regulated Depopulations (NB, Canada)



Conclusions

- NB ISA cases have decreased to zero starting with 2006 year class
- Major overhaul of the biosecurity measures in industry
- Depopulation was essential and became more practical when identify and not depopulate HPR0
- Living in a silo is unacceptable, regulators must consult with everyone

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ANIMAL HEALTH

Update on Cold Water Ulcer Disease in Canada

ACFFA Annual R&D Workshop, St. Andrews, NB

Nov 7, 2013

EVERY OCEAN. EVERY FISH.™

Agenda

Characterization of the pathogen / disease

Geographic Distribution

Phylogeny

Virulence Factors

Vaccination Trial Results

Conclusion

Moritella viscosa; A significant pathogen of Atlantic Salmon
(1) Characteristics of the pathogen / disease

- *Moritella viscosa* is a psychrotophic gram negative, motile curved or rod shaped bacteria that is the causative agent of winter ulcer disease
- One of the most frequently observed marine bacterial diseases in Norway with increasing incidences in Scotland and Canada
- Winter ulcers often appear during periods of cold water (most common below 10 deg C) and high salinity
- In Canada can be associated with falling or increasing water temperatures
- The disease is characterized by the formation of dermal and sub-dermal ulcers
- Scarring tissue can result in high percent downgraded fish at harvest
- Animal Welfare Concerns

Moritella viscosa; A significant pathogen of Atlantic Salmon
(1) Characteristics of the pathogen / disease

- Response to oral antibiotics generally poor as clinically infected fish tend not to eat
- Winter ulcer presentation increases susceptibility to secondary infection and may be exacerbated by concurrent infection with *Tenacibaculum* sp.
- *V. wodanis* commonly isolated in association with lesions
- The *Moritella viscosa* genome: http://www.sanger.ac.uk/resources/downloads/bacteria/moritella-viscosa.html has not yet been fully sequenced and published
- Specifically in relation to Canada, extensive phylogenetic and epidemiological studies of this organism have not been published

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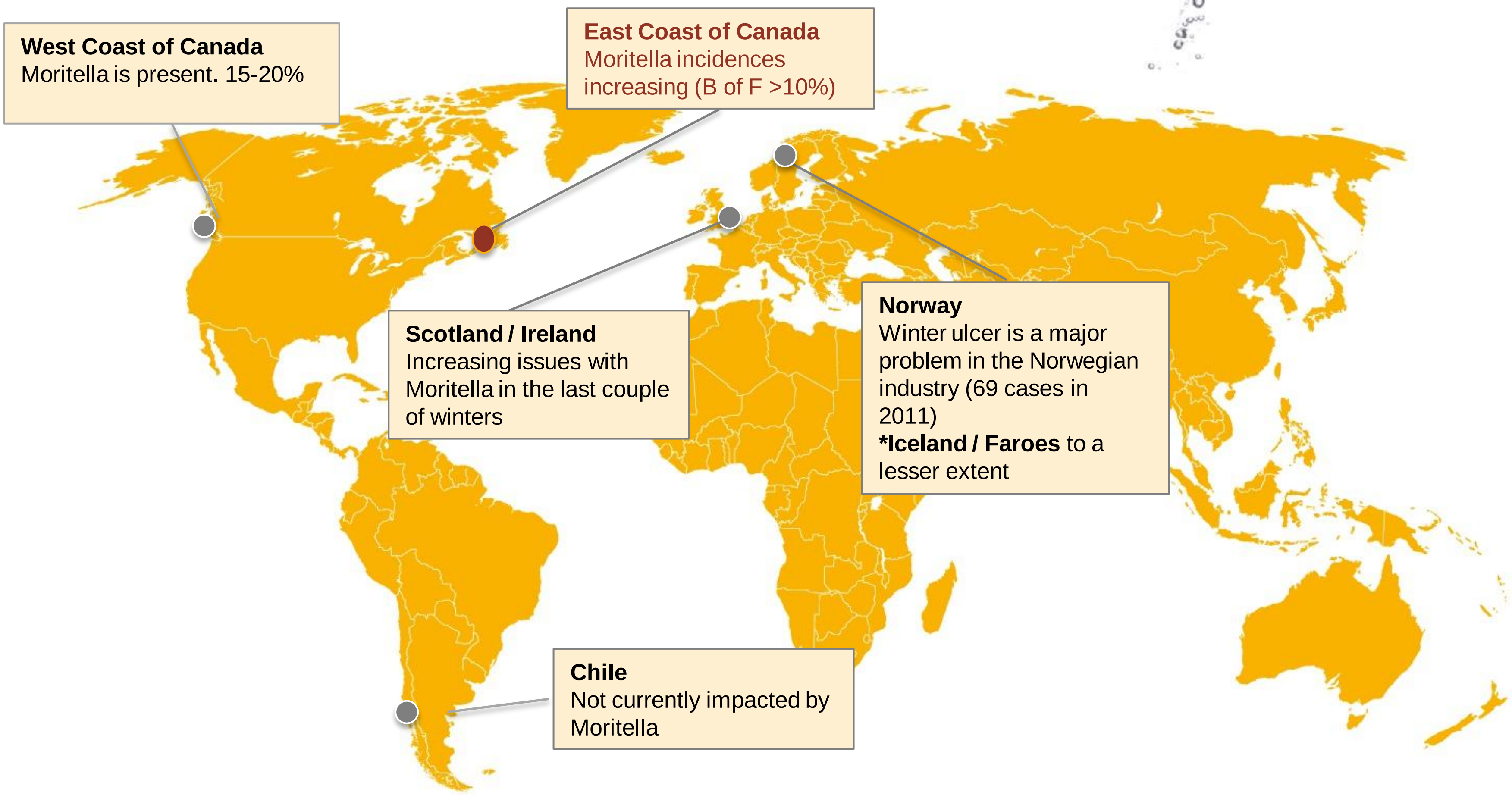
Moritella viscosa; A significant pathogen of Atlantic Salmon
(2) Geographical distribution and economic significance



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Suggested Method for Isolation

- ✓ Blood Agar with 2% NaCl
- ✓ Plates chilled to 12-15ºC prior to use
- ✓ Organism most often isolated from ulcer and internal organs such as kidney
- ✓ Incubation of cultures at 15ºC for 2-3 days
- ✓ Increased selectivity (recovery) of *M. viscosus* with blood medium containing 0.5µg/ml O129
- ✓ Co-cultivation of M. viscosus and V. wodanis, usually only observed growth of V. wodanis

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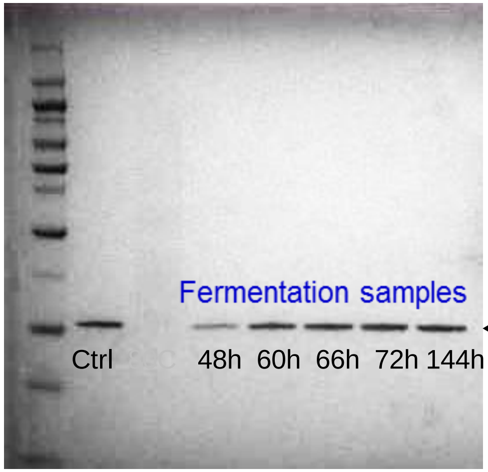
Moritella viscosa; A significant pathogen of Atlantic Salmon
(3) Phylogeny

- The genus Moritella currently consists of seven validly described species
- Only M. viscosa is associated with winter ulcer disease
- Regional phenotypes indicate minor variability in physiological and biochemical characteristics among M. viscosa isolates
- Genotyping / western blot assays suggests presence of sub-groups in Norway / Scotland /Faroes (‘Eastern Atlantic’) group and an Iceland / Canada (‘Western Atlantic’) group
- Although this indicates a division within the species it is not immediately clear whether the two identified groups of bacteria comprise ecologically distinct populations; cross-protection has been reported between Icelandic and Norwegian strains

Moritella viscosa; A significant pathogen of Atlantic Salmon
(4) Examples of known virulence factors

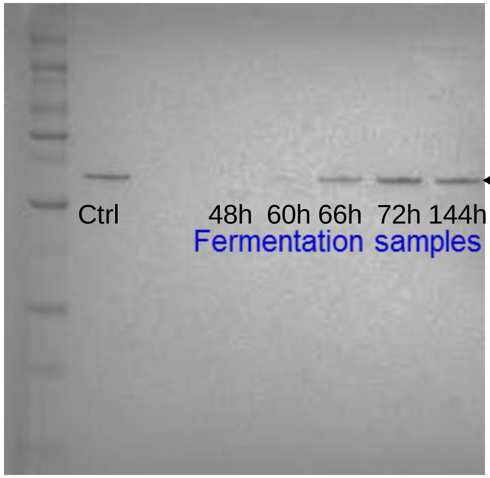


20KD
OMPA

OmpA

- Outer membrane protein considered to be a putative protective antigen

Time course expression of OmpA
* Western blot probed with monoclonal anti-OmpA antibody



38KD
MVP1

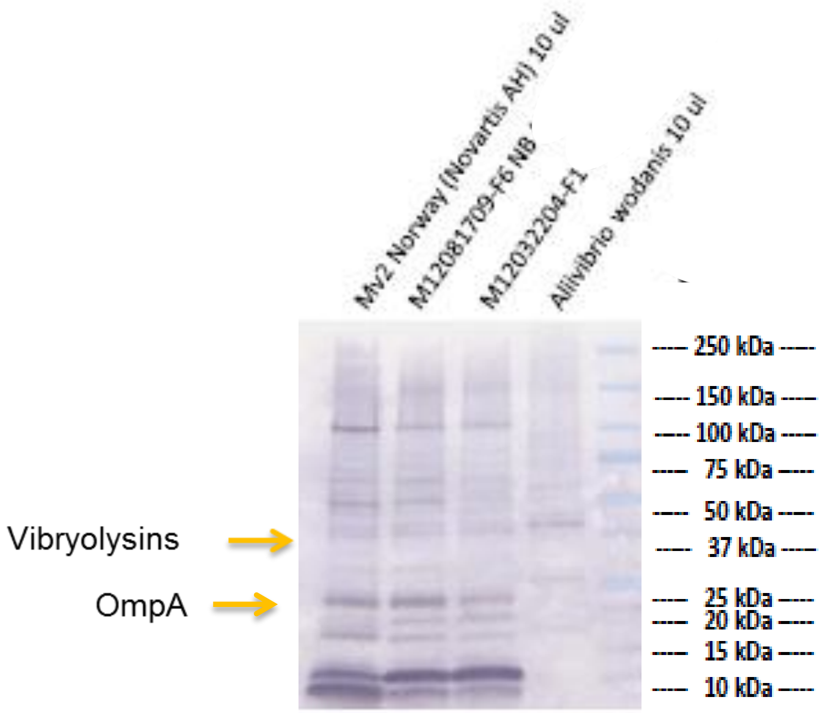
Vibriolysin (MVP1)

- An important component of the extracellular proteins expressed by *Moritella viscosa*
- A metallo-peptidase correlated with virulence

Time course expression of MVP1
* Western blot probed with monoclonal anti-MVP-1 antibody

Western Blot Analysis

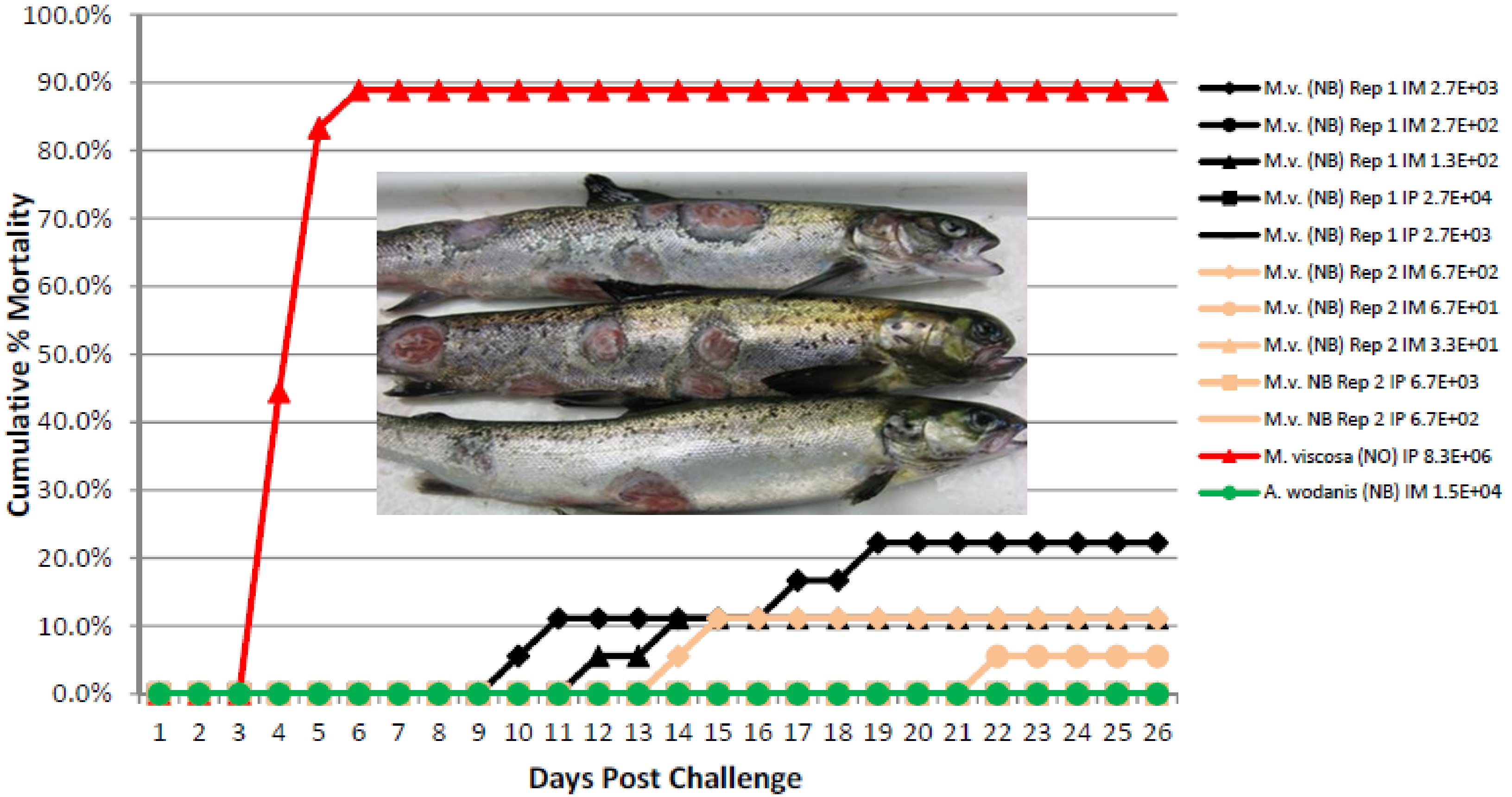
Bay of Fundy Isolates - 2012



Western blot analysis were performed per Grove et al. (2010) & Lunder et al. (2000). The primary antibody was provided by Novartis Animal Health and was used at a 1:5000 dilution. The secondary antibody was a peroxidase-labelled goat anti-rabbit Ig (Bio-Rad) used at 1:3000. Blots were developed using the Opti 4CN Substrate Kit (Bio-Rad).

Salt Water Dose Titration Studies

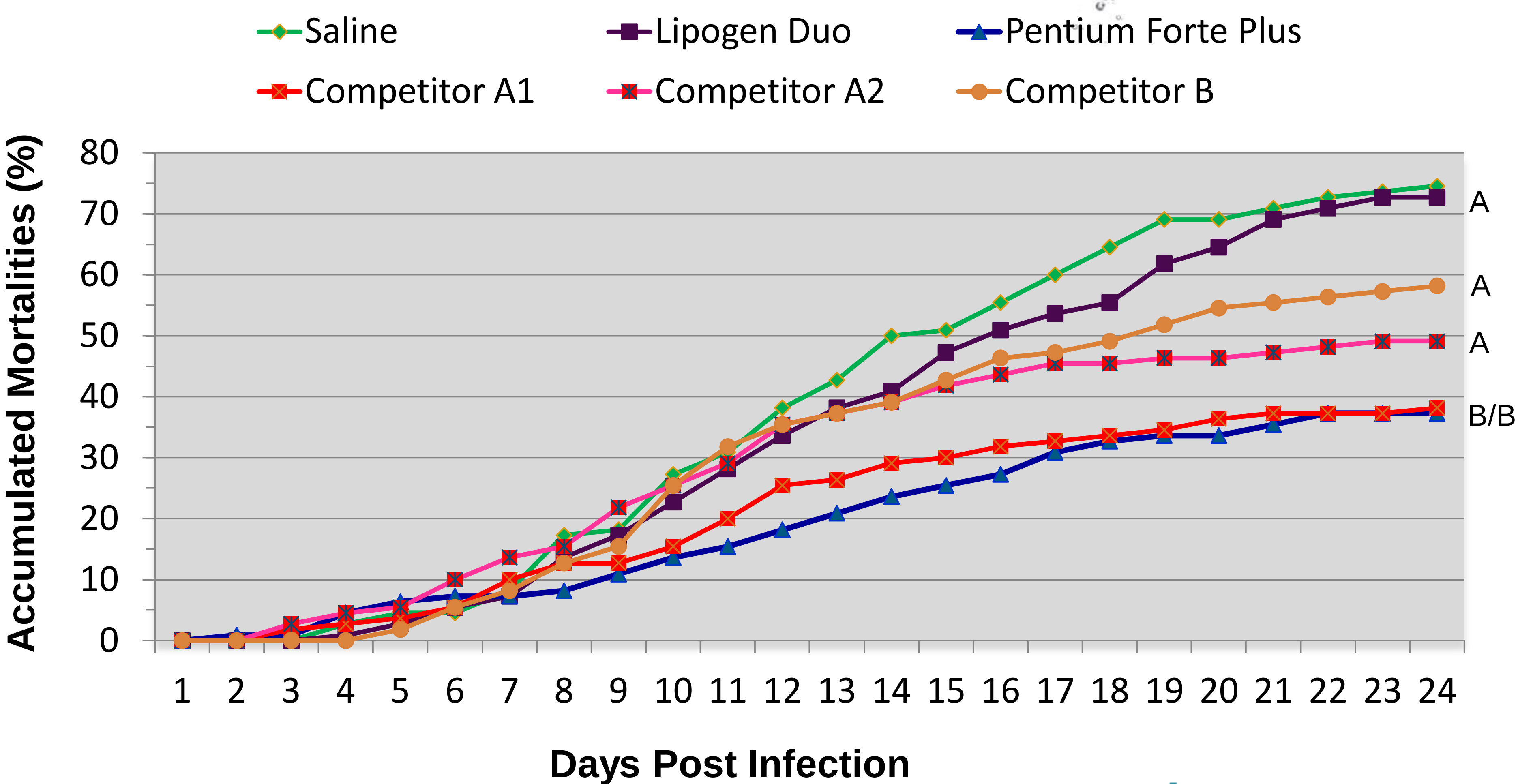
Mortality curve for exposure routes and doses using M. viscosa



Moritella viscosa; A significant pathogen of Atlantic Salmon
(4) Vaccination and Control

- Several companies produce vaccines for Winter Ulcer in the main traditional market in **Norway**, including Novartis Animal Health
- Novartis Animal Health is currently evaluating a trivalent micro-dose formulation containing Moritella in **Scotland** under an Animal Test Certificate and has applied for Provisional Marketing Authorization (PMA) in response to an emerging animal welfare need
- No products for this indication are currently licensed in **Canada.**
- Need to better understand virulence factors and antigen expression
- The current generation of Moritella vaccines confer significant efficacy but there is definitely scope for further improvement and NAH is investing significantly in active R&D programs

Comparative Efficacy Trials performed by VESO Vikan in Norway
Immersion challenge performed 1000 dd after vaccination (2012 data)



Different letters = significant difference verus the Lipogen Duo control group (P<0,05; Wilcoxon test)

Source: NAH GTS-11-008 Study Report, 2012, data on file

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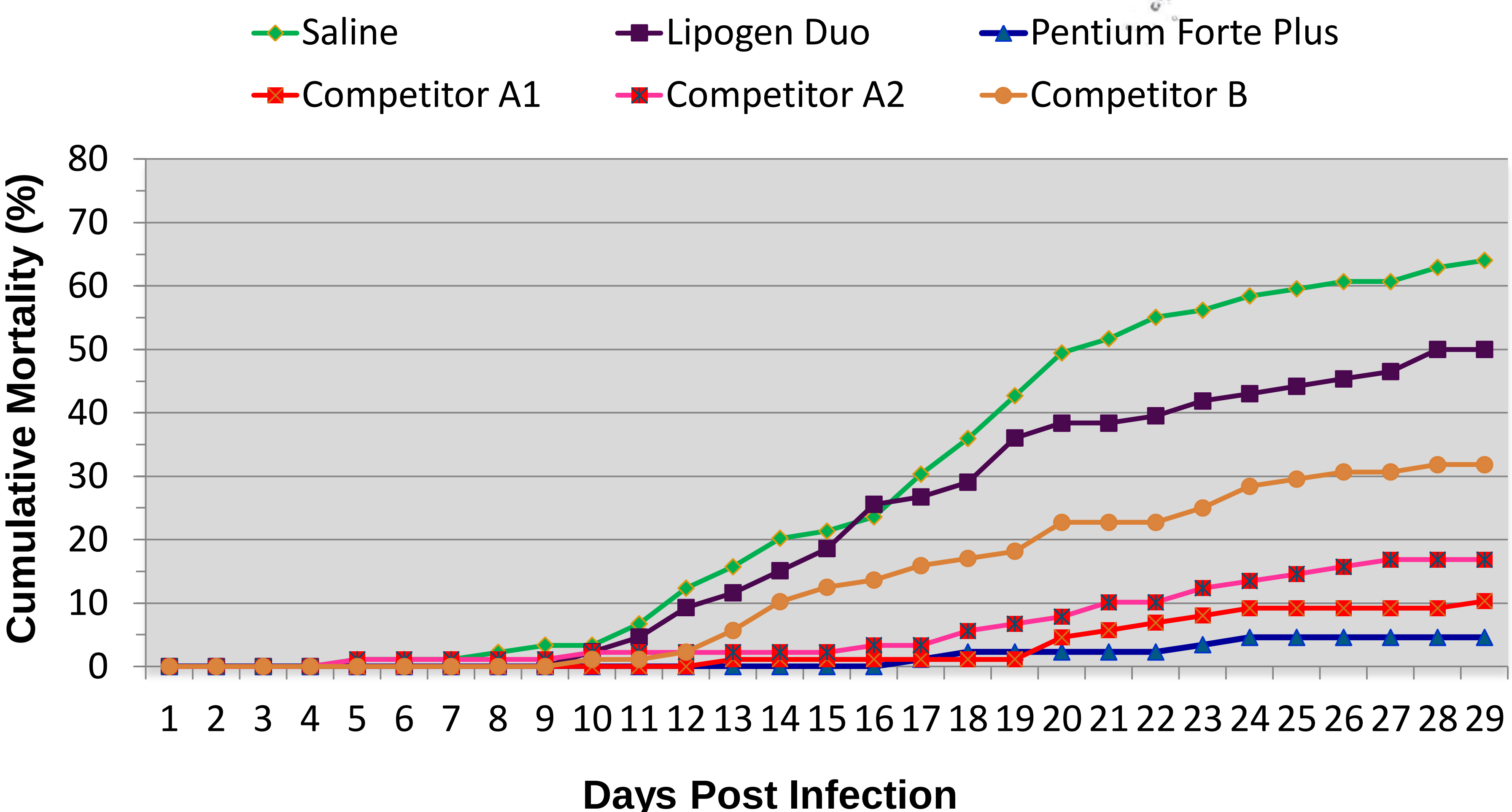
ANIMAL HEALTH

Comparative Efficacy Trials performed by VESO Vikan in Norway

Immersion challenge performed 1500 dd after vaccination (n = 90/group)



Source: NAH GTS-11-008 Study Report, 2012, data on file

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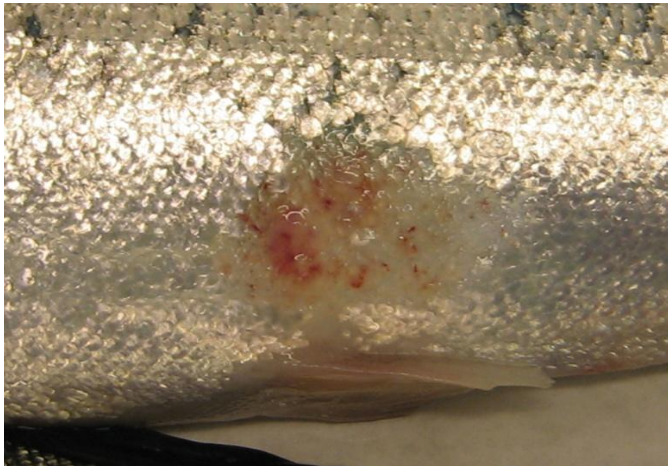
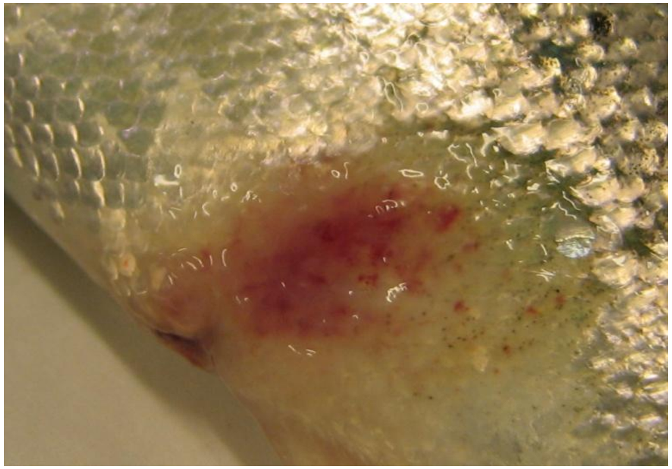
Typical Lesions seen in this challenge model

Grade 1

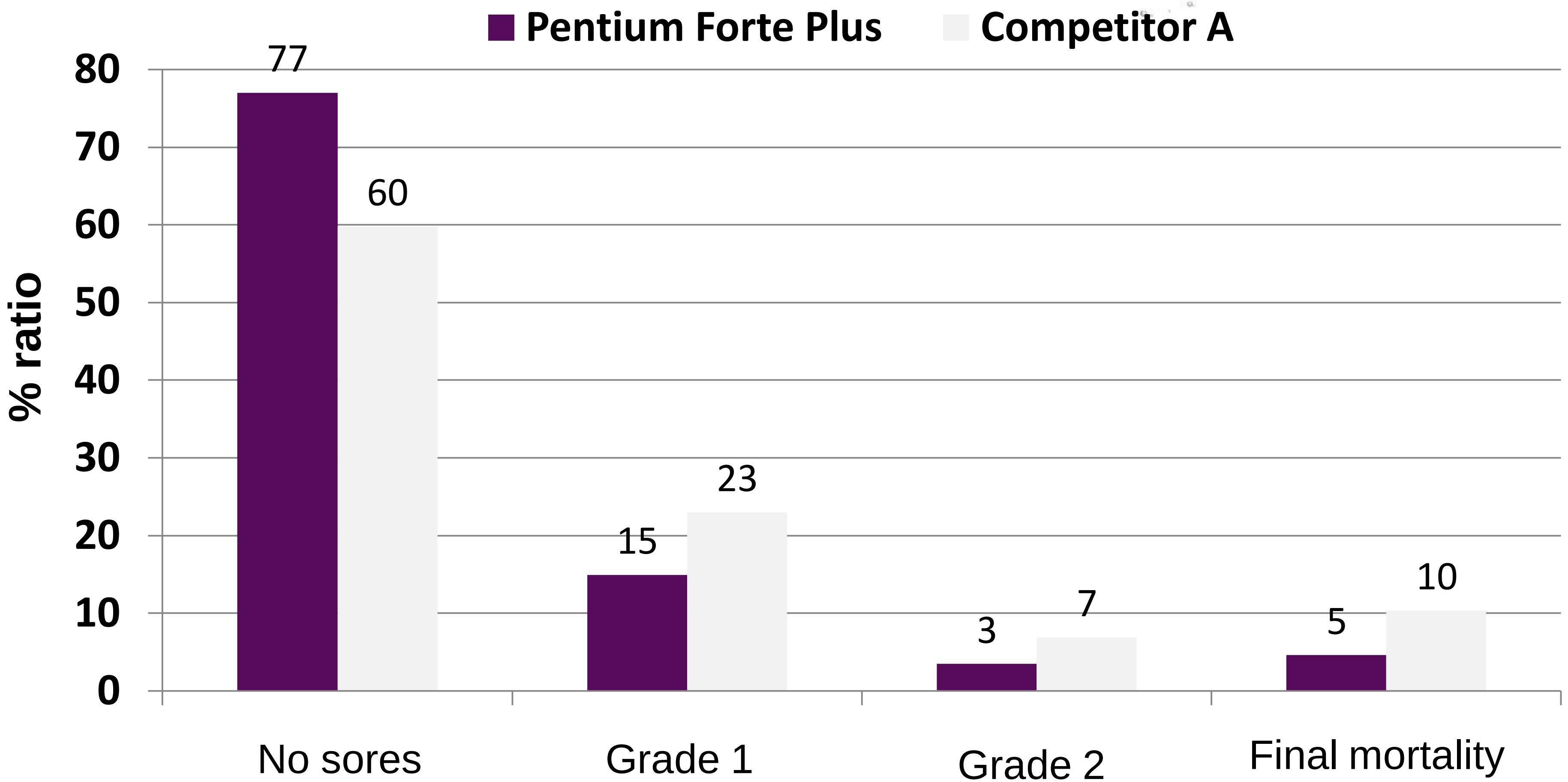




Grade 2

Comparative Efficacy Trials performed by VESO Vikan in Norway

Analysis of data relating to severity of sores recorded 27 days after challenge (1500 dd time point, 2012 data)



Source: NAH GTS-11-008 Study Report, 2012, data on file

NOVARTIS ANIMAL HEALTH

Conclusions

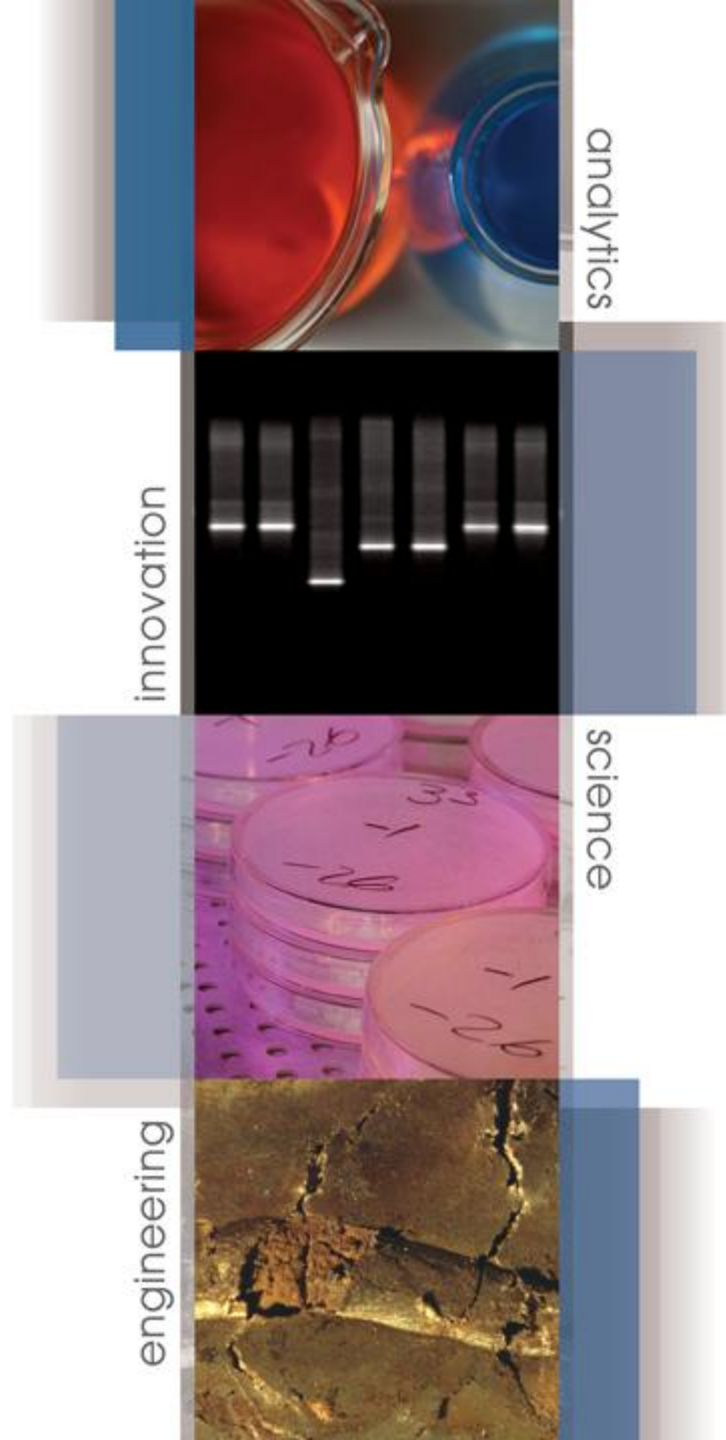
- *Moritella viscosa* is a significant emerging pathogen in Canada, affecting the industry in both Atlantic and Pacific
- Experience in Europe (Norway, Faroes & Scotland) is strongly supportive of a central role for vaccination as an aid to the control of Winter Ulcer
- Low virulence with recent Canadian field isolates posing issues for current established challenge model
- Novartis is working closely with CFIA exploring possibilities for registration of M. viscosa containing products for Canadian salmon industry to address this emerging animal welfare need.
  - Laboratory studies completed Sept ’13
  - Field trial studies proposed to evaluate vaccine performance

NOVARTIS
ANIMAL HEALTH

rpc
SCIENCE & ENGINEERING

BACTERIA
What are they good for?

Benjamin S. Forward, PhD



Bacteria are Good!

- Many perform essential functions
    - Nutrient cycling to digestion
- They are ubiquitous – mild to extreme environments
- Marine environments are relatively unexplored (<1%)
- Access to one of the most unique marine habitats (BoF)
- They represent a source of unique biosynthetic capacity
- They are culturable - sustainability

Beginnings

- ACOA AIF funded project to develop new aquaculture products from marine bacteria
  - Probiotics
  - Antimicrobials

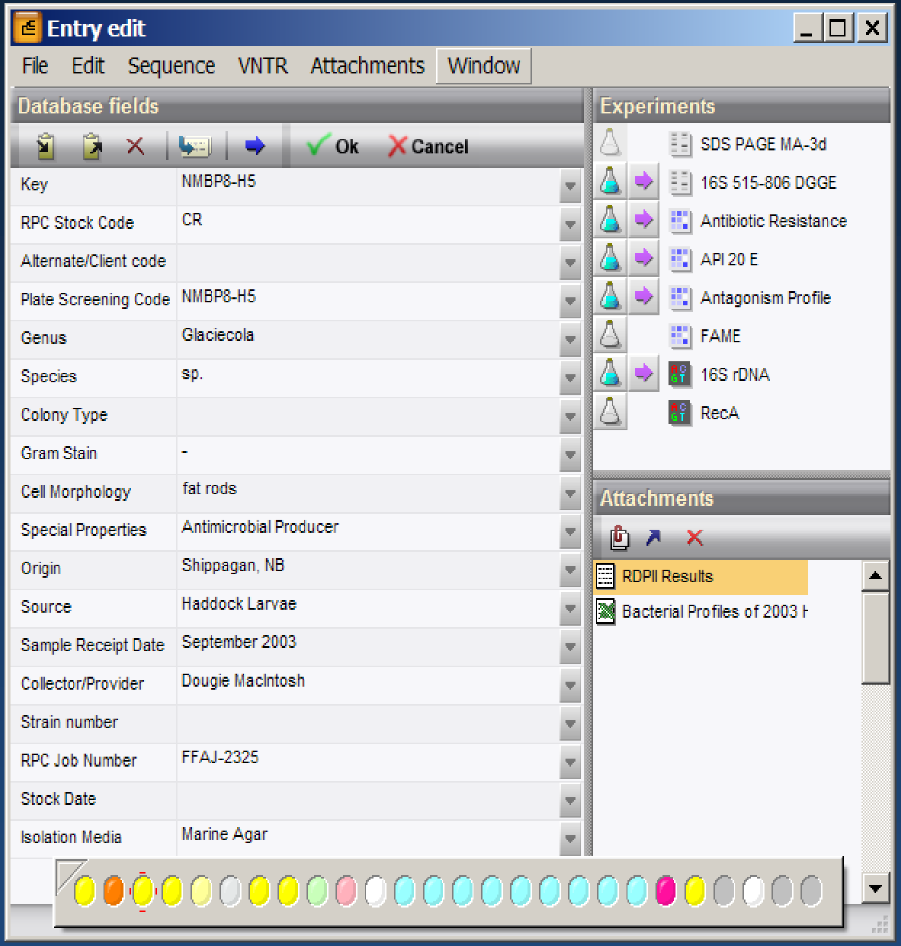
rpc


Novel bacteria 2005
Novel bacteria 2005
Novel bacteria 2005

Library Bioinformatics

Managing the collection

- Storage of isolate information
  - origin
  - identity, etc.
- Storage of Biodata
  - DNA sequence
  - Metabolic profile
  - Antibiotic sensitivity
- Run comparative analyses



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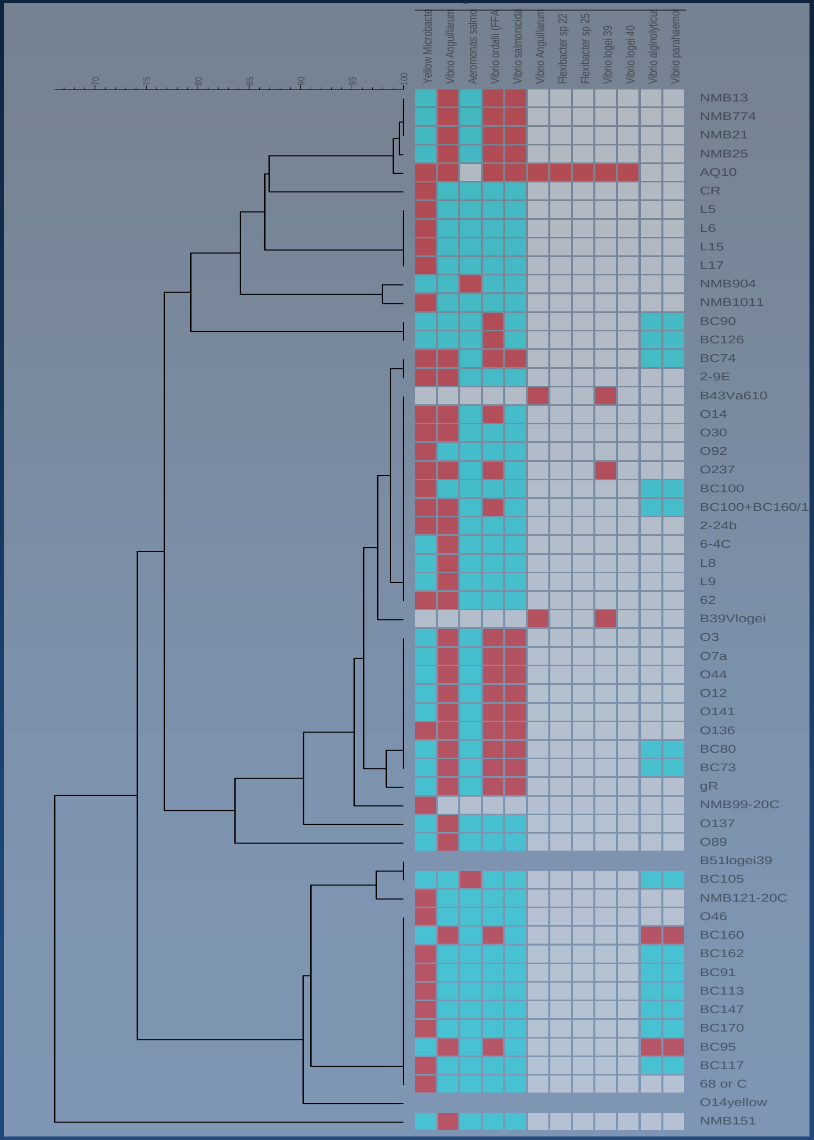
Library Screening

Searching for candidates

- Previous assays – 50/day
- High throughput – 4-8k/day
- Permits library screening under multiple conditions
- Develop large number of candidates



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Discovery Platform

Marine Bacteria Library

← Fish Health Screening Services
← Bacterial Forensics Services
← Environmental profiling R&D projects
← Various projects

+

Bioinformatics Database

+

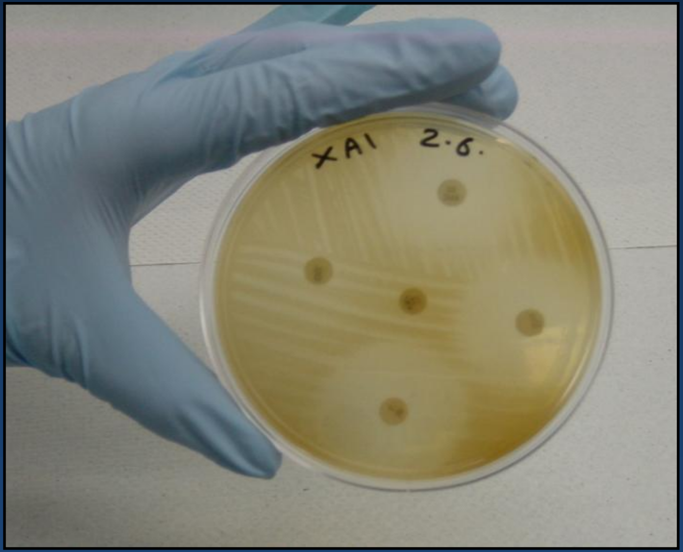
Adaptable HTS Methodology

=

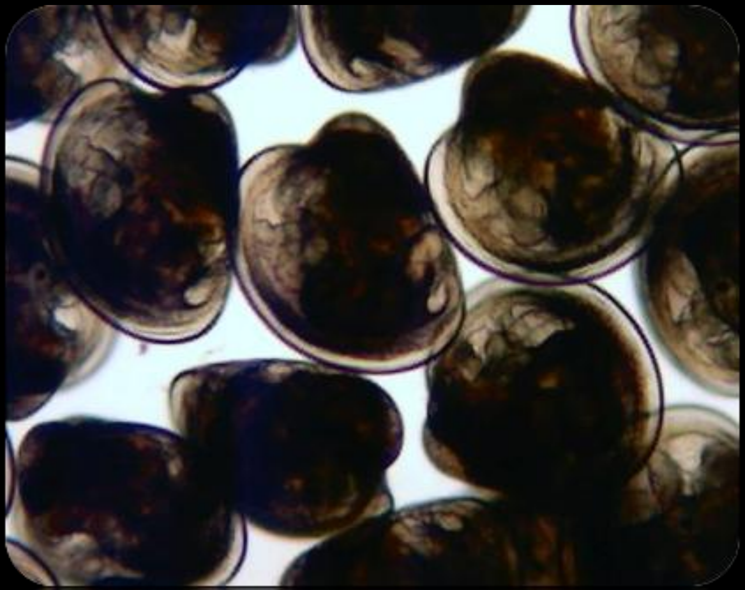
New Discoveries & Products

Findings

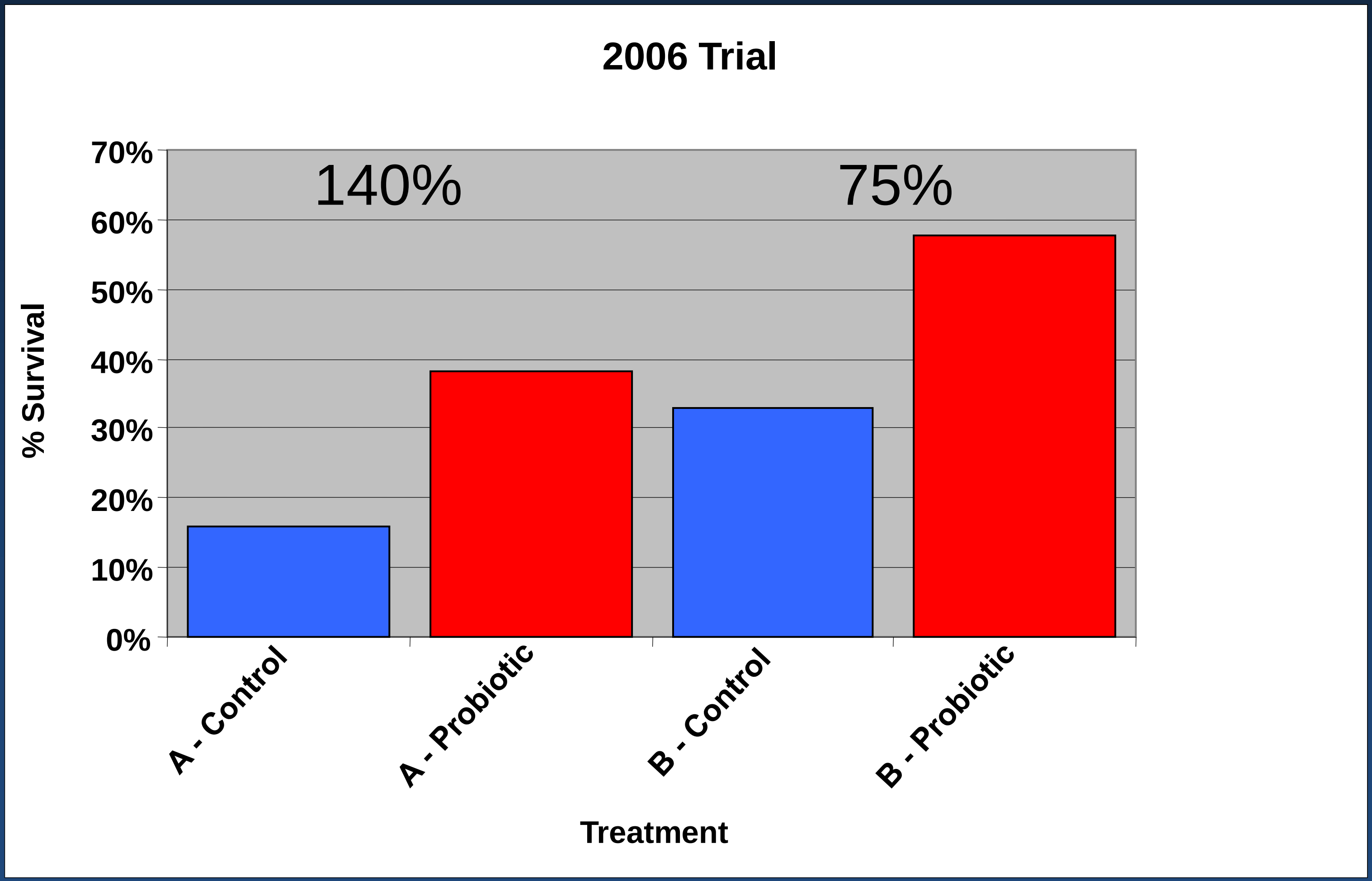
- Antibiotic producing bacteria
- Antiviral producing bacteria
- Probiotic bacteria
- PUFA producing bacteria
- Antifoulant producers
- Hydrolytic enzyme producers
- Anticancer agent producers



Marine Probiotics




Alternate Species Probiotics



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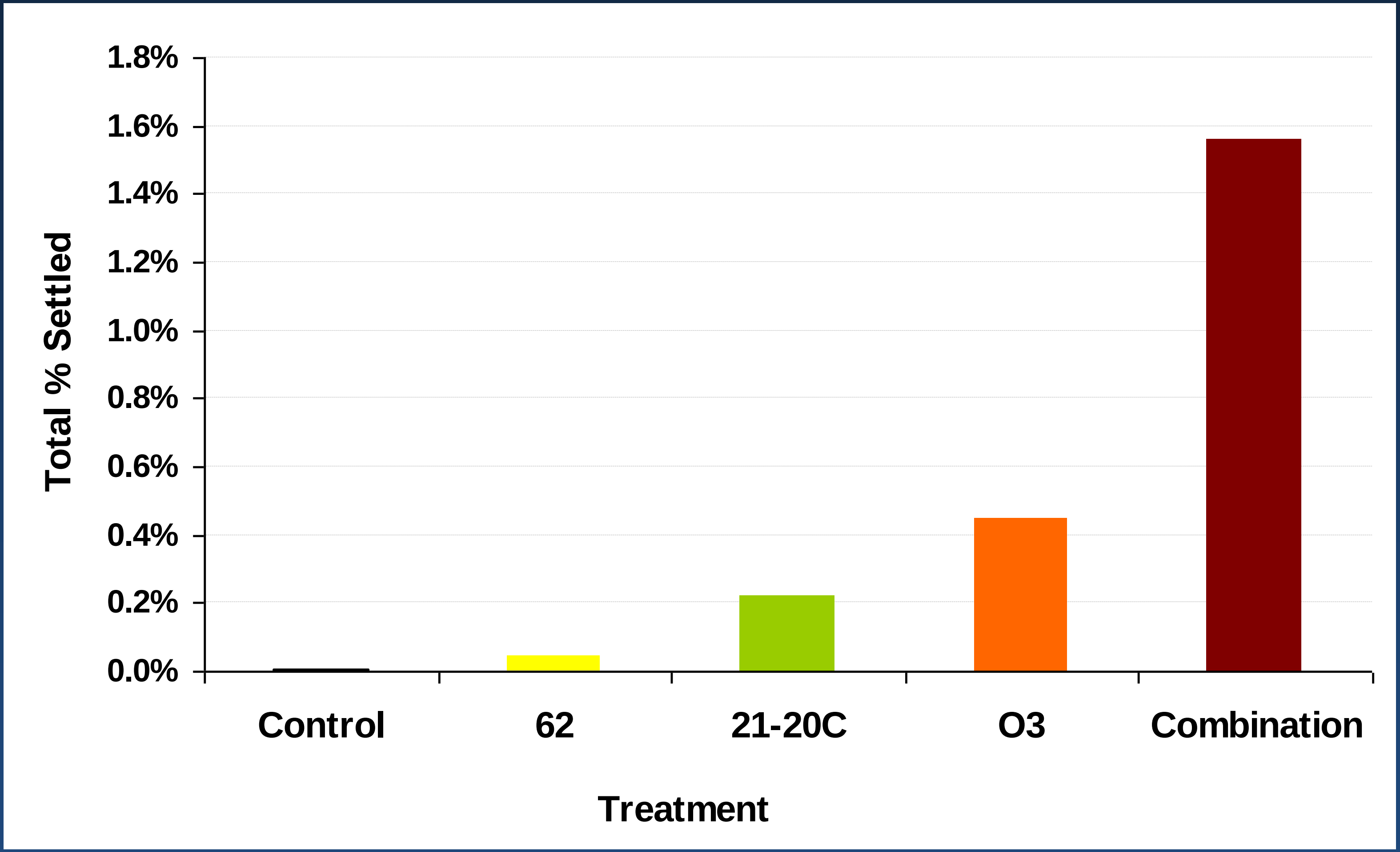
American Oyster - Total Yield

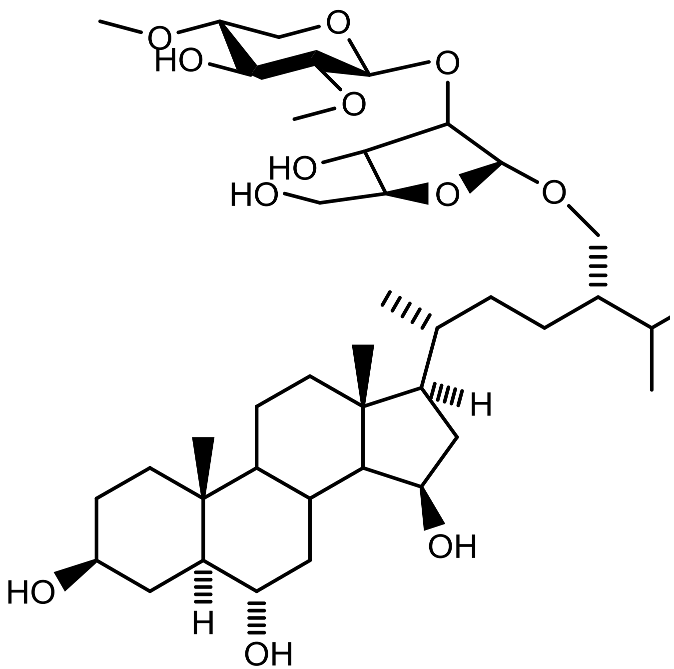


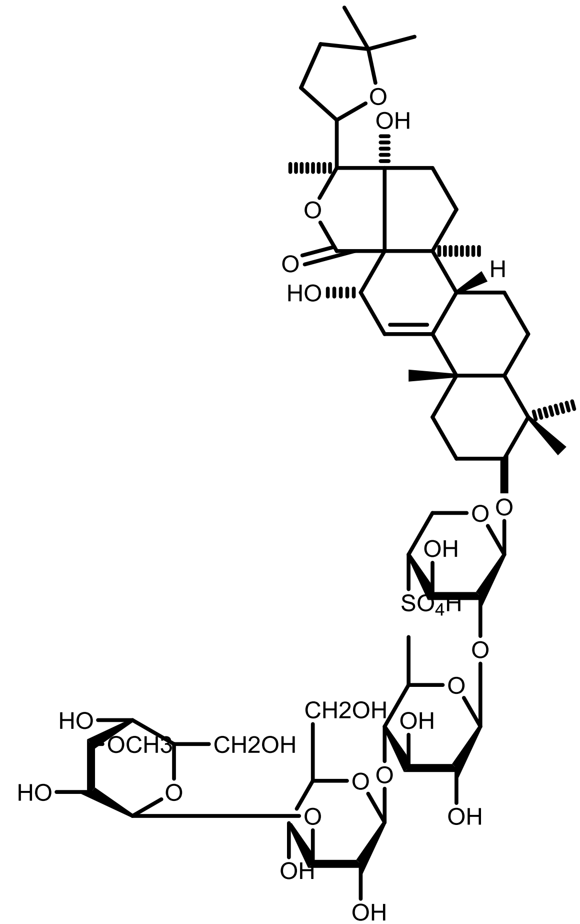
Anticancer

Collaboration

- Dr. Jeff Wright & Dr. Allison Stewart
- Anticancer & Antibiotic screens
- Human disease context

Cytotoxic: Strain 44





Pigments

Valuable Pigments

- Violacein: antibacterial, antiviral, anticancer, antitrypanisomal
- Retail $330 CAD per milligram
- Typical yield - 1.1 g of crude violacein/litre culture
- 50% pure - 550 mg
- $150 per mg that equates to $82,500 per L
- Crack Cocaine - $600-$1,000 per ounce (28g)
- What is the market?

rpc

Future

- Pursuit of commercial opportunities
- Hydrolytic enzymes for industrial processes
- Bio-pesticides
- Microbial fuel cells


Thank You!

TREAT

Genomic Tools to Resolve Environmental Impact And Treatment Resistance in Sea Lice

Purcell SL, Whyte S, Groner ML, Sutherland BJG, Koop BF, Poley J, Igboeli OO, Revie CW, Fast MD

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NOVARTIS
ANIMAL HEALTH

Objectives

- Create a SNP ('mutation') database for *L. salmonis*
  - Tool to study these mutations (SNP chip)
  - Genotype families and populations in Canada
  - Model – eventually predict resistance development
- Profile louse response to drugs
  - Across populations (BMA1/BMA2B/Nfld)
  - Multiple current (EMB, Alpha/BetaMax, Salmosan, etc.) and future drugs
- Enhance salmon responses to lice
  - Immune potentiation, vaccine prototype, etc.

Objective 1

- How do we create this (SNP - ‘mutation’) database for *L. salmonis?*
  - *In coordination with large lice sequencing initiatives in BC and Norway (generate list to design the tool)*
- Application
  - Are these mutations associated with drug resistance?
  - *Sample lice from throughout Eastern and Western Canada (population study)*
  - *Inbreeding of lice at AVC-UPEI from different BMAs in Eastern Canada (determine inheritance)*

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NOVARTIS ANIMAL HEALTH

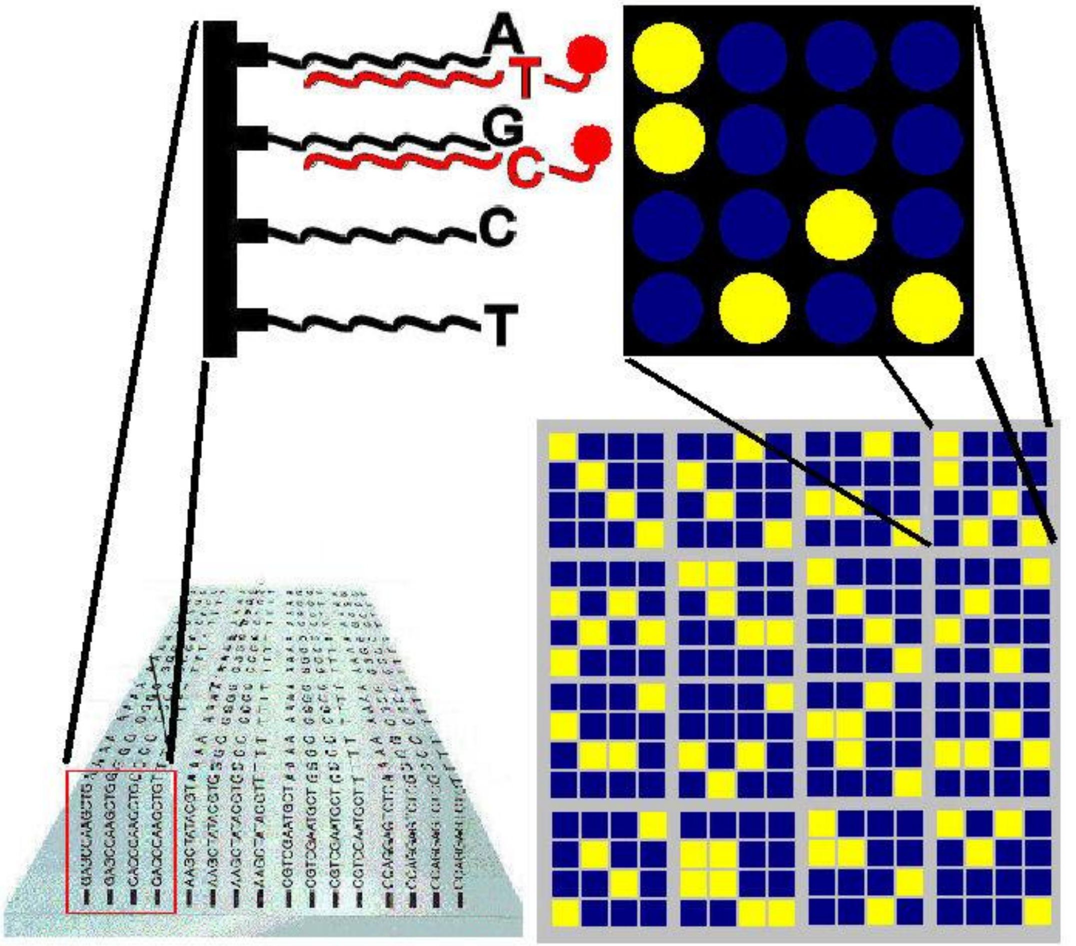
Genetics 101

The Tool (200K SNP chip)

-200,000 ‘**oligos**’ on a chip (short DNA strands)

-Lice sample ‘sticks’ only to those **oligos** to which they are perfectly complementary:
***~T~* SNP** allele binds to the ***~~A* oligo**,
***~C~* SNP** allele binds to the ***~~G* oligo**

=C / T heterozygote



http://www.mun.ca/biology/scarr/DNA_Chips.html

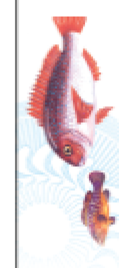
Once we have population structure data what can we do with it?

Apply to models of evolution of pesticide resistance in sea lice

Using *Anylogic* software

Building off a previous model published in JoFD and online: http://tinyurl.com/wrassemodel

Journal of Fish Diseases 2013, **36**, 195–208 doi:10.1111/jfd.12017



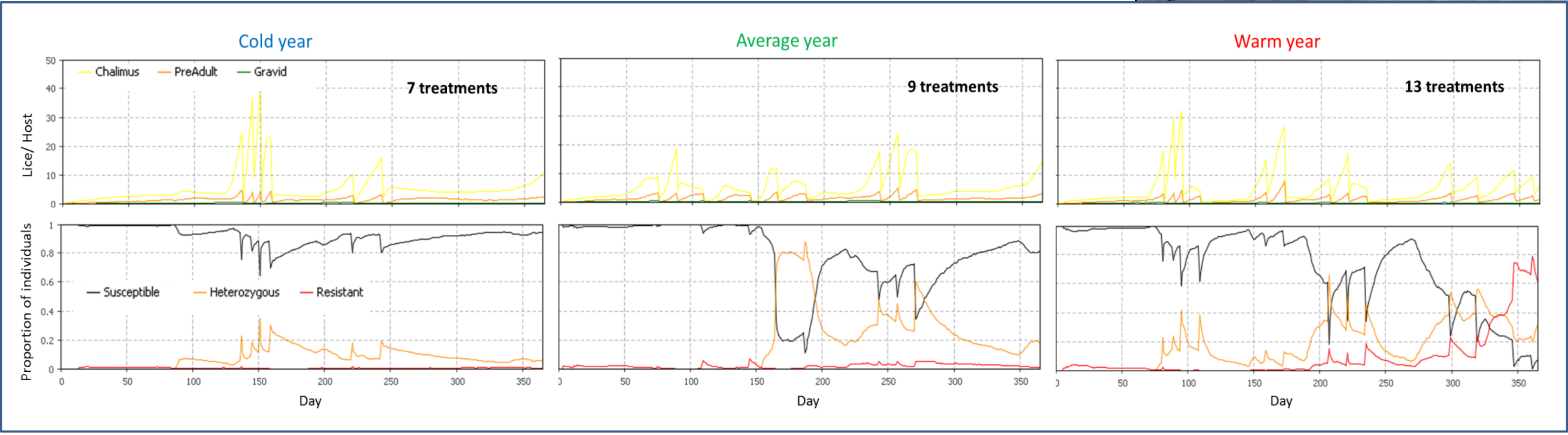
Use of agent-based modelling to predict benefits of cleaner fish in controlling sea lice, *Lepeophtheirus salmonis*, infestations on farmed Atlantic salmon, *Salmo salar* L.

M L Groner[1], R Cox[1], G Gettinby[2] and C W Revie[1]

1 Department of Health Management, Centre for Veterinary and Epidemiological Research, Atlantic Veterinary College, University of Prince Edward Island, Charlottetown, PE, Canada

2 Department of Mathematics & Statistics, University of Strathclyde, Glasgow, UK

Preliminary data



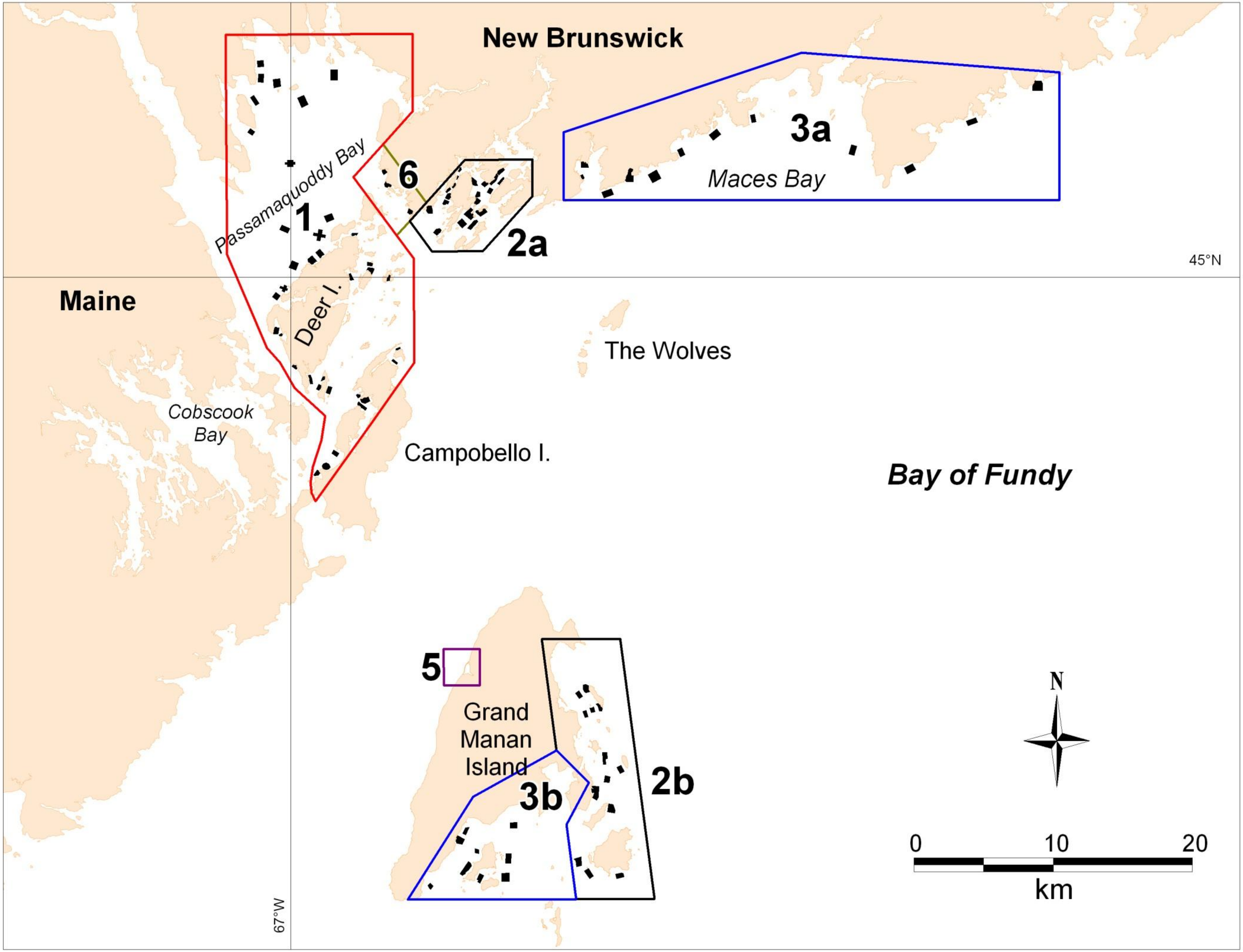
-Temperature influences the rate that resistance evolves and the number of treatments used

-How does this change based on inheritance of particular mutations?

-How does this work for different drugs?

Objective 2

- Profile louse response to drugs
  - Across populations (BMA1/BMA2B/Nfld)
  - Multiple current (EMB, Alpha/BetaMax, Salmosan, Ivermectin, H_2O_2, etc.) and future drugs


New Brunswick
Maine
Passamaquoddy Bay
1
6
2a
3a
Maces Bay
45°N
Deer I.
The Wolves
Cobscook Bay
Campobello I.
Bay of Fundy
5
Grand Manan Island
3b
2b
N
0
10
20
km
67°W

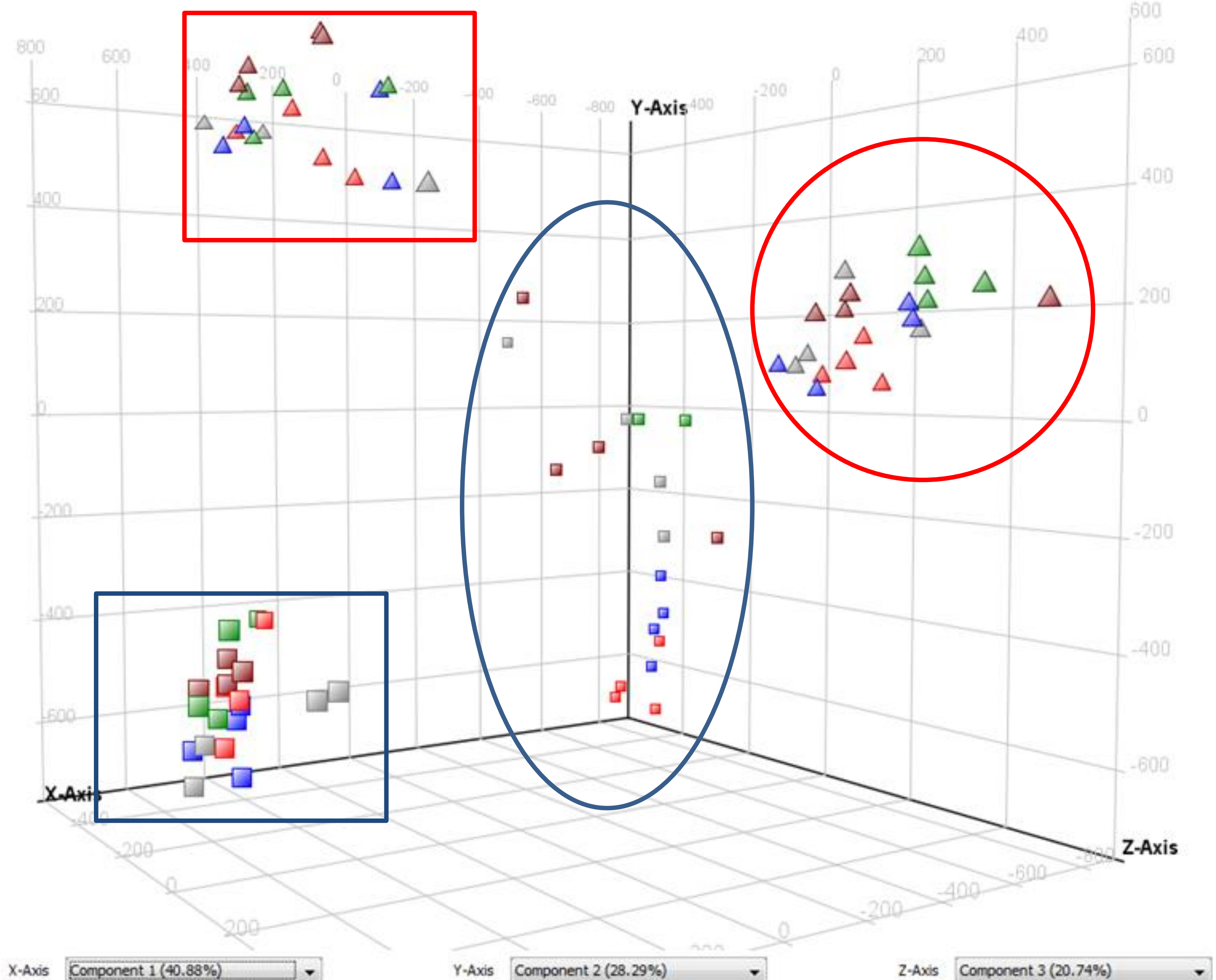
Sensitivity analysis of adult male and female sea lice populations exposed to emamectin benzoate (EMB) in a 24 h bioassay.

Sea lice source (and identity)	Emamectin benzoate concentrations (ppb)	Results [(EC_{50}- ppb; 95% confidence interval) or (% Survival)]
BMA 1 (R1-1)	0, 10, 100, 300, 1000	EC_{50}: Male- 329 (275, 394) Female- 304 (241, 383)
BMA 2a (R0a-2a)	0, 100, 200, 400, 1000	EC_{50}: Male- 840 (614, 1047) Female- 254 (218, 296)
BMA 2a (R1-2a) BMA 2b (S0-2b)	0, 0.1, 25, 300, 1000	EC_{50}: R1-2a: Male- 403 (230, 706) Female- 170 (56, 519) S0-2b: Male- 63 (11, 352) Female- 75 (13, 432)
(R3-2a) Crosses (RX1-3S F1) (RX2S F1)	200	% Survival: *R3-2a : Male- 100; Female- 100 *RX1-3S F1: Male- 94; Female- 70 *RX2S F1: Male- 100; Female- 67

Sensitivity analysis of adult male and female sea lice populations exposed to emamectin benzoate (EMB) in a 24 h bioassay.

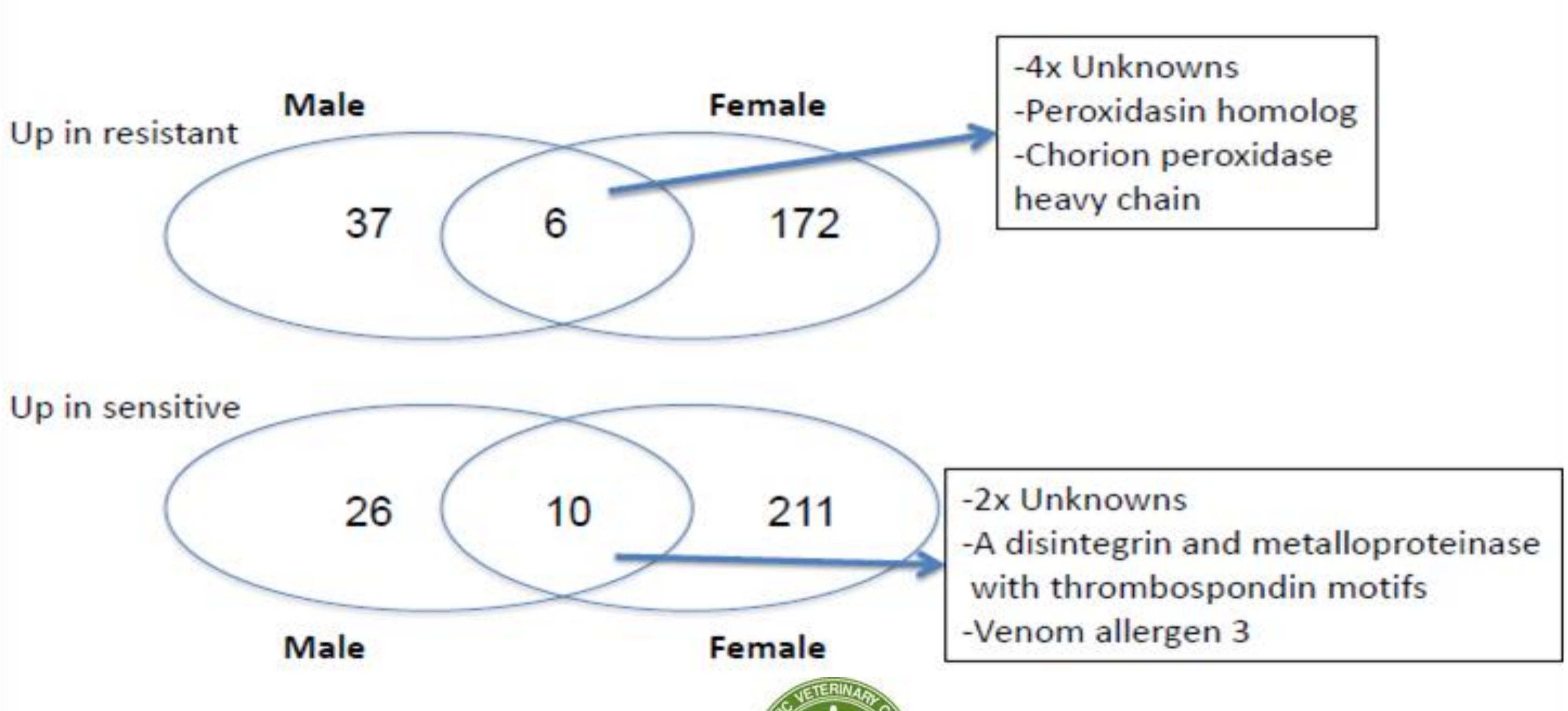
Sea lice source (and identity)	Emamectin benzoate concentrations (ppb)	Results [(EC_{50}- ppb; 95% confidence interval) or (% Survival)]
BMA 1 (R1-1)	0, 10, 100, 300, 1000	EC_{50}: Male- 329 (275, 394) Female- 304 (241, 383)
BMA 1 *C. elongatus*	0, 30, 100, 300, 1000	EC_{50}: Male- 105 (33, 334) Female- 55 (43, 69)
BMA 2a (R1-2a) BMA 2b (S0-2b)	0, 0.1, 25, 300, 1000	EC_{50}: R1-2a: Male- 403 (230, 706) Female- 170 (56, 519) S0-2b: Male- 63 (11, 352) Female- 75 (13, 432)
Nfld	0, 100, 300, 1000	EC_{50}: F1 Male: 232.88 (129.19, 419.80) Female: 267.58 (177.72, 402.87)

Transcriptomic Comparison of Lice Populations with/out exposure to SLICE



Objective 2

- Lice population and gender differ greatly
  - *Responses and starting points*



Different Populations and Drugs

Sea lice source (and identity)	EMB[1] (ppb)	Survival (%)	AZA[2] (ppb)	Survival (%)	DMN[3] (ppb)	Survival (%)
BMA 1 'EMB-resistant'	10	50	10	95	0.3	35
F1	100	0	100	95	1.0	0
BMA 2b 'EMB-sensitive'	10	0	10	<5	0.1	5
F1	100	0	100	0	1.0	0

[1] EMB – Emamectin benzoate, Avermectin (SLICE ™) [in-feed to salmon]
[2] AZA – Azamethiphos, Organophosphate (Salmosan ™) [bath]
[3] DMN – Deltamethrin, Pyrethroid (AlphaMax ™) [bath]

Conclusions + Future Directions

- Population and gender diversity in EMB sensitivity in Eastern Canada
- Resistance/sensitivity can be inherited
- EMB exposed populations can have greater resistance to other lice drugs (regardless of no prior history with that drug)
- Prior treatment can selectively enhance male survival when exposed to other treatments
- Transcriptional profiling of response to other drugs and SNP identification associated with drug resistance

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Acknowledgements

Progress Report: Trapping Technology on Salmon Aquaculture Sites

ACFFA - Annual Workshop and Research Review 2013

Shawn Robinson
Nathaniel Feindel
Fisheries and Oceans – SABS

Keng Pee Ang
Cooke Aquaculture Inc.

Trap development timeline

2011	2012	2013
Lab observations *Field observations*	*Continue lab experiments* *Pilot-scale field trials* *Field observations*	*Full-scale field trials* *Field observations* *Lab-based observations*

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Station Biologique De St Andrews

Talk Outline

Traps

- Design
- Performance
- Lice catch
- By-catch

Biology

- Distribution & abundance
- Swimming
- Hatching
- Oxygen demand

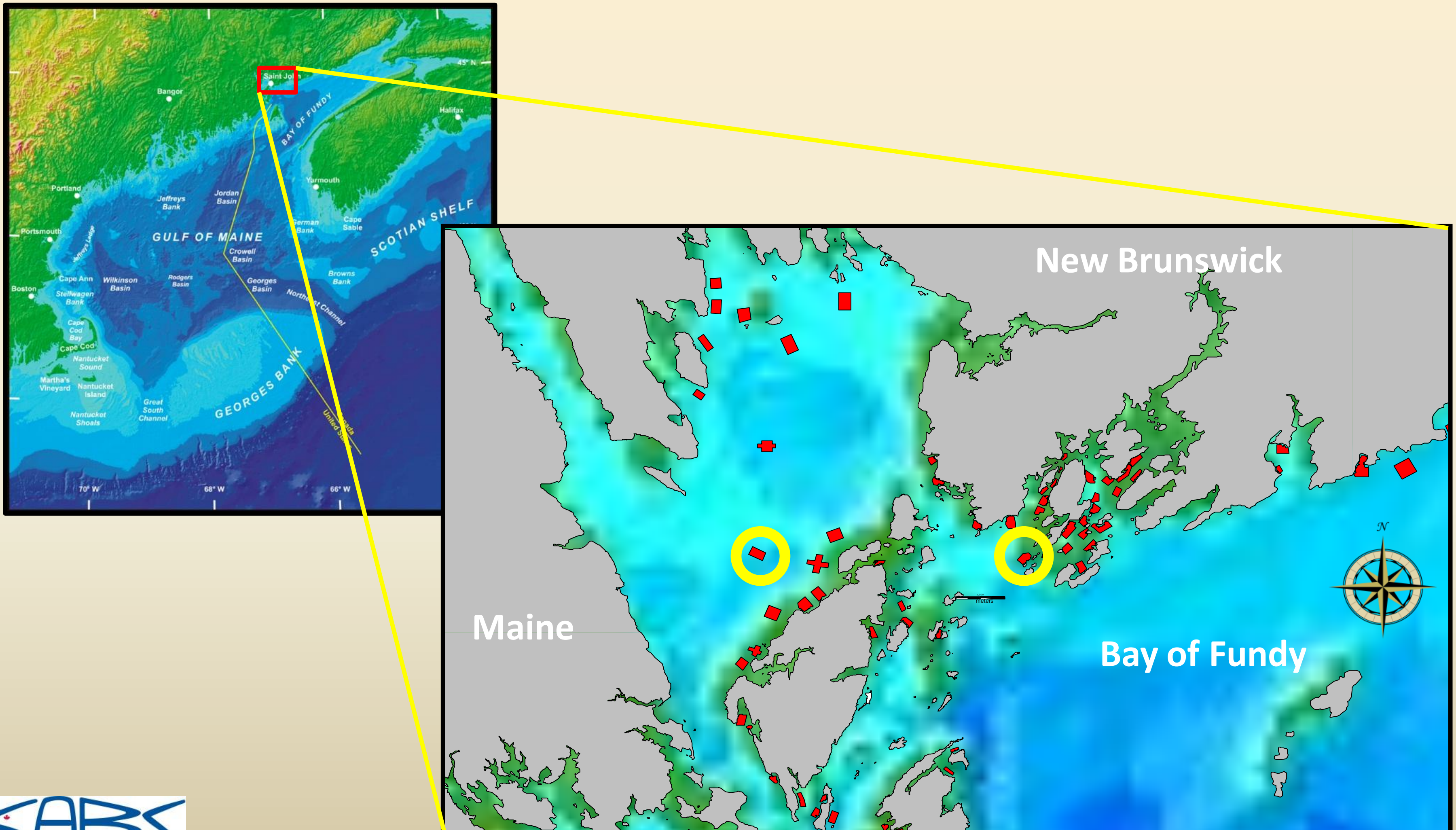
Objectives

- Develop and test traps (biological and physical) as a tool to help control sea lice.
- Develop a better understanding of the early life history ecology of sea lice

Lessons from 2011-2012

- Larvae are distributed mostly near salmon farms in relatively low numbers compared to other zooplankton
- Larvae are found simultaneously in surface and deeper waters (15 m)
- Larvae are attracted to light, particularly towards the blue wavelengths
- Larvae appear to have well-developed swimming abilities
- Larvae are easily captured by pumps or by filter-feeding shellfish (mussels, scallops, oysters, cockles)
- Simple light traps capture a wide-range of zooplankton that are not normally seen in the water at the farm suggesting that conditions at night are different

Study Area



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Sea Lice Sampling

SABS
St. Andrews Biological Station
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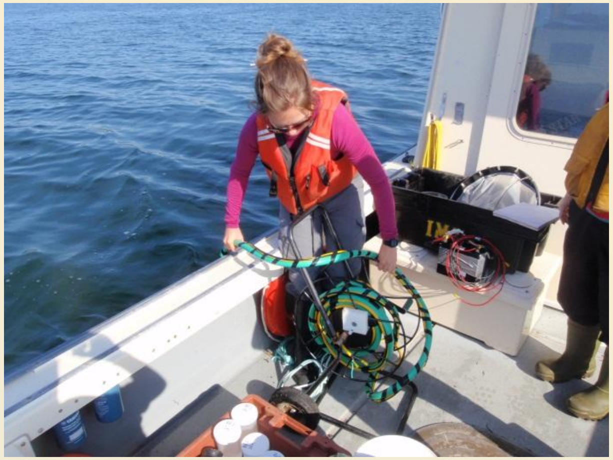
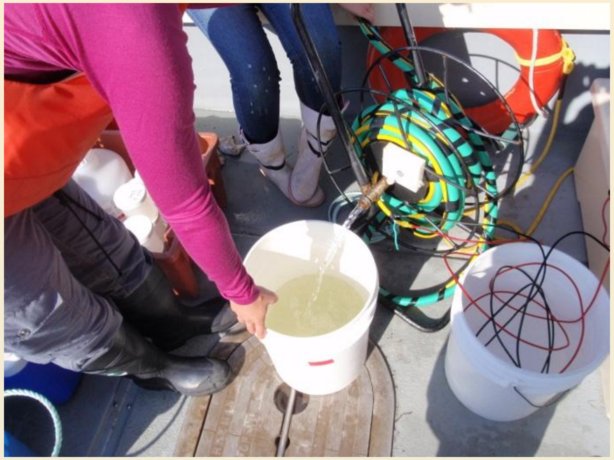
7

Larval sampling methods





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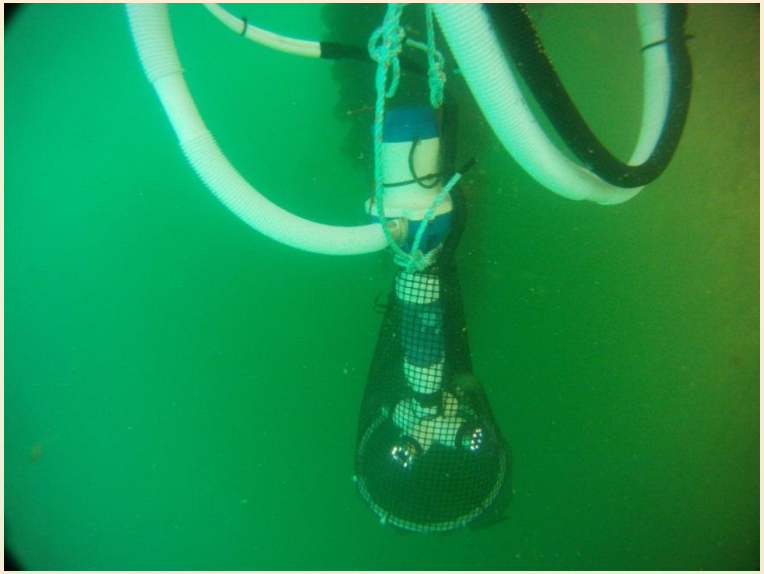
Trap Development



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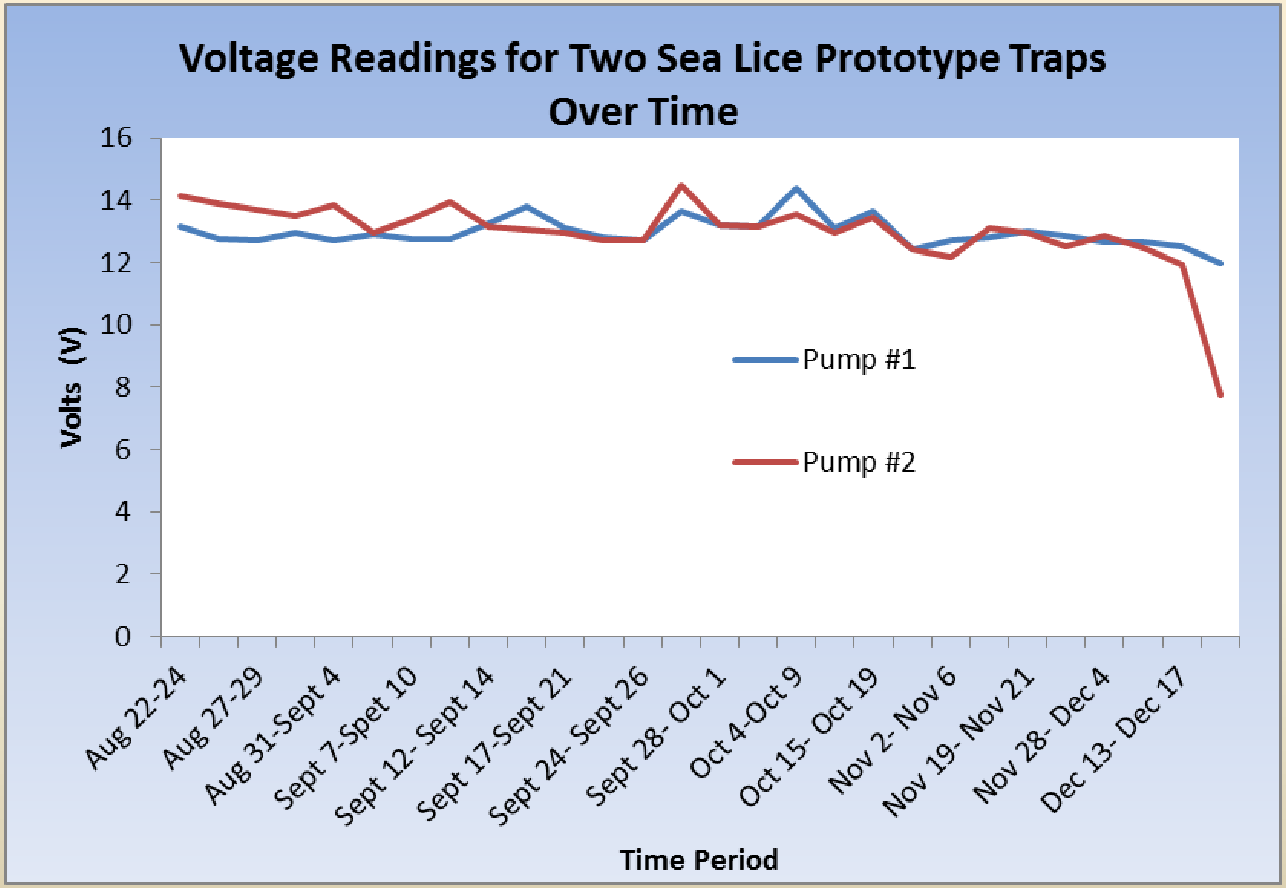
Light trap electrical performance



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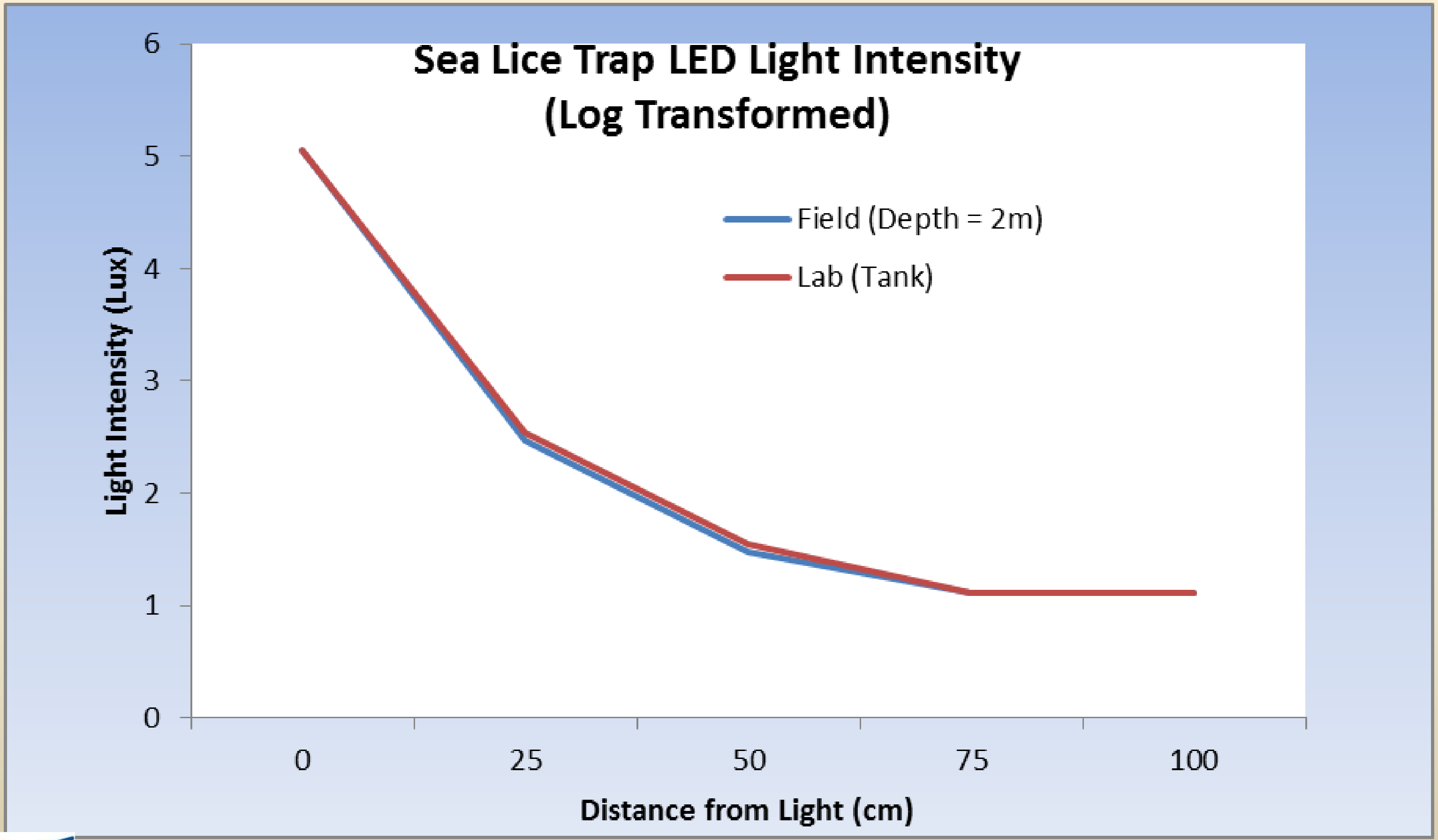
Trap performance (light penetration)



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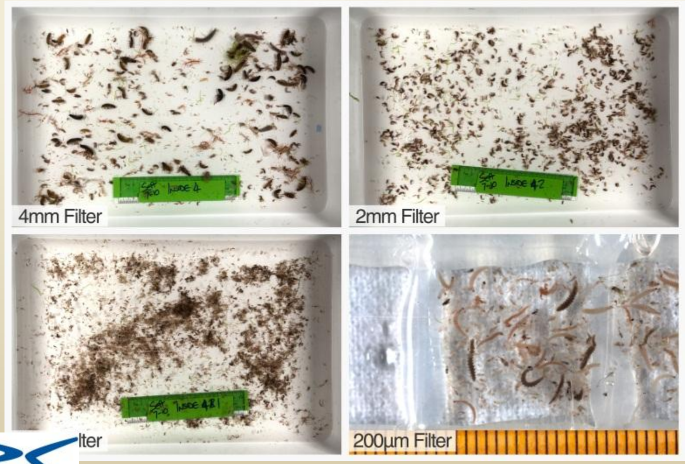
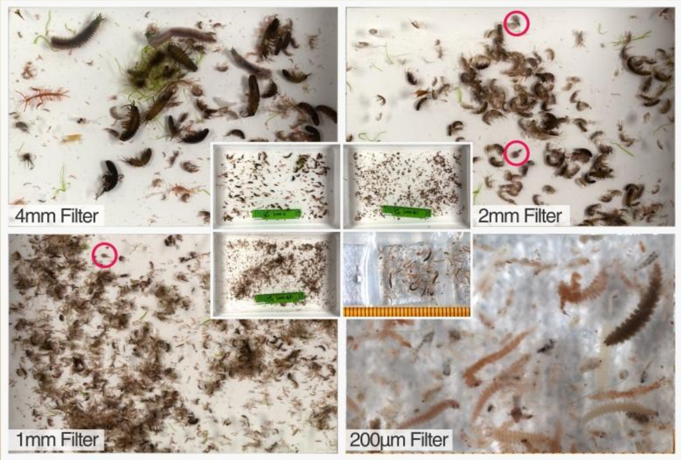
Sample processing





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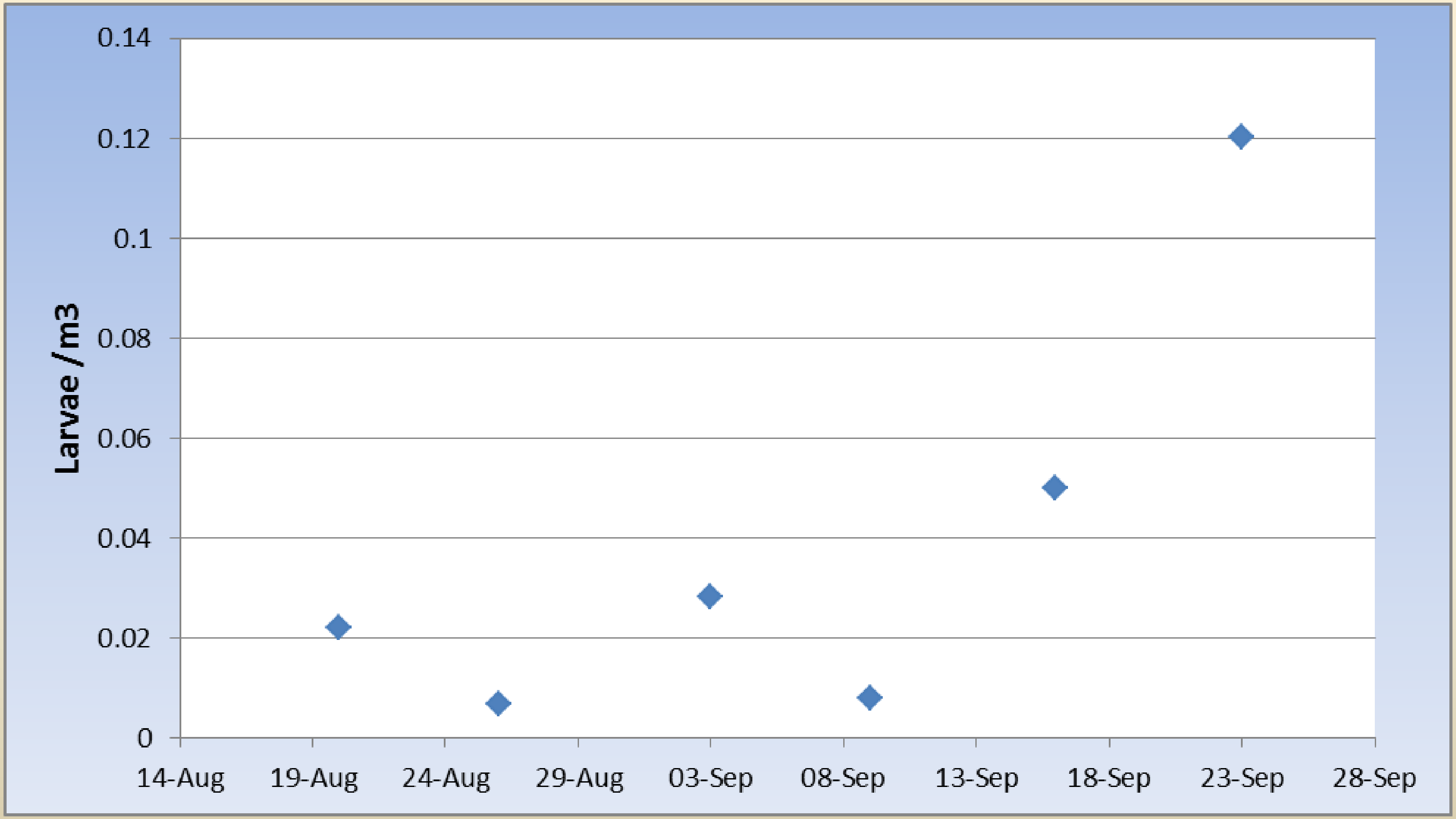
Larval Densities -1



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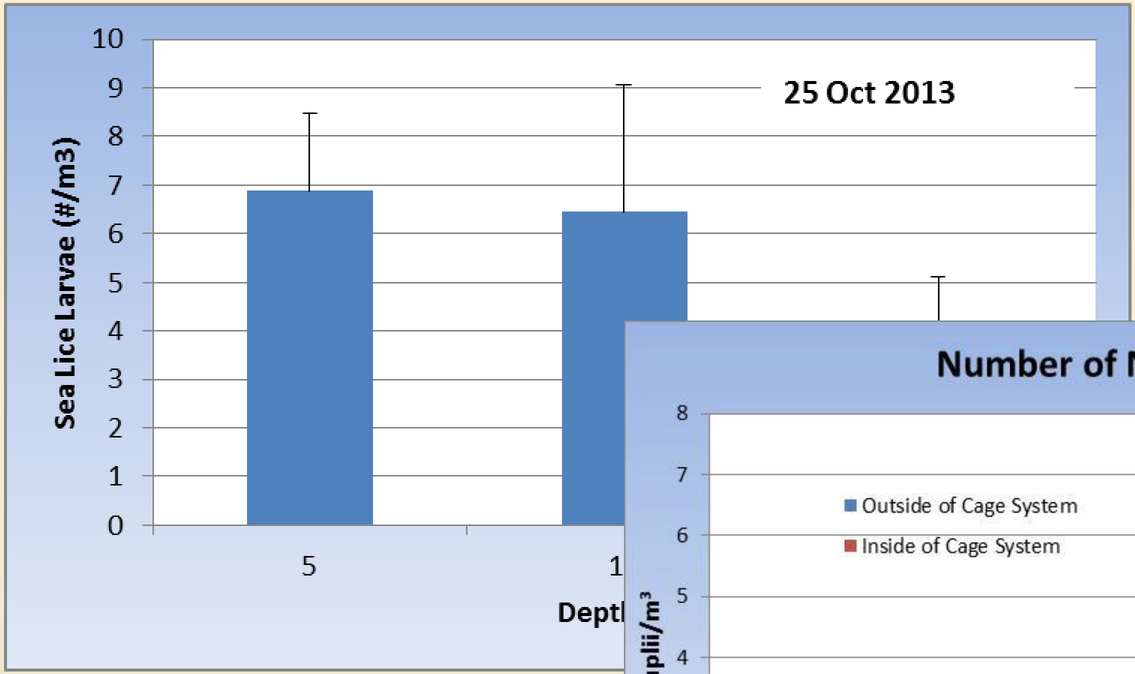
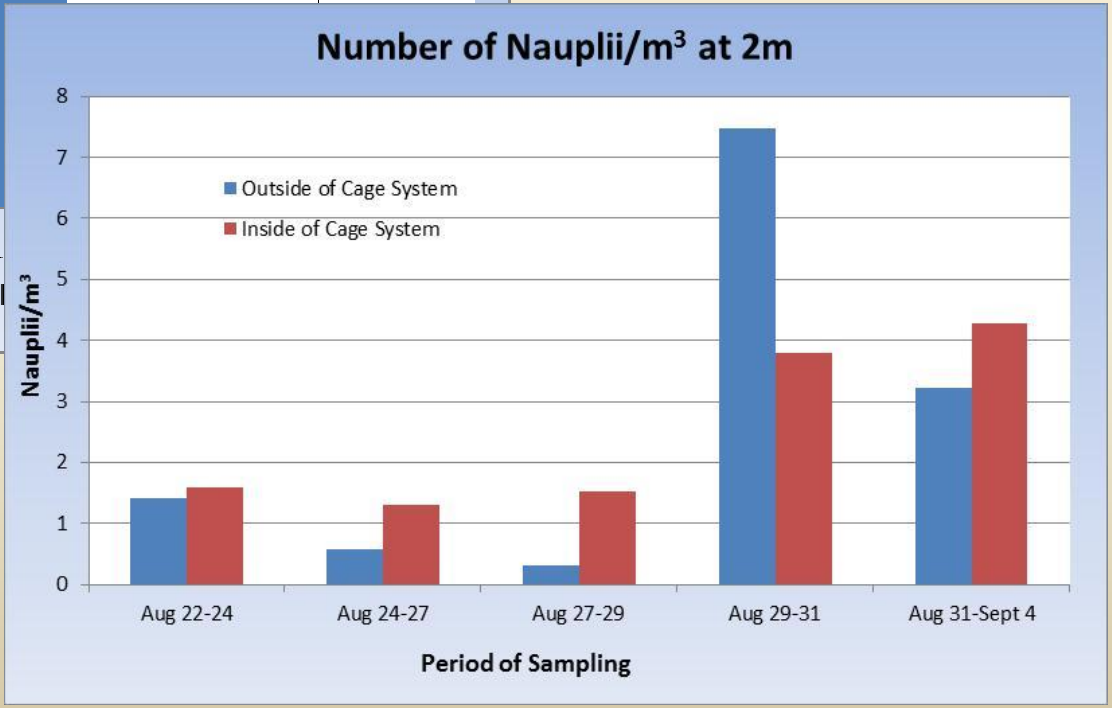
Larval Densities - 2





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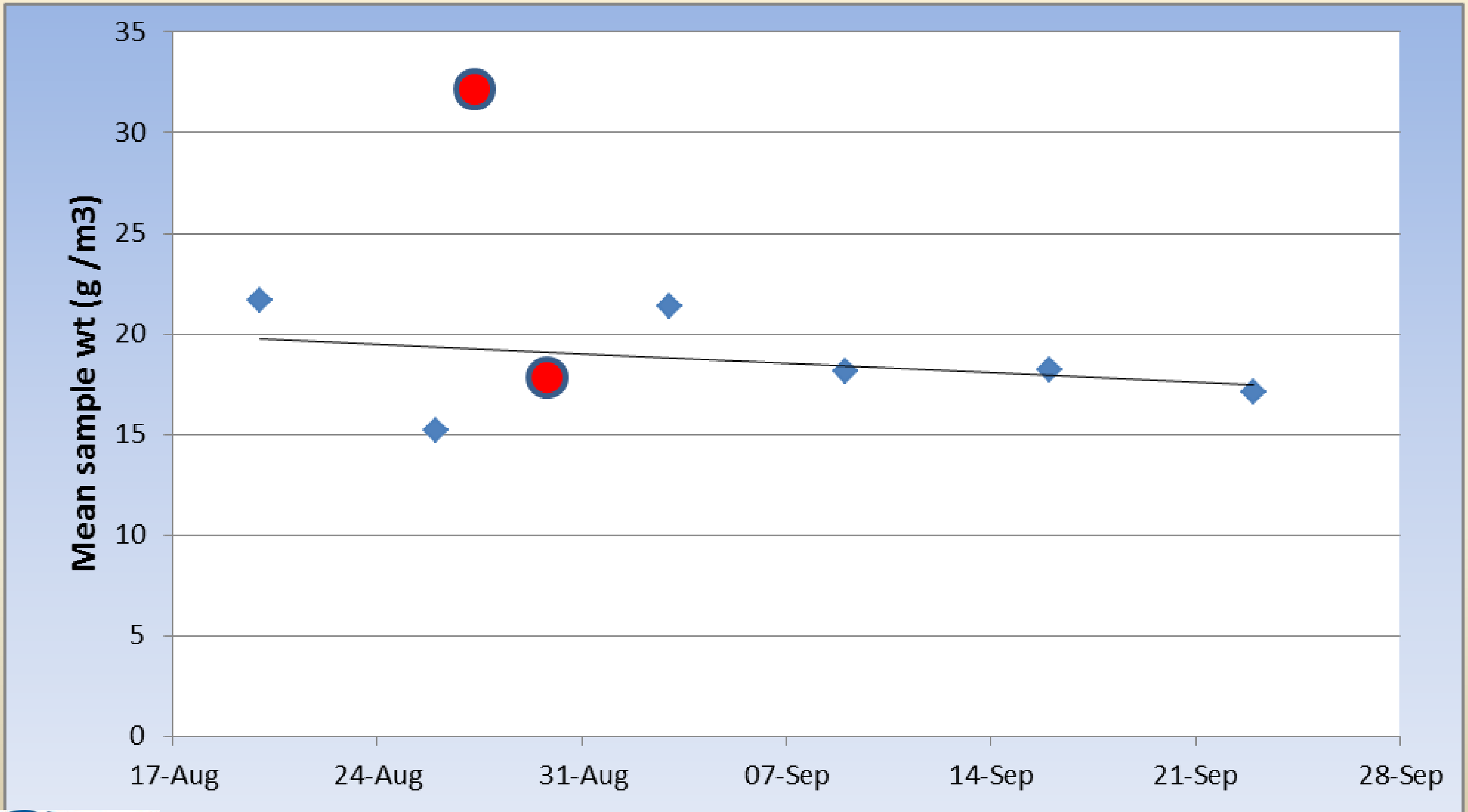
By-catch



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Analysis still to come …

- Lice counts on fish
  - Not all the data in yet
  - Some treatments on the site during experiment
  - No dramatic effects

- Plankton sample counts

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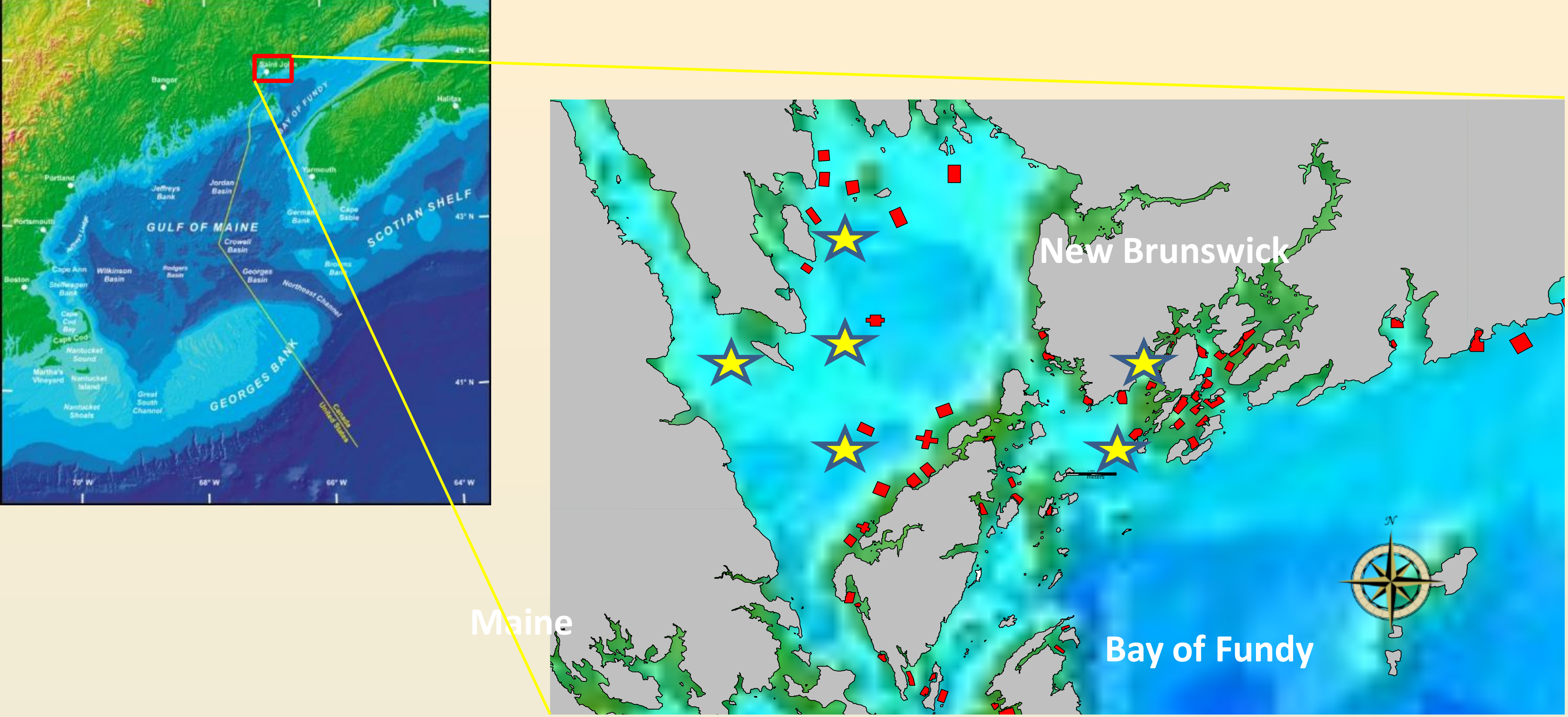
Talk Outline

Biology

- Distribution & abundance
- Swimming
- Hatching
- Oxygen demand



Larval Abundance On-Site vs. Off-Site at Surface, Mid-Water and Bottom Depths
(May – November)

		On-Site		Off-Site	
Depth	Samples	Nauplii	Copepodid	Nauplii	Copepodid
Surface	19	0	1	0	0
Mid-Water	19	2	0	0	0
Bottom	19	0	2	0	0

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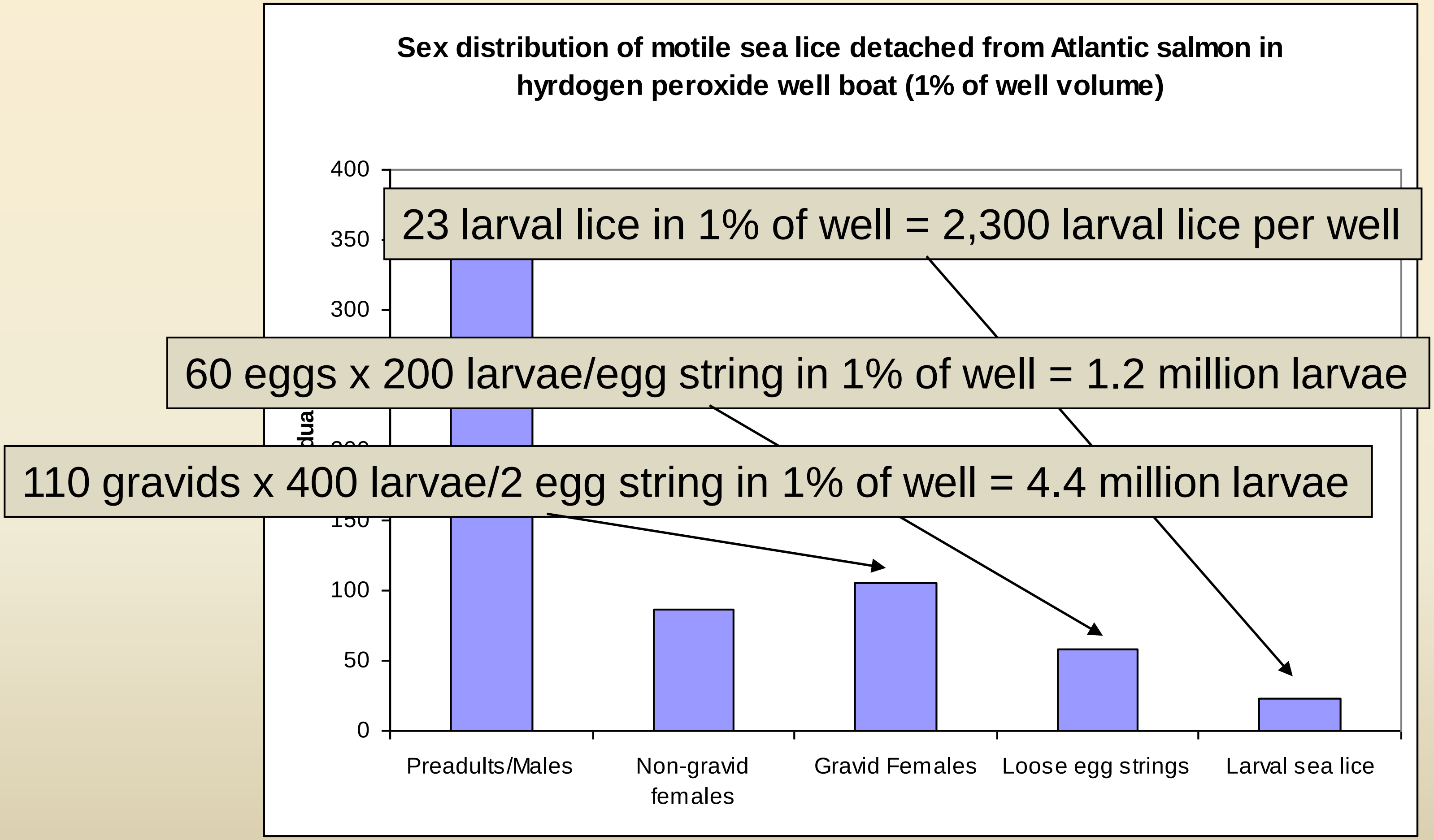
Sea lice by the numbers



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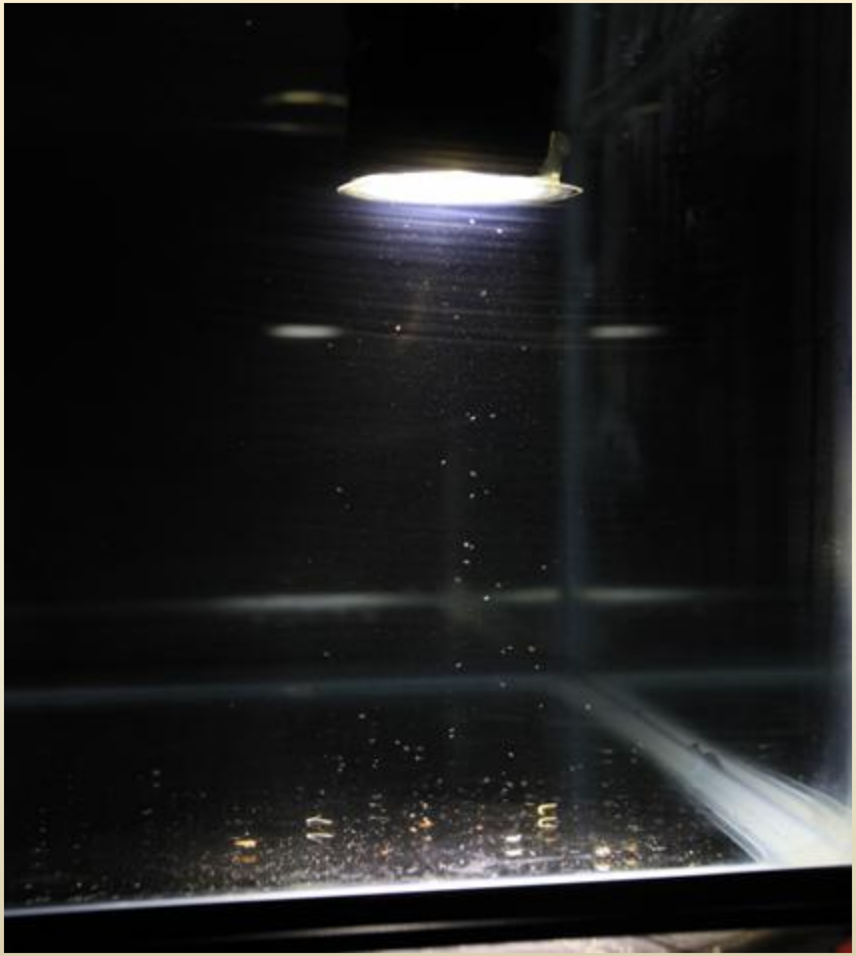
Swimming speed trials (2011)

- Light is an attractant for sea lice
  - Flamarique et al., 2009
  - Browman et al 2004
  - Pahl et al., 1999
- Move 50 cm in 60-120 s
  - Swimming speed: 4-8 mm/s
- Implications
  - 20 m per hour



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20

Sea lice race track

Height = 4.1m

= 8,200 body lengths

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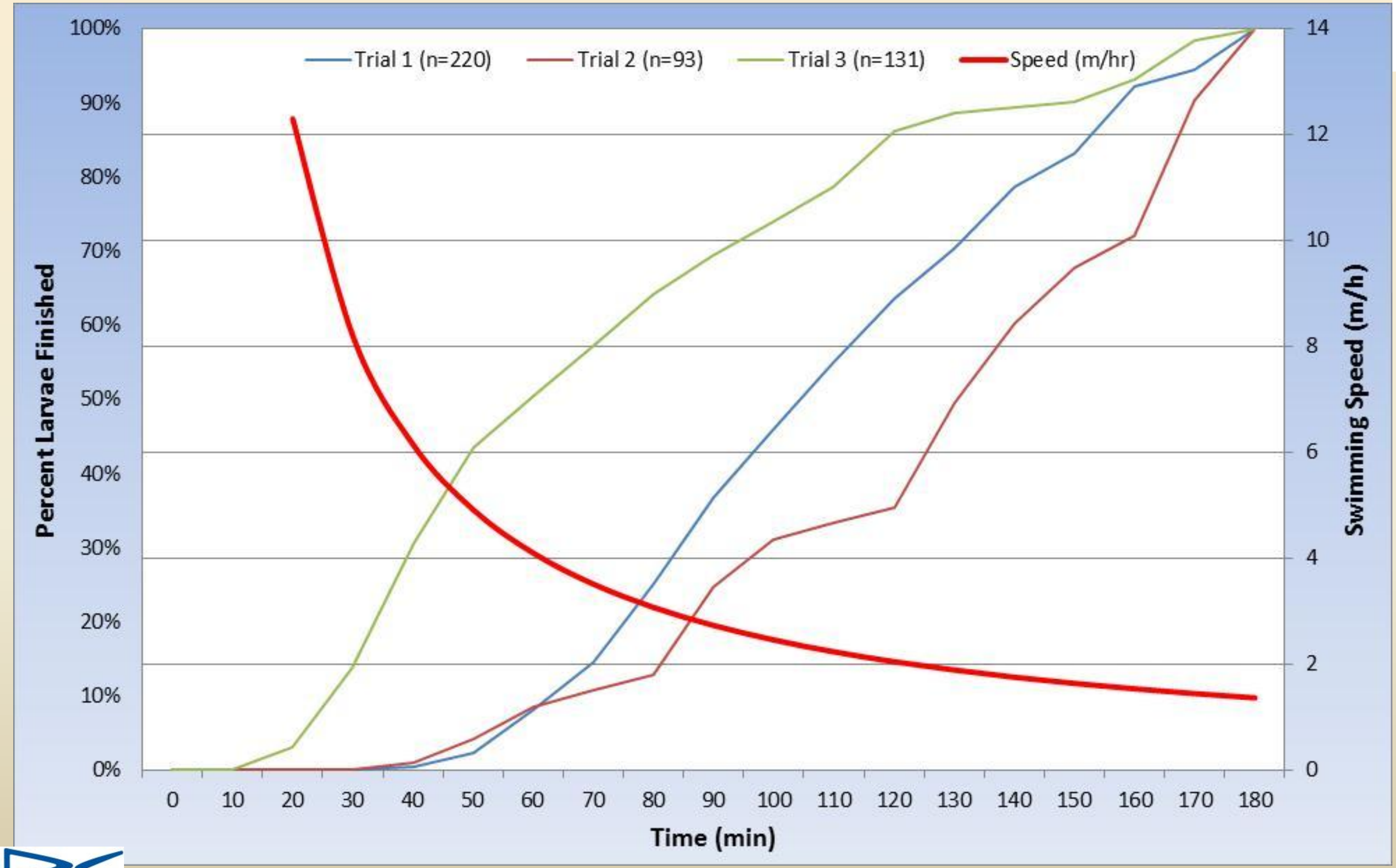
Sea lice larval races (4.1m)



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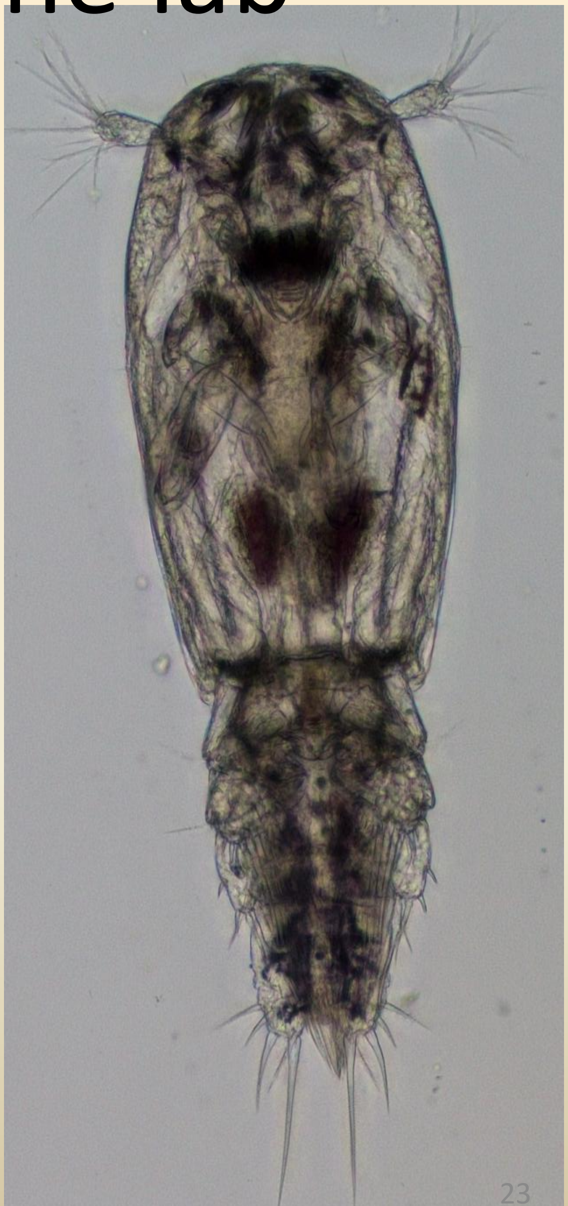
Day 5 vs Day 13 in the lab



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Hatching experiment

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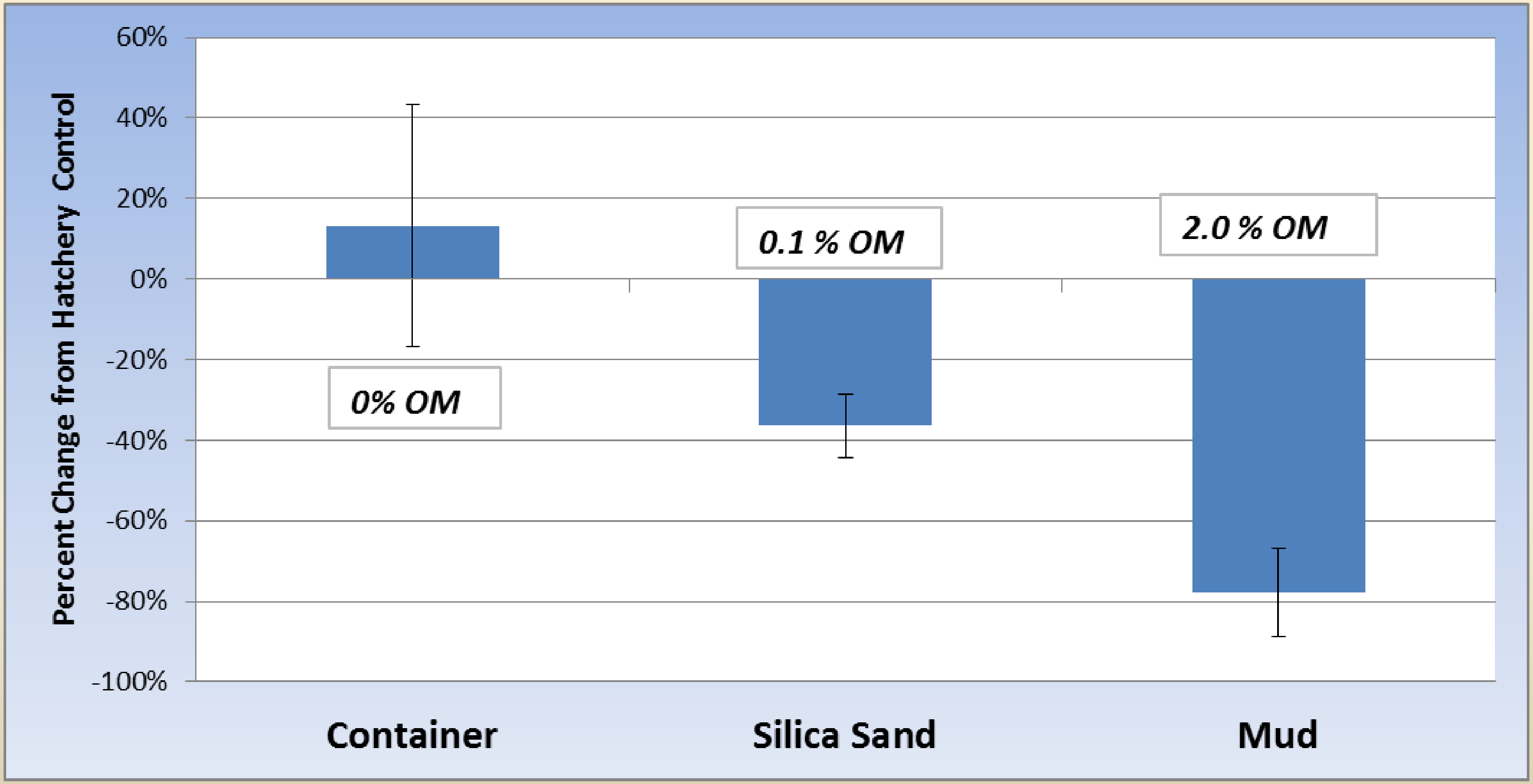
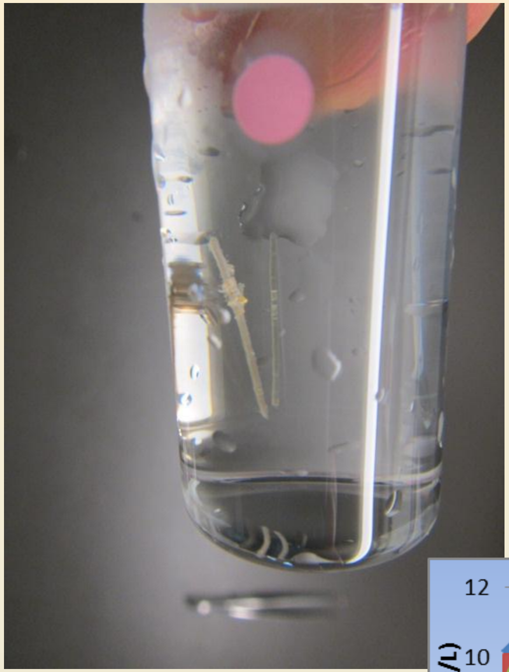
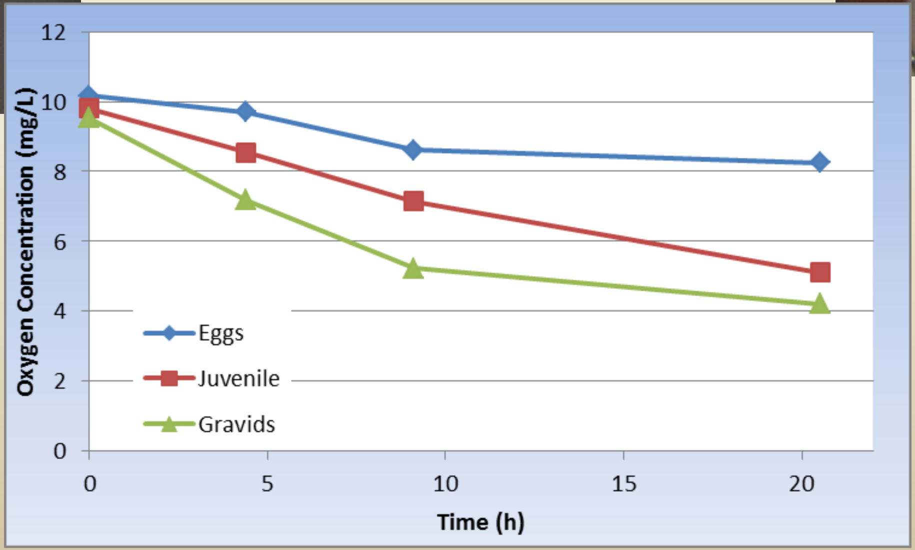
Hatching rates on sediment



Oxygen requirements





Conclusions - 1

- Sea lice are primarily associated with salmon aquaculture sites and are found at relatively low densities (1-8 /m^3) compared to other zooplankton that are often at 10,000 /m^3
- For a salmon site that is 100m x 100m x 20m, that means a larval standing stock of 200-800,000 larvae are available and looking for a host
- Traps are able to capture larval sea lice and easily fit on fish cages
- Light may not be enough with the current configuation. Power requirements of pump and lights are high. May also need an additional attractant; similar to agriculture.
- There is a by-catch of other zooplankton species. Filters can be modified to pre-filter the larger species and return to the sea.

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Conclusions - 2

- Data on lice densities on the salmon are not completely analyzed yet, but there are no obvious subjective differences.
- The larvae are found down to 20 m on a regular basis although we don't have a good understanding on the intermediate depths yet
- Swimming abilities of the larvae are impressive and some can maintain speeds up to10 m/hr over a 4 m track.
- The implications are that there are internal sea lice dynamics happening at the salmon farm sites that will have to be accommodated in order to control these parasites.

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Acknowledgements

- This work was supported by the DFO Aquaculture Collaborative Research Development Program (ACRDP)
- Thanks to Cooke Aquaculture Inc, particularly Jody Hanley, Keng Pee Ang, Michael Szemerda and Randy Griffin
- Particular thanks to Craig Smith, Terralynn Lander, Vikky Merritt-Carr
- Thanks to the captain and crew of the Canadian Coast Guard Viola M. Davidson for all their help

St. Andrews Biological Station Station Biologique De St Andrews

Questions?

“Cunner as Cleaner Fish” and “Cunner Breeding Program”

ACFFA Workshop

November 2013

CANADA'S BEST MANAGED COMPANIES Platinum member

Cooke AQUACULTURE Inc.

Wrasse Hatchery in Norway

Cunner Fish

Tank Trials at the Huntsman Marine Science Centre

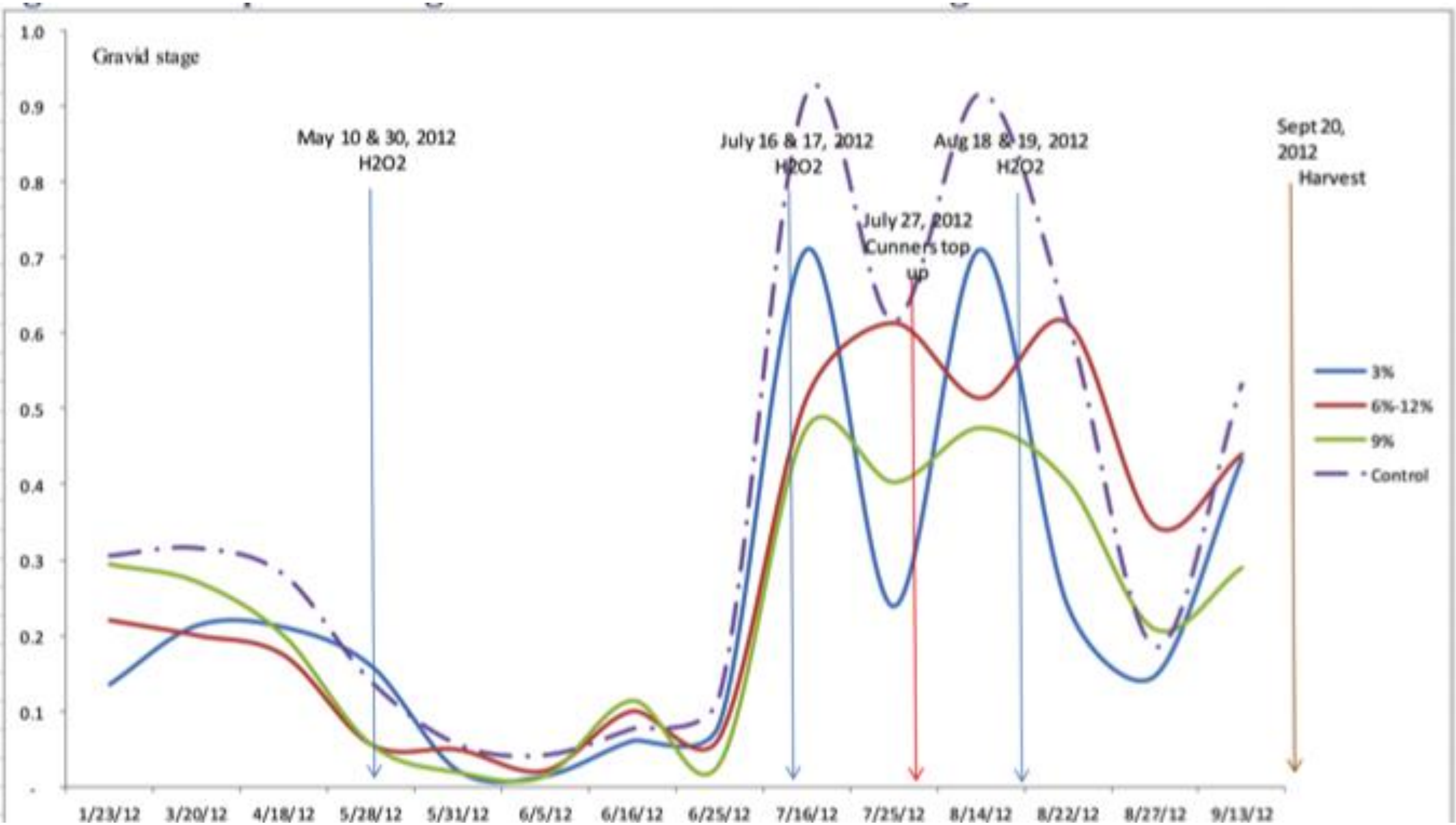
Transfer to Sea Cages for Field Trials

Field Trials at Back Bay Sea Site

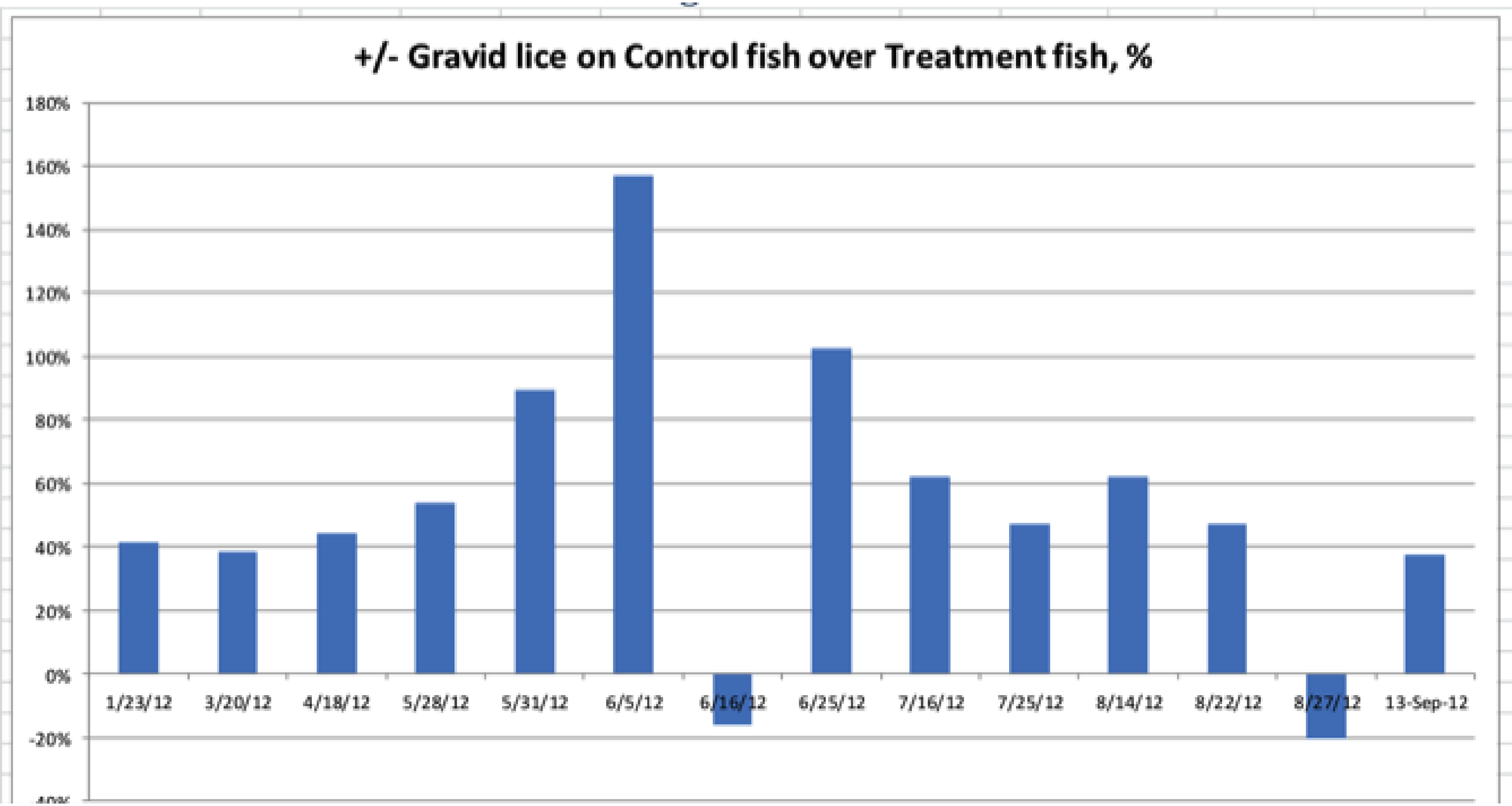
Behaviour ObservationTrials

Behaviour ObservationTrials

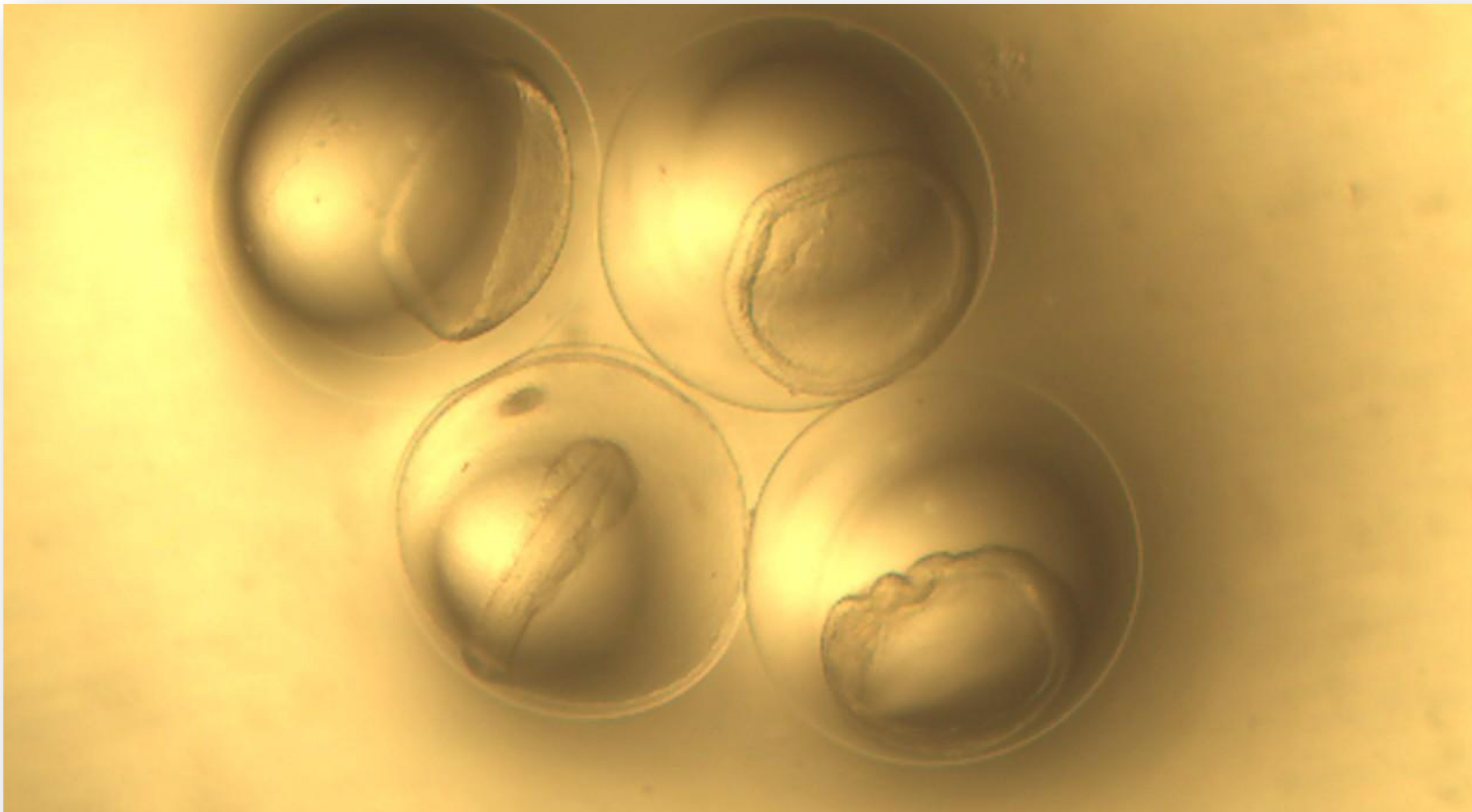
Graph showing trends in levels of Gravid stage lice



Graph showing percent higher or lower levels of gravids on fish in control cages over those on fish in the treatment cages.

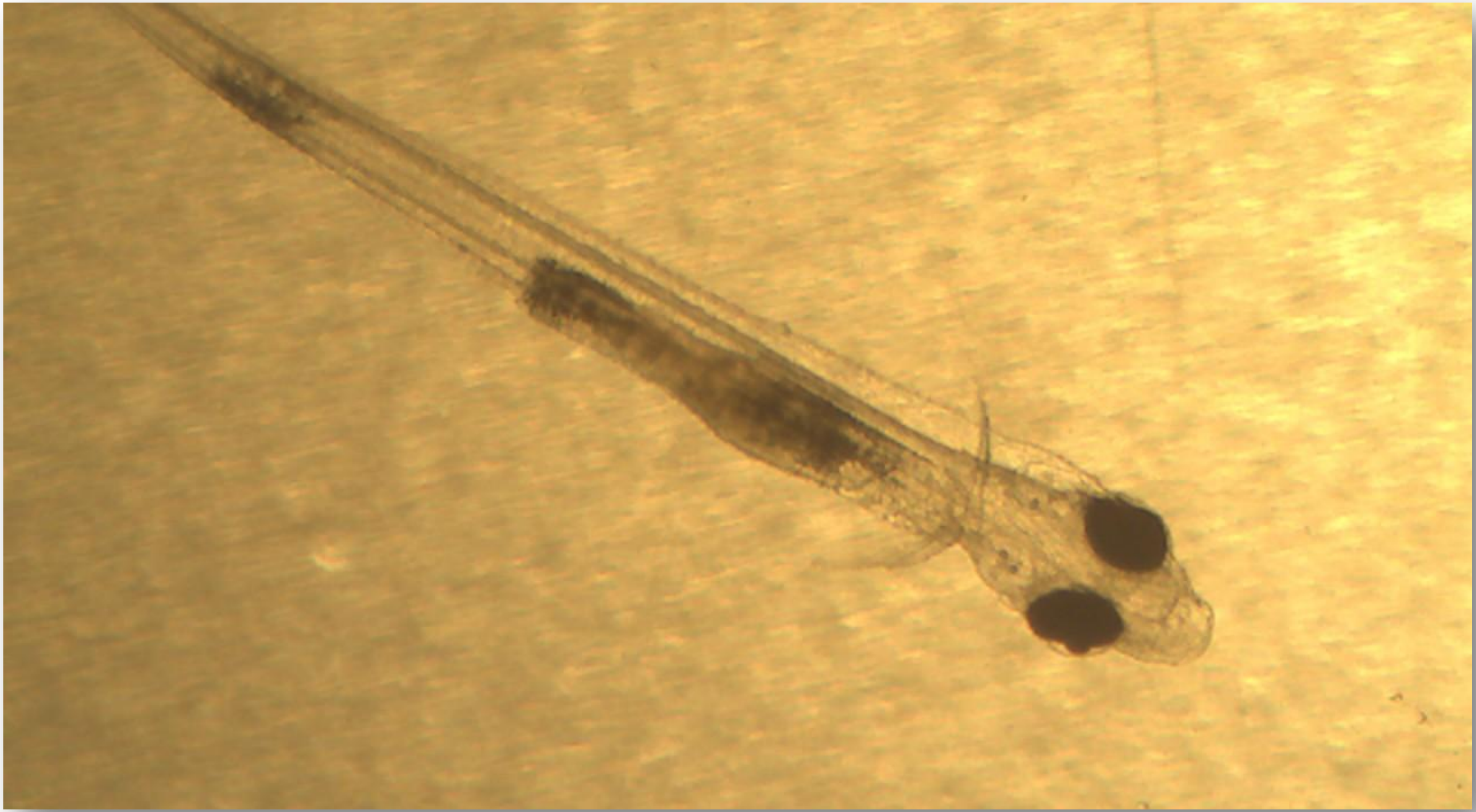


Cunner Eggs – August 2013

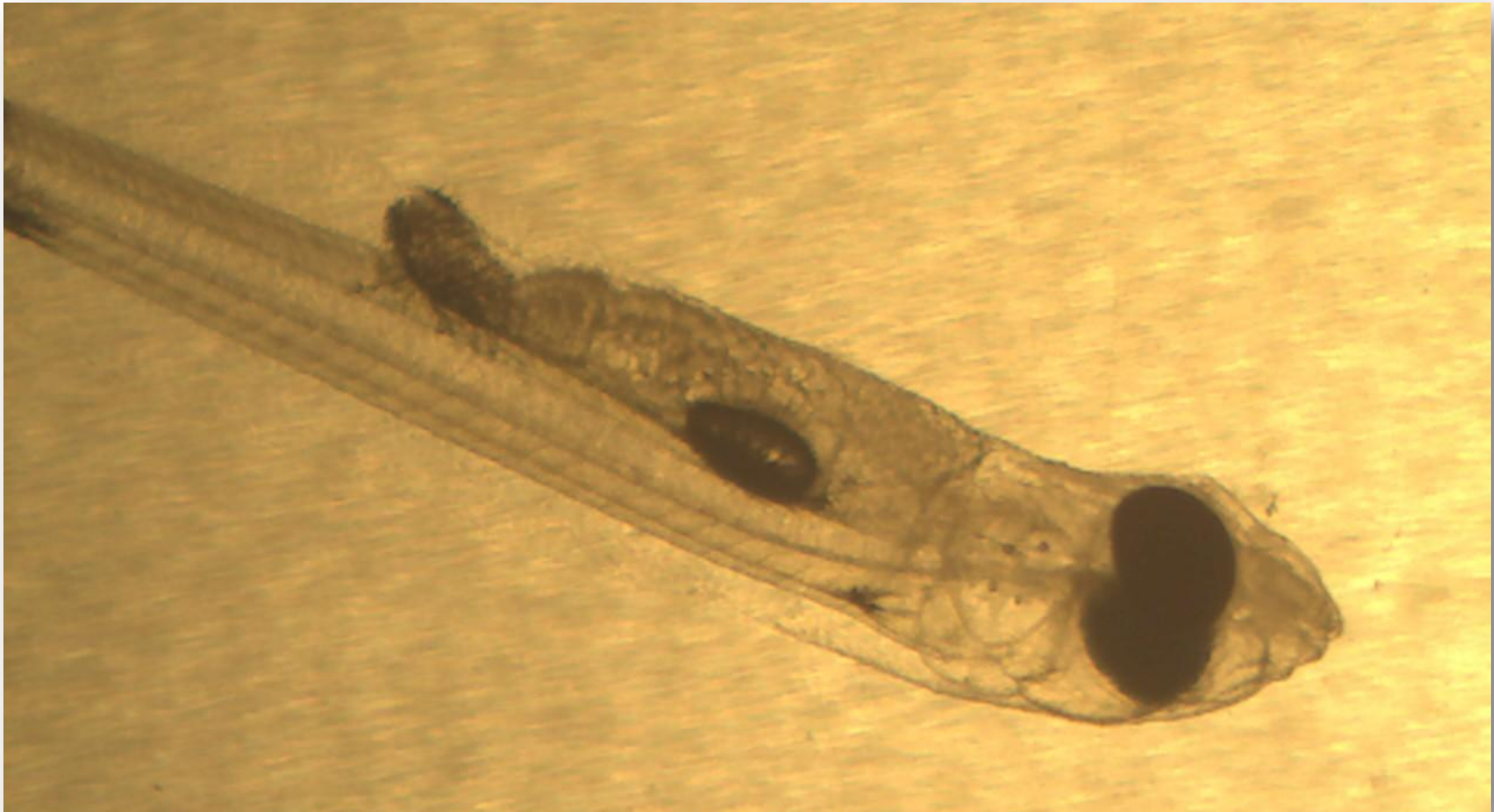


Cunner Eggs & Larva

Cunner Larvae – August 31



Cunner Larvae – September




Thank You

stingray

Stingray Marine Solutions AS

Optical Sea Lice Treatment

Esben Beck & John A. Breivik

Non-medical solution

stingray

- <u>The Problem:</u>

Salmon farmers biggest problem in many parts of the world is to fight sea lice.

- <u>Our Solution:</u>

To use camera vision, advanced software and laser to gently remove sea lice.

And it all started in the basement...

stingray

Medical Applications

Remote Interventions

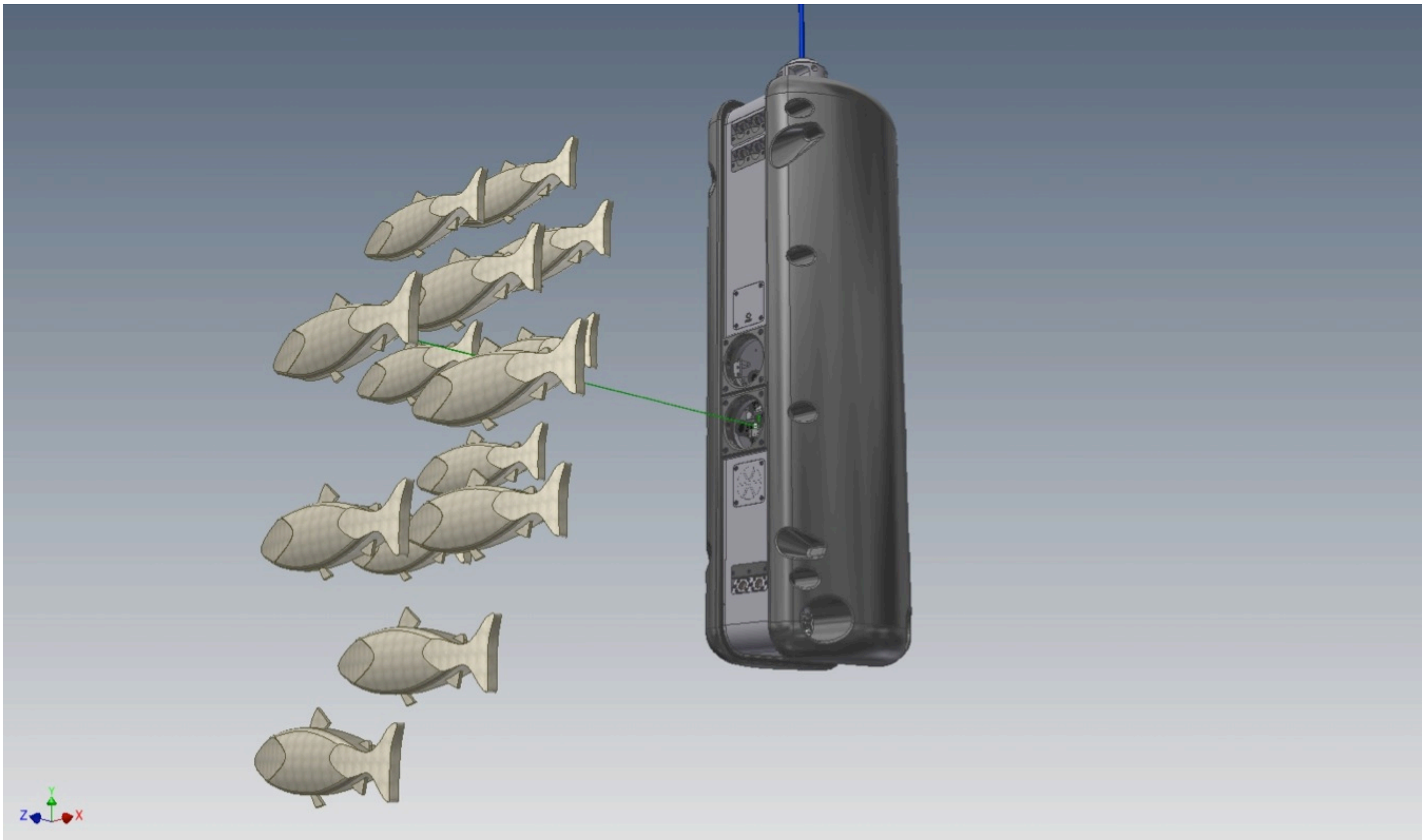
ROV - Technology

Optical Delousing – Basic Principles

stingray

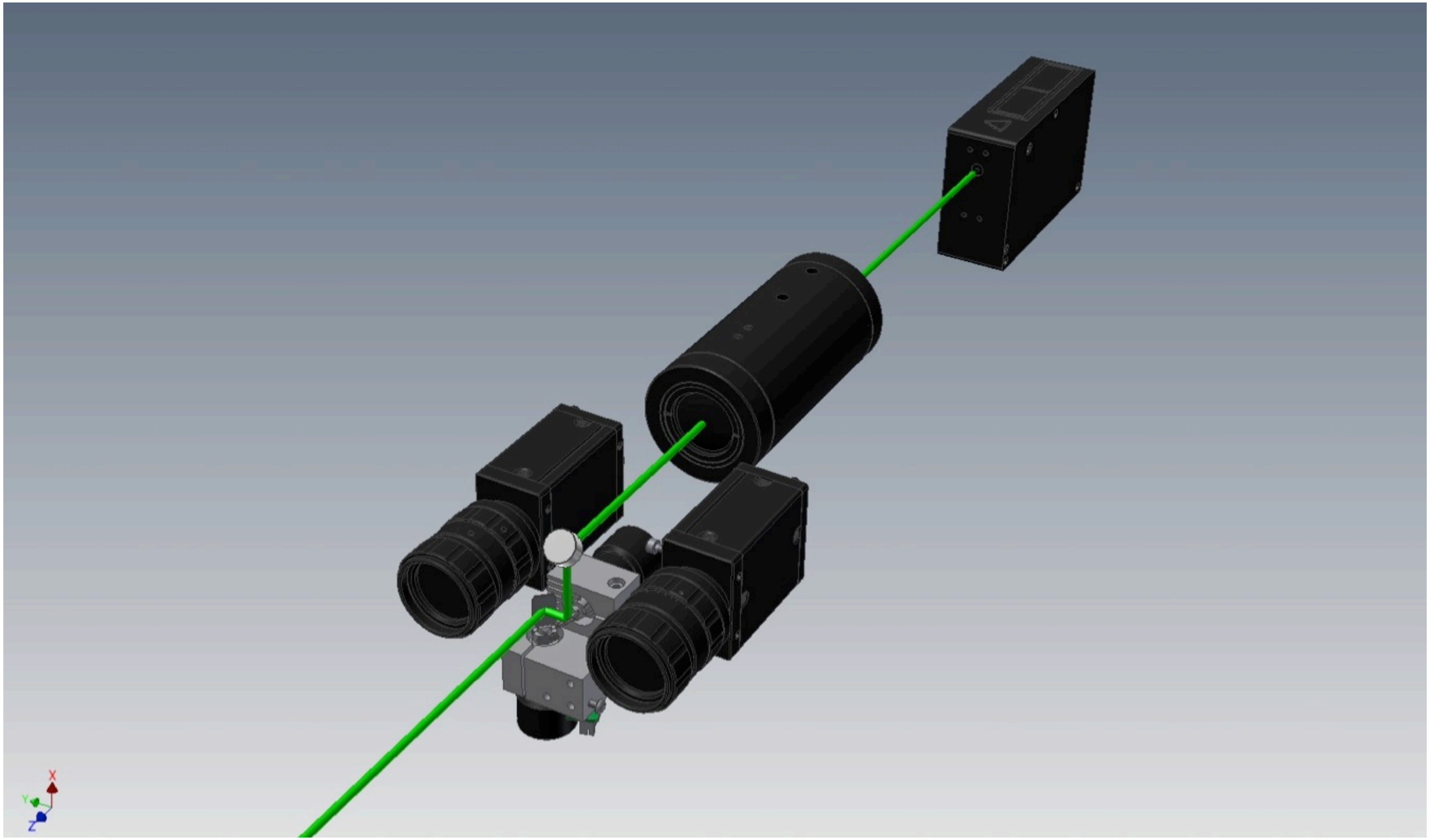
Stingray Main Components

stingray



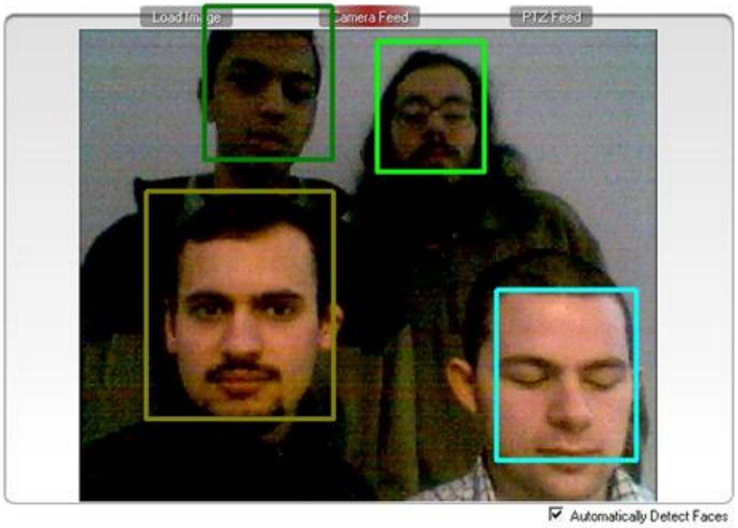
Optical Components – Industry Standard

stingray

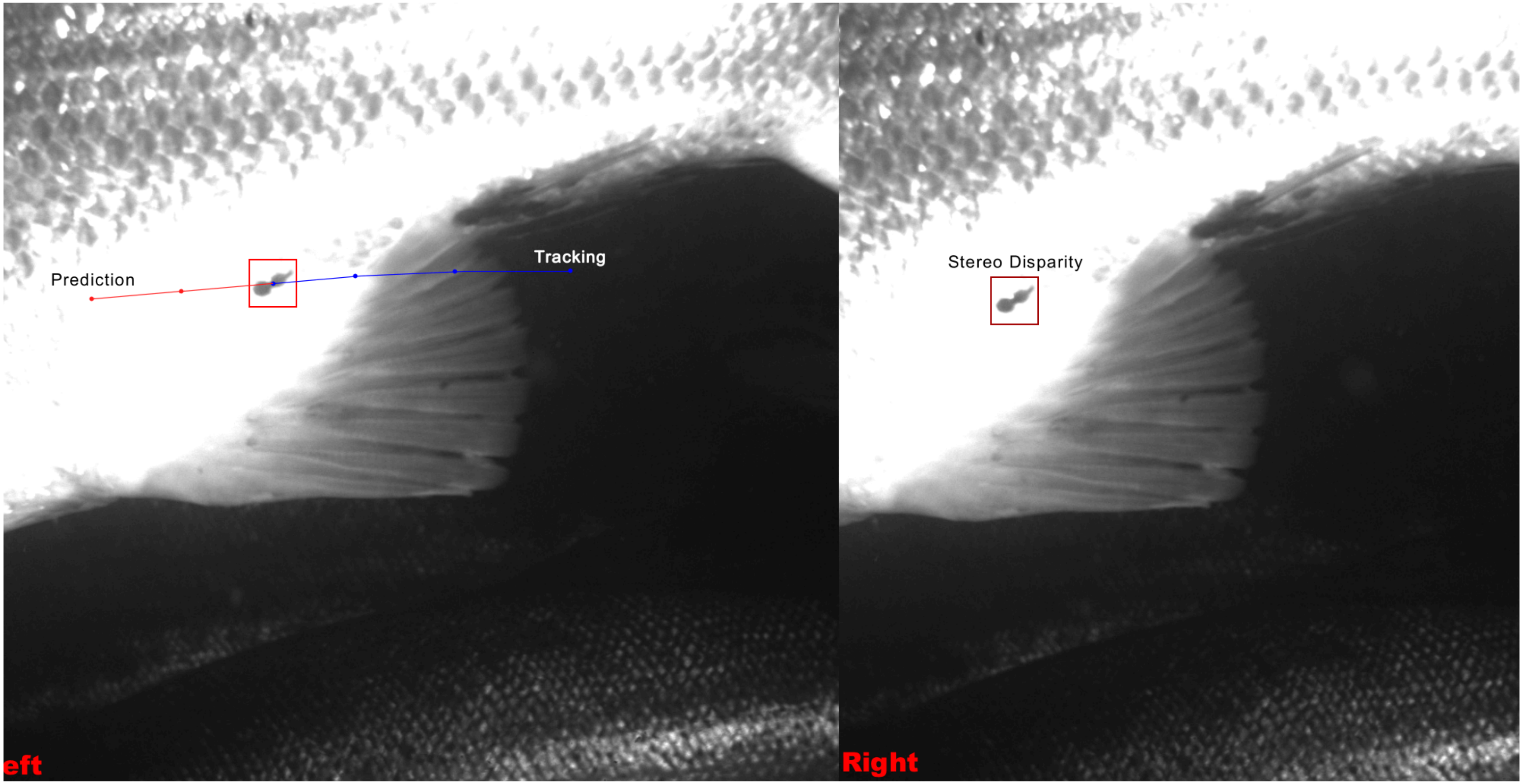


Machine Vision – A Proven Technology

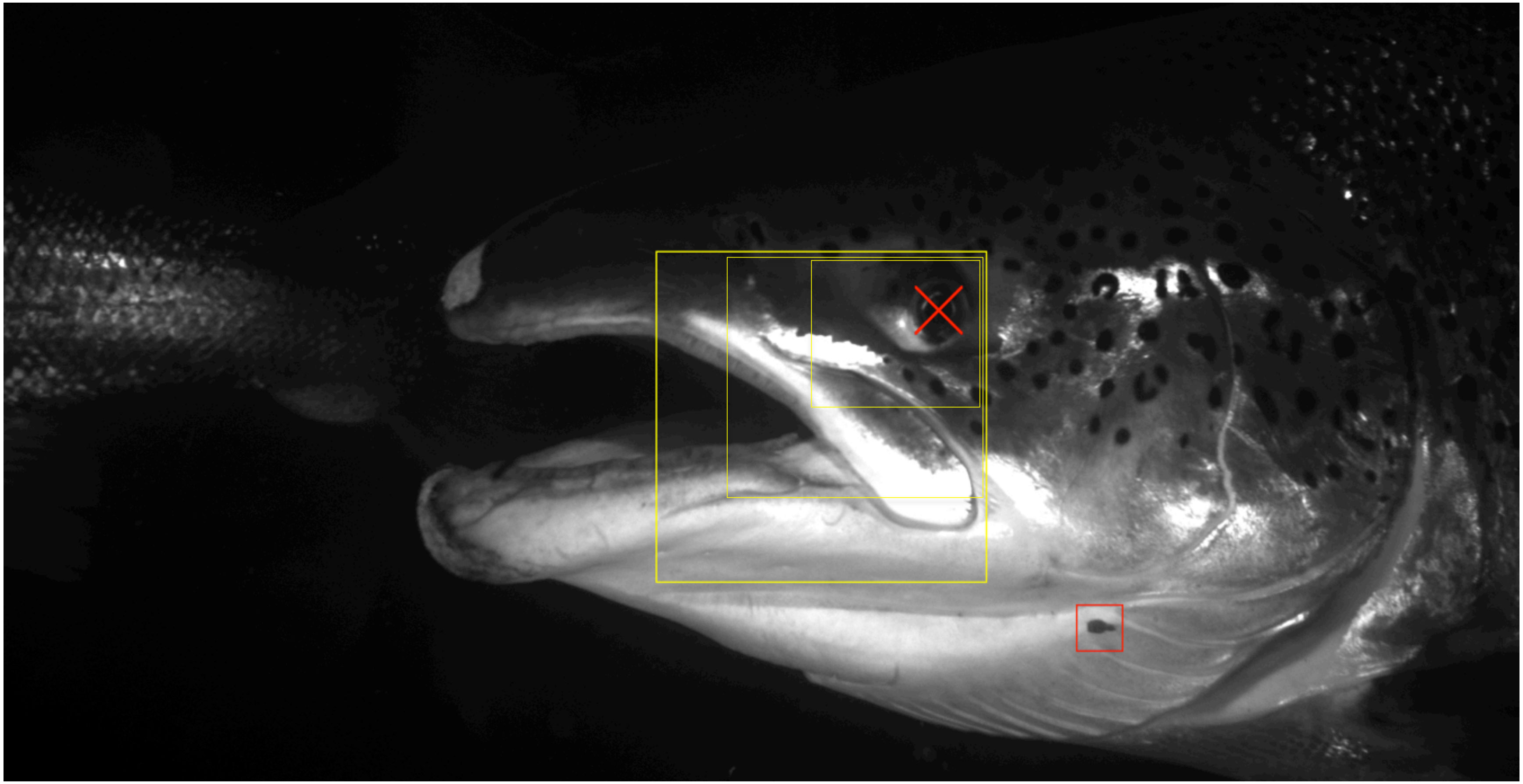
stingray



Stereo Vision



Eye Protection & Precision



Optical Sea Lice Treatment in Action

stingray

- Animation:

How to operate the system.

- Video from trials:

Capture – Detect – Track

A parasite that survives chemicals

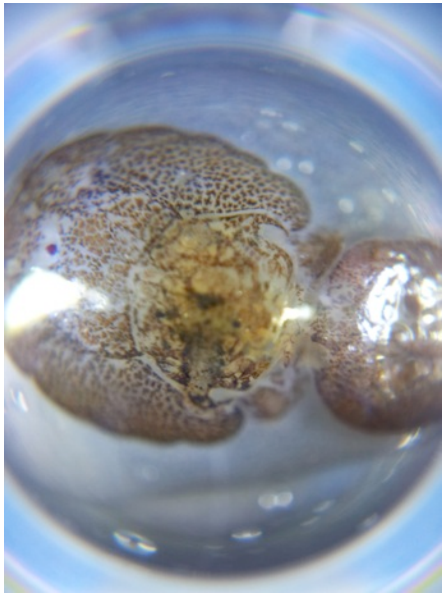
stingray

Sea Lice

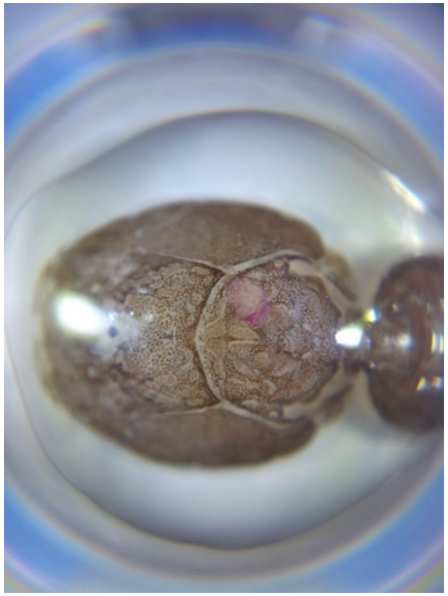
A health and environment issue!

Laser is lethal to Sea Lice

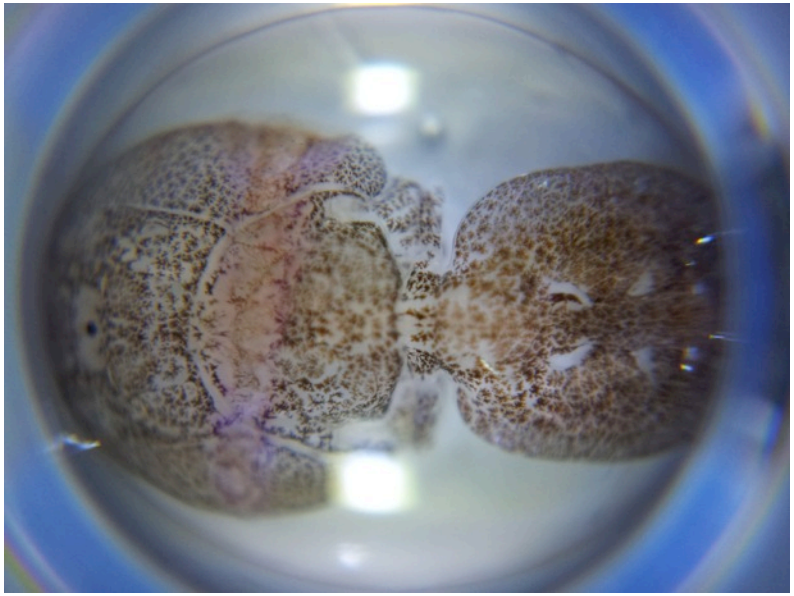
stingray



100 ms



20 ms



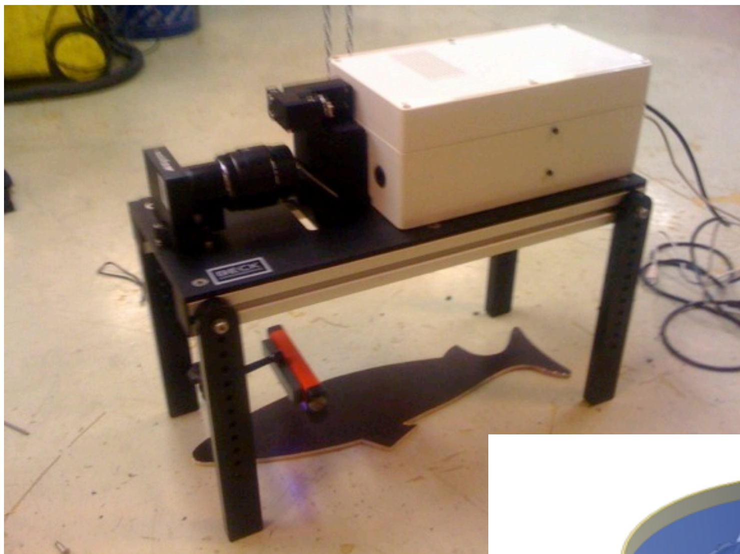
Swipe

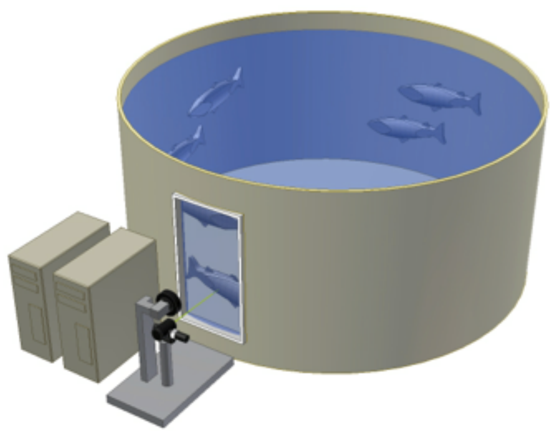
Background & The Stingray Team

stingray

- 15 years of "problem solving" in Beck Engineering AS. (Oil & Gas, Offshore Technology & Medical Applications)
- A highly skilled team with a proven track record.
- Advanced and patented technology.
- We control design, production in own facilities, R&D, assembly, testing, installation and support.

Our Journey so far...



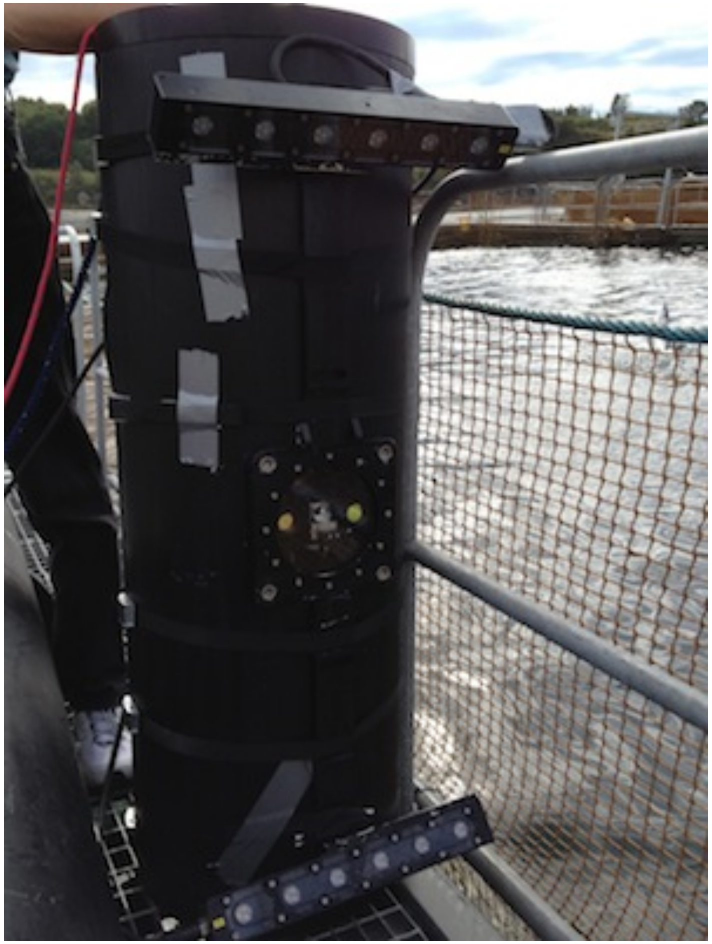


Initial testing of cameras and lasers in lab facilities.

How to wrap a complex technology into a smaller unit.

Stingray Version 1 & 2

stingray



Errors, Trials, Knowledge & Hard Work

stingray

Test unit with buoy and rack.

3 years of Research & Development

stingray

- Phase 1: Successful proof-of-concept in lab (2011)
- Phase 2: Development & production of test units (2012-13)
- Phase 3: Improvements in hardware & software (-> 2014)

PARTNERS:

- Project spending so far (per Jan. 2014): ≈ 40 MNOK ≈ 7 MCAD
- Total man hours in the project: ≈ 40,000

Comparing delousing methods

stingray

Optical Delousing

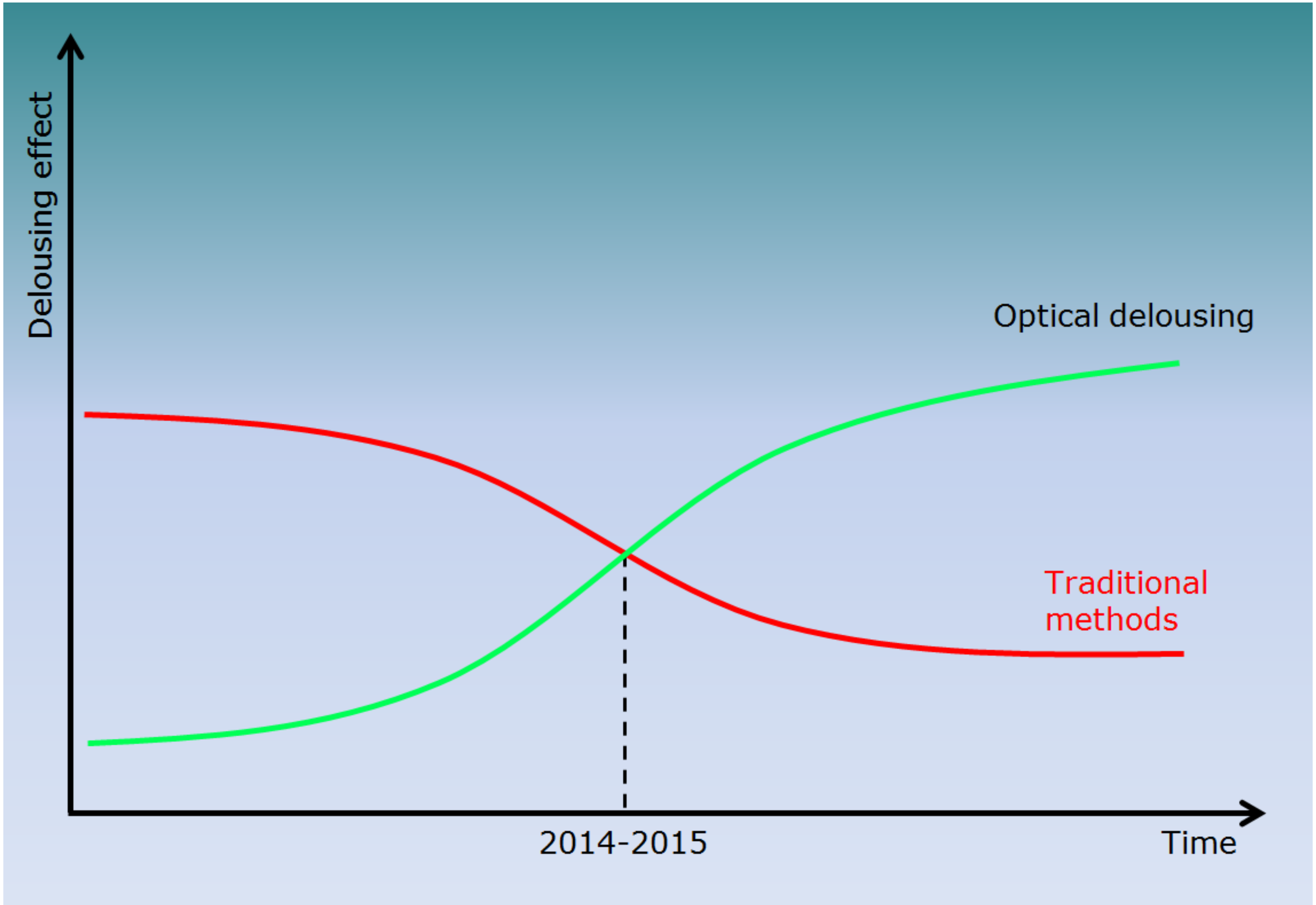
- Precise and effective.
- Automated and preventive.
- No stress and in “natural” setting.
- Information collecting 24/7.
- Cost effective and permanent.
- Sustainable and future oriented.

Existing methods

- Sea Lice become multi-resistant.
- Labour intensive and reactive.
- Chemicals create HSE-problems.
- Cleaner fish can’t give much info.
- Expensive to “lose” control.
- Harmful to fish welfare.

Effect from existing methods vs. Optical Delousing

stingray



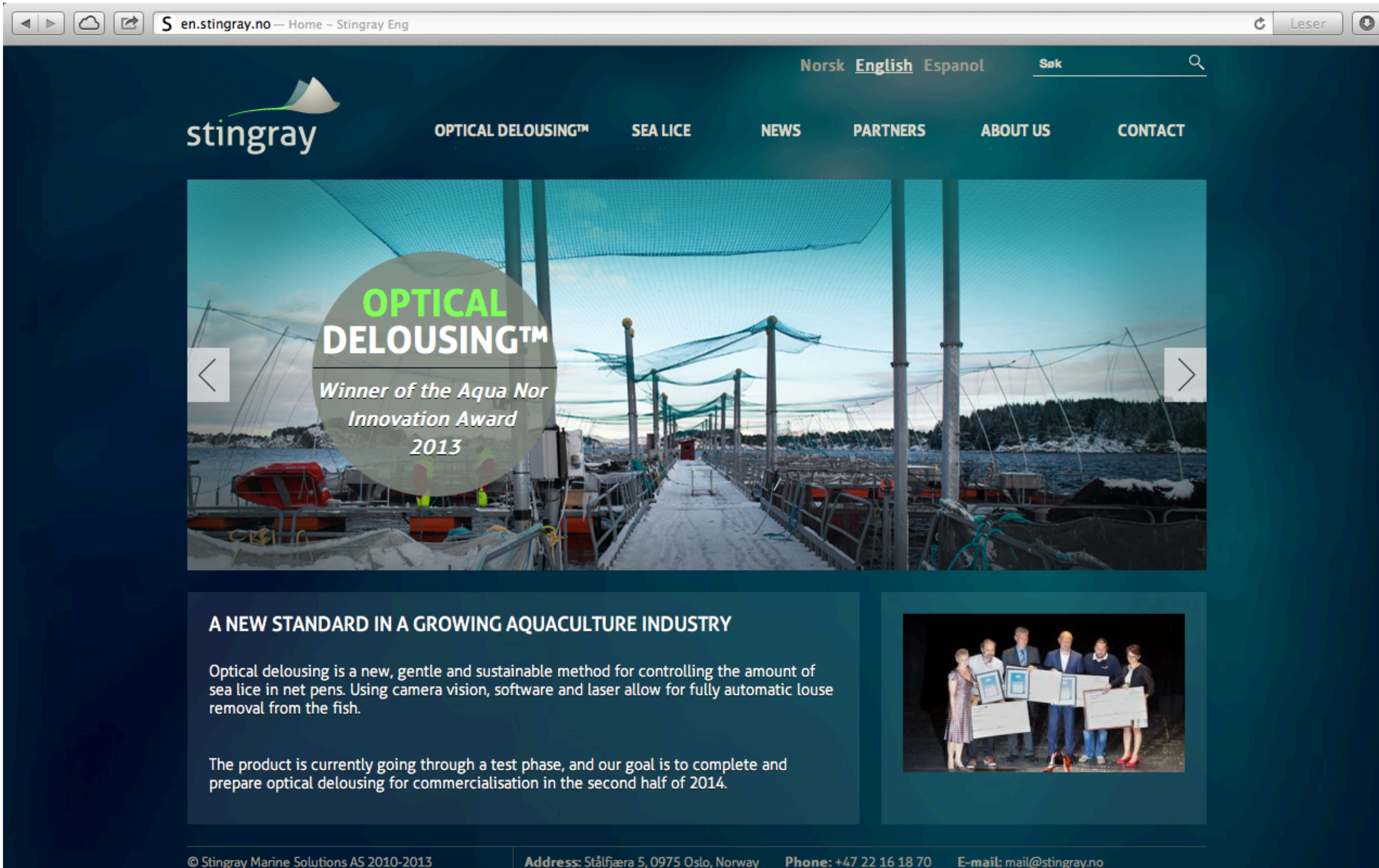
The Next Steps

stingray

- Stingray aim to be 1 of 3 preferred methods for delousing within the next 3-5 years.
- Prototype series during spring 2014, going to market in fall 2014, building capasity for growth and R&D.
- We hope to include Canadian farmers in future testing.
- Become an important solution for growth in Canadian fish farming with a sustainable method.

For more info visit stingray.no

stingray



Q & A

Thank you for your attention!

Contact: John A. Breivik
Mob: +47 4046 4040
E-mail: john.breivik@stingray.no

SORICIMED

Development of a new biopesticide against sea lice

Delphine Ditlecadet, PhD

Overview

- Soricimed Biopharma Inc. (SBI)
- The use of baculoviruses as biopesticides
- Application of SBI's technology to the sea lice's issue

SORICIMED

About Soricimed Biopharma Inc.

- Private company established in 2005 following the discovery of a small peptide called **Soricidin**

SORICIMED

Soricidin

- Paralytic peptide isolated in 2000 from the short-tailed shrew saliva

Blarina brevidauda (F: soricidae)

About Soricimed Biopharma Inc.

- Various R&D platforms all based on soricidin properties
  - Cancer treatment with a focus on ovarian cancer (Clinical Phase I)
  - Diagnostic tests for early detection of ovarian, breast and prostate cancers
  - Drug delivery platform to tumours and/or to lymph nodes
  - Pain treatment
  - Other applications

SORICIMED

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  - Drug delivery platform to tumours and/or to lymph nodes
  - Pain treatment
  - **Other applications: Paralytic peptide for use as a pesticide (US Patent 8003754 issued to Soricimed 23 August, 2011)**

SORICIMED

SORICIMED

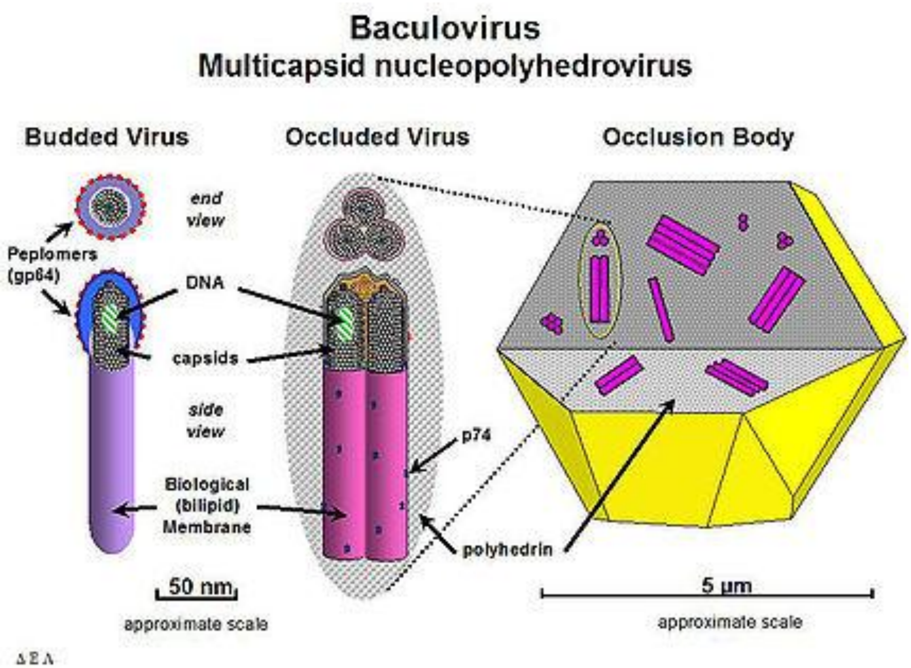
The use of baculovirus as biopesticides

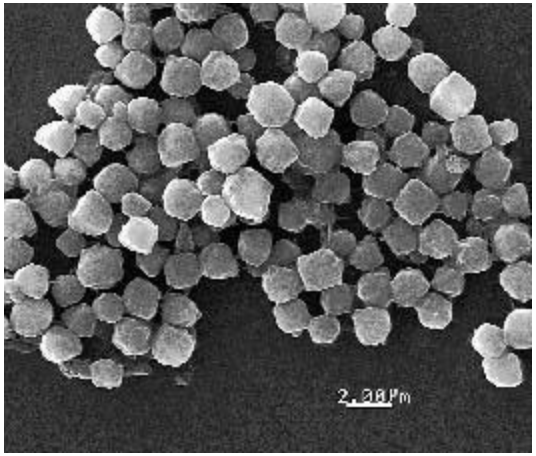
What are baculoviruses (BV)

- Baculoviruses are viruses highly specific to arthropods (insects, arachnids, crustaceans)
- Ubiquitous in nature
- Very well-known and documented
- Narrow range of hosts (species-specific)
- Used in agriculture/forestry for decades
- Do not infect vertebrates—safe to people, agricultural animals…
- Part of the "Low-risk candidate microbial pest control agents" (REBECA, 2007)

SORICIMED

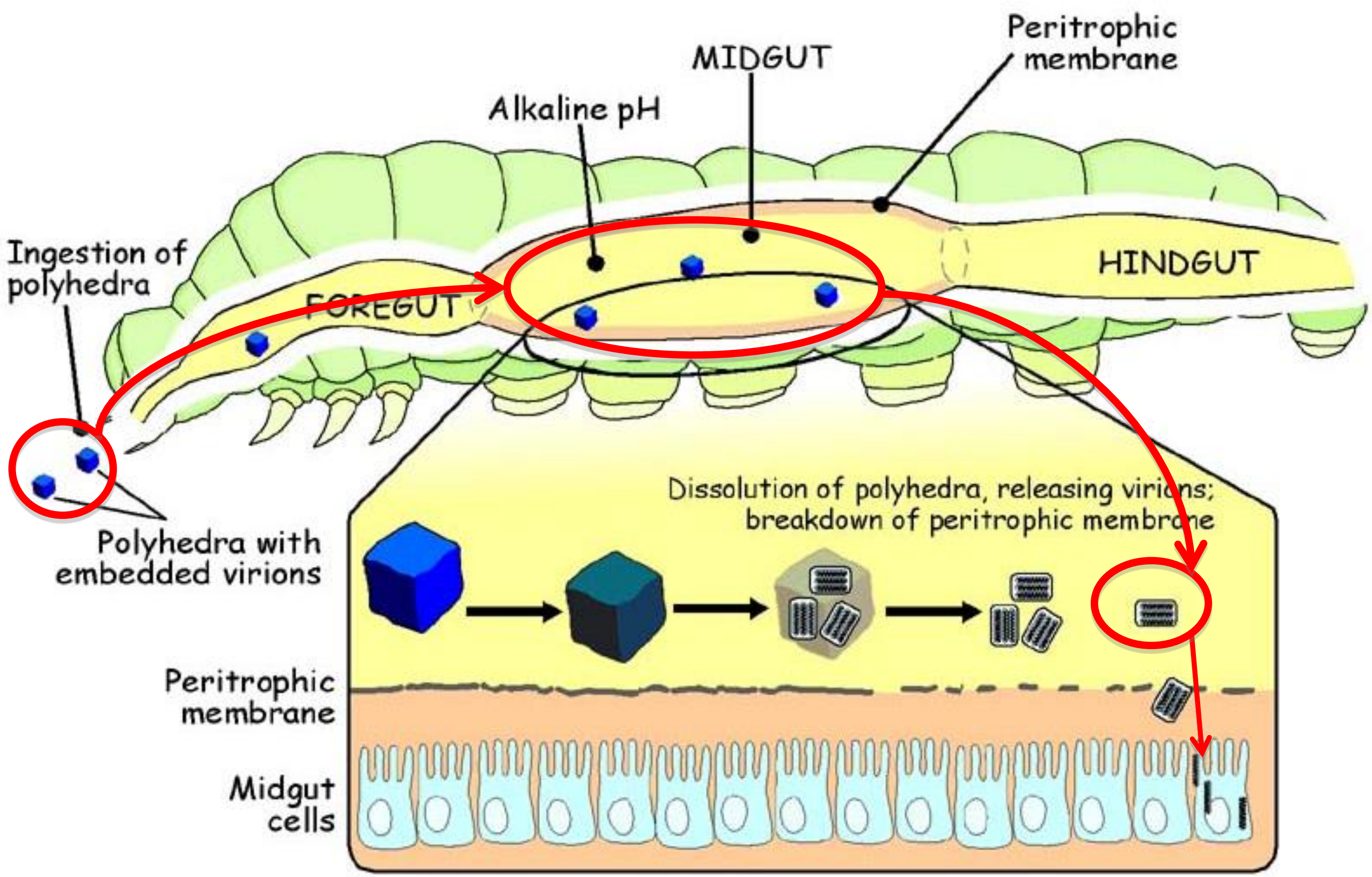
A NPV baculovirus





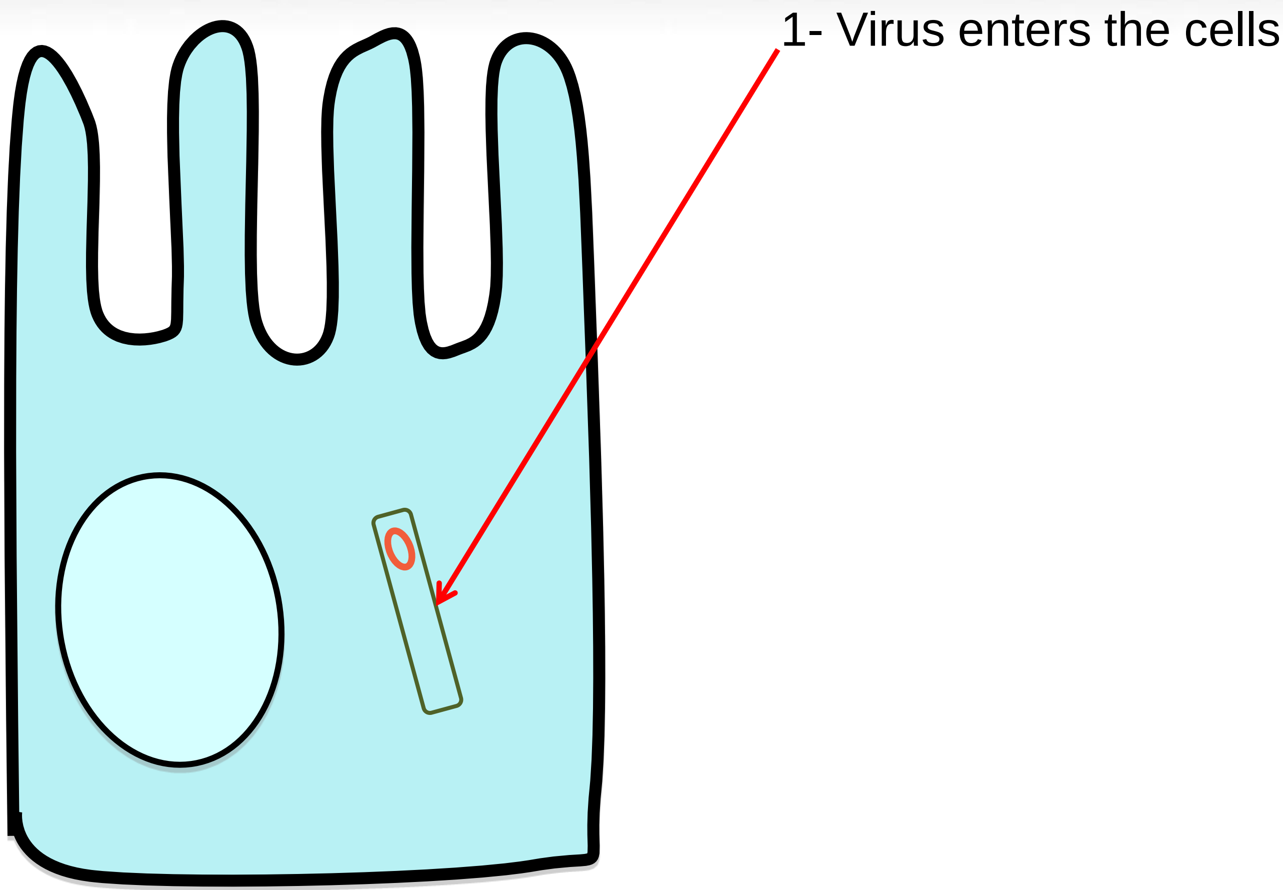
Occlusion bodies or polyhedra

SORICIMED



MIDGUT
Peritrophic membrane
Alkaline pH
Ingestion of polyhedra
FOREGUT
HINDGUT
Polyhedra with embedded virions
Dissolution of polyhedra, releasing virions; breakdown of peritrophic membrane
Peritrophic membrane
Midgut cells

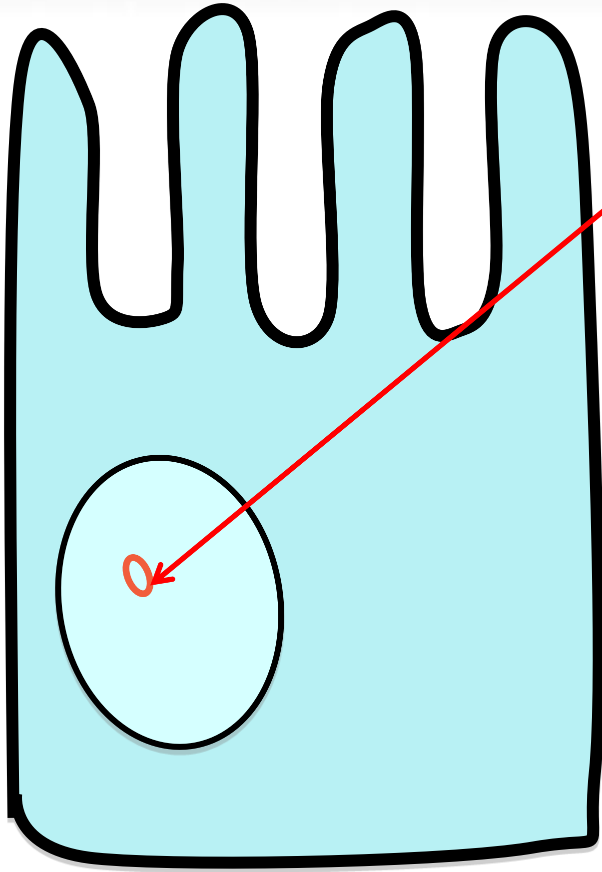
Insect's infection by BV



Midgut cells

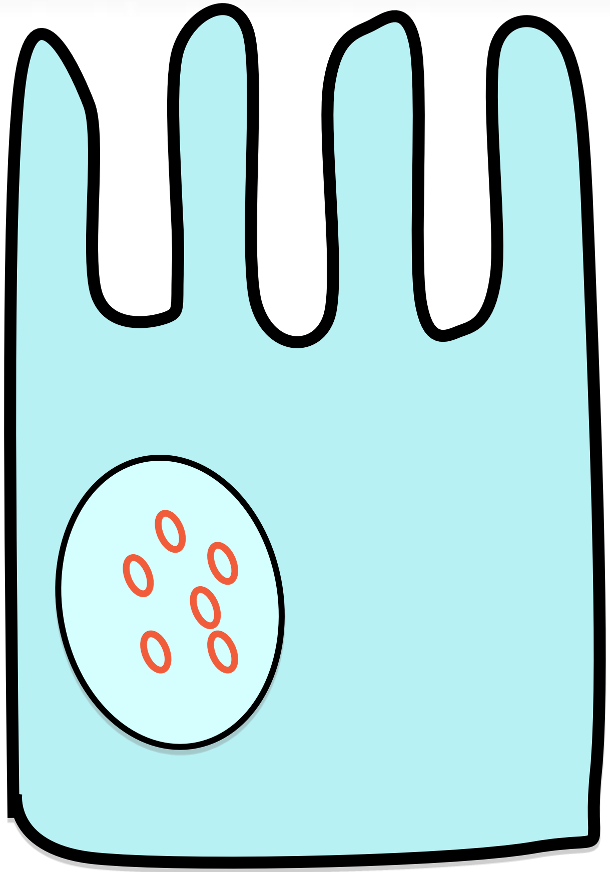
Insect's infection by BV

1- Virus enters the cells
2- Viral DNA enters the cell nucleus



Midgut cells

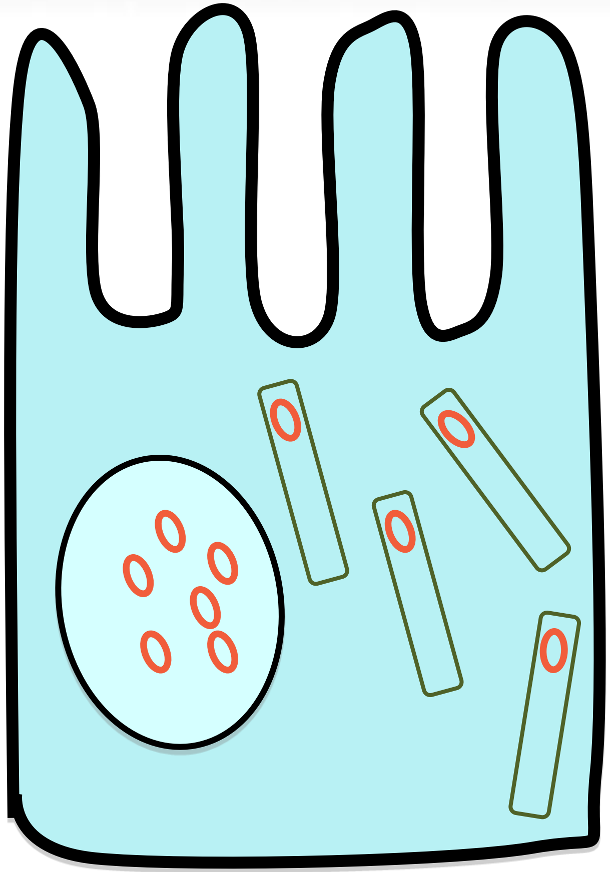
Insect's infection by BV



Midgut cells

1- Virus enters the cells
2- Viral DNA enters the cell nucleus
3- Replication of the viral DNA

Insect’s infection by BV



Midgut cells

1- Virus enters the cells
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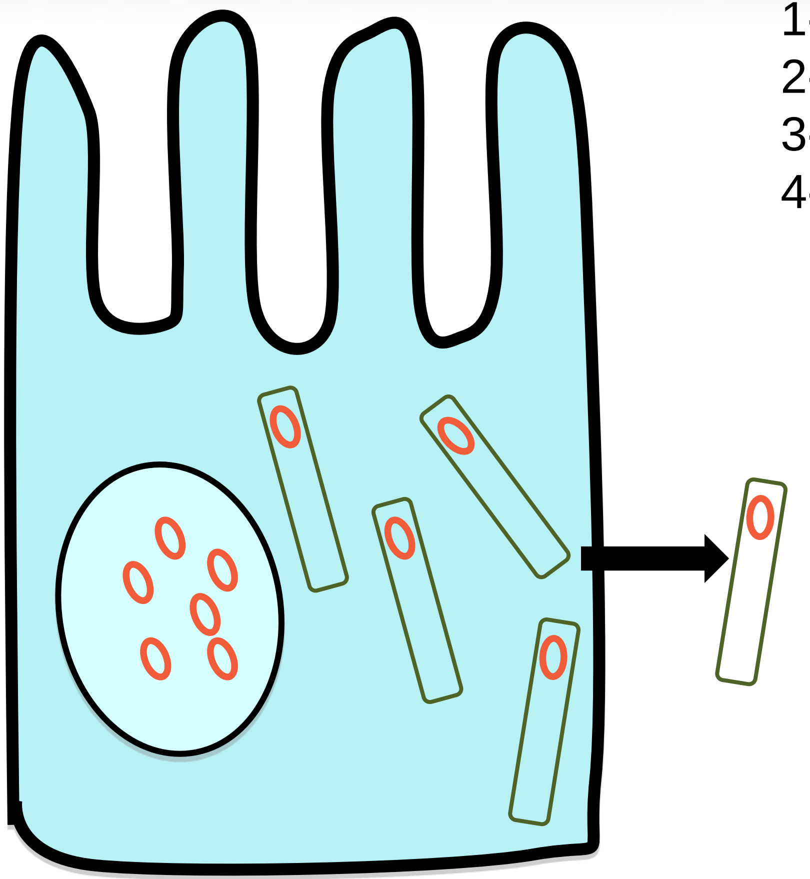
3- Replication of the viral DNA
4- Multiplication of the virus

Insect's infection by BV



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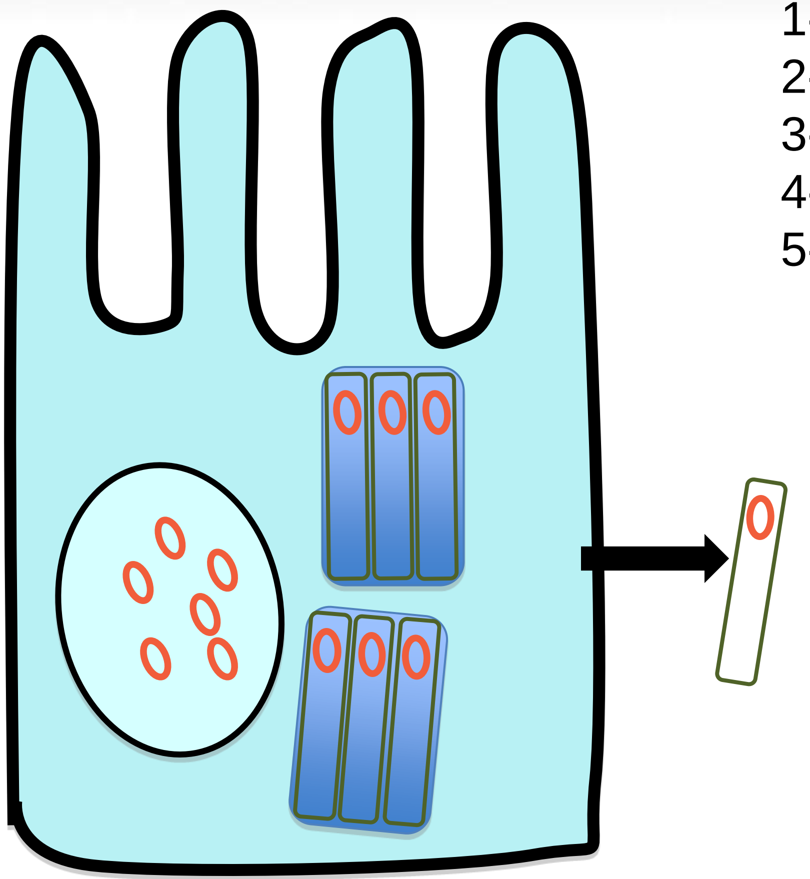
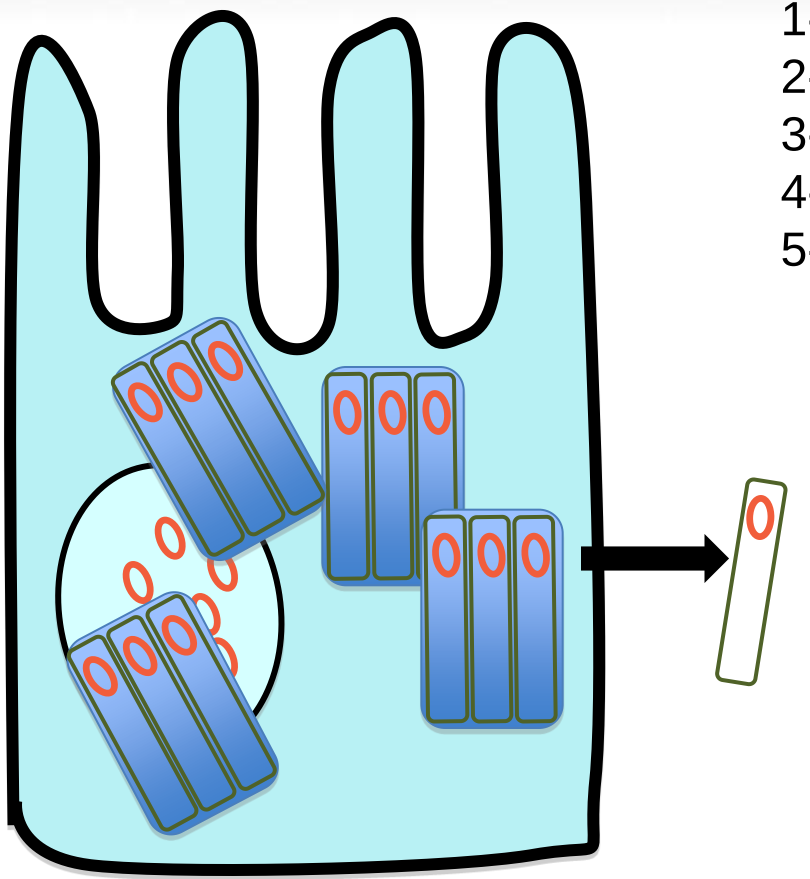


Midgut cells

1- Virus enters the cells
2- Viral DNA enters the cell nucleus
3- Replication of the viral DNA
4- Multiplication of the virus
5-Invasion of other cells **AND**
Formation of new occlusion bodies

Insect's infection by BV



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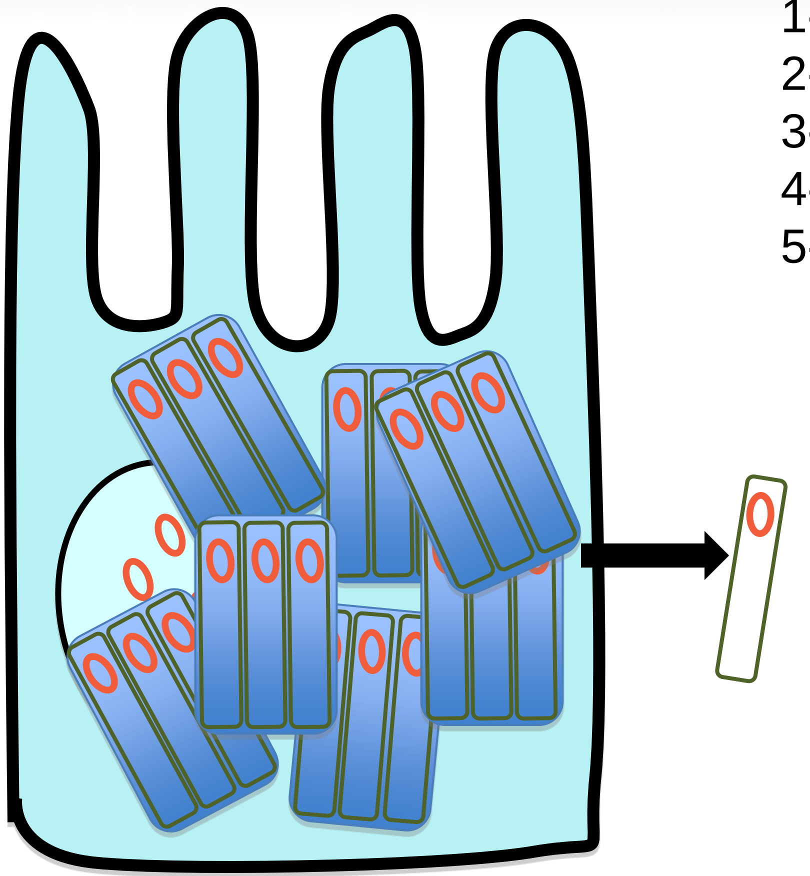

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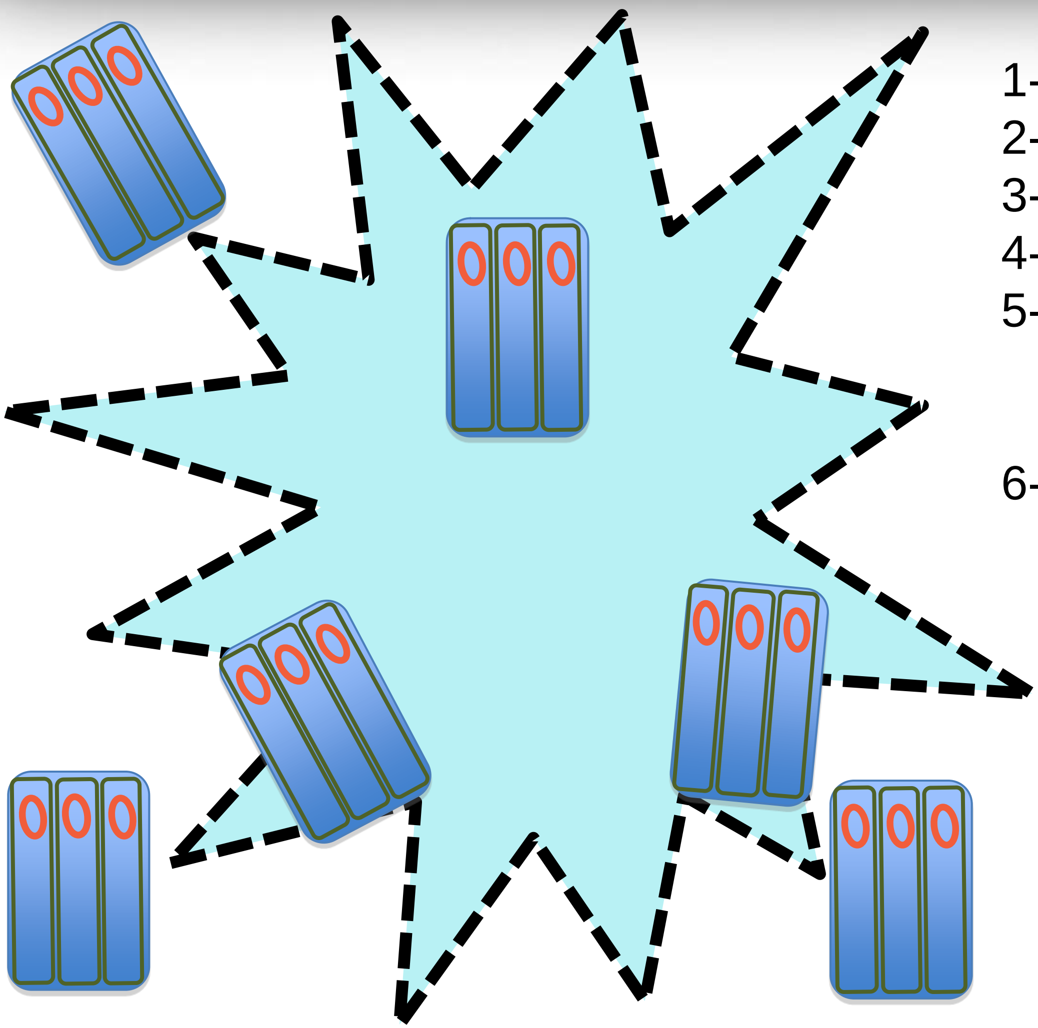

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5-Invasion of other cells **AND**
   Formation of new occlusion bodies

6- Cells disruption

The target organism dies
Occlusion bodies are released

Insect's infection by BV

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2- Viral DNA enters the cell nucleus
3- Replication of the viral DNA
4- Multiplication of the virus
5-Invasion of other cells **AND**
   Formation of new occlusion bodies

6- Cells disruption

The target organism dies
Occlusion bodies are released

Some used BV around the world

(only a few examples)

COMMODITY	INSECT PEST	VIRUS USED	VIRUS PRODUCT
Apple, pear, walnut and plum	Codling moth	Codling moth granulosis virus	Cyd-Xe(3)
Cabbage, tomatoes, cotton, (and see pests in next column)	Cabbage moth, American bollworm, diamondback moth, potato tuber moth, and grape berry moth	Cabbage army worm nuclear polyhedrosis virus	Mamestrin*(5)
Cotton, corn, tomatoes	*Spodoptera littoralis*	*Spodoptera littoralis* nuclear polyhedrosis virus	Spodopterin*(5)
Cotton and vegetables	Tobacco budworm *Helicoverpa zea*, and Cotton bollworm *Heliothis virescens*	*Helicoverpa zea* nuclear polyhedrosis virus	Gemstar LC, Biotrol, Elcar(3)
Vegetable crops, greenhouse flowers	Beet armyworm (*Spodoptera exigua*)	*Spodoptera exigua* nuclear polyhedrosis virus	Spod-X(3)
Vegetables	Celery looper (Anagrapha falcifera)	Anagrapha falcifera nuclear polyhedrosis virus	none at present
Alfalfa and other crops	Alfalfa looper (*Autographa californica*)	*Autographa californica* nuclear polyhedrosis virus	Gusano Biological Pesticide (3)
Forest Habitat, Lumber	Douglas fir tussock moth (*Orgyia psuedotsugata*)	*Orgyia psuedotsugata* nuclear polyhedrosis virus	TM Biocontrol(2)
Forest Habitat, Lumber	Gypsy moth (*Lymantria dispar*)	*Lymantria dispar* nuclear polyhedrosis virus	Gypchek(1)

Use of BV in Canada

- 5 BV registred for use in Canada (Forestry pests)
- Successful test of a BV against the Cabbage looper (Tomato, sweet pepper and cucumber)

A potential BV against sea lice?

- BV-like particules have been reported for sea lice (public domain)
- Isolation process is reported for sea lice BV (public domain)
- Techniques to produce BV on a high scale level are known
- Proof of concept is straightforward (cell testing, controlled sea lice testing, species specificity testing; pilot ‘plot’ testing)

Drawbacks of standard BV

- Significant lag time between standard BV infection and arrest in the feeding behaviour/death of the target

→ May have enough time to damage the fish

→ May have enough time to reproduce and eventually develop a resistance

SORICIMED

Joint effect of soricidin and BV

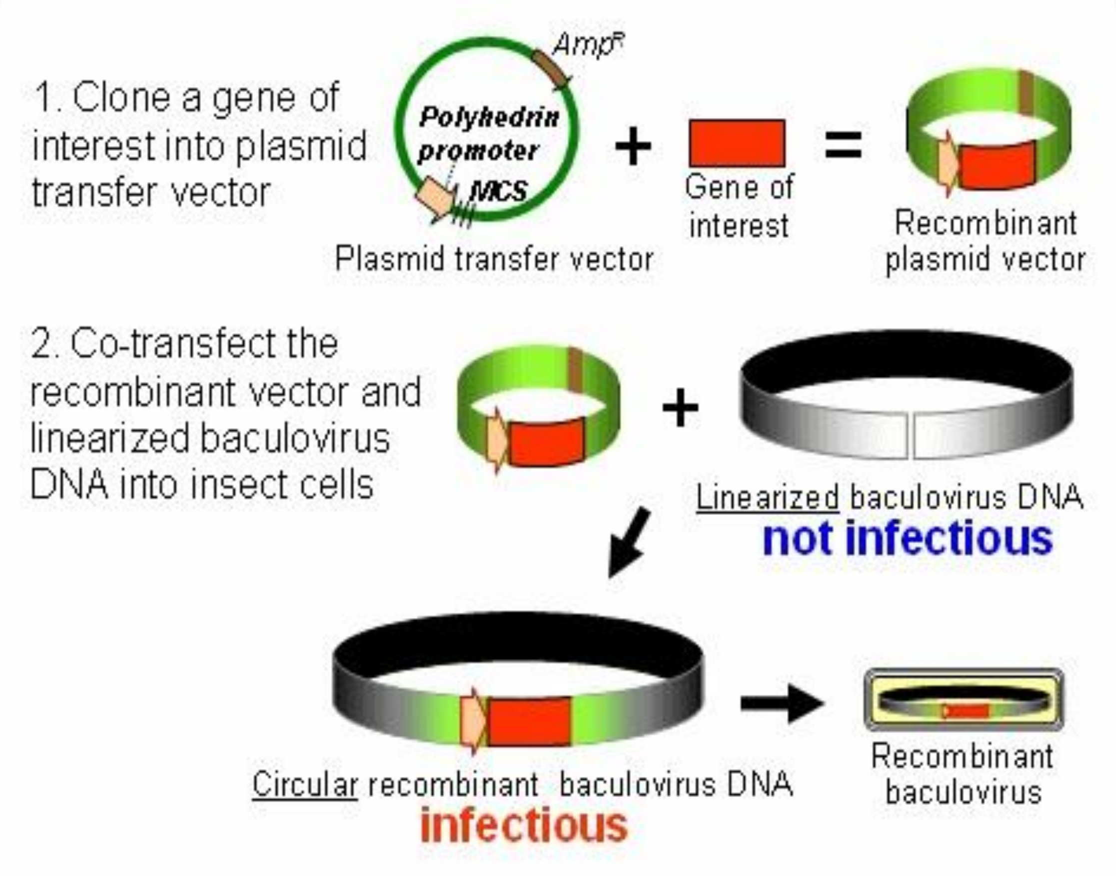
Soricidin augmented sea lice BV

Genetically augmented BV by inserting the gene encoding for soricidin in its genome

= Make infected sea lice produce soricidin to paralyze them

SORICIMED

Well-known technology



Use of modified BV in agriculture

- 27 modified baculoviruses have been tested to date that, at minimum, match chemical pesticides on a cost/benefit basis
- Insect toxins (e.g. scorpion, spider) decrease knock-down time and are more effective that the wild baculovirus
- Trials run in China (cabbage), Brazil (soy), Russia (orchards) and the USA (tomato)
- To date, no reports have been made concerning any unwilling events due to the use of modified BV

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Key developments required

- Test soricidin effect on sea lice (Lepeophtheirus salmonis)
- Prepare optimized cDNA coding sequence for soricidin with desired promoter etc. cloned into plasmid construct
- Produce recombinant viral DNA in insect cell culture
- Identify and grow up a baculovirus specific to sea lice
- Test its specificity to sea lice
- Identify specific cut-sites (just as easy to sequence the genome-only ~180 kbp long)
- Proof of concept
  - Is soricidin produced in cultured sea lice?
  - Does recombinant virus paralyze/kill sea lice on an effective manner?

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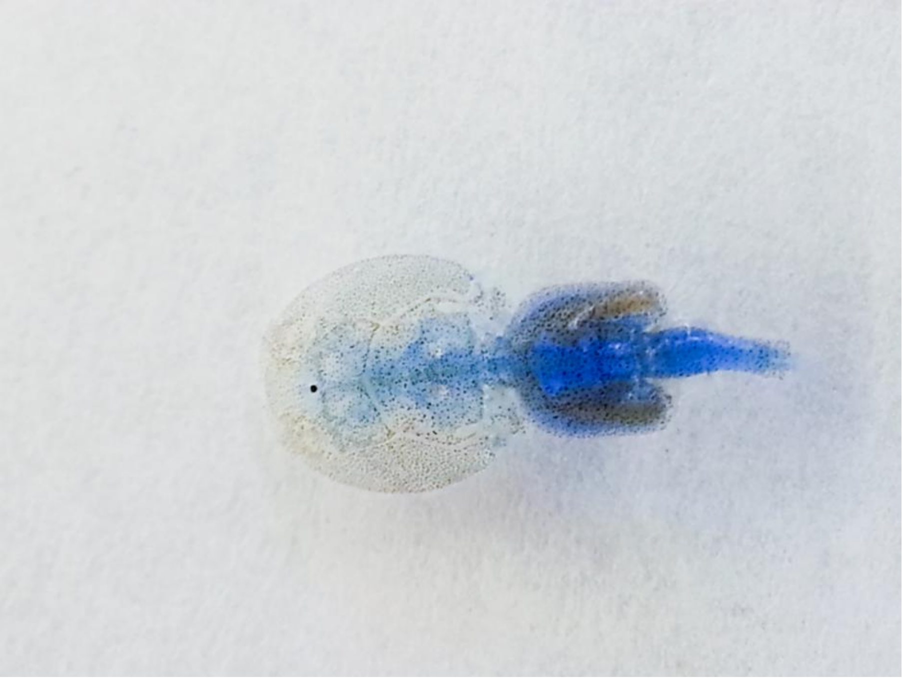
Does soricidin paralyzes sea lice?

Micro-injection experiment



Sea lice are injected through the gut using a micro-injection system

Does soricidin paralyzes sea lice?

3h post-injection of saline solution (T-)

- Sea lice kept sucking on the plate wall

- Active when pocked with a pipette

- Able to flip back in place when turned on their back

- Still alive and in the same condition 24h post-injection

Does soricidin paralyzes sea lice?

3h post-injection of 20ug Soricidin (T+)

- Sea lice unable to suck on the plate wall

- Inactive when pocked with a pipette

- Unable to flip back in place when turned on their back

- Still alive 24h post-injection. One recovered partially while the 3 others remained paralyzed

Key developments required

- **Test soricidin effect on sea lice (*Lepeophtheirus salmonis)***
- ***Prepare optimized cDNA coding sequence for soricidin with desired promoter etc. cloned into plasmid construct***
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  - Does recombinant virus paralyze/kill sea lice on an effective manner?

Additional Resources

- NRC Biotechnology Research Institute, Montreal
  - Dr. Amine Kamen, Animal Cell Technology
- NBCC/CCNB, Grand Falls, Kevin Sheill
  - Pilot scale production of virus and SBI-virus feasible
- Viral Molecular Genetics and Bioinformatics, U. Victoria
- Huntsman Marine Science Centre

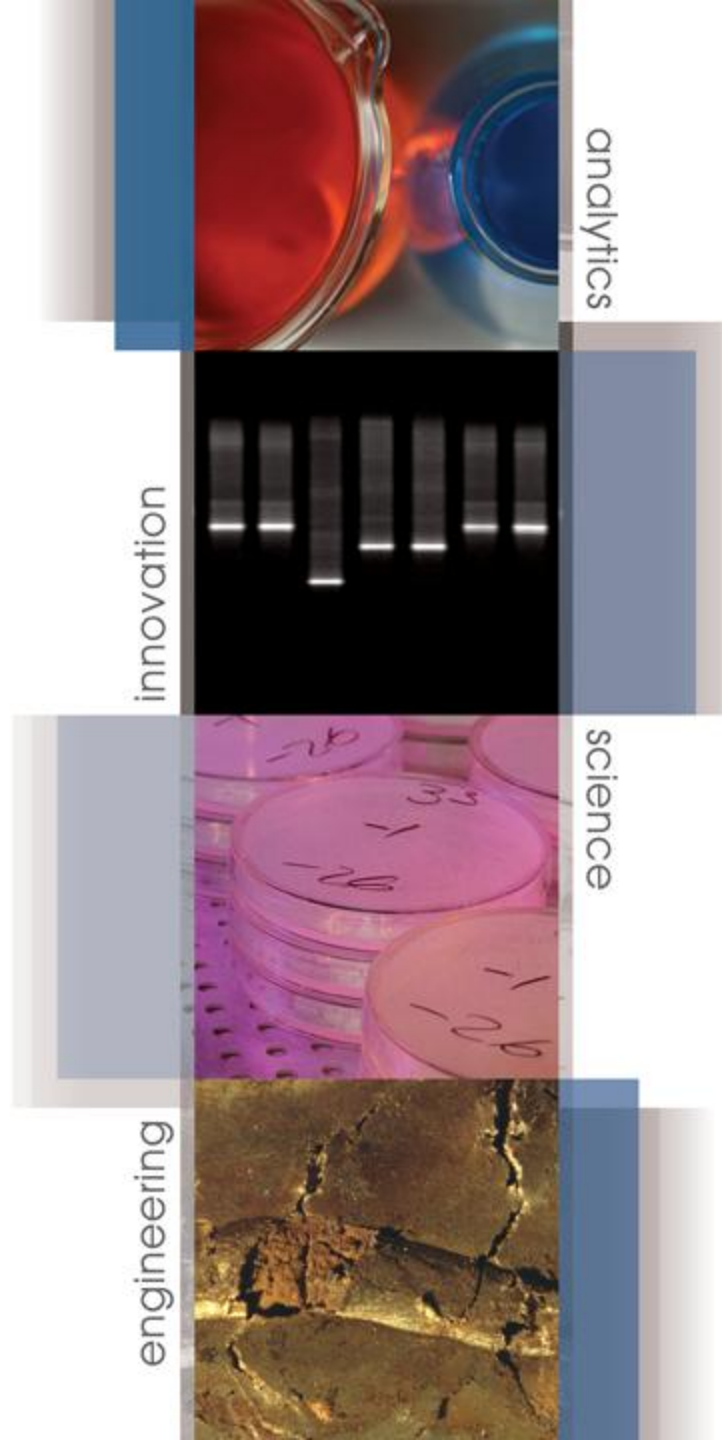
SORICIMED

rpc

SCIENCE & ENGINEERING

Offspring™

DNA Traceability System



Cooke AQUACULTURE Inc.

UNB

CELEBRATING 50 YEARS CÉLÉBRATIONS POUR 50 ANS

rpc

Atlantic Canada Opportunities Agency

Agence de promotion économique du Canada atlantique

Canada

Overview

Needs and Uses of DNA Traceability

Offspring^{TM} Program Components

DNA Traceability Needs

- Whole Food Chain Traceability – Food Safety & Consumer Confidence
- Family Assignment for Breeding
- Government compliance
  - Site specific marking – USA
  - Eco Certification
  - Protection of wild stock
- Competitive Edge

rpc


traceable
THIS FISH
Visit thisfish.info & enter this code:
T422469
Find out where your fish was caught, who caught it and how.
Fresh Haddock
$4.68
$17.61/kg
0.266 kg
Sobeys
Serving Atlantic
since 1907
KEEP REFRIGERATED
AM


Thisfish Code: T422469 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
STR alleles - Google Search
codis - Google Search
Thisfish Code: T422469
thisfish.info/catch/?code=...T422469&x=0&y=0
STR alleles
FISH
YOUR CODE:
T422469
Your Haddock was caught by Martin d'Entremont on the Scotia Shelf / Bay of Fundy and landed fresh in West Pubnico, Nova Scotia.
WHAT IS THIS FISH?
Haddock
WHO CAUGHT IT?
Martin d'Entremont
HOW WAS IT CAUGHT?
Bottom Trawl
WHO PROCESSED IT?
Inshore Fisheries Ltd.
INSHORE
WHO DISTRIBUTED IT?
A.C. Covert Distributors
You!
Saint John
Fundy National Park
Truro
Nova Scotia
Halifax
Maine
Acadia National Park
processed from Middle West Pubnico
landed in West Pubnico, Nova Scotia
Caught on the Scotia Shelf / Bay of Fundy
POWERED BY Google
Map data ©2013 - Terms of Use
SHARE this profile:
SAVE OR PRINT your catch results:
SEND a note to your fisherman, Martin d'Entremont, and supply chain
Scripts Partially Allowed, 4/6 (google.com, gstatic.com, google-analytics.com, thisfish.info) | <SCRIPT>: 41 | <OBJECT>: 0
Start
Presentations
2 Microsoft Offi...
Microsoft PowerP...
Thisfish Code: ...
Adobe Photosho...
11:32 AM

Program Overview

Production Level

- Broodstock (parents)
- Egg
- Birth/Hatch
- Growth & Development
- Processing
- Shipping
- Wholesale
- Retail
- Plate

System Components

DNA-based marking:

- Genotyping with marker panels
- Databasing of all parental genotypes
- Breeding strategy to increase assignment precision

Production Cycle Tracking:

- Whole-chain traceability software
- Animal ID & Movements
- Feeds & Vaccinations
- Environment
- etc.

Fish Tracking:

- DNA-based marking (Genotyping)
- Parentage assignment
- Database query

Marker Panel Strength

Probability of Identity

- CUSA7 - 1 in 4.23×10^{12} (n=12,600)
- King7 - 1 in 2.17×10^{6} (n=12,600)
- New8 - 1 in 1.65×10^{9} (n=92)
- Combined - 1 in 1.5×10^{28}
- CUSA7 + King7 - 1 in 9.17×10^{18}
- CUSA7 + New8 – 1 in 7.0×10^{21}
- Human Identifiler – 1 in 1.3 to 7.64×10^{17} (NA Hispanic – Caucasian)

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Genotyping for Database

- All parental fish are genotyped
- Typed at 7-14 loci
- Info feeds into database together with other data

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Breeding Strategies

- Goal is to prevent mating of genetically similar sets of parents

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Breeding Strategies

- Eliminate possible overlaps in breeding design that would result in assignments of offspring to more than one set of parents

Breeding Strategies

- Relies on genetic marker information while still allowing for use of traditional breeding information

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Cross Select Software

- Custom design
- Chooses genetically unique mating pairs
- Incorporates breeding value information
- Incorporates familial relationship information
- Increases the precision of DNA traceability of offspring
- All offspring trace to only one set or group of parents

Offspring™ Software

- Designed to assign offspring to parents
- Utilizes genotype information stored in database
- Functional with multiple DNA markers and Systems
- Provides detailed output

QA/QC

- Regulatory requirements for traceability in Maine ≥95%
- Periodic 3rd party sampling of operations to test the system
- QA/QC results using Offspring
    - ≥95%
- Tracking of errors
- Identification of areas of process improvement in data management and flow

Additional Testing

- Tested with Sea Bream
- Tested with European Icelandic Atlantic salmon
- Functional with other species and marker systems

Current Focus

- Marketing considerations
- Process improvements
- System auditing & QA/QC

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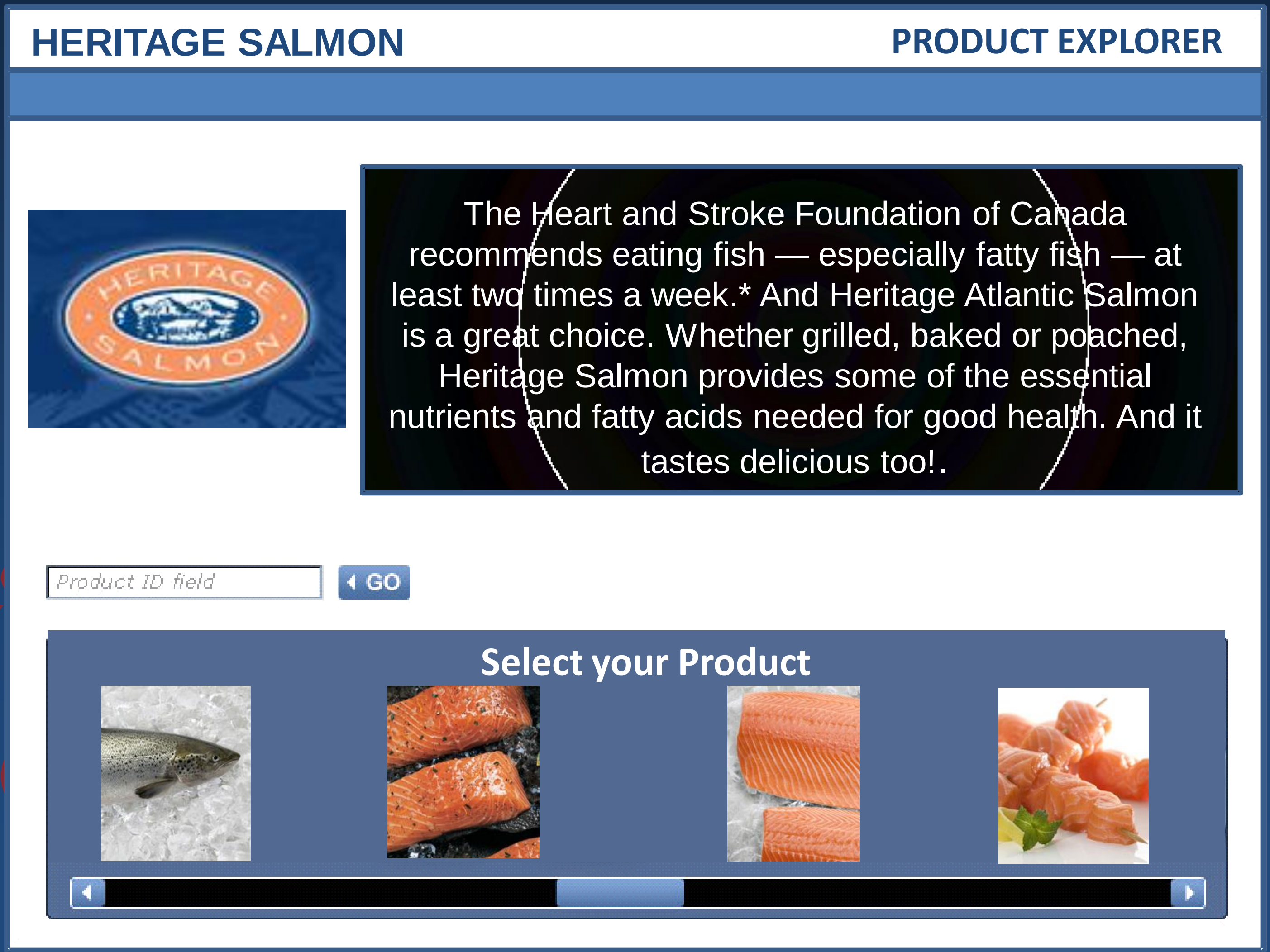
Web-based Interface



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Offspring
DNA Traceability System

Thank You!