Ecosystem-based Approaches to Environmental Interactions of Marine Aquaculture:

A Canadian Perspective

Ingrid Burgetz
Aquaculture Science Branch
Fisheries and Oceans Canada

Overview

- Fisheries & Oceans Canada role in Aquaculture
- Overview of Canadian Aquaculture Production
- Federal Research in Support of Sustainable Aquaculture
- Ecosystem Science approach for Aquaculture Science

Fisheries & Oceans Canada

- Federal Department with responsibilities for fish and fish habitat and supporting the development of successful and sustainable aquaculture
- Program for Sustainable Aquaculture supports federal research and development
- New Aquaculture Program initiative provides support for:
  - Aquaculture Governance and Regulatory Reform
  - Aquaculture Regulatory Science
  - Aquaculture Innovation Investments
  - Aquaculture Certification and Market Access

2005 Aquaculture Production by Region

Salmon	63,369
Trout	101
Clams	1,831
Oysters	8,011
Mussels	16
Scallops	50

Finfish	7,300
Mussels	3,200

Salmon	35,000
Trout	300
Oysters	4,714
Mussels	16,554

Finfish	5,704
Oysters	232
Mussels	2,300
Scallops	11
Shellfish	670

Trout	11

Trout	4075

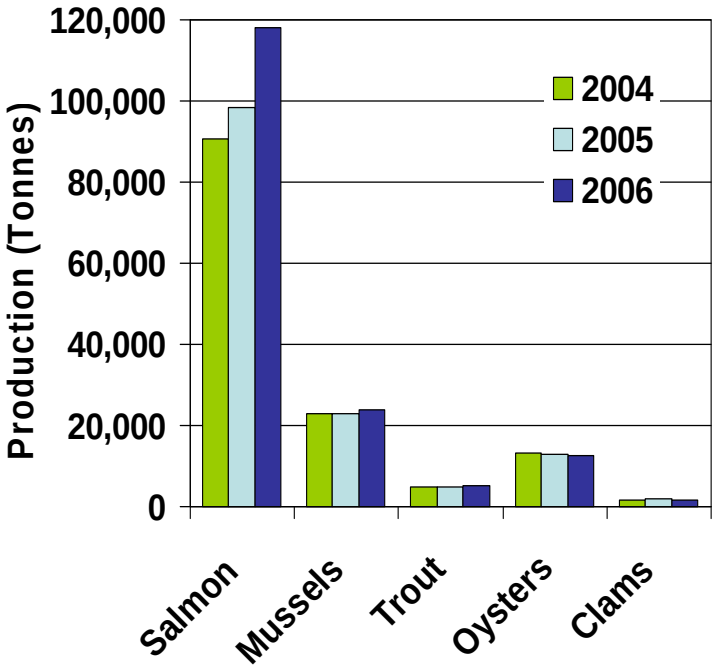
Trout	300
Mussels	753
Shellfish	162

Production (tonnes) (Source: Statistics Canada)

Canadian Aquaculture Industry Overview

- Aquaculture revenues in 2006 were at an all-time high for the second consecutive year, at $968.7 million – up 24.7% from 2005.

- Species under development for new or expanded production:
  - *Giant scallop*
  - *Clams*
  - *Geoduck*
  - *Atlantic cod*
  - *Sablefish/Black cod*
  - *Atlantic halibut*



Expansion of Aquaculture in the Bay D'Espoir, Newfoundland

- 50 new sites for Atlantic Salmon licensed since 2004
- Environmental Challenges:
  - Hard bottom surfaces
  - Current patterns unknown
  - Winter weather conditions
  - Influx of freshwater during winter
- Opportunities:
  - Space for expansion
  - Provide timely scientific advice for new site applications and to inform best management practices
  - Build on experience in New Brunswick to develop area-specific circulation and oceanographic models to support area management for increased sustainability

Canadian Government Aquaculture Research

- Regulatory research to increase relevant scientific knowledge base to support informed ecosystem-based environmental regulation and decision making related to aquaculture activities.
  - Initial research priorities include research to address:
    - Ecosystem Carrying Capacity
    - Ecosystem and Far-field indicators
- Collaborative research with industry is undertaken to address three priority areas:
  - Best Performance in Fish Production
  - Optimal Fish Health
  - Industry Environmental Performance

Ecosystem Science Approach for Aquaculture Science

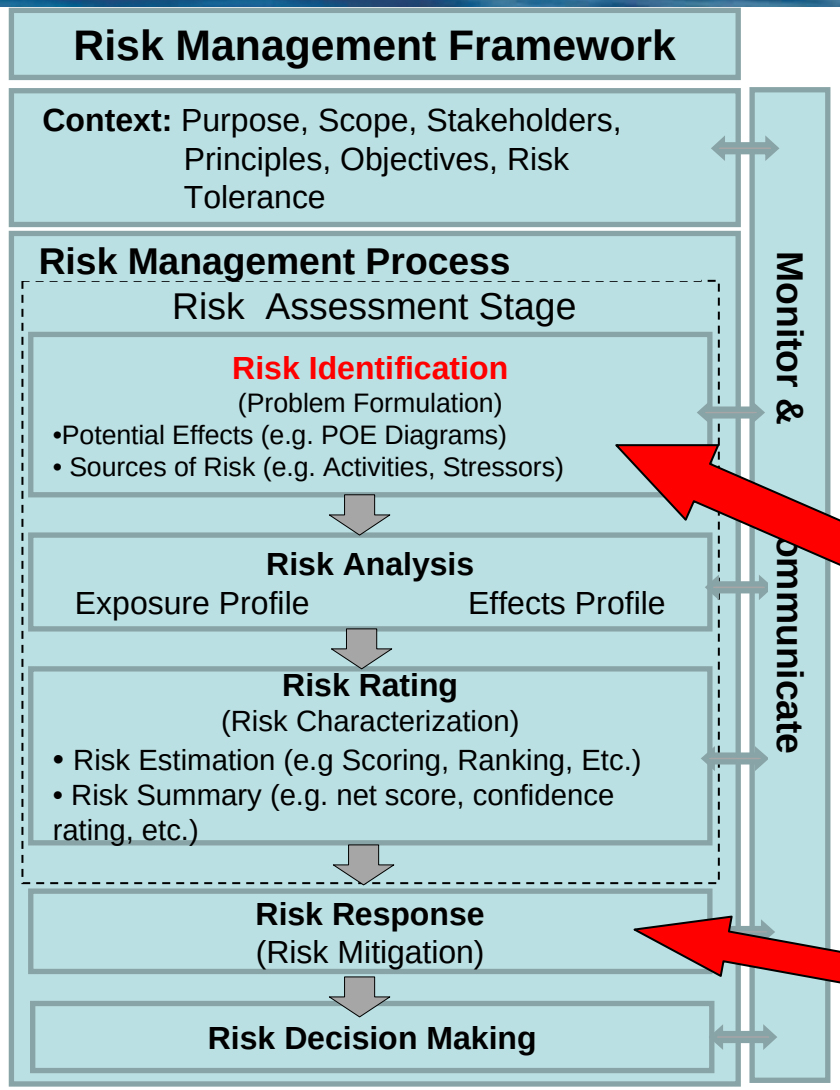
- Ecosystem Science Approach requires:
  - More comprehensive advice
  - Integration of knowledge
  - Identify, understand and monitor key components and relations in aquatic ecosystems
- Challenge:
  - Given the expanded scope related to an ecosystem approach to managing resources,

    how are we identifying and providing the necessary scientific research and advice?

An Ecosystem Science Approach to Integrated Marine Resource Management

Key Activities to Support the an Ecosystem Framework:

- Setting clear ***objectives*** for monitoring and protection
- Developing ***ecosystem indicators*** and reporting systems
- Developing ***risk-based*** frameworks
- Generating ***integrated information for fisheries management***
- Identifying ***habitats of special importance*** and sensitivity
- Considering impacts on aquatic ***biodiversity*** (*Species at Risk and invasive species*)
- Understanding ***pathways of effects*** driving changes
- Understanding ***climate variability*** and impacts on resources

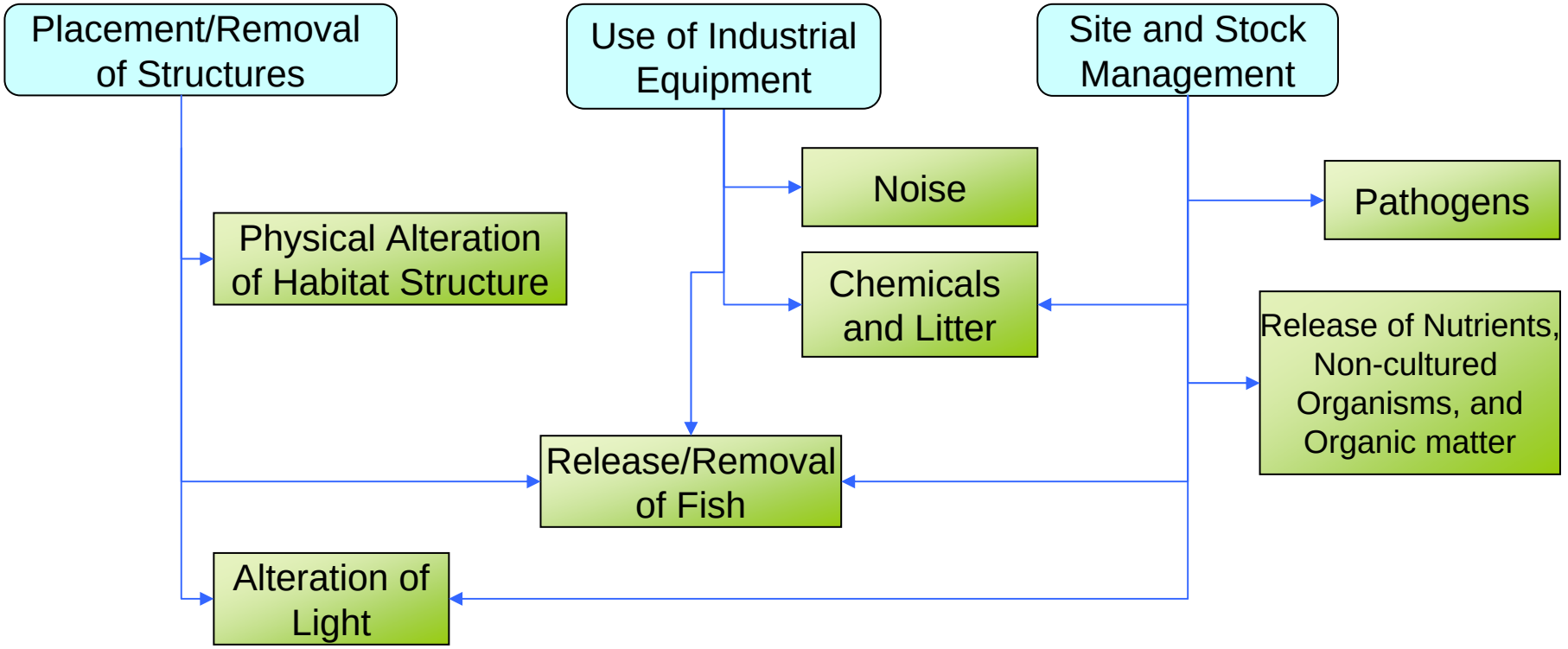


Consistent with ISO best practice in risk management, a typical approach:

- Incorporates a structured approach within a clearly described context
- Develops a common language to facilitate dialogue
- Develops a common understanding of the ecosystem effects of particular activities based on state of science knowledge
- Assesses the risks of a particular activity, and guides the appropriate mitigation response
- Ensures that risks are managed in a consistent and transparent manner.

Risk Identification: Potential Effects

Pathways of Effects for Suspended and Bottom Culture



Risk Response: Risk Mitigation

Science to Support the Reduction of Effects

Research to address knowledge gaps and support science advice for aquaculture management decisions

- Science to support new management approaches

  Case Study: Area Management

- Science Advice on new Technologies to Reduce Interactions

  Case Study 1: A Review of Closed Containment Technologies for Atlantic Salmon

  Case Study 2: Development and Evaluation of Integrated Multi-Trophic Aquaculture in Canada

Science to Support Management Approaches

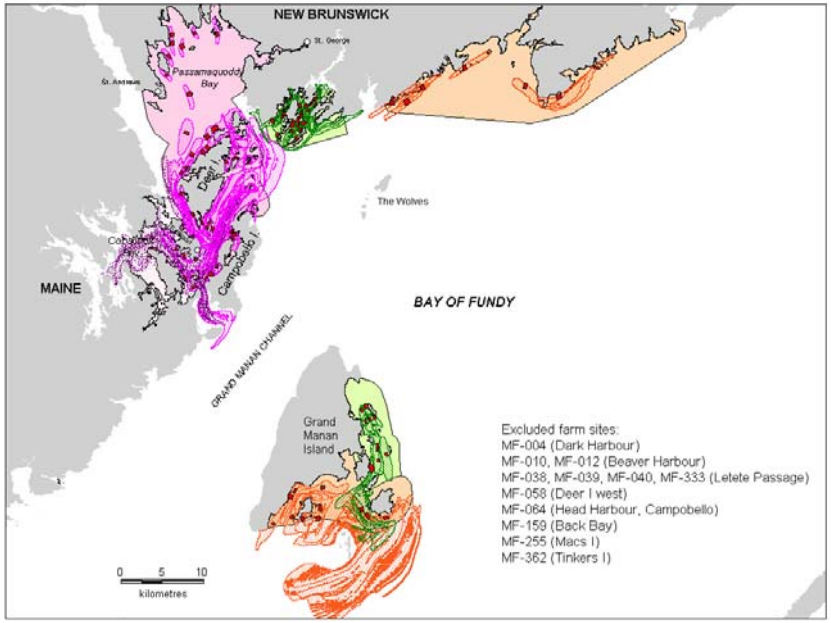
Area Management

Area Management Approaches

- Bay Management Areas: Fish health, oceanographic and business considerations
- Single year-class farming
- 3-year site rotation with 1-year mandatory fallowing

Drivers

- Standardization of fish health management practices
- Improve production efficiencies
- Environmental sustainability



Scientific Research in Support of Aquaculture Management Areas

Predicting Near and Far-field Effects

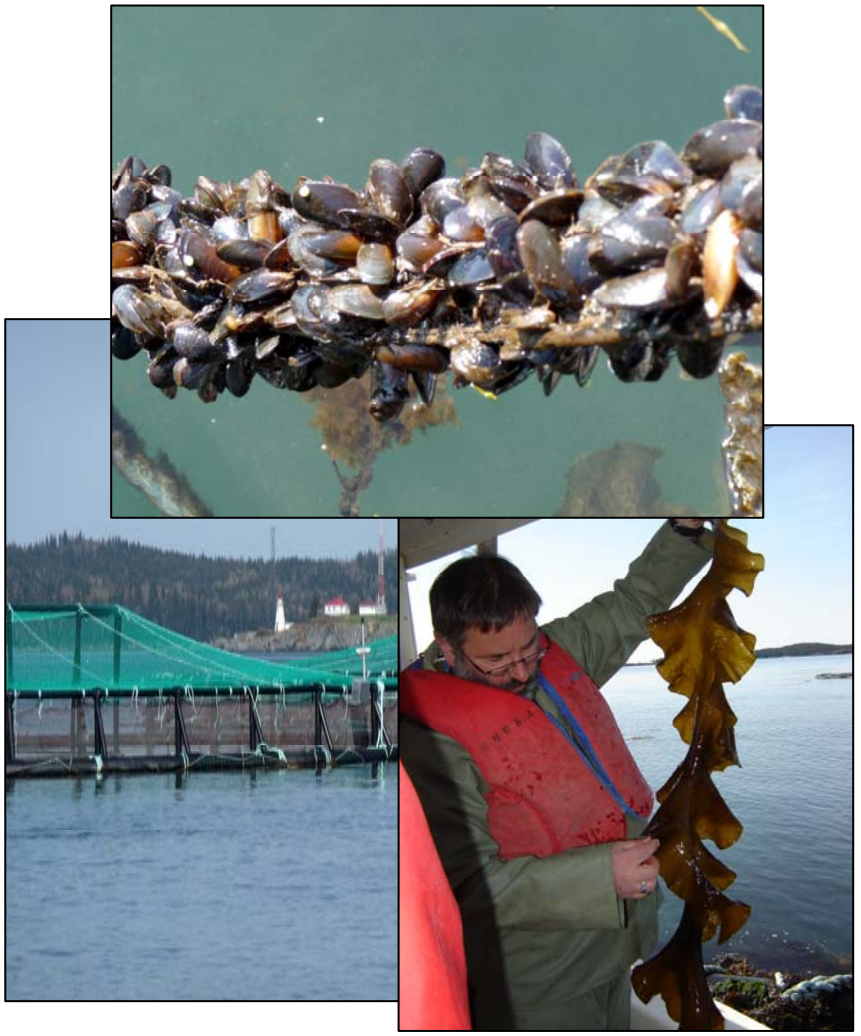
- Introduction of Organic and Inorganic Materials
  - Measuring and monitoring the impacts
  - Indicators for benthic community changes
- Deposition and Circulation Models
  - Prediction of deposition of particles to predict degree of sedimentation and associated changes to benthos
  - Predicting exposure and transmission of pathogens or parasites
- Biomarkers and tracers for non-cultured organism exposure to feed, theraputants, etc

Mitigating Aquaculture/Environment Interactions

- Limit Genetic Interactions
  - Monosex and reproductive containment strategies
- Limit Interactions: Closed Containment
  - No successful commercial-scale experiences rearing exclusively adult Atlantic salmon
  - Land-based flow-through freshwater and recirculating systems for juvenile salmon, trout and tilapia, and other high value species
  - Remaining Challenges
    - Water quality
    - Disease management
    - Engineering challenges for different systems (floating, recirculating)
    - Operating and capital costs

Integrated Multi-Trophic Aquaculture (IMTA)

- Combining cultivation of:
  - + fed aquaculture species (e.g., finfish)
  - + Organic extractive aquaculture species (e.g., shellfish)
  - + Inorganic extractive aquaculture species (e.g., seaweed)
- IMTA Research Project has had excellent results and progress to date
  - – Mussels and kelp 50% increase in growth rates
  - – No food safety or disease issues
  - – High quality products



An Ecosystem Approach to Aquaculture Science

Given the expanded scope related to an ecosystem approach to managing resources, *how are we identifying and providing the necessary scientific research and advice?*

- **Pathways of Effects** – Synthesizing current knowledge in a larger context of activities and effects
- **Addressing Gaps through Research** – Priority to key knowledge gaps for sustainable aquaculture management
- **Holistic Ecosystem Approach to Sustainable Aquaculture** – Multi-disciplinary research that integrates ecosystem aspects and considerations

Thank you

- Questions?

Example Pathway of Effect Diagram