Canadian Technical Report of
Fisheries and Aquatic Sciences 2492

August 2003

Report of the Applied Coastal Ecosystem Science (ACES) Workshop, 28-30 January 2003, St. Andrews, New Brunswick

B.D. Chang, R.L. Stephenson, T.W. Sephton, P. Lawton,
F.H. Page, D.E. Aiken, and K. Haya (Editors)

Fisheries and Oceans Canada
Maritimes Region, Science Branch
Biological Station, 531 Brandy Cove Road,
St. Andrews, New Brunswick, Canada E5B 2L9

This is the two hundred and fifty-first Technical Report of
the Biological Station, St. Andrews, NB

Cat. No. Fs 97-6/2492E ISSN 0706-6457

Correct citation for this publication:

Chang, B.D., Stephenson, R.L., Sephton, T.W., Lawton, P., Page, F.H., Aiken, D.E., and Haya, K. (editors). 2003. Report of the Applied Coastal Ecosystem Science (ACES) Workshop, 28-30 January 2003, St. Andrews, New Brunswick Can. Tech. Rep. Fish. Aquat. Sci. 2492: iv + 41 p.

Table of Contents

Executive Summary

The St. Andrews Biological Station (SABS) of Fisheries and Oceans Canada (DFO) has proposed a multi-disciplinary research program, with a focus on applied ecosystem issues, under the name of Applied Coastal Ecosystem Science (ACES). Coastal zone issues are becoming increasingly important and it is recognized that these issues require integrated, ecosystem-based science in order to provide sound advice to managers. The current organizational structure of SABS has scientific staff located within sections which focus mainly on single subjects, such as stock assessments and research, aquaculture, oceanography or the marine environment. The ACES project would allow more cooperation among scientists from different sections, thus facilitating an integrated research approach to issues that we are being asked to address.

As an initial step, a workshop was held in St. Andrews on 28-30 January 2003, to examine how other institutes and agencies have approached such issues, as well as how such issues are viewed from within DFO. Seven plenary papers, each followed by an open discussion period, were presented and included speakers from Australia (University of Sydney), the New Brunswick Department of Agriculture, Fisheries and Aquaculture, the Canadian Forest Service (Natural Resources Canada) and DFO. The papers discussed international, national and regional perspectives and issues related to the science and management of integrated research and provision of advice for ecological risk analysis. The next step in the process will be to hold internal workshops to further develop the ACES concept and determine priority issues and projects.

Sommaire

La Station biologique de St. Andrews (SBSA) du ministère des Pêches et des Océans (MPO) a proposé la mise en place d'un programme de recherche appliquée multidisciplinaire axé sur les écosystèmes qui porterait le nom de Recherche appliquée sur l'écosystème côtier. Comme les questions liées aux zones côtières prennent de plus en plus d'ampleur, il ne fait plus de doute qu'elles doivent faire l'objet d'une recherche intégrée axée sur les écosystèmes dans le but d'offrir de judicieux conseils aux gestionnaires. La structure organisationnelle actuelle de la SBSA se compose de scientifiques affectés à des sections ne s'occupant que d'un seul secteur comme l'évaluation des stocks et recherche, l'aquaculture, l'océanographie ou le milieu marin. Le projet de recherche appliquée sur l'écosystème côtier permettrait une plus grande collaboration entre les scientifiques de diverses sections, ce qui favoriserait une approche intégrée en matière de recherche sur les dossiers de l'heure.

Comme point de départ, il s'est tenu un atelier à St. Andrews du 28 au 30 janvier 2003. L'atelier avait pour but d'examiner la méthode adoptée par d'autres instituts et organismes pour traiter de ces dossiers ainsi que la façon dont ces questions sont perçues par le MPO. On a présenté sept exposés en séance plénière, chacun suivi d'une période de discussion ouverte. Des conférenciers de l'Australie (Université de Sydney), du ministère de l'Agriculture, des Pêches et de l'Aquaculture du Nouveau-Brunswick, du Service canadien des forêts (Ressources naturelles Canada) et du MPO y ont participé. Les exposés traitaient de points de vue et de questions d'envergure internationale, nationale et régionale portant sur l'étude et la gestion de la recherche intégrée et sur la prestation de conseils pour l'analyse des risques écologiques. La prochaine étape consistera à tenir des ateliers internes afin de développer la notion de recherche appliquée sur l'écosystème côtier et de déterminer quels sont les dossiers et les projets prioritaires.

Background

The Bay of Fundy/Gulf of Maine is a unique coastal ecosystem. The decision to establish Canada's first marine research facility in St. Andrews a century ago was based largely on the opportunities to study important fisheries and the physical and biological aspects of this highly diverse ecosystem. In the last two decades, there has been a rapid expansion and development of a substantial marine finfish aquaculture industry in the Bay of Fundy. This industry is in proximity to, and overlaps with, a number of other valued ecosystem components (VECs). There is also a growing potential for shellfish and marine plant culture in the area. Unlike aquaculture in many other areas of the world, aquaculture in the Bay of Fundy interacts with a variety of sensitive habitats, for example, those of several species at risk (e.g. salmon, whales, ducks), and important fisheries resources (lobster, bivalves, herring). The aquaculture industry must integrate with users of the ecosystem such as the commercial harvest fisheries, a growing ecotourism industry and increasing first nations' ventures. The scientific review of applications to conduct activities in the marine environment (e.g. salmon aquaculture, wharf construction) requires defensible and integrated scientific advice. This is hampered by an incomplete set of reference points or objective criteria related to VECs and by the lack of a framework in which these diverse considerations can be integrated and evaluated. In particular, the existing system lacks proper consideration of the broader ranges of spatial and temporal dynamics important to ecosystem stability. These issues are further complicated by the adjacency of the Canada-United States border, which requires that scientific advice for regulations and policies must also consider transboundary issues.

The St. Andrews Biological Station (SABS) is part of a national network of scientific research laboratories within Fisheries and Oceans Canada (DFO), a department of the Canadian federal government. SABS is located within DFO's Maritimes Region. The regional science headquarters are located at the Bedford Institute of Oceanography, in Dartmouth, Nova Scotia.

In contemplating this problem, the science management team at SABS has conceived a new institution-wide research theme in Applied Coastal Ecosystem Science (ACES). Among our existing research groups we have the nucleus of a multi- and inter-disciplinary program that includes coastal oceanography, inshore harvest fisheries, aquaculture, coastal ecology, pollution, toxicology and other relevant disciplines. Our location within the Bay of Fundy and Gulf of Maine is strategic for dealing with emerging local and international issues in the coastal environment. For these and many other reasons we should be leading inter-disciplinary research (in collaborations and partnering arrangements with others) and providing integrated coastal ecosystem advice.

The SABS science management team is comprised of the Station Director, T.W. Sephton (also Manager of the DFO Maritimes Region's Aquaculture Division) and the heads of the scientific groups at SABS: R.L. Stephenson (Marine Fish Division, Gulf of Maine Section), P. Lawton (Invertebrate Fisheries Division, Gulf of Maine Crustacean Fisheries Section), F.H. Page (Ocean Sciences Division, Coastal Ocean Sciences Section), D.E. Aiken (Aquaculture Division, Sustainable Aquaculture Section) and K. Haya (Marine Environmental Sciences Division, Environmental Sciences Section).

Within the ACES theme we have identified the term Ecological Risk Assessment to represent the operational process of formulating science advice (with or without new focused research activity) in response to concerns on a specific ecosystem perturbation.

In an effort to help develop the conceptual framework and focus for ACES, a workshop was held at the Fairmont Algonquin Hotel in St. Andrews from 28-30 January 2003. The purpose of this document is to record the highlights of the workshop. The outline and agenda are given in the next section. The reports on each presentation are derived from the electronic versions of the slides (where available) or from notes taken by the rapporteur (B.D. Chang).

Workshop Outline

Day 1: *To identify and describe the science context of an Ecological Risk Assessment from different perspectives.*

- What scientific information is required to provide the advice for management and policy development?
- What is the approach, the range of disciplinary expertise, skill sets and resources required to provide the science for ecological risk assessments?
- What is required to build a better structure in order to facilitate cooperative and collaborative endeavours?

AGENDA: Introduction to ACES and presentation of three perspectives, with discussion

- **ACES: Applied Coastal Ecosystem Science**
  SABS Science Management Team (presented by Thomas Sephton)
- **Australian perspective on science issues**
  Tony Underwood, Director, Centre for Research on Ecological Impacts of Coastal Cities, University of Sydney, Australia
- **A forests perspective on science issues**
  Bruce Pendrel, Science Director, Forest Health and Biodiversity, Atlantic Forestry Centre, Canadian Forest Service, Natural Resources Canada
- **A regional management perspective**
  Roland Cormier, Assistant Deputy Minister, Fisheries, Aquaculture & Policy Division, New Brunswick Department of Agriculture, Fisheries & Aquaculture

Day 2: *To identify who and what is required to make regional management decisions with regard to ecological risk assessment in the coastal environment.*

- What is the range of science information sought to make decisions?
- What is typically available? What is missing but required to make the best or complete decisions?
- What is the most desirable structure to both identify the issues and the science required to address the issues?

AGENDA: Presentation of three case studies, with discussion

- **Ecosystem-based management: science needs**
  Paul Keizer, Manager, Marine Environmental Sciences Division, Maritimes Region, DFO & Chair, ICES Marine Habitat Committee
- **A regional perspective on the scientific needs of the existing management system**
  Paul Boudreau, Acting Manager, Habitat Management Division, Maritimes Region, DFO
- **Marine science future directions**
  Michael Sinclair, Regional Science Director, Maritimes Region, DFO

Background papers:

- **Basic functions of DFO Science**
  Serge Labonté, Director General, Fisheries, Environment and Biodiversity Science Directorate, DFO Ottawa (presented by Thomas Sephton)
- **Applying information management to the decision-making process**
  Patrice Cousineau, Marine Environmental Data Service, DFO Ottawa

Day 3: *To describe the current state of what and how science is delivered to address the existing mandate of the St. Andrews Biological Station and what needs to change to be able to deliver the science for an ecological risk assessment mandate.*

- What are the strengths of the existing SABS science programs?
- How do we fit what has been described as the science required to deliver an ecological risk assessment mandate? What is the mandate we need?
- What research, people and resources need to be identified, changed, strengthened and facilitated to meet this new mandate? Can we envisage a way to meet the future needs of both the federal government, DFO and our clients?

AGENDA

- **St. Andrews Biological Station: strengths & attributes**
  Thomas Sephton, Director, St. Andrews Biological Station and Aquaculture Division Manager, DFO
- **Discussion on potential issues and research for ACES**

ACES: Applied Coastal Ecosystem Science

SABS Science Management Team
Presented by ***Thomas W. Sephton*** *(Director, St. Andrews Biological Station and Manager, Aquaculture Division, Science Branch, Maritimes Region, DFO)*

What is ACES?
- Working together (a paradigm shift)
- A multidisciplinary framework for addressing major issues in the coastal ecosystem
- An enhanced environment for scientific interaction

Why do we need ACES?
- Society expects integrated science
- The divisional approach does not facilitate integrated ecosystem science
- The current organizational structure provides limited incentive for interdivisional collaboration.

How will it work?
- Mandate
- Management
- Funding

Mandate
- Discipline mandate
- Geographic mandate
- Integrated science mandate

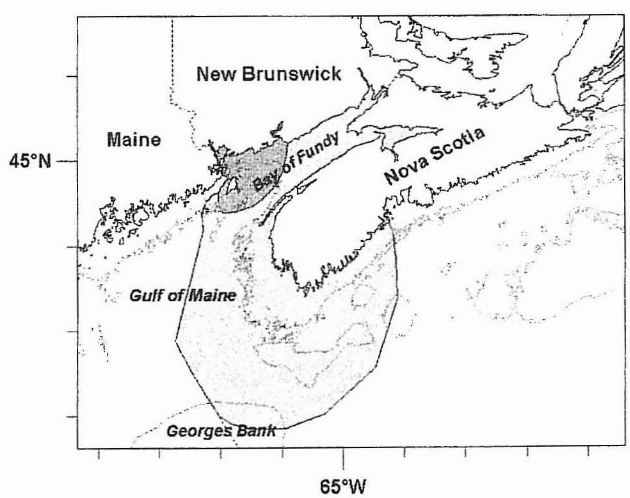
Discipline mandate:

Conduct multidisciplinary research in the physical and biological sciences of coastal ecosystems	• **Science**
Provide a forum for the integration of other disciplines of relevance to coastal ecosystems	• Economics • Sociology • Politics

Geographic mandate:

Integrated science in the coastal ecosystem of:

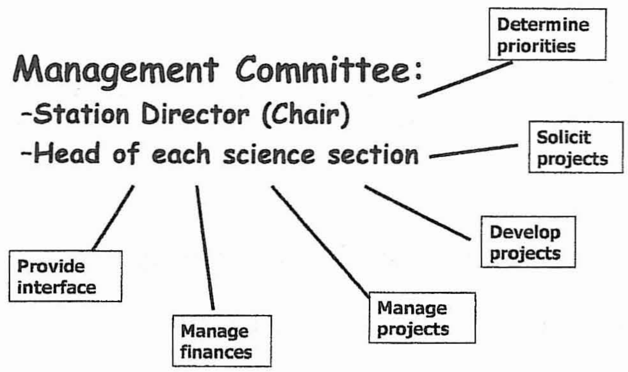
- local area near SABS:
  southwest New Brunswick
  (darker shading)
- wider geographic area:
  Bay of Fundy, Gulf of Maine,
  Georges Bank, southwest Nova Scotia
  (lighter shading)



Integration mandate:

- provide integrated coastal ecosystem science, by facilitating increased interaction among science sections at SABS.

Management:
(Administration):



Management (Projects):

- ACES projects will be:
  - Collaborative, multidisciplinary, interdivisional
  - Variable in size and duration
  - Reactive or proactive in nature
  - Scientist-driven

Management (Finances):

- Seed money will be needed to:
  - Provide base funding for high-priority projects while they seek outside funding;
  - Augment outside-funded projects with funds for graduate students, summer students, etc;
  - Consolidate emerging knowledge by funding workshops, travel to conferences, etc;

In summary, ACES . . .

- Will enhance institutional relevance by creating organizational flexibility;
- Will support integrated, multidisciplinary science;
- Will foster integrated advice on coastal ecosystem issues.

Discussion and Comments (all participants)

Do we need a new organizational/management structure for ACES?

- some felt that a new structure is required, while others felt that we should not concentrate on organizational structure as a constraint.
- organizational structure is sometimes considered a constraint at SABS, due to off-site management of most Sections.
- ACES would be a subset of existing activities, in support of coastal zone management.
- we need to move beyond the current management structure, but we have not yet determined what the appropriate structure will be and who it would involve.

The success of the program should not be based on the amount of funds leveraged.

The public already expects us to be doing work on coastal zone management; but we have been unable (or unwilling) to answer many of the questions within the existing structure (e.g. impacts of aquaculture, rockweed harvest, fishing).

Australian Perspective of Science Issues

Tony Underwood *(Director, Centre for Research on Ecological Impacts of Coastal Cities, University of Sydney, Sydney, Australia)*

Dr. Underwood's presentation dealt with the difficulties of providing scientific input to satisfy the needs of management of issues in complex, multi-species systems. Various examples from the Australian experience were given.

Science and management

- We are trained as scientists, not as managers: How can we bridge the gap between management and science?
- Scientists need to better sell (to management) what they can do.

How can we measure change in complex systems?

- we generally do not understand the ecosystem which may be impacted.
- we need to clearly define the question that a monitoring program is intended to address.
- monitoring must done in appropriate spatial and temporal scales.
- we need special analytical tools to measure change in complex, multispecies systems over space and time.

Spatial scales:

- there is no single spatial scale: many processes operate simultaneously at different scales.
- the scale of sampling can affect the results of monitoring studies:
- the relative abundances of two species may appear to have different relationships, depending on the scale of sampling (e.g. size of quadrat; distance between sampling sites).
- a species' response to a stress may appear different, depending on the scale at which you are sampling.
- different species (even closely related ones) can react in different ways to the same environmental stress.
- usually we do not know the size of the zone of impact (e.g. from a sewage outfall) and we do not have a good understanding of the ecosystem at the impacted area..
- therefore, to measure potential impacts we need to sample at multiple spatial scales with nested sampling designs; e.g.:

shores (100s of metres)

$\Rightarrow$ sites within shores (10s of metres)

$\Rightarrow$ quadrats within sites (metres)

Temporal scales:

- frequency of sampling must account for interannual, seasonal and other temporal variation.
- long time series of observations are required to understand changes: response times (e.g. after storm events) can be in the order of 10-15 years.
- the amount of damage can affect the speed of recovery of seaweeds (and associated species): if only fronds are damaged by a storm, then recovery may be relatively fast; but if holdfasts are also damaged, recovery will be slower.

Species interactions:

- predicting impacts becomes more difficult when dealing with multiple species systems.
- we need to understand assemblages in order to understand impacts and recovery: indirect effects may be important; e.g.:
- harvesting of tunicates can affect the abundance of other species associated with the habitat provided by the tunicates.
- removal of seaweed cover can reduce whelk predation on barnacles, resulting in increased abundance of barnacles.

Monitoring tools

- we need research on the science of monitoring and measuring itself (i.e. the tools required to get data).
- there is a lack of good tools to examine change in multi-species ecosystems over space and time.
- we need good taxonomic work as base for these studies.

General points

- you can't deal with complex systems unless you do the science.
- we need experiments *and* long-term monitoring to get answers; this requires long-term funding.

Discussion and Comments

The issue of uncertainty:

- decision-makers are afraid of uncertainty
- we need to be able to explain uncertainty to the decision-makers, providing "real" scenarios
- to get more certainty, we need to invest in science
- once decisions to proceed are made, take advantage of the situation to do experiments which can help in the process the next time
- we need to protest when decisions are made not based on science (especially when it is said that it is)

In Australia, fishers pay a levy which supports research.

- this means that fishers have input into priorities
- it also means that scientists must educate fishers

ACES should be issue-driven.

- must start with existing expertise
- but then must build on the existing expertise to fill in gaps
- don't let existing expertise dictate the projects
- should move away from just dealing with commercial species
- habitat issues are important, especially habitat fragmentation
- concern over biodiversity issue has potential to lead to better understanding of ecosystems.

What does ecosystem-based management (EBM) mean?

- generally means looking beyond just a single target species
- there is a concern that EBM can get dominated by water chemistry and other measurables that can be used by modelers
- despite problems, EBM is still better than the previous single species approach
- a better term may be *ecologically*-based management

Science in society:

- there are now more scientists than ever before and funding for science is higher than ever; i.e. society is investing in science.
- scientists need to focus on what society's problems are and also help to guide society.
- a lot of science is commercially-driven. e.g. with sea urchins, there is lot of interest in research on genetics, with relatively little on the ecological processes that would help to manage the fishery.
- scientific work must be published in readily accessible journals (vs. internal reports which are not widely distributed).

A Forests Perspective on Science Issues: Strategic Planning at the Canadian Forest Service

Bruce Pendrel *(Director of Science, Forest Health and Biodiversity)*
Derek MacFarlane *(Director of Science, Forest Production and Protection)*
Bill Anderson *(Forestry Research Project Officer)*
Atlantic Forestry Centre (AFS), Canadian Forest Service (CFS), Natural Resources Canada (NRCan)

Department of Natural Resources Act - the Minister shall:

- Have regard to the sustainable development of Canada's natural resources and the integrated management thereof;
- Assist in the development and promotion of Canadian scientific and technological capabilities;
- Seek to enhance the responsible development and use of Canada's natural resources and the competitiveness of Canada's natural resources products;

The Minister Shall:

- Promote cooperation with the provinces and non- governmental organizations ... with governments of other countries and international organizations;
- Gather, compile, analyse, coordinate and disseminate information respecting scientific, technological, economic, industrial, managerial, marketing and related activities and developments affecting Canada's natural resources

NRCan/CFS Mandate

- NRCan - to promote the sustainable development and the responsible use of Canada's mineral, energy and forestry resources.
- CFS - to promote the sustainable development of Canada's forests and competitiveness of the forest sector or the well-being of present and future generations of Canadians

That is to say:

- No regulations
- No policing
- No management authority

Under this mandate, the CFS is:

- an agent of the federal government
- a creator of knowledge and a source of information and expertise on forest-related matters
- an influencer of forest policy and a stimulator of dialogue
- a consensus builder

Cooperation in Forestry

- Provinces own 71% of Canada's forests (Constitution Act 1867)
- Federal government owns 23% (mostly in the territories with devolution ongoing)
- Tradition of cooperation - Canadian Council of Forest Ministers (CCFM)
- CCFM Framework for Cooperation: shared responsibilities in S&T, regional development, and the environment

How our point of view changed: 1994 Program Review

- Withdrawal from functions that are the responsibility of others
- Forest Resource Development Agreements - not renewed
- 2 centres closed and 5 remaining centres reduced (personnel from 1400 to 850; resources from $200M to $100M)

- National S&T Networks established to respond to national forestry issues: Shift from regional focus to delivering national S&T programs

Canadian Forest Service Strategic Plan - 1998-2003
- Developed by HQ committee (minimal staff input)
- Mixed level of detail
- Shopping list of activities and programs
- Not well received & little buy-in

1998-2003 Strategic Directions
- Enhance Canada's capacity to practice sustainable forest management (SFM)
- Strengthen ability to measure progress toward SFM
- Promote the application of SFM
- Develop a national consensus on forest issues
- Position to address global forest issues
- Deliver federal responsibilities; provide other agencies with science and policy advice

Audit and Evaluation of 1998-2003 Strategic Plan
- Improvement needed:
  - Partnering
  - Relevancy – primarily with the science program
  - Visibility – not just an issue related to communications
  - Entrepreneurship – opportunities and access to resources
  - User Friendly – avoid alienation of constituents
  - Organizational culture – the way we do business

Context for a new Strategic Plan 2003-2008
- Earnscliffe Report - clients do not know us; need for science and technology (S&T) recognized but our program largely unknown
- S&T Futures Study - NRCan S&T *not* well managed
- Peer Reviews of Networks
- RATs (Reallocation And Transformation)
- ADM Discussion Paper
- Staff input to issues and strategic directions
- New Plan will role out April 1, 2003
- Strategic Plans for Centres to follow with
  - Business Plans and Work Plans

What is the approach, the range of disciplinary expertise, skill sets and resources required to provide the science for ecological risk assessment (sustainable management)?
What is required to build a better structure in order to facilitate cooperative and collaborative endeavours?
- Find answers in the context within which we operate.

Earnscliffe Report
- Public polling company - in-depth interviews with CFS stakeholders
  - CFS is virtually unknown by key stakeholders and central agencies (PCO, TBS, Finance)
  - CFS lacks political will or influence
  - CFS is not an active player in critical issues – lack of resources argument is unacceptable

- Clients want:
  - a say in setting priorities and future direction of the CFS;
  - CFS *engaged* in major forest issues, e.g., climate change, biodiversity and market access

In the Future

- CFS needs to be:
  - Integrated within the forest sector
  - Influential with partners
  - Relevant to clients
  - An effective representative of the Government of Canada
- Partnerships – the way to do business

Principles for a new CFS Strategic Plan

- Move up the value-added chain (data, information, knowledge - synthesis)
- Use science - to lead the way; national forest agenda working in the same direction
- address emerging issues (e.g. economics, trade issues, (water?)) - develop internal capacity
- CFS to be a science-based policy organization
- Play role as advocate in major forest issues
- Primary client focus
  - Federal government - support public policy development
  - Forest land managers - support stewardship, knowledge management and competitiveness
- Public policy will be driver for CFS direction
  - Environment
  - Trade
  - Economic development
  - Foreign policy
- Partnerships the norm for doing business

Partnerships

- MOUs concerning cooperation in forestry - Four Atlantic Provinces
  - Purpose:
    - to enhance cooperation with provinces on (e.g.): international trade; national coordination; science and technology; and regional development.
  - Objectives:
    - To establish bilateral coordination mechanisms;
    - To identify S&T priorities;
    - To develop joint initiatives;
    - To develop collaborative agreements with regard to priorities.
- Cooperative Research Agreements with industry and other government departments (JD Irving, CFIA)
- Collaboration with universities (Dalhousie, New Brunswick, Toronto, Beijing ...)
- Model Forests
- CDCs, Nature Conservancy ...

The AFC – Challenge

- Balance long-term research with short-term deliverables while responding to priorities (governmental and departmental)
- Science projects that have scope and strength sufficient to garner impact and visibility
- Generate knowledge and products contributing to the sustainability of Canada's forest resources
- Dovetail a new regional plan with the national CFS strategic plan

AFC Priorities – Next Planning Period

- Forest Knowledge Management (Decision Support System [DSS], socio-economics, information synthesis, data bases)
- Forest Productivity/Dynamics (integrated pest management, natural disturbances, tree propagation, non-timber products, soil ecology, water, climate change)
- Forest Health and Biodiversity (natural stressors, air quality, exotic pests, forestry practices impacts, biodiversity conservation, climate adaptation)

Lessons Learned

- Start process early
- Engage <u>all</u> staff
- Establish Priorities - "If you don't know where you're going any road will get you there" – George Harrison
- Consult, consult, consult (partners, staff, other government departments, collaborators)

Summary

- What science information is required? – we have found that just about anything you do as a scientist can be justified (e.g. sustainable management). The real question is a harder one – What, among your many priorities is not absolutely required or is the work of others?
- Science vs. policy: how are you organized, integrated? (CFS strategic plan).
- A word on "Blue Sky Research" (see discussion below).
- Approach? - choose issues carefully: focus, don't try to be everything to everyone, come to grips with who your clients really are.
- Range of expertise? – as scientists we need to fight and lobby for maintenance of our core expertise, BUT what is required in your centre, when are you losing focus, when does it contribute to a team (and thus your visibility) and when is it just trying to cover all of the bases?
- Resources? – there will never be enough so get beyond complaining: partner; build a (5NR) case (e.g. exotics, biodiversity); focus; be strategic.
- Building a better structure? – Networks which define a few strategic projects of significance, composed of a team of researchers working toward common objectives while contributing their own expertise. A senior manager should chair each network. A network should be relevant beyond your centre.
- Structure? – Be flexible, willing to change, willing to leave behind some of your work.
- To Managers: recognize and support a willingness to change (despite the research scientist promotion system).

Discussion and Comments (all participants)

Canadian Forest Service:

- centres do not have a strict geographic focus.
- it is felt that the move to concentrate on national issues has not undermined regional issues.
- Atlantic Forestry Centre has chosen not to be involved in certain topics which other CFS centres are doing (e.g. fire research); clients in this region requesting advice on such issues are referred to the appropriate CFS centre.
- plan is to have funding allocated from central headquarters, with regional input.
- allowing scientists to do 10-20% "blue sky" research is widely accepted by upper levels within CFS; such research does not have to be "applied" (i.e. it does not have to address immediate issues).
- CFS is somewhat autonomous within NRCan (it has its own Assistant Deputy Minister).
- CFS is approximately 70% natural sciences and 30% socio-economics. The AFC includes one sociologist and one economist.

- CFS is not an advocate for industry; it is science-based, promoting the value of science in dealing with issues.

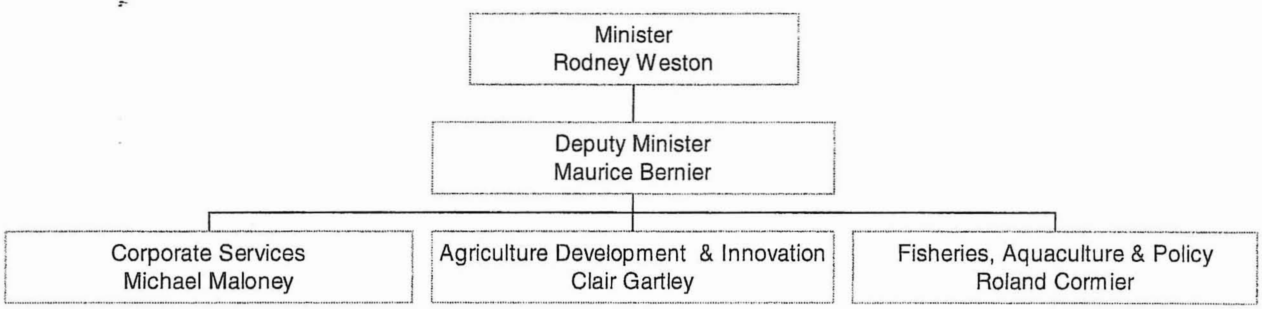
Does DFO have an advocacy role?
- is DFO Science an advocate for fisheries or aquaculture? Rather than be an advocate for these industries, our role should be to provide scientific advice for these industries.
- is DFO Science an advocate for Marine Protected Areas (MPAs)?

A Regional Management Perspective

Roland Cormier *(Assistant Deputy Minister, Fisheries, Aquaculture & Policy Division, New Brunswick Department of Agriculture, Fisheries & Aquaculture)*

Some background on the salmon aquaculture industry in the Bay of Fundy:
- has invested heavily
- generally good corporate citizens
- has been cooperative in surveillance programs
- has suffered heavy losses in recent years
- is working hard to develop better husbandry practices

Organizational structure of the New Brunswick Department of Agriculture, Fisheries & Aquaculture (NBDAFA)



Fisheries, Aquaculture & Policy Division has 6 branches:
- Policy and Planning
- Fisheries Resource Management
- Fisheries Development
- Aquaculture, Bay of Fundy
- Aquaculture, East Coast
- Licensing & Compliance (created in January 2003)

Management decisions:
- must be accountable to the Department, general public, and entire provincial government
- there must be a balance between specific sectors and the general public good.
- senior managers must rely on colleagues in the province and federal government
- often must make recommendations on unfamiliar subjects
- must also take into account other factors:
  - overarching policies
  - government direction, including policies and directions of all other departments.

Current direction of NBDAFA includes:
- strive for clear policies
- solidarity with other departments (provincial and federal)
- coordination of regulatory framework
- environmental sustainability
- promotion of the fishing industry
- value-added products
- separation of enablers and enforcers

Where can NBDAFA benefit from scientific advice?

- what does sustainable development mean and what are the thresholds?
- what is the potential for offshore aquaculture?
- how can we redefine Bay Management Areas? What is the capacity of a Bay Management Area (BMA) and what are the indicators?
- What is the capacity of any one site? (The current formula for estimated site potential is based on physical parameters only.)
- what is the relationship among the various stakeholders?
    - e.g. what is impact of aquaculture on fisheries? We have some information on the importance of fisheries near aquaculture sites, but what is the actual impact?
- fish health is currently the top priority:
    - we need to better understand infectious salmon anemia (ISA) and how to manage this disease.
    - but NBDAFA lacks the knowledge and funds to solve the problem alone
    - are options such as nursery sites feasible and acceptable?
- production increases and boundary expansions: how should we study this and what are the thresholds?
- what are cumulative effects and how do we measure them?
- how do we measure environmental impacts at the ecosystem level?

Integrated management:

- there is a proposal being discussed (involving DFO and NBDAFA) on coastal zone management.
- would involve other provincial departments.
- we need a game plan among the various government departments, before going to public consultation.

NFDAFA and DFO have similar goals. We need to improve communications and trust between them.

The Province of New Brunswick is committed to achieving equilibrium between fisheries and aquaculture.

Discussion and Comments (all participants)

Role of zoning in integrated coastal zone management (ICZM):

- current NBDAFA includes "exclusion zones" based only on conflicts with traditional fisheries.
- for environmentally sustainable aquaculture, something more is required.

Approaches to management:

- an adaptive management approach, with built-in experiments would have advantages.
- current CEAA approach may be too narrow: scale may be too small; focusses only on top priority issue.
- Australian experience with "repeated" activities: can get buy-in from industry to pay for more environmental assessment at the start, with the understanding that there would be fewer requirements in similar projects in the future.
- need to define broad conservation objectives, so we can set a common bar for all industries.
- a challenge for integrated management is how to move from the Fisheries Act's single species/single project approach.

Access to production data:

- aquaculture research is hindered by the inability of scientists to obtain production data from farms due to confidentiality concerns.
- compliance with production levels is difficult to enforce because it is not feasible to count the number of fish at a site. Are there other parameters we could use?
- some of the information that scientists want could be obtained from site audits.
- in Norway, there is no limit on the number of fish allowed per site, but there are limits on the amount of feed that can be used at a site.

Ecosystem-based Management: Science Needs

Paul D. Keizer *(Manager, Marine Environmental Sciences Division, Science Branch, Maritimes Region, DFO)*

Overview
- What is ecosystem-based management?
- What is the role of science?
- The European experience
- Current DFO initiatives
- What's next?

What is ecosystem-based management?
- Oceans Act
  - Oceans Management Strategy
  - Marine Protected Areas

Oceans Management Strategy
- national strategy for the **management of** estuarine, coastal and **marine ecosystems** in waters
  - sustainable development
  - integrated management of activities
  - precautionary approach

Management of marine ecosystems
- An Ecosystem-based approach is ...
  - Taking into account all knowledge that we have regarding the functioning of marine ecosystems
- We don't manage ecosystems - we manage human activities

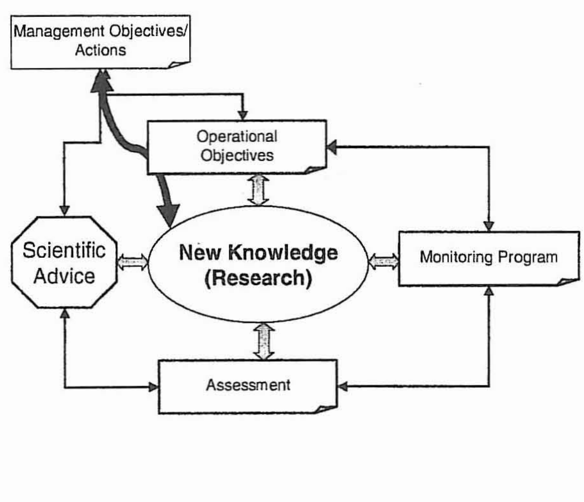
Science challenge
- Providing knowledge in a usable form
- advising on the risks associated with various actions

⇒ so how do we determine what knowledge is needed?

The role of science
- Provide scientific advice to a Management Team (which has its management objectives)

⇒ How do we do that?

The Process
- Adaptive (responsive) management, supported by new knowledge (research)



The European Experience

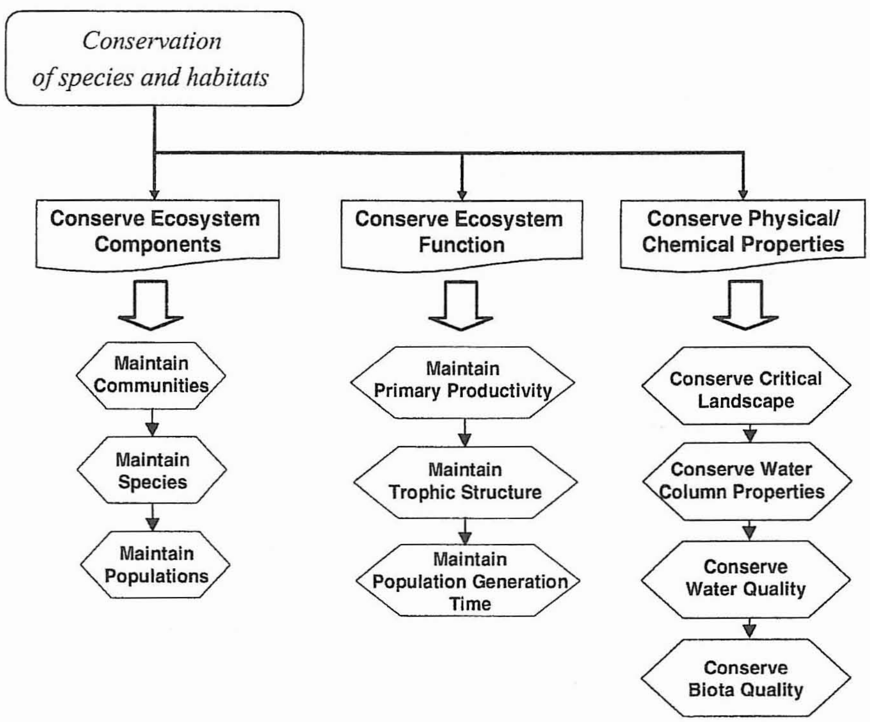
- Drivers
  - OSPAR (Oslo-Paris Commission), HELCOM (Helsinki Commission), EU
  - Water Framework Directive
  - Quality Status Reports
- Progress
  - Ecosystem Quality Objectives (EcoQO) based on broad policy objectives
    - Targets for EcoQOs hard to define
      - policy objectives "soft"
  - Quality Status Reports (QSR) based on random monitoring
    - Difficult to determine trends in QSRs
      - difficult to use monitoring data
- ICES work - Working Group on Ecological Effects of Fishing (WGECO), Advisory Committee on Ecosystems (ACE), Study Group on Information Needs for Coastal Zone Management (SGINC)

DFO Initiatives

- Working Group on Ecosystem Objectives
- the Sidney workshop
  - ecosystem objectives framework
  - formal recognition
  - pilot project - ESSIM (Eastern Scotian Shelf Integrated Management)

Ecosystem Objectives Framework

- Overarching goals:
  - Sustainability of human usage of environmental resources
  - Conservation of species and habitats (environmental component)



An Example: Aquaculture Impacts

Conserve critical landscape and bottomscape features

⇒ Conserve benthic structural/functional features (abiotic and biogenic)

⇒ By maintaining topography, sediment structure

⇒ By maintaining natural scales of physical/biological variability

⇒ By maintaining essential/critical habitat

⇒ Limit % cover of bottom type X to below Y%

- What does this mean?
- How do we determine what are relevant "bottom types"?
- How do we determine what % of bottom type we need to conserve?

We need to know the role of habitat in maintaining biodiversity and the function of ecosystems

Another example

- Environmentally sustainable aquaculture
  - does economically sustainable imply this?
  - vs. DFO's Habitat Policy
- Scientifically what does this mean?
  - Maintain ecosystem structure and function
  - Maintain habitat
- What are the operational objectives?

The Challenge

- Develop knowledge of ecological processes to identify sensitive and practical indicators for ***operational objectives***.
- Including the reference points and targets for those indicators.
- Rather than asking for projects suitable to existing expertise, we need to identify the issues and then find the appropriate expertise.

Discussion and Comments (all participants)

ACES should not be exclusively SABS staff: some of the required expertise may be outside of SABS.

We need two processes:
- fast-track approach to identify broad operational objectives to deal with immediate issues.
- longer-term "unpacking" exercise to identify research requirements.

Need to be flexible, to be able to adapt to change:
- industry will change, so issues will change.
- industry priorities are constantly changing.
- industry is expanding into new geographic areas.
- there is a changing landscape in how science is done.

Development of decision alternatives:
- is subject of management science.
- objectives are not always clear.
- unpacking often shows that objectives are political, not scientific.

- some of the objectives are actually strategies and tactics.

Should science be conducting monitoring?
- proponent should be conducting compliance monitoring, but do it well.
- science should do follow-up on monitoring data.
- science should identify what to monitor: indicators must be sensitive, useful and associated with operational objectives.

A strength of an integrated research program is that the entire program is not derailed if one component project is terminated or re-directed.

Scientists must be proactive in educating managers about what they should know about science.

ACES is well-situated to integrate cross-over between activities such as aquaculture, fisheries, oil and gas. The process examining aquaculture exclusion zones is trying to do this.

Need for ecological research on habitat structure and definition
- bring GIS and acoustic mapping into operational use.
- need to build framework and models for accumulating future knowledge.

There have been two sectoral approaches up to now:
i) use of water quality for marine environmental quality (MEQ)
ii) use of fishery data and biomass for fisheries management
- now need an integrated approach; need to be equally fair to different activities.
- cross-over between sectoral approaches could be a theme of ACES.
- still much experimental research required before we can compare different activities.

Need to include sociological and economic issues into advice to managers.
- humans are part of the ecosystem, so socio-economic factors must be included, without compromising the biology; socio-economic issues do not affect fundamental biological thresholds
- CFS model forests include biology, economics and sociology. It takes time to develop such teams.
- at SABS, our role is biology. At what stage should socio-economic factors be brought in?

A Regional Perspective on the Scientific Needs of the Existing "Sparsely-Integrated, Not-so-Ecosystem-based, with very little socio-economic input" Management System: with some views to the future

Paul Boudreau *(Acting Manager, Habitat Management Division, Oceans and Environment Branch, Maritimes Region, DFO)*

Key Activities of Habitat Management Division

- Deliver regulatory mandate of Fisheries Act and Canadian Environmental Assessment Act habitat protection
- Develop, promote & facilitate stewardship in aquatic habitat protection & enhancement
- Ensuring proper work near water to ensure no net loss of fish habitat

Habitat Management - Legal Mandate

-Section 35 of the Fisheries Act:
"NO PERSON SHALL CARRY ON ANY WORK OR UNDERTAKING THAT RESULTS IN THE HARMFUL ALTERATION, DISRUPTION OR DESTRUCTION OF FISH HABITAT." (without an authorization from the Minister)

If an authorization is required, DFO must also carry out an environmental review under the Canadian Environmental Assessment Act (CEAA)

How illegal is illegal?

- Hijacking a plane
- Stealing money from a bank
- Fishing without a license
- Trafficking in marijuana
- Possession of a "small" amount of marijuana
- 'Cheating' on a travel claim
- Driving above the posted speed limit

For Habitat: How Illegal is Illegal?

- Large Oil Spills
- Excessive sedimentation
- Use of small culverts
- Building a breakwater (without an authorization and CEAA Screening)
- Infilling of intertidal areas (without an authorization and CEAA Screening)
- Removing beach sand/stones
- Walking on submerged vegetation

Management Needs for Science

- Identify existing habitat
- Quantify "negative" impacts
- Develop compensation for losses (if required for an authorization and CEAA)
- Monitor to ensure no loss (if required for an authorization and CEAA)
- Collect evidence re violation
- Provide expert witness in court

Identify existing habitat
- What is where?
- Consistent, accepted, accessible "Habitat" maps
- An agreed useful "Habitat characterization
- Credible supporting scientific information and experts

Quantify "negative" impacts
- What is the predicted impact of an activity on the known habitat?
- Is the impact expected to be negative?
- Is the impact expected to be "significant"
- Is the impact expected to be temporary or permanent?

Develop compensation for losses
- Under the Habitat Policy, the Minister can authorize a HADD if compensation is provided
- How can the proponent ensure "no net loss" by improving elsewhere?
- How can we measure productivity?
- How can productivity be increased elsewhere?

Monitor to ensure no loss
- What to monitor and how?
- QA/QC of proponents monitoring efforts?
- What are the decision points?
- How can scientifically credible monitoring be properly described in the legal authorization document?

Collect evidence re violation
- Support Habitat Staff and Conservation & Protection Officers collect the necessary and appropriate information
- Develop guidelines and procedures

Provide expert witness in court
- Need to convince a judge - not a colleague or statistician
- Requires juridic rigour not necessarily scientific rigour
- Needs expert opinion - in many cases the scientist is the sole expert

Simple example of success: Environment Canada high seas oil slick
- Monitoring & Surveillance in place
- Evidence collected according to protocols
- Willingness to go to court
- Awareness in court of seriousness
- Favourable decision
- <$100,000 fine - insignificant
- Public awareness - INVALUABLE!

Complex habitat issues require ACES multidisciplinary approach
- Where and what is habitat?
- How can it be impacted?
- What activities result in significant negative impacts?
- How do we manage for "no net loss" - i.e. sustainability of ecosystem?
- How do we know when a HADD occurs?
- How do we prove a HADD?

Science plays an essential role in existing system

- DFO has legal mandate
- DFO is responsible for regulations
- DFO has management responsibility
- DFO has legal and policing

Science can play an increasing role in improving the system

- Pro-active Integrated Management
- Defining and quantifying management areas such as Large Ocean Management Areas (LMOA), Bay Management Areas, MPAs, etc.
- Developing ecosystem-based management tools (MEQs?) that can be incorporated and enforced under regulations

Charge to presenters:

- What information is sought to make decisions?
  - Various
- What is typically available?
  - Various
- What is missing but required to make the best or complete decisions?
  - Now?
  - Future?
- What is the most desirable structure to both identify the issues and the science required to address the issues?
  - consistent, coordinated, scientifically credible, single contact

Discussion and Comments (all participants)

Habitat management needs:

- can always use more science.
- how do we deal with cumulative effects? We have to do the best we can with the available information.
- what scale is significant to courts?
  - Courts are malleable: we need to educate prosecutors and judges.

Science is being asked for advice in HADD agreements related to aquaculture development:

- need to identify habitat.
- is it DFO's or industry's role to identify presence of species? When done by industry, quality is often poor and data is not incorporated into databases.

Peer review of scientific advice:

- RAP process is starting to be used for certain types of activities.
- but is it feasible for individual cases? Probably yes, for large projects under CEAA, but not for individual smaller projects.
- can bring in outside expertise.

Separation of Habitat Management Division from Science has created some problems. There is a commitment to creating bridges between HMD and Science.

Habitat science research requirements:
- need to study cumulative impacts.
- habitat has a temporal component (e.g. seasonal and diel migrations); scientists need to put a value on the temporal component.
- there is a need for processes to account for variability and uncertainty in abundance/distribution data.
- definition of critical or essential habitat:
  - what does critical or essential habitat mean? We have some good data from life history studies.
  - how much is present and what impacts would be?
  - use of habitat mapping and classification for identifying habitats and zoning.
- what is the relationship between biodiversity and habitat?
- need for diversity of habitats; e.g. some species require a feeding area and a refuge (from predation) in close proximity.
- interpretation of data:
  - a major deficiency is how to apply existing information.
  - identification of habitat may be a dependant on the sampling methods used.
  - a rare species may be currently reduced to existing only on a sub-optimal habitat; therefore you cannot assume that where you find a species is its optimal habitat.

Habitat policy issues:
- no net loss policy implies zero tolerance.
- in reality, are we accepting a certain amount of loss?
- should we worry about habitat loss in degraded areas (e.g. Halifax harbour)?
- compensation as a tool in habitat management can create problems, because the compensation is likely to destroy other habitat.

Marine Science Future Directions

Michael Sinclair *(Regional Science Director, Maritimes Region, DFO)*

Underlying issues:
- We are a government laboratory and have an advisory role.
- There is a regime shift in management from sectoral to integrated (ecosystem-based) management (broader conservation objectives).

Drivers have been various meetings and agreements over the last decade:
- ICES strategic plan (Copenhagen Declaration in 2002): need to provide scientific advice for integrated management.
- Reykjavik Declaration on Iceland fisheries: need for responsible fishing; setting of conservation objectives.
- Canada's Ocean Act: declared in 1997, but policy slow to develop.

DFO policy for conservation aspects of integrated management (June 2000)
- Policy has two parts:
  i) Large Ocean Management Areas (LOMAs):
     - 5-6 LOMAs on east coast, based on administrative convenience, rather than ecosystem boundaries. Some issues will span more than one LOMA.
  ii) Broad ecosystem objectives:
     - maintenance of ecosystem diversity
     - maintenance of species diversity
     - maintenance of genetic variability within species
     - need to develop indicators and reference points for each of above

Types of questions we are facing have changed:
- impacts of aquaculture on herring migrations, wild salmon, and benthos
- impacts of rockweed harvesting on juvenile fish
- impacts of transportation on right whales
- impacts of Petitcodiac causeway

The nature of the problems we are facing now involve:
- complex ecological issues
- complex species interactions
- complex habitat characteristics
- increased concern for benthos
- spatial context
- conflicts between users

⇒ for most of these issues there are few guidelines or rules to follow.

Future science directions:
- need to respond to and anticipate new, emerging issues
- within the framework of integrated management
- DFO is no longer "the only game in town."

Research questions:

- at the time of the northern cod crisis, scientists had too much "*hubris.*"
- examples of where we have been unable to provide scientific advice:
  - grey seals:
    - abundance has risen from 2,000-3,000 in 1970 to 300,000-400,000 now.
    - estimated that each grey seal eats about 2 t of fish per year
    - amount of fish eaten by entire population has therefore risen from about 4,000 t per year to around 600,000 t.
    - about 8-12% of the fish eaten by grey seals are cod.
    - scientists have been unable to provide good advice on whether grey seals are impacting the cod populations or not.
  - cod natural mortality:
    - historically, natural mortality has been 20% annually
    - in the late 1980s, natural mortality rose to 50-60%
    - scientists cannot explain this rise
  - wild salmon
    - populations have shown little recovery, despite cessation of fishery and little change in habitat
    - increase in mortality at sea cannot be explained.
  - lobster
    - fishing mortality is >60% annually, with most at age before reproduction
    - this would generally be considered unsustainable
    - despite this, landings are as high as ever; science cannot explain why

Reykjavik Conference 2001 (report to be published in 2003)

- structure and function of marine ecosystems:
  - is control from bottom→up or top→down?
  - conclusion: cannot generalize on impact of removal of large predators or forage species
  - complex models are not yet feasible
- food webs in oceans:
  - Stellar sea lion decline:
    - many have attributed decline to the Alaska pollock fishery
    - conclusion: is not the fishery; is more complex
- impacts of fishing on ecosystem structure and function:
  - in offshore areas, it is difficult to determine impacts of fishing
- capability of modelling for ecosystem-based management:
  - unrealistic to expect that we can use models to generate options for the advisory process

Areas of progress:

- herring
  - purely descriptive work (no experimentation) on spawning areas and oceanographic features
  - has led to considerable explanatory power
- east coast data set
  - biogeographic shifts detected from monitoring data
  - e.g. capelin showed instantaneous reaction to southern extension of cold water in 1998.

⇒ descriptive biology can provide considerable explanatory power.

Future advances:

- need good descriptive studies; monitoring of important issues.
- take advantage of experimental opportunities

Suggested 5 year plan for ACES, with two themes:

i) development of guidelines for integrated management
   - use literature and workshops
   - develop operational ecosystem objectives
   - best practices for conservation objectives

ii) area specific questions
   - aquaculture; fisheries-aquaculture interactions; biodiversity
   - benthic habitat
   - dispersal processes
   - spatial patterns for zoning of activities
   - new technologies:
     - multibeam and sidescan sonar
     - circulation modelling
     - GIS capability

Biodiversity research

- 3 levels: seascape (ecosystem); species; genetics
- 3 activities: inventory; processes that control changes; monitoring
- 3 × 3 matrix
- ACES could serve as a "node" for research on threats to biodiversity

Monitoring

- is a high priority within DFO; in association with data management and making the data accessible.
- ACES could provide data products and indicators for integrated management. Products could include:
  - a state of ecosystem report for this area (reflecting management issues)
  - provision of advice on cost-effective monitoring

Strategies:

- need to stay connected internationally
- need to involve stakeholders from the beginning, if what we develop is to be used.

Discussion and Comments (all participants)

Possible ACES research directions:

- biotechnology can assist in various aspects of our mandate; e.g. fisheries management, MPAs, research on stressors. Biotechnology is also a source of funding.
- we must be careful not to let the project be directed by the sources of available funds.
- we need to deal with tractable problems.
- we need to incorporate fishers' information and hypotheses as credible input. DFO is at the forefront in this regard.
- we may have to provide advice that is less quantitative, but still useful; i.e. more qualitative assessments.

State of marine ecological understanding:

- in the fisheries context, the state of marine ecological understanding appears to be at a relatively early stage.
- fisheries scientists need to interact more with the rest of the ecological community (e.g. terrestrial) where the state of ecological understanding may be more advanced.

Basic Functions of DFO Science

Serge Labonté *(Director General, Fisheries, Environment and Biodiversity Science Directorate, DFO Ottawa)*
(presented by Thomas W. Sephton)

Monitoring

- monitoring of aquatic resource and the aquatic environment or determine trends necessary in the provision of scientific advice and information to decision-makers and clients, e.g. repetitive activities such as resource surveys, ocean monitoring, contaminants, etc.

Managing data & Information

- managing of data and information as collected by staff and used to provide advice and information to decision-makers and clients.

Science advice

- information (includes consultation, analysis, reports, peer-reviewed advice) that is given as a result of research and monitoring, e.g. fish stocks and environmental assessments.

Targeted Research

- research ranging from very specific/mono-disciplinary scientific investigations to multi-disciplinary/multi-institutional/multi-year research programs that may form the basis of specific scientific advice, e.g. risk posed by toxic chemicals to important fish stocks, or add more generally to the overall science knowledge base in alignment with departmental priorities.

Products & Services

- actual products & services provided to clients (other than scientific advice) that may include the actual sale of products, e.g. CHS maps, charts, and publications.
- Patents

Leading & Managing Science

- coordination of the various science activities at the regional, zonal and national levels in interactions with other sectors, departments, clients and partners, e.g. Atlantic Zone Science Directors Committee, Aquaculture Collaborative Research and Development Program (ACRDP).

Applying Information Management to the Decision-Making Process

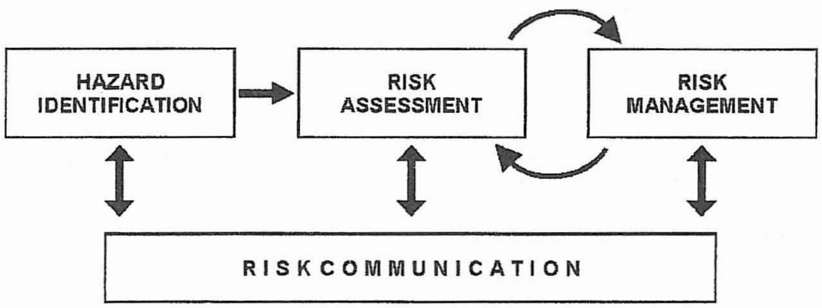
Patrice Cousineau *(Computer Scientist, Marine Environmental Data Service, DFO Ottawa)*

Facts and Statistics

- Worldwide
  37% of earth's population live within 60km of a coast
  58% of coral reefs are threatened
- Canada
  25% of the country's population live in coastal areas
  21 of the 43 north Atlantic ground-fish stocks are in decline

What is Ecological Risk Assessment (ERA)?

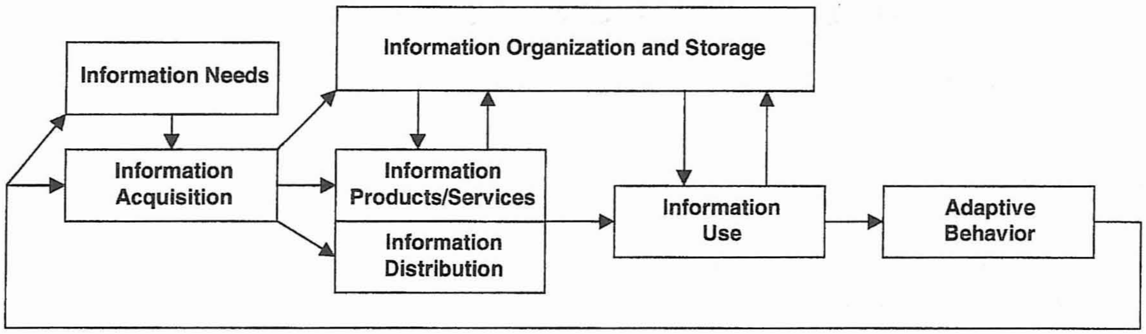
- A process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors (US EPA, 1992).
- ERA is part of a larger process known as risk analysis:
  - Hazard Identification
  - Risk Assessment
  - Risk Management
  - Risk Communication



What is Strategic Information Management (SIM)?

- Data are raw facts and figures
- Information is data organized into a meaningful context
- Knowledge is information that has been understood and applied

A set of skills ranging from records and information management, information technology, to strategic management that will enable professionals and their organizations to make well-informed decisions resulting in a distinct competitive advantage in the business world (ARMA.ORG 2003).



What is Knowledge Management (KM)?

- A systematic process of finding, selecting, organizing, distilling and presenting information in a way that improves an employee's comprehension in a specific area of interest (U Texas 2003).
- Strategies and structures for maximizing the return on intellectual and information resources. Because intellectual capital resides both in tacit form (human education, experience and expertise) and explicit form (documents and data), KM depends on both cultural and technological processes of creation, collection, sharing, recombination and reuse. The goal is to create new value by improving the effectiveness of individual and collaborative knowledge work while increasing innovation and sharpening decision-making (destinationKM 2002).
- The knowledge management process embraces the entire information-transfer cycle, from the creation, structuring and representation of information to its dissemination and use (Lucier 1990).

How can SIM help improve the ERA process?

- Even though risk assessment focuses on data analysis and interpretation, acquiring the appropriate quantity and quality of information for use in the process is critical.
- Through an iterative process, new information can be incorporated into risk assessments, which can lead to better environmental decision making.
- Monitoring data can be used to identify changes in ecological conditions, evaluate a risk assessment's predictions and determine whether mitigation efforts were effective.
- Even more crucial to the decision making process is how well the research and technical information can been linked together using the appropriate tools and techniques.

St. Andrews Biological Station: Strengths & Attributes

Thomas W. Sephton *(Director, St. Andrews Biological Station and Manager, Aquaculture Division, Science Branch, Maritimes Region, DFO)*

Location
- Commercial fisheries: fish & invertebrates
- Trans-boundary stocks and Gulf of Maine Council
- Aquaculture: salmon, new species aquaculture, polyculture
- Species-at-risk: salmon, mammals, birds
- Recreation & ecotourism
- Provincial & municipal development

Quality Salt Water
- High volume, high quality salt and fresh water for large scale wet lab research
  - short and long term research
  - controlled environments
  - toxicology and behavior studies
  - broodstock holding and larval rearing
  - fish and shellfish

History of Partnerships, Joint Ventures, Collaborations
- Strong working relationships with partners - Southwest New Brunswick Area Director's Office (DFO), Canadian Food Inspection Agency (CFIA), Environment Canada, New Brunswick Department of Agriculture, Fisheries & Aquaculture (NBDAFA)
- Non-governmental Organizations (NGOs): Huntsman Marine Science Centre, Atlantic Salmon Federation, Aquaculture Association of Canada
- Strong interaction and support from Industry and Associations - traditional ecological knowledge.
- First Nations
- Tradition of developing a mix of activities being almost solely lead and conducted at SABS
- Long standing support from Bedford Institute of Oceanography, Gulf Fisheries Centre and elsewhere for services and platforms

Our Scientific Expertise
- Analytical assessment and modeling of finfish and invertebrate harvest fisheries within the Bay of Fundy, Gulf of Maine and Georges Bank with additional involvement on the Scotian Shelf.
- Most aspects for finfish and shellfish aquaculture with an emphasis on salmon aquaculture, new marine fish species and invertebrates.
- New investment in species at risk with a present focus on wild salmon, right whales and porpoise.
- Environmental chemistry and toxicology of anthropogenic chemicals, marine organisms and their interactions
- Phytoplankton monitoring - harmful algal species
- Analytical and modeling oceanography of the coastal zone with an emphasis on physical and biological (phytoplankton and zooplankton) linkages and applications to fisheries and aquaculture

Our Scientific Expertise

- Integrated benthic ecology with an emphasis on Geographic Information Systems (GIS), habitat structure, impact assessment, population dynamics.
- Dedicated professional technical support staff, hardware & systems

History of Successful Development of Highly Qualified Personnel

- Staff training & development
- Collaborative research through universities for MSc and PhD programs
- College & university student internships
- Federal Student Work Experience Program (FSWEP) and YMCA internships
- Co-op students (all levels)
- Visiting scientists & post-doctoral fellows

Rebuilding of Infrastructure

- New office/dry lab complex
- New wet lab facility
- New roads and security
- New wharf
- Maintain saltwater filtration, storage facilities, Lauzier Building, Atlantic Reference Centre
- Re-investment in capital equipment?

Informatics & Communications

- Data management & servers
- Application development & maintenance
- Technical service & support
- Library holdings & support staff
- On-site communications officer

Administrative Support & Facilities Services

- Dedicated administrative support officers for all Sections
- Facilities technical and administrative support staff: keeping SABS operational
- On-Site? Human Resources-Staffing, Financial, Real Property Management

Dedicated Vessel Support

- CCGC *Pandalus III* year-round with experienced Captain and Crew
- CCGC *J.L. Hart* seasonal assignment
- *Gemma*, *Salar*, Zodiac Fast Craft and runabouts
- Vehicles and trailers

Discussion and Comments (all participants)

Additional SABS strengths:

- diversity of aquatic environments in vicinity
- Atlantic Reference Centre
- dive program
- modelling expertise
- capacity to host conferences and workshops
- proximity to industries, including fisheries and aquaculture

Deficiencies in expertise at SABS:
- statistics and experimental design
- diadromous fisheries
- marine geology
- mapping
- genetics
- engineering

Other SABS weaknesses:
- some clients are relatively distant (e.g. southwest Nova Scotia).
- reliance on short-term funding creates short-term employment, resulting in constant cost in training (although it was noted that government funding is more stable than at universities).
- difficult administrative structure.
- inadequate support for students.

ACES issues:
- we need to build teams around the requirements of the issues.
- there is buy-in by Division Managers.
- ACES does not require an institutionalized management team: it needs to be flexible.
- You cannot draw a distinction between applied and academic research. You need to strive for better science. There is no danger in "applied" research, provided that standards of good, peer-reviewed science are maintained.
- for best science, need full-time researchers (cf. universities which rely heavily on student researchers), but also want student researchers.
- Agriculture Canada has eliminated "stovepipe" structure; similar changes may occur at DFO (ACES may be a pilot project for this).
- there still is a need for single focus research.
- it was suggested that ACES could eventually represent about 30% of SABS science; the remainder of our science will continue much as it is now.
- Some groups at SABS are already beginning to work on issues suggested for ACES.
- ACES must identify a short-term (within 2-3 years) deliverable, in order to demonstrate that this concept will work and to attract people and funds. This does not have to be a scientific deliverable, but could be an interactive workshop with stakeholders.

Discussion on Potential Issues and Research for ACES

At the end of the first day of the workshop, participants were asked to identify three to five issues related to integrated management where DFO Science could contribute. Responses were received from about half of the participants. A compilation of the responses is included as an Appendix.

Comments and discussion on issues for ACES:

- overall issue is research on the scientific basis for integrated management.
- need to study the biological basis for management in a changing environment.
- overall issue of change: what is "normal"?
- need to be forward thinking, rather than reactive; need to anticipate what the issues will be in the future (e.g. offshore aquaculture).
- should move from understanding what is currently happening (inventory, biodiversity) to understanding how certain activities will affect the environment and to manage these activities.
- what are the consequences of habitat changes? Habitat mapping itself is not sufficient.
- biodiversity: what is it, why is it important, how can we measure it?
- which is better: intensive aquaculture in a small area or extensive aquaculture over a larger area?
- should we look at manipulation of populations to increase productivity (rather than just conservation of populations)?

Suggested process for ACES:

- identify the issues.
- identify the desired outcomes to respond to these issues.
- determine the outputs and activities required to achieve these outcomes.
- determine the expertise required (and compare to what we currently have).

Comments on suggested process:

- it was noted that this is similar to the process used for developing the ecosystem objective framework.
- science can have input into framing the issues: scientists need to meet with managers to discuss issues.
- we need to choose issues that will have the greatest impact.

Where do we go from here?

- A report will be produced on this workshop.
- Internal SABS workshops will be held to further "unpack" the issues. This requires participation from a broad representation of SABS staff.
- Each Division/Section should also have internal discussions to discuss ACES issues.
- We need to enhance our relationships with the SWNB Area Director's Office, Habitat Management Division, First Nations, HMSC, other government departments, industry and other partners.

List of Participants

Last Name	Affiliation	Location
Akagi, Hugh	DFO, Marine Environmental Sciences Division	SABS
Astephen, Stephanie	DFO, Habitat Management Division, SWNB Area Office	St Andrews, NB
Anderson, Bill	NRCan, Canadian Forest Service	Fredericton, NB
Boudreau, Paul	DFO, Habitat Management Division	BIO, Dartmouth, NS
Burridge, Les	DFO, Marine Environmental Sciences Division (SABS)	SABS
Buzeta, Maria-Ines	DFO, Oceans, SWNB Area Office	St Andrews, NB
Chang, Blythe	DFO, Aquaculture Division	SABS
Clark, Don	DFO, Marine Fish Division	SABS
Cormier, Roland	NBDAFA	Fredericton, NB
Costello, Mark	Huntsman Marine Science Centre	St Andrews, NB
Cousineau, Patrice	DFO, Marine Environmental Data Service	Ottawa, ON
Dowd, Mike	DFO, Ocean Sciences Division	SABS
Glebe, Brian	DFO, Aquaculture Division	SABS
Guay, Claude	DFO, Marine Environmental Data Service	Ottawa, ON
Harmon, Paul	DFO, Aquaculture Division	SABS
Harris, Lei	DFO, Marine Fish Division	SABS
Haya, Kats	DFO, Marine Environmental Sciences Division	SABS
Hurley, Ed	NRCan, Canadian Forest Service	Fredericton, NB
Justason, Andrew	Canadian Food Inspection Agency	Blacks Harbour, NB
Keizer, Paul	DFO, Marine Environmental Sciences Division	BIO, Dartmouth, NS
Lawton, Peter	DFO, Invertebrate Fisheries Division	SABS
Madill, Hugh	NBDAFA	St George, NB
Marshall, Larry	DFO, Diadromous Fish Division	BIO, Dartmouth, NS
Martin, Jim	DFO, Aquaculture Division	SABS
Martin, Jennifer	DFO, Marine Environmental Sciences Division	SABS
Martin-Robichaud, Debbie	DFO, Aquaculture Division	SABS
Noel, Paula	Huntsman Marine Science Centre	St Andrews, NB
Page, Fred	DFO, Ocean Sciences Division	SABS
Pendrel, Bruce	NRCan, Canadian Forest Service	Fredericton, NB
Peterson, Richard	DFO, Aquaculture Division	SABS
Pohle, Gerhard	Atlantic Reference Centre, Huntsman Marine Science Centre	St Andrews, NB
Robichaud, David	DFO, Invertebrate Fisheries Division	SABS
Robinson, Shawn	DFO, Aquaculture Division	SABS
Sephton, Thomas	DFO, Aquaculture Division	SABS
Sinclair, Michael	DFO, Science Branch	BIO, Dartmouth, NS
Smedbol, Kent	DFO, Marine Fish Division	SABS
Stephenson, Rob	DFO, Marine Fish Division	SABS
Stevens, April	Huntsman Marine Science Centre	St Andrews, NB
Stone, Heath	DFO, Marine Fish Division	SABS
Strong, Mike	DFO, Invertebrate Fisheries Division	SABS
Stuible, Shirley	NBDAFA	Fredericton, NB
Taylor, Suzanne	DFO, Communications	SABS
Tsang, Peggy	DFO, Science Sector	Ottawa, ON

Last Name	Affiliation	Location
Underwood, Tony	University of Sydney	Sydney, Australia
Van Guelpen, Lou	Atlantic Reference Centre, Huntsman Marine Science Centre	St Andrews, NB
Waddy, Susan	DFO, Aquaculture Division	SABS
Wildish, David	DFO, Marine Environmental Sciences Division	SABS

Abbreviations:

BIO	Bedford Institute of Oceanography
DFO	Fisheries and Oceans Canada
NBDAFA	New Brunswick Department of Agriculture, Fisheries & Aquaculture
NRCan	Natural Resources Canada
SABS	St. Andrews Biological Station

List of Potential Issues and Research

Participants were asked to submit their priority issues and research topics. These have been grouped within broad categories.

AQUACULTURE – ENVIRONMENT INTERACTIONS

- Near-field aquaculture effects.
- Inclusion of considerations of all potential threats of containment aquaculture to the ecosystem, e.g. as potential displacement of sedentary and migratory species, as vectors of disease and parasites, and domestication of populations.
- Balance potential oriented investigations on aquaculture with investigations on potential impacts to the whole ecosystem.
- Would the Bay of Fundy Stakeholders Forum be useful for getting stakeholder definition of "environmentally sustainable" and for "sustainable development?" Such definitions could provide the basis for determining ecosystem objectives and associated targets.
- Evaluation and management of aquaculture interaction/impact.
- What is the capacity for inshore cage culture sites in the Fundy Isles? Have we exceeded it with present sites?
- At least one thing to get done by 2005: Definition of capacity of Bay Management scale for salmon aquaculture.
- Holding capacity for areas currently used for intensive salmon aquaculture.
- Environmental impact of marine fish culture: comparison with salmon.
- The effects of light in sea cages on non-target organisms.
- Offshore technology/nursery sites: Research is need in this area to address the request from industry to move in this direction. Information on habitat oceanography, cage technology, etc. is needed to move further on this issue.
- New species: Biological Station has been instrumental in development of new species. It is time to support this with greater human and monitory resources.
- Environmental impacts related to siting/expansion of finfish aquaculture sites.
- Proactive, science-based system for aquaculture site allocation (most likely to have well under way by 2005).
- Polyculture to mitigate impacts resulting from single species culture.
- Undertake an epidemiological study of the Bay of Fundy salmon culture industry – "in which the proper level of environmental data is collected."
- Better understand environmental factors which influence aquaculture productivity; including definitions of sustainable sites (so that maps could be prepared in anticipation of development.
- Regional effects of salmon aquaculture – on community structure and water and sediment quality, BOD, etc. – holistic ("ecosystem") approach (more wild stocks, migration routes, spawning, nursery areas).
- Compare environmental impacts of polyculture vs. single species aquaculture. Is there any environmental benefit to utilizing new culturing techniques?

- What is the maximum amount of coastal ecosystem which can be utilized for aquaculture? What information is necessary to determine a "sustainable" level of aquaculture?

AQUACULTURE – FISHERY INTERACTIONS

- Impacts of aquaculture on wild stocks (e.g. salmon, urchin, lobster, scallop, etc.) and their habitats during different life stages.
- Fisheries – aquaculture harmonization of approaches and expectations to sustaining the environment (re: M. Sinclair's points).
- Lack of A-base funding for Invertebrate Fisheries Division to perform aquaculture site environmental impact assessment work. Areas adjacent to new and existing sites need to be evaluated for impacts on recruitment, etc. This work is currently being done on an ad-hoc B-base funding basis, but remains an on-going requirement to supply DFO and NBDAFA managers with appropriate information.

CLIMATE CHANGE AND ENVIRONMENT

- Effects of climate change on diversity and productivity of aquaculture, fisheries and species at risk.
- Implications of climate change on the trophic web in the lower Bay of Fundy – continue as primary feeding ground for cetaceans?

HABITAT CLASSIFICATION AND BIODIVERSITY MAPPING

- Mapping of benthic seascapes/ecosystem types of Fundy Isles to guide zoning options and Marine Protected Area (MPA) considerations.
- Habitat assessment for future aquaculture development (and other activities), i.e. determining suitability of areas where there is currently no aquaculture (e.g. offshore; area east of Point Lepreau), but where industry is likely to expand.
- Understand the biological importance of pockmarks on Passamaquoddy Bay productivity.
- Characterize the diversity and structure of the marine seascapes of the Quoddy Region encompassing their physical features, biodiversity attributes and functional significance for valued ecosystem components.
- Habitat classification, dynamic biodiversity inventory for the lower Bay of Fundy – what, where, when, how many; additionally – how and why (function process)
- Identify and quantify management areas with an ecosystem base.
- Identify and quantify "high priority" impacts that can be measures and avoided.
- Integrated Management for West Isles – habitat classification – define where habitat types are and are they "rare" or common – recommend where "protected" areas should be.
- Inclusion of wild transient/diadromous fish and their habitat in the near or distant geographical bounds of ACES.

CONSERVATION OBJECTIVES/UNPACKING EXERCISE – ENVIRONMENTAL SUSTAINABILITY

- Workshop to unpack the ecosystem objectives framework for a management objective of environmentally sustainable human activity in the Fundy Isles Region – looking at the issue solely from a scientific perspective will provide a basis for broader consultation in an IM framework. It will identify major knowledge gaps so that funding/collaborative opportunities can be taken advantage of.
- Biological and physical basis of guidelines for integrated management.
- Data products and indicators for integrated management in the lower Bay of Fundy.
- Definition of conservation objectives for IM, with some unpacking for aquaculture, fisheries etc. to make them operational (set a common standard for conservation for all activities).
- Environmental sustainability – what are the thresholds of limits (standards) used to indicate environmental sustainability? There is an ongoing need to augment information on the impacts of aquaculture on the environment and the environment on aquaculture.
- Relate life cycles of various species to environmental parameters to understand what management activities are practical.
- Identify decision points, monitoring, etc. that can change man's activities to minimize impacts.

REPORTS

- Prepare a state of the ecosystem report.

FISHERY – ENVIRONMENT INTERACTIONS

- Population dynamics (using genetic profiling) of marine species of economic importance (in order of priority), and factor in impacts of climate change, fishing, management strategies, developments, etc. and model/predict future scenarios useful to all key DFO mandates and legislative responsibilities.
- "Big picture" interactions – How does "offshore" affect "inshore." This could be fishing or simply the physical-chemical nature and what that means. Conversely how does near-shore activity affect the off-shore?
- Fish stock management relative to species, i.e. a similar species may occupy the niche vacated by depressed species thereby impeding recovery.
- A first step to an ecosystem approach to fisheries management should be to eliminate destructive gear types from harvest fisheries. This could be done by buying out dragger licences and reallocating these vessels to fisheries using less destructive gear types, etc.
- We do not fully understand the impacts of harvesting at primary trophic levels. Such "experimental" fisheries should be curtailed from expansion until appropriate studies can be done.
- Rockweed harvesting – community effects, e.g. nursery areas for gadids (pollock, tomcod, cod).
- Habitat and community effects of destructive fishing gear (e.g. intensive scallop dragging in the St. Croix estuary).
- Is sustainable harvest of soft-shell clams impacted by the closures of harvest areas due to coastal contamination?

TOOLS/METHODS/SCALE – SAMPLING

- Development of techniques to assess cumulative impacts/effects in coastal environments.
- Development of acoustics as a spatial/temporal monitoring tool in ICZM (towards benthic macro-faunal community maps).
- Development of sediment profile imaging as a method of assessing sediment "health."
- Develop a universally applicable method to determine the holding capacity of cultured fish.
- Habitat compensation… options in different systems, freshwater and marine. Measuring "no net loss."
- Using the information from monitoring programs. Why are we asking for monitoring on projects if we are not going to use the information? Should it be "banked" to use in the future, or is there a way to use it now?
- Projects requesting to do work over the winter season. Freshwater systems, in-stream work. Help in addressing some of the impacts and ways to avoid them.
- How to deal with scale.
- Hydrography and its effects on distribution (dispersal/retention) on the early life stages of lobster (or others, e.g. herring) in the lower Bay of Fundy (or other): implications for the population.
- The existing system lacks proper consideration of the broader range of spatial temporal dynamics important to ecosystem stability.
- Data sets – co-ordinate, hindcast for prediction.

INTEGRATED COASTAL ZONE MANAGEMENT / MARINE PROTECTED AREAS

- Marine Protected Areas: conceptual basis, characteristics, uses, using lower Bay of Fundy as case study.
- Integrated coastal zone management dealing with cumulative impacts of multiple, often conflicting, activities.
- Model forest approach.
- Short term goal – Pilot ICZM decision support system.
- DFO has a mandate problem in its role to deliver what is itemized in the Fisheries Act and the Oceans Act. The devolution of many of its responsibilities to the provinces with MOUs has left it impotent to deal with many issues with aquaculture.
- ACES – a structure to evaluate ongoing knowledge, direct new knowledge, and address gaps in knowledge, and most importantly to synthesize knowledge - for synthesis give recommendations on new knowledge needed (or monitoring needed), conservation objectives, conservation areas required.
- Is the resolve to make this work really in the room? Sometimes the best intent gets beaten into submission by lack of support from above. W. Watson-Wright's 1½ years of strategic planning for the Station disappeared. DFO bureaucracy seems to be at the whim of industry. Is upper management listening? How do we get through the layers of middle management?
- Can we strengthen the bonds within ACES without weakening the bonds within Divisions (to Halifax for example)?

- Can we maintain an integrity to produce good science that is issue driven (without input from all involved) without worrying about how the funds are solicited?

CHEMICALS

- Toxicological risk assessment.
- Impact of a major oil spill in the Bay of Fundy shipping lane – oil dispersal and ecosystem/economic/social effects.

ECONOMIC DEVELOPMENT

- Impact of the Bayside Port on the St. Croix estuary.
- Effects of moving shipping lanes on all trophic levels.

SPECIES AT RISK

- Protection and restoration of species at risk in relation to anthropogenic factors.

MANAGEMENT ISSUES

- There is currently a huge void between Science (DFO) and Area Directors' managers. Decisions are frequently made with little or no science input. In some cases, the science info is not solicited by managers. The consequence is often subsequent fire-fighting to rectify poorly made management decisions and DFO science is often left holding the bag. Recently an experimental sea cucumber dragging fishery was approved by area director for an in-shore region during summer months where lobsters are know to aggregate for molting and reproduction. It was later revoked as a result of rebellion by local lobster fisherman. This entire fiasco could have been a process for science consultation prior to approval of this licence.
- Need to include fisheries, aquaculture, environmental protection, ecotourism, coastal dwellings, shipping/boaters, cables/pipelines, infrastructure (roads, breakwaters), sewage disposal, new users unthought of today.