

Canada – National Activities contributing to FUTURE

Prepared for:

FUTURE Advisory Panel Interim Meeting

Seoul, Korea

August 16-18, 2010

Robin Brown
Jackie King
Tom Therriault

FUTURE Research Themes and Implementation Objectives

1. What determines an ecosystem's intrinsic resilience and vulnerability to natural and anthropogenic forcing?
2. How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future?
3. How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?

1. What determines an ecosystem's intrinsic resilience and vulnerability to natural and anthropogenic forcing?

1.1. What are the important physical, chemical and biological processes that underlie the structure and function of ecosystems?	***
1.2. How might changing physical, chemical and biological processes cause alterations to ecosystem structure and function?	**
1.3. How do changes in ecosystem structure affect the relationships between ecosystem components?	**
1.4. How might changes in ecosystem structure and function affect an ecosystem's resilience or vulnerability to natural and anthropogenic forcing?*	*
1.5. What thresholds, buffers and amplifiers are associated with maintaining ecosystem resilience?*	*
1.6. What do the answers to the above sub-questions imply about the ability to predict future states of ecosystems and how they might respond to natural and anthropogenic forcing?*	*

2. How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future?

2.1. How has the important physical, chemical and biological processes changed, how are they changing, and how might they change as a result of climate change and human activities?	***
2.2. What factors might be mediating changes in the physical, chemical and biological processes?	**
2.3. How does physical forcing, including climate variability and climate change, affect the processes underlying ecosystem structure and function?	**
2.4. How do human uses of marine resources affect the processes underlying ecosystem structure and function?	**
2.5. How are human uses of marine resources affected by changes in ecosystem structure and function?	**
2.6. How can understanding of these ecosystem processes and relationships, as addressed in the preceding sub-questions, be used to forecast ecosystem response? [Strait of Georgia Ecosystem Research Initiative]	*
2.7. What are the consequences of projected climate changes for the ecosystems and their goods and services?	0

3. How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?

3.1. What are the dominant anthropogenic pressures in coastal marine ecosystems and how are they changing?	***
3.2. How are these anthropogenic pressures and climate forcings, including sea level rise, affecting nearshore and coastal ecosystems and their interactions with offshore and terrestrial systems?	**
3.3. How do multiple anthropogenic stressors interact to alter the structure and function of the systems, and what are the cumulative effects?	*
3.4. What will be the consequences of projected coastal ecosystem changes and what is the predictability and uncertainty of forecasted changes?	*
3.5. How can we effectively use our understanding of coastal ecosystem processes and mechanisms to identify the nature and causes of ecosystem changes and to develop strategies for sustainable use?	**

Strategies

- Data compilation and retrospective analyses
- Forecasting
- Improved data and tools

FUTURE Implementation

- To increase understanding of climatic and anthropogenic impacts and consequences on marine ecosystems, with continued leadership at the frontiers of marine science;
- To develop activities that include the interpretation, clarity of presentation, peer review, dissemination, and evaluation of ecosystem products (e.g., status reports, outlooks, forecasts)
- establish a process for engaging interested institutions and other recipients.

AICE

- Integrated understanding of past coastal ecosystem change caused by anthropogenic forcing, especially hypoxia, eutrophication, chemical pollution, and fishing-related shifts in community or size structure and how societies have been affected by these changes;
- Comparing the responses of sensitive organisms to specific anthropogenic perturbations and internal community shifts using retrospective data analysis, ecosystem models, field studies, and laboratory and manipulation experiments;
- Understanding how continued eutrophication, pollution, fishing, and other anthropogenic pressures change future coastal marine ecosystems and how these affect societies
- Evaluating how societies can sustain their resilience to inevitable ecosystem changes, and which societal choices lessen the stresses placed on ecosystems.

COVE

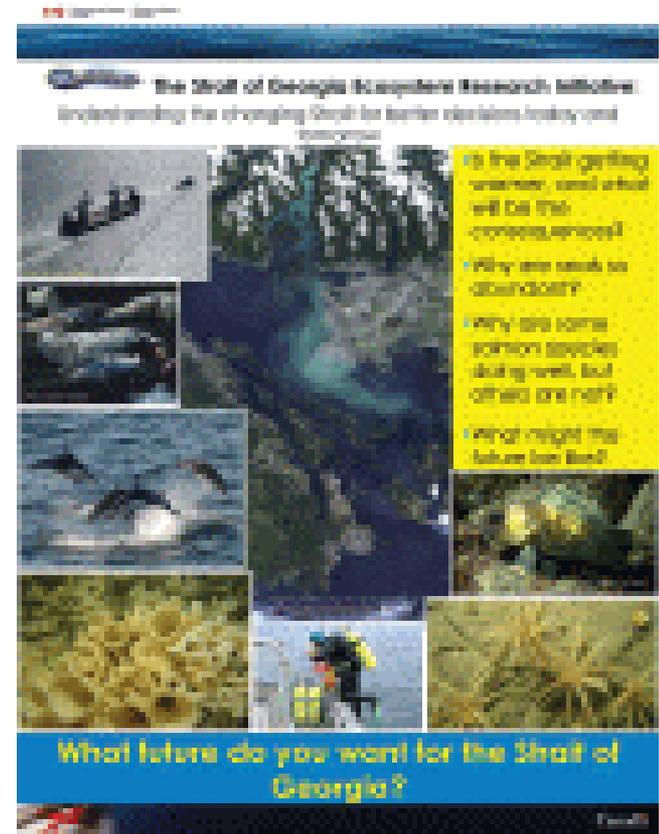
- Identifying organisms and processes that are sensitive to perturbations such as: long-term trends in physical oceanography and changes in interannual (ENSO) and decadal (e.g., PDO, NPGO) variability;
- the interaction of natural climate variability and greenhouse gas influences; and regional or short-term events such as storms and tsunamis;
- Evaluating the intrinsic resiliency of ecosystems to pressures and perturbations, and understanding how ecosystem responses may be amplified or buffered through the influence of seasonal changes in physical (e.g., altered upwelling timing) and chemical conditions (e.g., hypoxia, eutrophication, ocean acidification), food-web dynamics, and other factors.

COVE and AICE together

- Understanding how natural and human perturbations cascade through ecosystems;
- The relevance of key species concepts in North Pacific marine ecosystems and their sensitivity to perturbation;
- Identifying amplifiers and buffers of perturbation effects in marine food webs and what scales and magnitudes of perturbations may induce irreversible ecosystem change;
- Understanding the mechanisms of recruitment variation in populations of commercially valuable organisms such as finfish, shellfish, shrimp, squid, kelp, *etc.*

Canada – DFO Ecosystem Research Initiatives

- Small-ish research program to develop tools and approaches
- On the Pacific Coast, this is focused on the Strait of Georgia
- Retrospective analysis; modeling and some new observations (limited)



Canada – DFO Climate Change Science Initiative

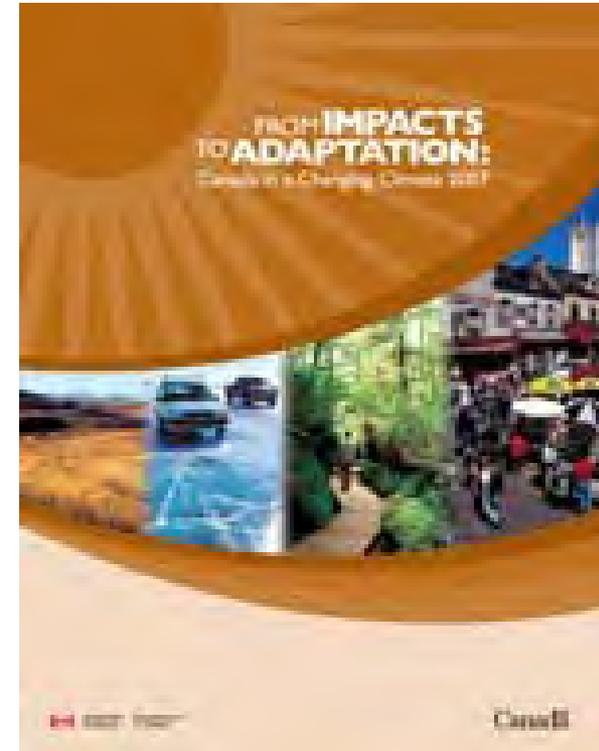
1. understanding the role of oceans in regional climate
2. assessing impacts of climate change on ecosystem composition, structure and function
3. investigating emerging issues that could impact ecosystem health.
4. Climate change scenarios/outlooks
 - Initial prediction and scenario projects for the CCSI will focus on downscaling climate change scenarios for ocean-ice variability in the three basins (Atlantic, Pacific and Arctic)
 - Regional scale ocean climate/ocean ecosystems models in development
5. Emerging issues: hypoxia and ocean acidification.

SOFE

- *Status Reports, Outlooks, and Forecasts*
 - *Status Reports* provide timely information on current conditions relative to historical information.
 - *Forecasts* are quantitative products with associated uncertainty measures.
 - *Outlooks* are products that do not yet fully meet the requirements of *Forecasts*.
- *Observation systems, Data management, and Dissemination*
- *Engagement: Establish Dialogs with Recipients of Potential FUTURE Products*

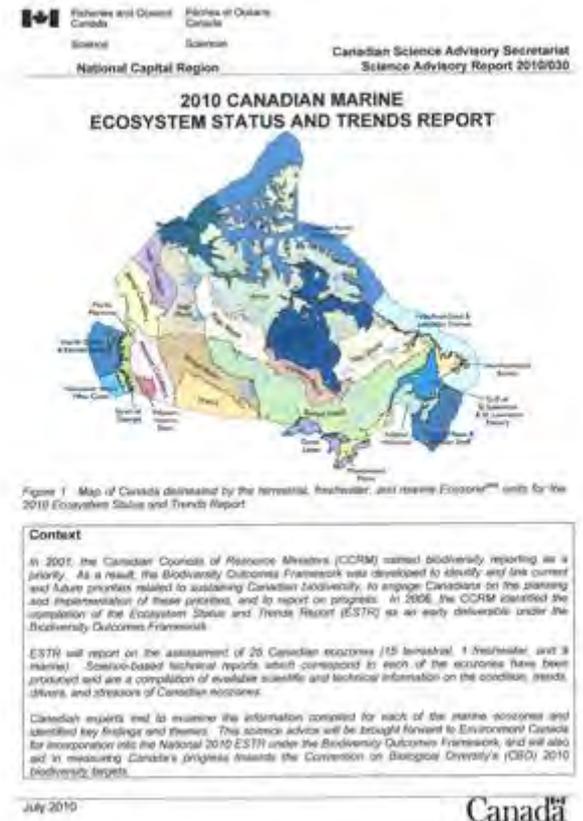
Canada – Status Reports

- 2007 - From Impacts to Adaptation Report
- Regional approach (Canada is a large country)
- Vulnerability and adaptability assessed
- Focus on terrestrial and aquatic ecosystems (not so much marine)



Canada – 2010 Marine Ecosystem Status and Trends Reports

- Reports for nine marine ecozones around Canada
- Other reports for terrestrial ecozones and the Great Lakes
- Part of Canada's undertakings under the Convention on Biological Diversity (CBD)
- Peer-reviewed and published by DFO
- Short summary report and long , detailed supporting reports



Canada – Annual State of the Ocean Reports (Pacific)

- Published annually
- Covers the NE Pacific and inshore waters
- Canadian and US Scientists contribute
- Short report (~20 pages) and a long, detailed report (146 pages)

STATE OF THE PACIFIC OCEAN 2009



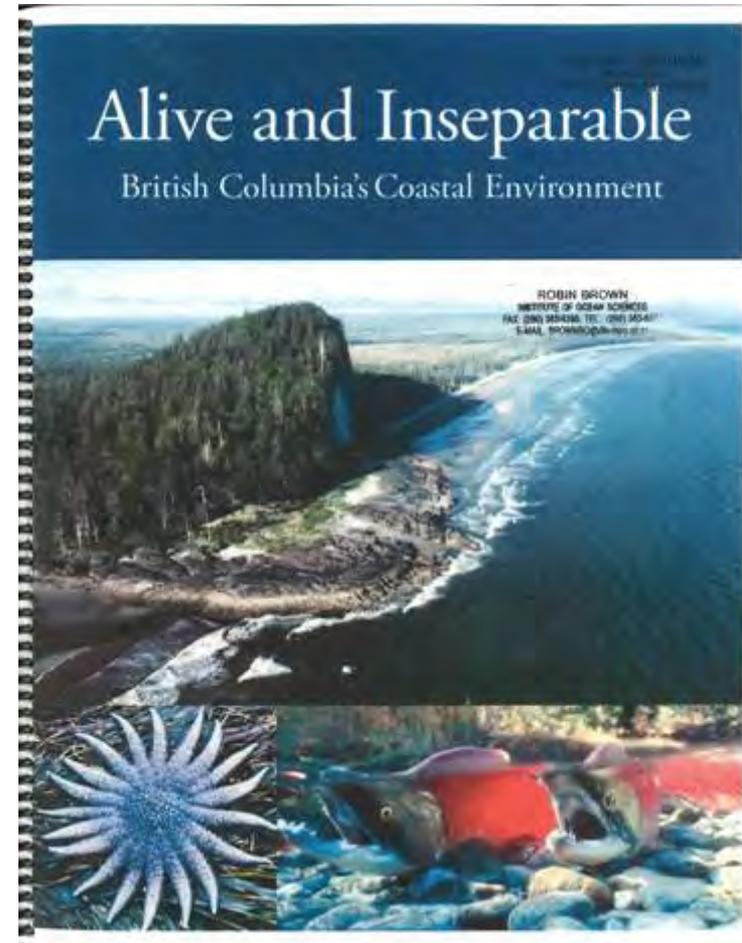
Context:

Pacific Canadian waters lie in a transition zone between coastal upwelling (California Current) and downwelling (Alaskan Coastal Current) regions, and experience strong seasonality and considerable freshwater influence. Variability is closely coupled with events and conditions throughout the tropical and North Pacific Ocean, experiencing frequent El Niño and La Niña events particularly over the past decade. The region supports important resident and migratory populations of invertebrates, groundfish and pelagic fishes, marine mammals and seabirds.

Monitoring the physical and biological oceanographic conditions and fishery resources of this region is done semi-regularly by a number of government departments. To understand the natural variability of these ecosystems and how they respond to both natural and anthropogenic stresses. Support for these programs is provided by Fisheries and Oceans Canada, and Environment Canada. Contributors to this report are members of the Fisheries and Oceanography Working Group of the DFO Pacific Centre for Science Advice, with additional contributions from U.S. fisheries and climate scientists.

Canada-BC: Alive and Inseparable – BC Coastal Environment 2006

- Includes more socio-economic data
- Report plus brochure (outreach component)



Canada – General Status Report on Wild Species



- More of a ‘conservation status report’ than a “ecosystem status report”
- All vertebrates; all vascular plants some invertebrates
- Fairly infrequent updated (every 5 years)
- Includes fishes, but no marine invertebrates
- Coarse-scale assessment:
 - *Extinct, Extirpated, At Risk, May Be At Risk, Sensitive, Secure, Undetermined, Not Assessed,*
 - *Exotic or Accidental*
- Feeds into Canada’s Species at Risk program

<http://www.wildspecies.ca/wildspecies2005/index.cfm?lang=e>

Canada - Outlooks and Forecasts – Management of Fisheries

- Two important policy instruments - the *Sustainable Fisheries Framework* and the *Wild Salmon Policy* commit DFO to regular status evaluations and identification of benchmarks
- For salmon, an annual “Outlook” document is prepared for ~300 stocks
- Forecasts/outlooks are prepared at various intervals for other stocks (annually to every three years?). These are formalized, peer-reviewed and published
- Extensive engagement with stakeholders on this

Canada – Outlooks and Forecasts - Weather/Climate

- Long term global climate forecasts through an Earth System Model with ocean biogeochemistry
 - CGCM4/CanCM4 -Canadian Centre for Climate Modeling and Analysis
- Seasonal Climate forecasts provided by Meteorological Service of Canada
- Higher resolution Regional Scale Climate models in development (CanRCM4)

<http://www.ec.gc.ca/ccmac-cccma/default.asp?lang=En>

http://www.weatheroffice.gc.ca/saisons/index_e.html

Canada – New/Novel Observation Systems

- NEPTUNE Canada
 - continental shelf and offshore cabled observatory
 - Supplies power and high bandwidth communications to/from sensors
- VENUS
 - Inshore (Saanich Inlet and Strait of Georgia) equivalent to NEPTUNE
- Both developed and operated by the University of Victoria
- Sophisticated data management/distribution systems
 - Even has iPhone app!

Canada – New/Novel Observation Systems - POST

- Pacific Ocean Shelf Tracking
 - Arrays of acoustic receivers to track fish tagged/implanted with special transmitters
 - Currenty coverage – Oregon to Alaska
 - A Census of Marine Life program
 - Extensively used for studies of salmon migration

Canada- Engagement

- Variable commitment to engagement
- Some activities (status reports mostly) built with modest engagement strategies
 - Websites and brochures mostly
- Agencies less comfortable with outreach/engagement on FORECASTS than STATUS
- DFO – Community engagement “Climate Change and Pacific Fisheries”
 - Very positive response