Climate Change and Fisheries: A Socioeconomic Perspective on Impacts and Adaptation

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Socioeconomic Research Needs (from Halifax 2000 Workshop)

- **Impacts Research Priorities**
  - Assess what can be said now about impacts on fisheries
  - Assess spatial changes in species, habitat, and ecosystem boundaries
  - Retrospectively link biological/fishery data to climate-driven parameters
- **Adaptations Research Priorities**
  - Increase participation of stakeholders in review and decision-making
  - Assess resilience and adaptive capacity of stakeholders, users, and industry
  - Iteratively develop and report longer-term forecasts
  - Improve methods to assess/manage CVC risks in fishery management
  - Measure fishery capacity, utilization of productivity potential, and scope for adaptation within and among fisheries
  - Embedding of fishery considerations into the regional landscape and societal contexts, and determining the influence those contexts exert

Climate Change Impacts: Direct and Indirect

Climate Change

- Related Physical Changes

  (e.g. Sea Level, Ocean Temperature)
- Biological Implications

  (e.g. Changes in Fish Distribution)
- Direct Impacts on Human Uses

  (e.g., Fishing, Tourism)
- Induced Impacts on Human Society

  (e.g., Social, Economic, Community)

Interacting Impacts

Climate Change impacts interact with a wide range of other economic change processes…

- Demand Shifts
- Globalization of Markets
- Technological Change
- Economic Specialization
- Urbanization

Socioeconomic Impacts Checklist

- Economic Structure and Adaptability
- Benefits, Costs and Net Benefits
- Distributional Impacts by sector
- Distributional Impacts by location
- Impacts on Markets
- Impacts by spatial scale:
  - Local, Regional, National, International
- Impacts by time scale:
  - Short-Term, InterAnnual, Decadal, Long-Term

BIOPHYSICAL / FISH IMPACT ⇒	⇒ SOCIOECONOMIC IMPACT
Important salmon stocks from Fraser and southern rivers may decline. In northern BC rivers, salmon productivity may increase.	Distributional impacts: south communities may suffer versus north ones, and capital-intensive fishers may also do relatively well.
Pacific cod abundance likely will be reduced. Exotic species will be introduced into the Pacific area from the south.	Lower profits, new opportunities. Fishers and communities that are adaptable will do well. Multi-species licensing policy crucial.
Changes to salinity of the Bras d'Or lakes may impact Cape Breton's oyster culture industry.	Highly local impacts on fisheries, aquaculture imply the need to avoid 'one-size-fits-all' policies, to encourage local management..
Environmental changes could lead to increased catchability for lobster, scallops and other Atlantic invertebrates.	Higher profits. Management changes (e.g., decreased trap limits, capacity limits) will be needed to avoid over-exploitation.
Some Arctic species (e.g., sea otter, warmer water fish) could move into new territories.	Distributional impacts: some lose, some gain, unless licensing allows larger fishing zones.
Cumberland Sound turbot fishery prosecuted from ice surface, and so is vulnerable to changes in ice thickness and distribution.	Investment in new fishing methods may be needed or markets may be lost; some fishers may need to shift to other fisheries.
Storm surges and coastal erosion will affect wetlands (and thus fish habitat).	Loss of habitat on coast could have relatively negative impact on coastal small-boat fishers.

Socioeconomic Analysis of Impacts

- Benefit-Cost Analysis
- Social Impact Assessment
- Cost and Earnings Studies
- Market Analysis / Supply and Demand
- Institutional Economics
- Ecological Economics
- Contingent Valuation
- Sustainability Indicators
- Simulation / Bioeconomic Modelling

A Bioeconomic Model of Fishing with Climate Change

- Given an ecosystem of n exploited species
- Choose n harvest levels $\mathbf{H}_t$ over time
- Maximize $\Sigma\, \alpha^t\, [p(\mathbf{H}_t,\mathbf{e}_t)\cdot\mathbf{H}_t - \mathbf{c}(\mathbf{H}_t,\mathbf{e}_t)]$
- Subject to $\mathbf{X}_{t+1} = F(\mathbf{X}_t\text{-}\mathbf{H}_t,\mathbf{e}_t)$
- Where climate change is incorporated in **e**, a set of environmental variables including trends and random fluctuations, which affect population dynamics as well, through $F(\cdot, \mathbf{e})$.

Adaptation in Fisheries

"Adaptation of the fishing industry to climate change is closely connected with investigations of the consequences of the effect of climatic anomalies and climate change scenarios. Because the effects of changes in climate factors will have different consequences for various species, development of special measures aimed at adaptation of the fish industry is regional in character and falls into the category of important socioeconomic problems."

- IPCC (2001)

Adaptation and Resilience

- Resilience is the ability to persist, absorbing shocks and perturbations without collapsing, self-destructing or otherwise entering an intrinsically undesirable state
- A resilient fishery is comprised of…
  - A resilient ecosystem
  - A resilient management institution
  - A set of resilient fishing communities
  - A resilient socioeconomic structure

Socioeconomic Resilience

- "Socioeconomic resilience is the capability of a society to prevent or cope with the impacts of climate change and sea-level rise, including technical, institutional, economic, and cultural ability. Enhancing this resilience is equivalent to reducing the risk of the impacts on society." (IPCC 2001)
- "The task is to make institutional arrangements more diverse... to make natural system - social system interactions more responsive to feedbacks; and to make management systems more flexible, accommodating of environmental perturbations." (Folke and Berkes 1995)

Socioeconomic Options for Adaptation

- How to deal with climate variability?
  - Adaptability, resilience are crucial; multi-species fishing lowers mean profits but reduces income variability too.
  - Risk management methods help manage, reduce or cope with risk, e.g., with design changes to make operations more 'robust'
- How to deal with long-term climate change?
  - For example, if target species shift northward, mobile fleets can move as well, albeit with higher travel costs
  - Community-based fisheries may need to change species mix, diversify markets and diversify the overall economy
  - Enterprises may invest to increase fishing vessel mobility, but this has impacts on the sustainability of the resource…

Adaptation through Policy: Robust Management

Robust management is that which has reasonable success in meeting societal objectives, even given an incorrect understanding of the fishery, its environment and processes of change, and imperfect capability to control fishing activity.

- Adaptive Management Portfolio
- Self-Regulatory Institutions
- Fishery System-level Planning
- Livelihood (Income) Diversification
- Using All Sources of Knowledge

Approaches for Robust Management

- Develop Flexible, "SafeFail" Management
- Avoid the Illusion of Certainty
- Avoid the Fallacy of Controllability
- Incorporate a Precautionary Approach
- Accept Complexity, Embrace Diversity
- Institutionalize Adaptive Learning
- Promote Local Management
- Seek Appropriate Use Rights
- Encourage Multi-species Fisheries
- Encourage Multiple Sources of Income
- Diversify the Economy