



C-CIARN Fisheries

State-of-Play Report

2006-2007



C-CIARN Fisheries Sector – State-of-Play Report

*The Status of Climate Change Impacts and Adaptation
from the Perspective of C-CIARN – Fisheries Sector*

Table of Contents

| | |
|---|---|
| Preface | 1 |
| 1. Introduction | 3 |
| 2. Key Climate Change Impacts on the Fisheries Sector | 4 |
| 3. Key Stakeholders | 6 |
| 4. Strategies for Stakeholder Engagement | 6 |
| 5. Engaged Stakeholders | 7 |
| 6. Unengaged Stakeholders | 7 |
| 7. Unanswered Research Questions | 8 |
| References | 8 |

Preface

In the last year of C-CIARN's mandate (July 2006-June 2007), each C-CIARN office was asked to write a report summarizing their perspectives on the state of climate change impacts and adaptation within their region or sector.

The resulting State-of-Play reports identify, from the point-of-view of C-CIARN, the key climate change impacts, as well as the key stakeholders and adaptation decision-makers (including how these stakeholders/decision-makers were most successfully engaged) of each representative region and sector of Canada. The reports also include a description of the important research questions which, from the perspective of C-CIARN, need to be answered, as well as the steps that need to be taken to both increase the level of engagement on the issue and to facilitate the decision-making that is needed to reduce vulnerability, across Canada, to the impacts of climate change.

It is anticipated that the State-of-Play reports will serve as a valuable point of reference for climate change impacts and adaptation initiatives carried out across Canada, post-C-CIARN.

1. Introduction

The C-CIARN Fisheries Sector was created to address and focus growing awareness among stakeholders in the aquatic community across Canada of the need to anticipate and prepare for climate change in the fisheries sector.

The development of communication tools and knowledge-sharing activities across a wide network of stakeholders on climate change impacts and adaptation in aquatic systems was the top priority of the Fisheries Sector office throughout its mandate from 2002 -2007. There were several critical elements to achieving this mandate. The approach we took involved the following goals and objectives:

- Establish a national network of C-CIARN Fisheries Members consisting of researchers and stakeholders from the fisheries and aquatic sciences community across Canada
- Facilitate research on climate impact and adaptation responses of fish and fisheries in Canada
- Develop and maintain communication tools including a C-CIARN Fisheries website
- Develop and maintain a database of relevant literature that broadly covers fish and fisheries responses to climate change impact and adaptation
- Facilitate impact and adaptation research by organizing workshops and conferences
- Identify state of knowledge and key research gaps
- Identify climate change impacts and adaptation funding opportunities
- Specific activities of the C-CIARN Fisheries Sector office that highlight these efforts include:
 - C-CIARN Fisheries Sector membership in 2007 was 727;
 - Coordinated one session at a national conference (Canadian Conference for Fisheries Research 2007) and organized an international conference (Climate and Fisheries: Impacts, Uncertainty and Responses of Ecosystems and Communities;
 - C-CIARN Fisheries and American Fisheries Society co-sponsored conference, Victoria, 2005).
 - Conducted over 100 scientific and public presentations between September 2002 and March 2007;
 - Produced and distributed 12 electronic membership updates (E-Bulletins) through the C-CIARN Fisheries membership list serve;
 - Participated and facilitated a number of strategic partnerships and research collaborations with agencies, NGO, industry, universities, communities and First Nations.

2. Key Impacts on the Fisheries Sector

Through its mandate to increase awareness and knowledge, the C-CIARN Fisheries Sector deliberated on the most pressing issues with regard to impacts of climate change on fish and fisheries in Canada. We are now aware that the impacts of climate change are present across the country, although accepted scientific support for these continues to be developed. The most pressing climate impacts vary widely and involve a large number of ecosystems and species. Below we highlight three major stressors that were brought to the attention of the C-CIARN Fisheries office across the last 5 years of communications and research coordination.

Changes in fish distribution and the unknown impact of invaders

Distribution patterns of fishes, especially pelagic species, respond to climate-induced change as shown by analyses of long-term trends in abundance (McFarlane et al. 2000). Observed and expected changes in fish distribution and community structure reflect the adjustment of ecosystems to modifications in water properties, currents, and/or atmospheric forcing (King et al. 1999; Shuter et al. 2002). There is a small amount of evidence that the distribution of Pacific salmon may be expanding into Arctic waters during their ocean phase (Babaluk et al. 2000) with unknown impacts to those ecosystems. In conjunction with more frequent El Nino events, Pacific hake populations have extended their range, where the furthest northerly occurrence of this species was documented in 2005/6. Contraction and expansion of highly abundant predatory fishes such as hake may modify ecosystems through increased mortality of prey species along the Pacific coast (Hollowed et al. 2001; Brodeur et al. 2005). On the Atlantic, the significant reduction in distribution of cod that was brought about by overexploitation and

climate-induced changes in cod survival (Stige et al. 2006) has demonstrated the capacity for ecosystem shifts under the combined influences of fishing and climate. Shellfish species (crab, lobster and shrimp) are now the dominant fisheries in the region and increases in the abundance of these species are correlated to warming trends (Drinkwater 1997). Changes to other ecosystem components related to the increase in shellfish species in the Atlantic remain unknown. Increased climate warming suggests that further changes in fish distribution and their associated ecosystems are imminent.

The change in climate observed over the past 100+ years demonstrates that changes on a global scale can occur rapidly. One concern associated with rapid change is that organisms, particularly those with life history types that are non-motile, subject to new environmental conditions may not be given sufficient time to adapt. Such changes may lead to extirpations and possible extinctions (Perry et al. 2005), likely to be assisted by invasions by new competitors and predators, both native and exotic in nature. Invasive species are known to cause extensive shifts to ecosystem structure and function and are thus a particularly concerning risk to aquatic biodiversity and species distributions (Simon and Townsend 2003; Occhipinti-Ambrogi 2007).

Changes in freshwater and marine water properties: impacts on salmon

Both marine and freshwater habitat conditions are susceptible to a changing climate and are believed to be of critical importance to salmon survival. It is known that salmon survival in freshwater is dependent on high quality habitat that includes a narrow tolerance range for temperature (Welch et al. 2001) and timing and rate of water flow (Rand et al. 2006). A changing climate is likely to impact the hydrologic characteristics of freshwater environments by altering precipitation cycles, temperature, and seasonal and permanent snow pack and ice which may result in

changes to water supply and flow. In the marine environment, climate-forcing is believed to be a prominent driver in the survival and global distribution of salmonids (Hare et al. 1999, Mueter et al. 2005). The complex of salmon-habitat interactions that may be impacted by climate change was summarized by CCIAP (2004).

All species of salmon in Canada are susceptible to habitat changes associated with a variable climate. Along the Pacific coast, results from recent studies suggest that increased temperature and decreased water flow in freshwater habitat have impacted salmon populations negatively. Delays in migration of sockeye salmon returning to the Fraser River were strongly associated with high temperatures in the river and its tributaries (Rand et al. 2006). Further, the occurrence of drought that significantly decreased water levels in the Somass Watershed in 2002 was correlated to a decrease in salmon reproductive success (Hyatt et al. 2003). Studies on juvenile Atlantic salmon showed similar mortality responses to high temperature and drought (Solomon and Sambrook 2004). There is an apparent influence of climate on multiple life stages of salmon in freshwater, and thus is a high priority for researchers across the sector.

Variations in ocean temperature, salinity, wind and circulation patterns are factors that contribute to climate impacts in the marine environment. Coastal waters in the North Pacific Ocean are influenced by climate conditions, especially during El Niño events. Strong El Niño events result in the transport of warm equatorial waters northward along the coast and results in the presence of unusual mixes of zooplankton and fish species (Hooff and Peterson 2006). The impact of changes in ocean conditions on the survival of salmon is well documented (Beamish and Noakes 2002), where warmer, southern waters associate strongly with decreased salmon production in the North Pacific (Hare et al. 1999). There is concern among researchers that ocean

conditions that are favourable to salmon will be highly variable and less prevailing along the coasts as climate change and warming progresses.

The resource community: socio-economic consequences

Fish distribution and abundance in aquatic systems determines opportunities for fishing and shapes the ongoing development of fishery management systems. It is accepted that ocean-climate variation and change results in shifts in the distribution and abundance of marine species, and that further shifts may be expected to accompany climate change (Beamish & Bouillon 1993, Welch et al. 1998; Perry et al. 2005). However, the sum of the effects of shifting productivity and distribution of species on the fishing industry is not well understood and current management systems do not have adequate policy frameworks to regulate drastic or rapid change.

While the value of Canadian commercial and recreational fisheries from marine and freshwater resources include strong economic benefits, people also value the activity and livelihood as a significant measure of quality of life. Small communities that are highly reliant on fisheries could be greatly affected by changes in harvests, such as the well documented example from the Newfoundland cod collapse (Hamilton 2004). First Nations social, economic and cultural well-being may be severely impacted by a changing climate because of their highly specific connections to local species and phenology.

Lastly, aquaculture is playing an increasingly important role in Canada's coastal areas in the reliable production of seafood products. While the industry is likely to be more adaptable than net-fisheries to rapid changes, the costs associated with relocation and construction of farms, and training staff at new locations may perhaps be understated should climate change impacts on aquatic systems also provoke problems for fish and shellfish health (Harvell et al. 2002).

3. Key Stakeholders

The list of stakeholders involved in fisheries issues is long because of the dependency and integrated relationships many industries and communities have with aquatic systems. Awareness of climate change and its impact on aquatic systems have increased over the past five years in part because of C-CIARN initiatives, but also because stories of natural events have been linked to climate change in the national media. However, stakeholders responsible for decision-making who will negotiate and mediate the outcome of key impacts identified by C-CIARN Fisheries are central to government bodies.

- Fisheries and Oceans Canada (including both policy and science branches) is a key stakeholder that must be engaged for adaptation decisions to be made to reduce risks to the fisheries sector related to climate change impacts.
- Researchers and academics have been supported by federal and provincial funding to study impacts of climate change on environments and have strong outreach capacity.
- First Nations, particularly where legal rights to resource access may be overruled by necessity of conservation.

4. Strategies for Stakeholder Engagement

Four key tools for communication were identified as most successful in building and engaging stakeholders and key decision makers on impact and adaptation responses of fish and fisheries to climate change. They included:

- (1) C-CIARN Fisheries engaged the active participation of up to 26 prominent individuals from a variety of stakeholder groups to form a National Advisory Committee. The committee helped to define the context and direction of sector activities and communicated with constituent stakeholder groups on behalf of C-CIARN Fisheries. This strategy was very successful in building collaborations and supporting engagement of stakeholders.
- (2) C-CIARN Fisheries organized workshops, conferences, and gave public information presentations to engage stakeholders. Details of specific conference and workshop activities are presented in C-CIARN Fisheries Sector annual reports. The Canadian Conference for Fisheries Research was a useful annual venue to engage stakeholders, as were workshop sessions associated with the Ocean Management Research Network (OMRN). The Climate and Fisheries Conference (Victoria, Oct 2005) was organized by C-CIARN Fisheries to bridge the American Fisheries Society (AFS) Canadian and North Pacific Chapter meetings and was the office's most successful venue to engage stakeholders and attract new membership. C-CIARN Fisheries sought enrolment of new members through sign-up lists at conferences and workshops.

- (3) C-CIARN Fisheries used web-based tools to communicate to members and stakeholders. A webpage was actively maintained through the 5 year mandate. The C-CIARN Fisheries Sector website was an effective communication tool because it was regularly updated with the most current information. The site included reports, relevant web links to fisheries and aquatic resources sectors, links to agency and industry websites, and contact information and registration details for upcoming climate change fisheries events and conferences. The webpage was also used to widely distribute e-bulletins which briefly discussed office activities and issues of interest to stakeholders.
- (4) C-CIARN Fisheries was active in writing various publications and reports in order to promote climate impacts and adaptation research. Four types of reporting were considered successful in engaging and informing stakeholders. These communication methods included i) scientific publications, ii) ongoing new releases or editorials, iii) regularly updated e-bulletins, and iv) reports for key federal decision makers. The C-CIARN Fisheries manager, coordinator and members of the National Advisory Committee conducted media interviews and published editorials and other media intended for the general public. The media was effectively used to engage the general public and key decision makers.

5. Engaged Stakeholders

The key stakeholders with whom we had the most communication were those in the academic and government research community (62%). The impacts of climate on fisheries that were determined to be of highest priority to C-CIARN Fisheries Sector members have the potential to have high level ecosystem impacts and associated repercussions for fishing and coastal economies.

There may be a mismatch in timing with respect to reporting the outcome of C-CIARN Fisheries impact on stakeholder decision-making processes and what guided their decision to become involved or to adapt. It is not clear whether there has been any motion toward adaptation in the fisheries sector at this time.

6. Unengaged Stakeholders

Unengaged stakeholders from the fisheries and aquatic community included key government decision makers including resource managers and policy makers at federal, provincial and local regional levels, as well as First Nations and resource and environmental industry representatives. C-CIARN Fisheries was among the first government initiatives to engage people from fisheries and aquatic resources across all regions and work domains. We suspect that time and exposure to the issue over the last 5 years has allowed for the formation of both strong opinion and increased knowledge on the part of unengaged stakeholders.

There is sufficient disbelief or interest in climate change impacts to be of concern to many stakeholders. Decision-makers therefore remain largely unengaged because the consequences of being incorrect out way the repercussions of directing policy changes toward managing climate change impacts.

More clear and effective communications from engaged stakeholders would assist unengaged stakeholders in determining their knowledge and level of understanding of the issue, and consequential responses.

Strategies that may improve engagement among these groups are:

- 1) Develop increased awareness in governments on climate impacts specific to departmental mandates and policies;
- 2) Increased public debate to create informed constituents;
- 3) Consideration of First Nations and industry perspectives on climate impacts and adaptation;
- 4) National coordination and communication of case studies, events and issues related to impact and adaptation responses; and
- 5) World-class research and scientific communication.

7. Unanswered Research Questions

While there is evidence that aquatic ecosystems respond to shifts in climate, there are pressing gaps in our understanding of long term impacts of climate on species and ecosystems and how past climate has shaped the communities that appear today. Greater understanding of the factors that may drive populations to vulnerable or peak states in terms of climate warming may indicate the required adaptation actions that should be initiated in the present.

Because we are aware that changes in climate can occur rapidly with considerable impact on resources, investigations into the best methods to increase the resilience of fishery communities and systems and improve their ability to respond to change are needed. These questions will be more easily answered should better methods for

improving science communication and collaboration among scientists, policy makers and stakeholders be developed.

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