FISHERIES AND OCEANS CANADA

Climate Change Risk Assessment Report

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EXECUTIVE SUMMARY

Fisheries and Oceans Canada (DFO) has a role to play in Government of Canada (GoC) initiatives to develop a long-term climate change plan for Canada. As part of its management responsibilities, DFO needs to consider the impacts of climate change in the management of Canada's waters and aquatic resources. DFO wants to ensure that the management decisions it takes today and in the future are based on an informed understanding of the climate change risks that it faces, and the potential impact of those risks.

Climate change issues are characterized by complexity and uncertainty. Climate change and its impacts represent a complex, multi-layered and inter-related cause and effect chain. One of the most often repeated and emphasized comments encountered during the assessment was that it will be difficult to predict what the changes will be, or when and where they may occur. However, there was a strong consensus among Departmental participants in this exercise that climate change is an important issue that has the potential to jeopardize the Department's ability to meet its mandated obligations and commitments. Climate change is a horizontal issue that affects all sectors and regions.

This risk assessment is not a scientific research and analysis paper and does not attempt to confirm or refute existing scientific assessments of the impact of climate change on natural systems; the report references the science only to the extent necessary to provide context. Rather, the report presents a strategic Department-wide view of DFO's risk profile, from a business perspective, focusing on the potential consequences to DFO should the climate change impacts on natural systems occur.

The risks that have been identified were defined with sufficient breadth to span the Department's mandate. Six risk events were identified, logically grouped into two categories.

The first category, Ecosystem and Fisheries Management risks, addresses risks to oceans and fish habitat management, and fisheries and aquaculture programs. These risks primarily affect DFO's strategic outcomes associated with Healthy and Productive Aquatic Ecosystems and Sustainable Fisheries and Aquaculture. They address events that could jeopardize the Department's ability to further its sustainable development program to support a strong economy while protecting the environment.

Risk 1: Ecosystem-based Management

There is a risk that climate change will jeopardize DFO's ability to meet its strategic and policy objectives related to oceans management, and the sustainable development and integrated management of resources in Canada's aquatic environment.

This risk focuses on DFO's stewardship role as it takes a risk-based approach to managing and protecting the ecosystem, and highlights the pressures that the Department will face as it assumes its leadership role in Canada's Ocean Strategy and the sustainability of the oceans and their resources.

Risk 2: Changes in Biological Resources

There is a risk that climate change will jeopardize DFO's ability to manage and protect the abundance, distribution, and quality of harvested fisheries and aquaculture stocks.

Sustainable use of fisheries resources and aquaculture is critical to protecting the significant socio-economic benefits that derive from the utilization of Canada's fish stocks, shellfish and marine mammals.

Risk 3: Species Reorganization and Displacement

There is a risk that climate change will jeopardize DFO's ability to protect species diversity and species at risk.

This risk has a considerable relationship to DFO's policies, processes and responses to the Species at Risk Act (SARA). The effects of climate change will increase the complexity of DFO's decision-making related to the protection of species at risk and species diversification.

These risks are also related to the three principles of Canada's Ocean Strategy – sustainable development, integrated management and the precautionary approach.

For all three risks, the uncertainty associated with the impact of climate change may lead to increased complexity in decision-making related to oceans, ecosystem and habitat management, particularly those decisions related to human use. Simply put, the uncertainty associated with climate change adds a significant "wild card" to the already complex and sensitive decision-making processes of the Department.

The second category of risks are related to the safety and accessibility of waterways. These risks are focused on the delivery of the priorities of the Canadian Coast Guard (CCG) and Small Craft Harbours. The risks jeopardize the Department's ability to protect lives, facilitate marine commerce, maintain adequate infrastructure, support marine security and protect the aquatic environment against contamination from marine incidents.

Risk 4: Emergency Response

There is a risk that climate change will jeopardize DFO's ability to provide acceptable levels of environmental response and search and rescue activities.

The emphasis in this risk is on the potential for an increased incidence of marine incidents due to climate change factors, and the associated strain on CCG's capacity to respond.

Risk 5: Infrastructure Damage

There is a risk that climate change will result in damage and the need for alterations to DFO vessels, coastal and Small Craft Harbour infrastructure.

DFO maintains considerable infrastructure to support its operational and scientific activities in both the marine and freshwater environments. The effects of climate change could cause direct physical damage to DFO's infrastructure.

Risk 6: Navigation and Accessibility

There is a risk that climate change will jeopardize DFO's ability to provide safe access to waterways.

This risk deals with impeded access due to changes in factors such as sedimentation, water levels, severe weather and wave energy.

The uncertainty associated with the three risks in this category is primarily related to the timing and extent of risk impact. There is somewhat less complexity in the decision-making related to managing these risks, in that the dynamic nature of aquatic ecosystems is less of a factor in the analysis. These are risks related to the ability of the Department to deliver operational services: a failure to prepare for climate change would jeopardize access to Canadian waterways and the safety and integrity of Canada's marine infrastructure.

All six risks were assessed to represent medium-high to high exposure to the Department, with risks in the first category ranking somewhat higher than those in the second. Departmental participants in the risk assessment exercise agreed that the Department should consider taking action to reduce its exposure to all six risks.

Addressing climate change risks will require a strategic investment of resources. In keeping with the Department-wide nature of the risk assessment, the options for mitigating DFO's climate change risks address top-down strategic responses, designed to better position the Department to both prevent the occurrence of, and react to, climate change risk events. The near-term investment of resources should focus on establishing the management infrastructure for climate change decision-making and resource allocation.

Effective management of climate change risks, however, does not necessitate radical changes to the Department's directions or management principles. Indeed, institutionalization of the principles of Canada's Oceans Strategy are seen to be critical to the success of any climate change risk response strategy for DFO. Given the horizontality and complexity of climate change, integrated management, premised on a sound basis of scientific knowledge, forms the core of the top-down risk response mechanisms that should initially be pursued by the Department.

Sound science, coupled with an identification of the appropriate strategic investments to stabilize capacity, is seen as the core response mechanisms to the risks that jeopardize marine safety, accessibility and infrastructure.

As a final word, this risk assessment focuses on the potential negative outcomes to the Department caused by the direct and indirect risk factors associated with climate change. However, climate change can potentially also lead to positive outcomes from the perspective of DFO's mandate, particularly related to the health of aquatic ecosystems and sustainable

fisheries and aquaculture. In the near term, the impacts of climate change will almost certainly be considered undesirable. An understanding of the exposure to climate change risks, however, can better position the Department to take the necessary steps, and make the appropriate investments, to ensure that the negative impacts are minimized in the near term, and any longer-term opportunities can eventually be realized.

1 INTRODUCTION

1.1 BACKGROUND AND SCOPE

Fisheries and Oceans Canada (DFO) has a role to play in Government of Canada (GoC) initiatives to develop a long-term climate change plan for Canada. As part of its management responsibilities, DFO needs to consider the impacts of climate change in the management of Canada's waters and aquatic resources.

DFO wants to ensure that the management decisions it takes today and in the future are based on an informed understanding of the climate change risks that it faces, and the potential impact of those risks. As such, DFO engaged Interis Consulting Inc. to undertake an assessment of its risks related to climate change.

This report documents the results of the climate change risk assessment. The scope of the assessment includes the identification and evaluation of risks in the 10 to 20 year planning horizon. This includes risks that will potentially materialize within the planning timeframe, as well as those risks for which mitigation action must be taken within the timeframe.

In keeping with the nature of this risk assessment, the identified risk events have been defined with sufficient breadth to span the Department's mandate. The risk assessment presents a strategic Department-wide view of DFO's risk profile, from a business perspective. While an exhaustive body of scientific knowledge exists for climate change, the risk assessment references this science only to the extent necessary to provide context for the risk profile.

1.2 STRUCTURE OF THIS REPORT

This document presents the risk identification and assessment results in a structure that is consistent with the risk assessment methodology outlined in Appendix A.

Section 2 documents the Department's climate change risk events. This includes a discussion of the climate change risk factors, or the key drivers of climate change risks for DFO, the potential risk events and associated impacts that result from the risk factors, and the current capacity of the Department to address the risks. Section 3 presents the risk assessment participants' evaluation of the degree of risk exposure presented by each of the risks. Finally, Section 4 outlines a number of response options that the Department could consider to reduce its climate change exposure.

2 DFO CLIMATE CHANGE RISK EVENTS

2.1 RISK FACTORS/DRIVERS

INTRODUCTION

This report does not attempt to re-examine the extensive body of climate change knowledge that has been amassed. However, there are some broad physical impacts of climate change that are of particular relevance to the Department. These impacts are the key factors that drive climate change risk within DFO.

Climate change and the impacts of climate change represent a complex, multi-layered and inter-related cause and effect chain. One of the most often repeated and emphasized comments encountered during the assessment was that it will be difficult to predict what the changes will be, or when and where they may occur.

At it simplest, warming global temperatures, due to the accumulation of heat-trapping greenhouse gases, lead to a variety of changes in climate systems. Projections of the impact of climate change must consider the expected level of emissions of greenhouse gases in the future, and the known and expected responses of different aspects of climate to the emissions. This, in itself, is a complex scientific undertaking.

These changes in climate systems can, in turn, have a physical impact on oceans, lakes, rivers, and other aquatic environments. While the Department must have a solid scientific understanding of the impact of greenhouse gases on climate systems, it is the impact of the climate system changes on the oceans and fresh waters for which DFO has responsibilities that is of direct concern from a strategic, policy and operational decision-making perspective.

The physical impacts of climate changes are expected to occur over the long-term. However, DFO stakeholders are in general agreement that the changes may not be progressive, and that fluctuations may occur at different times in different regions. Findings from the Arctic Climate Impact Assessment indicate three scenarios for climate change and its impact on aquatic environments, any or all of which could occur:

- A smooth change, but rapid in comparison to naturally driven climate system fluctuations;
- Increased variability in the climate system, more so than seen naturally; and,
- Threshold changes, or shifts in the system from one seemingly stable state to another over a very rapid time frame, perhaps in a stepped fashion.

Threshold changes represent perhaps the greatest concern, given that they [illegible] prises" .

In themselves, these physical changes are not necessarily risk events. A risk, from the DFO perspective, must be recognizable as a future event that has the potential to jeopardize the achievement of one or more of the Department's objectives. However, these physical changes can lead to risk events.

This section outlines the changes that can affect the oceans, rivers, freshwater bodies and estuaries, leading to risks related to DFO's mandate and strategic outcomes.

PRIMARY RISK FACTORS

The following lists the key risk factors and the primary physical impacts that are relevant to DFO. Each of the risk factors below can, in themselves, lead to physical changes that affect oceans and fresh waters. However, rarely will a risk factor have an impact in isolation: the degree of the physical changes will result from the combined effect of a number of factors.

Changes In Water Temperature, Quality, Composition, and Circulation Patterns

An increase in water temperature, coupled with resulting changes in water composition, is seen to be one of the most significant risk drivers related to the oceans and fresh waters for which DFO has mandate responsibilities.

Table 1 lists the risk factors associated with changes in water temperature, quality, composition, and circulation patterns.

Physical, Chemical and Biological Impacts	
Changed nutrient levels	Changes in the sunlight levels at depth
Changed salinity levels	Altered food sources
Changed oxygen levels	Changes in levels of sedimentation
Increased disease and bacteria	Changes in the seasonal cycle
Increased Toxic algal blooms	Improved conditions for invasive species
Changes in water levels (usually increases in coastal areas, and decreases in other regions)	Changes in water quantity (shortages or excesses)
Changes in freshwater/seawater mix	Altered current dynamics

Table 1: List of Physical, Chemical and Biological Impacts Due to Changes in Water

Changes In Precipitation, Cloud Cover, Humidity and Wind Patterns

A decrease in precipitation, coupled with evapo-transpiration, is seen to most likely affect freshwater levels, although the impact of climate change is less certain for freshwater than for sea levels. The Atlantic regions are most likely to experience increased, rather than decreased, levels of precipitation.

Table 2 lists the risk factors associated with changes in precipitation, cloud cover, humidity and wind patterns.

Physical Impacts	
Erosion	Changes in relative proportions of fresh, brackish and salt water
Landslides	Drying up of aquifers
Changes in water levels	Increased incidence of forest fires
Changed freshwater oxygen levels	Changes in water quantity (shortages or excesses)
Changes in freshwater flow	

Table 2: List of Physical Impacts Due to Changes in Precipitation

Increasing Frequency of Severe Weather Events

Climate change may lead to an increasing incidence of severe weather events, such as hurricanes, tornadoes and storms. However, risk assessment participants cautioned that it is not clear that there is a direct link between severe weather events in Canada and climate change factors.

Physical Impacts	
Coastal erosion and retreat (including estuaries and inner tidal zones)	Increased wave energy, wave height
Sedimentation	Stratification offset

Table 3: List of Physical Impacts Due to Severe Weather

Sea Level Rise

Climate changes can lead to sea level rise primarily through thermal expans[redacted]e melting of glaciers and ice caps.

On the East Coast, sea level rise can be expected to affect the north shore of Prince Edward Island, the Gulf coast of New Brunswick and the Atlantic coast of Nova Scotia, parts of Charlottetown, and Saint John and Truro.

In the West, the most affected areas will likely include parts of the Queen Charlotte Islands, the Fraser Delta, and portions of Victoria and Vancouver.

The largest projected increases of sea level are expected to occur in the North. Parts of the Beaufort Sea coast, including the outer Mackenzie Delta and Tuktoyaktuk Peninsula, are the most likely affected areas in the Arctic.

Specific concerns for Quebec include the Gaspé peninsula, the Magdalen Islands and the North Shore. As well, changes in sea level would affect water levels and tides in the St. Lawrence.

Physical Impacts	
Coastal erosion and slumping	Increased pollution from land-based sources (including those owned by DFO)
Near-coast flooding and inundation	Sediment re-distribution
Salt water intrusion, increased salinity in bays and estuaries	Coastline re-configuration
Higher sea surface temperatures	Higher waves and wave energy

Table 4: List of Physical Impacts Due to Sea Level Rise

Changes in Ice Cover and Sea Ice

It is expected that increased air temperature, coupled with changes in wind patterns, will affect the quantity, location, duration, distribution and seasonality of sea ice and ice cover.

Changes in sea ice may have less of an impact on habitat in the Pacific Region than elsewhere. In the Atlantic, a key concern is cold freshwater flows from melting Arctic ice cover leading to stronger stratification, making it more difficult for deep water nutrients to flow upwards.

There could also be a significant increase of the flow within the cold intermediate layer of water in the Gulf of St. Lawrence, of cold melt water from the Labrador current via the Strait of Belle-Isle, which could result in the import of Arctic plankton species new to the Gulf of St. Lawrence.

Physical Impacts	
Changes in salinity levels	Increased ice movement
Stronger stratification (from cold freshwater ice)	Changes in water composition and quality
Erosion	Altered river flows
Sediment loading materials	Changes to glacial subsidy to freshwater systems
Silt deposits	Changes to contaminant transport pathways
Increased incidence of forest fires	Modified distribution for seals and polar bears
	Changes in water quantity

Table 5: List of Physical and Biological Impacts Due to Changes in Ice Cover

INDIRECT SOURCES OF RISK

Indirect risk factors relate to the human response to the direct physical changes that occur as a result of climate change.

For example, warming in the Arctic is likely to lead to increased human activity and waterway traffic. Tourism and commercial activity (e.g., Beaufort Sea drilling), can, in turn, result in pollution and contamination and the introduction of invasive species from ballast water. Along the same line, shoreline changes in the Great Lakes could alter the type and nature of commercial activities, leading to increased dredging requirements, in turn affecting the aquatic environment.

As another example, decreased ice, snow cover and precipitation can increase the incidence of accidental forest fires, in turn damaging near-shore ecosystems and resulting in increased nutrients and sediments.

With a drier environment, it can also be expected that there will be increasing competition for the use of water resources (e.g., irrigation, hydro-electric dams to support green energy generation, increased demand for water from the U.S.), potentially leading to further stress on aquatic ecosystems. As well, the migration of invasive species from southern waters into Canada may increase as a result of diversion projects

Climate change is also likely to increase the actions of both private and public landowners to protect or buffer high value waterfront from, for example, salt water intrusion due to a rise in sea level, affecting the shoreline and aquatic habitats.

2.2 RISK EVENT INTRODUCTION

This section outlines six DFO risk events that could result from the primary and indirect risk factors related to climate change.

In keeping with the nature of this risk assessment, the risk events have been defined to have sufficient breadth to span the Department's mandate. While regional perspective are provided for clarity, each risk has policy relevance across DFO. It is acknowledged, however, that climate change will affect each region differently, and operational responses will be driven by the unique demographic and geographic circumstances of the particular region.

The relationship between risk factors and risk events is not one to one: typically, a combination of risk factors lead to one or more risk events. In other cases, risk factors can offset each other. For example, a change in sea ice is expected to lead to stronger stratification from the cold freshwater ice. This could be offset, however, by a mixing effect from severe storms.

The risk events are often inter-related and may have cause and effect relationships among themselves. This is due in part to the complex inter-relationships among DFO's strategic objectives, but can also be attributed to the broad nature of each of the six risks.

The following two sections outline the six risk events in two logically grouped risk categories: risks related to ecosystem and fisheries management; and risks related to the safety and accessibility of waterways. The applicable risk factors that drive the risks, the associated impacts, and a discussion of the degree to which DFO is currently positioned to control or mitigate the risks are also included.

2.3 ECOSYSTEM AND FISHERIES MANAGEMENT RISKS

INTRODUCTION

The ecosystem and fisheries management category addresses risks to oceans and fish habitat management and protection, and fisheries and aquaculture programs. These risks primarily affect DFO's strategic outcomes associated with Healthy and Productive Aquatic Ecosystems and Sustainable Fisheries and Aquaculture. The risks jeopardize the Department's ability to further its sustainable development program to support a strong economy while protecting the environment.

Ecosystem and Fisheries Management Risk Events

Risk 1: Ecosystem-based Management
There is a risk that climate change will jeopardize DFO's ability to meet its strategic and policy objectives related to oceans management, and the sustainable development and integrated management of resources in Canada's aquatic environment.

Risk 2: Changes in Biological Resources
There is a risk that climate change will jeopardize DFO's ability to manage and protect the abundance, distribution, and quality of harvested fisheries and aquaculture stocks.

Risk 3: Species Reorganization and Displacement
There is a risk that climate change will jeopardize DFO's ability to protect species diversity and species at risk.

The three risks in this category are directly aligned with DFO's legislative obligations under the Fisheries Act, the Oceans Act, and the Canadian Environmental Assessment Act. Risk 3, Species Reorganization and Displacement, also addresses DFO's obligations under the Species at Risk Act (SARA).

While closely related, each risk addresses specific elements of the Department's mandate.

Risk 1, Ecosystem-based Management, represents a key component of the Minister's overall responsibility to manage and protect aquatic ecosystems and fish habitat from disruptive and destructive activities. This risk is of particular relevance to DFO, given the emerging emphasis on an ecosystem approach to ocean management. Risk 2, Changes in Biological Resources, is closely aligned with the Departments' activities and objectives related to sustainable fisheries and aquaculture.

These risks are also related to the three principles of Canada's Ocean Strategy: sustainable development, integrated management and the precautionary approach.

For all three risks, the uncertainty associated with the impact of climate change may lead to increased complexity in decision-making related to oceans, ecosystem and habitat management, particularly those decisions related to human use. Simply put, the uncertainty associated with climate change adds a significant "wild card" to the already complex and sensitive decision-making processes of the Department.

That being said, there are concerns that the Department will not place sufficient emphasis on the consideration of climate change in its decision-making processes. For example, there is a concern that the decision-making regime may favour a narrow regulatory focus on preserving existing habitats. While this would perhaps avoid short-term impacts, it may not consider the longer-term impacts of climate change, and could actually contribute to an accelerating recession of coastlines and submergence of habitats.

RISK FACTORS

The primary climate change risk factors that give rise to all three risks in this category include:

- Changes in water temperature, quality, composition, and circulation patterns;
- Changes in precipitation, cloud cover, humidity and wind patterns;
- Increasing frequency of severe weather events;
- Sea level rise; and,
- Changes in sea ice and ice cover.

Indirect sources of risk include:

- Pollution and contamination in the Arctic due to increased vessel and human activity;
- The harmful alteration, disruption or destruction of habitat due to increased human activity in the Arctic;
- Forest fire damage;
- Increased competition for the use of water resources; and,
- Actions taken by landowners to protect waterfront.

RISK 1: ECOSYSTEM-BASED MANAGEMENT

There is a risk that climate change will jeopardize DFO's ability to meet its strategic and policy objectives related to oceans management, and the sustainable development and integrated management of resources in Canada's aquatic environment.

This risk focuses on DFO's stewardship role as it takes a risk-based approach to managing and protecting the ecosystem, and highlights the pressures that the Department will face as it assumes its leadership role in Canada's Ocean Strategy and the sustainability of the oceans and their resources.

Ecosystems are naturally dynamic, and change is expected. However, climate change factors are expected to both accelerate the rate of change and increase the unpredictability of change. This, in turn, could accelerate the timing and magnitude of potential conflicts related to managing Canada's marine environments, straining the Department's capacity to respond.

This risk addresses a healthy ecosystem; as such, it directly influences the abundance of populations and species diversity. However, changes to the environment do not necessarily result in unhealthy ecosystems and fully negative outcomes. Changes in biophysical conditions could favour different types of species, but the ecosystem could still be considered healthy.

RISK 2: CHANGES IN BIOLOGICAL RESOURCES

There is a risk that climate change will jeopardize DFO's ability to manage and protect the abundance, distribution, and quality of harvested fisheries and aquaculture stocks.

Sustainable use of fisheries resources and aquaculture is critical to protecting the significant socio-economic benefits that derive from the utilization of Canada's fish stocks, shellfish and marine mammals.

The value of marine resources are clearly recognized, and Canada has re-affirmed its commitment to the application of the precautionary approach in the management of those marine resources. The precautionary approach, or "erring on the side of caution" in an environment of uncertainty, has particular relevance in the increased uncertainty and unpredictability introduced by climate change.

It was emphasized by risk assessment participants that extreme care must be taken when predicting the impact of climate change on fish stocks and biological resources. There is considerable uncertainty, and generalizations will not consider impacts at the local and regional level. It is difficult to predict the local responses of species to climate change, given

that a variety of other factors may influence the abundance, quality, and distribution of biological resources and fish stocks.

The degree to which fish populations can adapt, and the net effect of climate change on fish resources, are not fully known. The overall biomass may not decrease, but some areas may suffer negative impacts, while others may benefit. For example, important marine fish stocks in the Arctic, such as cod and herring, are likely to benefit from improved conditions due to moderate warming, while others, such as northern shrimp, could be negatively affected.

It can be expected that the unpredictability associated with climate change may increase the instances warranting the application of the precautionary approach when making decisions on future sustainability. However, such decisions could negatively affect stakeholders in the short term, and could severely strain stakeholder relationships.

It should be noted that stock changes that affect fisheries, aquaculture and fishers can also provide opportunities. However, these opportunities will likely only be realized over time and with the proper investments, and the near term conflicts will be difficult to manage.

Similar to Risk 1, climate change could accelerate the timing and magnitude of potential conflicts related to managing and protecting the sustainability of Canada's marine resources, straining the Department's capacity to respond.

RISK 3: SPECIES REORGANIZATION AND DISPLACEMENT

There is a risk that climate change will jeopardize DFO's ability to protect species diversity and species at risk.

This risk has a considerable relationship to DFO's policies, processes and responses to the Species at Risk Act (SARA). The effects of climate change will increase the complexity of DFO's decision-making related to the protection of species at risk and species diversification.

There is a risk that climate change factors will lead to changes in the location and type of species in the various Canadian aquatic habitats. Some species may entirely disappear and be replaced by others. Slight changes in climate and water temperatures could limit or extend a range for a given species or population. Any changes in habitat could affect the ability of species to reproduce or find food, the predator/prey balance, and the incidence of diseases and parasites. The introduction of invasive species, in concert with even minor changes to the aquatic environment, is a particular concern, in that such species may be genetically better-adapted to the new conditions than existing species.

SARA provides DFO with the legal mandate to protect species at risk. There is a concern that, unless climate change factors are explicitly considered, the SARA regime may lead to efforts to protect species that are declining in Canadian waters due to factors other than human activity. SARA may be perceived to be establishing unattainable objectives for some species: when climate change is a key factor leading to risk for a species, there may be little

that can be done. In such cases, Departmental research and monitoring resources may be directed towards such listed species, at the expense of those that are not listed and those for which DFO may have greater ability to control.

IMPACTS OF ECOSYSTEM AND FISHERIES MANAGEMENT RISKS

Table 6 lists the potential impacts associated with the three risks in this category, against the Departmental outcomes.

Strategic Outcome	Potential Impact of Climate Change
Safe and Accessible Waterways	♦ Small craft harbours (SCH) may need to be adapted to adjust to fish stock re-distribution, and ensure that SCH continues to meet needs of changing fishing and aquaculture industry ♦ In the Great Lakes, vessel movement may be restricted, due to increased risk from invasive species in ballast water
Sustainable Fisheries and Aquaculture	♦ Habitat changes and losses to riparian productivity could alter fish stocks. This may jeopardize: ♦ the viability of commercial and subsistence (Aboriginals) fisheries, and aquaculture ♦ recreational fishing and tourism ♦ Changes in the type of available harvest could also result in adaptation costs for fisheries ♦ Altered fish stocks could also: ♦ decrease food sources for subsistence fishers, particularly in the Arctic ♦ affect the livelihood of fishers and aquaculturists ♦ affect the Aboriginal way of life ♦ Ecosystem and habitat changes, and changes in fish stocks and species diversity, could have a broad impact on entire communities within the coastal zone, including economic displacement of a community that was supported both directly and indirectly by fisheries.
Healthy and Productive Aquatic Ecosystems	♦ Increased costs and effort for DFO related to shoreline protection as a result of sea level rise and erosion (e.g., impact assessment, approvals, legal costs) ♦ Increased costs and effort associated with regulatory approval activity, including environmental assessments ♦ Increased effort associated with decision-making, including inter-departmental consultations related to Oceans Management ♦ Diminished credibility for DFO if enforcement and regulatory approaches are seen to aggravate property and economic losses ♦ Alteration, disruption or destruction of fish habitat due to increased human activity in the Arctic .

Table 6: Summary of Impacts Related to Ecosystem and Fisheries Management Risks

CURRENT DEPARTMENTAL CAPACITY TO MITIGATE AND CONTROL

This section outlines the degree to which DFO is currently positioned to control or mitigate the three risks related to Ecosystem and Fisheries Management. Given the inter-relationship among the three risks in this category, the strengths and weaknesses elements of the mitigation and control environment generally apply to all three risks.

Planning and Priority Setting

There appears to be an increasing awareness within DFO of the need to consider climate change when managing and making decisions. Risk assessment participants expressed optimism that DFO is beginning to recognize the importance of climate change. For example, Small Craft Harbours in the Maritimes Region is starting to integrate climate change considerations into its planning cycle, partly due to the fact that storms are having a negative impact in terms of damage and associated costs.

Furthermore, the principles of the Oceans Management Strategy and Action Plan (sustainable development, integrated management and the precautionary approach), coupled with the Department's commitment to ecosystem-based management, are seen to be very positive directions that will better position DFO to address climate change.

That being said, there is a perception that the Departmental culture remains somewhat crisis-oriented. The responsive priorities of the day tend to take precedence over the more strategic and longer-term planning approach that will be required to effectively address climate change.

There is also a sense that the Department has many concurrent and diverse national, regional and global objectives related to climate change, which may be competing for scarce resources.

Information, Monitoring, and Science

Strong climate change scientific knowledge and prediction capability are seen as critical for the Department to be able to manage its ecosystem and fisheries management risks.

There is a strong body of knowledge related to climate change, particularly the primary physical risk factors that drive the DFO risks. Considerable expertise and knowledge exists within the Department. The Departmental Science Sector is placing emphasis on ecosystem analysis, and is considered a Departmental strength. There are also plans to revive the Departmental science plan, which will be a positive step towards development of an adaptation strategy.

The recovery strategies developed by the Department for species at risk has also generated valuable knowledge. There are lessons learned related to both process and outcome for the 44 recovery strategies developed for the 86 species under study.

However, considerable uncertainty remains and the traditional models and predictors are becoming less relevant in the face of the increased variability associated with climate change.

The Department's current scientific tools and methods are not seen to be adequate to predict with any certainty the type or severity of climate change impacts that are relevant to DFO. Furthermore, any southern coastal models may not be relevant in the Arctic coastal region.

The Department's approach to monitoring and assessing climate change impacts, and conducting stock assessment, is based on a traditional evaluation of past events, and is primarily based on a single stock approach. However, the historical data related to climate change are limited, and there is little capacity to conduct multi-species stock assessments. The traditional models are not fully adequate when attempting to predict the impact of climate change on ecosystems and fish stocks. For example, stock assessments and predictions concerning salmon abundance are based on historical records and models, and the changed environment undermines DFO's predictive capability.

An ecosystem approach is seen to be a critical element to improving DFO's ability to cope with the stressors of climate change. While risk assessment participants indicated that some tools have been developed related to the key indicators that would support ecosystem-based management, the tools have not been operationalized in any comprehensive manner. Furthermore, risk assessment participants express concern that the Department does not have the appropriate scientific knowledge to put these tools into operational practice.

As an example from the Pacific region, the focus has been on salmon but there will be a climate change impact on other species. The impacts on marine fish and the marine ecosystem are not certain, and developing models to aid in prediction may be difficult:

- Would some marine species benefit from changes in the ocean and which ones?
- What happens to marine productivity, including feeding and reproductive areas, in the north Pacific?
- What happens to patterns of larval distribution for species with water-transported larvae and eggs?
- Will there be more or less stratification and associated nutrient up-welling?
- Will there be range extensions or reductions for species?
- Will the frequency of unusual events change (e.g., El Niño, La Nina, puddles of warm and cold water), and how would this affect the ecosystems and marine fish?

Internal Communications, Integration and Governance

Climate change is a horizontal issue that cuts across regional and sectoral lines. A strong governance regime that facilitates and drives internal connections and linkages will be necessary to effectively respond to climate change issues.

The Department is pursuing integrated management, with the Oceans Sect[redacted] lead role, and climate change is expected to be one element of a more integrated regime. Risk assessment participants expressed optimism that DFO is strengthening its communication and

decision-making frameworks. Some areas continue to work in isolation, but there is an increased emphasis on co-management, linkages and sharing of information on climate change and its effects.

However, a concerns remains that the Department will find it difficult to bridge its stovepipes. While the Oceans Sector can facilitate change, real integration will need to be driven by Departmental and Regional management. As an example, a DFO Climate Change working group has been struck at the Director level. This group is used as a mechanism to distribute information throughout the organization. In practice, however, the distribution of information is often not extended to the local level.

External Linkages and Stakeholder Engagement

The horizontality of climate change extends beyond the Department, and DFO will be unable to address its risks effectively without engagement from its related stakeholders. Key stakeholders include other government Departments (OGDs) and jurisdictions that have a shared mandate in dealing with climate change issues, research groups, and affected communities.

The challenge of multi-level governance will be compounded by climate change. Strong linkages with the provinces are considered particularly essential to manage the multi-jurisdictional issues associated with sea level rise, the physical dynamics of the coastal edge and the highly managed water in the Central and Arctic region. However, risk assessment participants were concerned that there may be a gap in the multi-jurisdictional leadership regime, and that agreement is required regarding both collaboration and resources. Federal resourcing for expertise, studies and response in partnership with Province is not seen to be adequate.

Equally important are the inter-departmental linkages and collaboration with OGDs, such as Environment Canada, the Canadian Tourism Commission, and Transport Canada. In many cases, risk control mechanisms may lie outside the DFO, such as the introduction of aquatic invasive species from ballast water. Climate change will increase the reliance on governance and decision-making mechanisms that extend beyond the Department. However, there is a concern that existing arrangements are inadequate to effectively address climate change risks and issues. For example, there is no established inter-departmental senior-level committee that could focus on climate change impact, adaptation and response issues. While a committee exists, it meets infrequently and focuses on the Kyoto Protocol.

From a federal and provincial government perspective, there are some structures and entities in place that could be leveraged to address climate change issues and cross-related to inter-departmental science planning activities, including, for example, the Northern Strategy interdepartmental ADM committee, and the Federal Council in the Maritimes. Furthermore, Treasury Board Secretariat is in the process of identifying senior advisors on strategic horizontal issues.

Finally, the Climate Change Impacts and Adaptation Research Network (C-CIARN), Fisheries Sector, supported by DFO and Natural Resources Canada, is a research and stakeholder network to provide a national presence of fisheries and aquatic science to stakeholders, industry and researchers across Canada. This network is seen to provide real opportunities to address climate change knowledge gaps. Funding for C-CIARN, however, is not assured beyond this fiscal year.

Operational Infrastructure and Capacity

Climate change is expected to place an increased strain on resources within the Department. However, DFO is currently in a cost-reduction exercise, and there is concern that capacity issues will arise.

There was a commitment in the Government of Canada's planned 2005 budget for $28 million over two years to implement Phase 1 of the Oceans Action Plan, half of which would flow to DFO. However, the funds are targeted towards improving the management of ocean ecosystems on a sustainable basis, rather than specific climate change programs.

Funding has expired for some interdepartmental programs that support climate programs within the Department. While some A-base resources exist, all significant B-base funding that came into the department from inter-departmental programs have expired on April 1st, 2005 (e.g., Climate Change Action Fund, Action Plan 2000, the Program on Energy Research and Development) This has affected fundamental monitoring programs, such as ARGO, ocean climate and ecosystems variability, and sea-level observation.

Feedback from risk assessment participants indicates there is a concern related to human resources and the potential loss of (or inability to transfer) the scientific knowledge of DFO's current employees. The health of science programs is considered to be an essential capacity for the Department to address climate change issues and risks. Science will provide the Department with not only the information to manage the risks to its core objectives, but also to contribute to broader information requirements of Canada, such as the role of the oceans as "sinks" for carbon emissions.

While resource capacity may be an issue for all programs, there is particular concern that the SARA programs are not sufficiently resourced. SARA represents a significant horizontal program within the department. Eighty-six species are currently being examined, and the resource capacity is seen to be inadequate to handle additional listed species. Resource capacity is a particular concern for the Central and Arctic region, which has a high number of SARA listed species.

Furthermore, the Department's policy and procedures regime related to SARA may not be robust enough to support decision-making and management in the increased environment of uncertainty introduced by climate change.

That being said, the Department is reviewing its SARA delivery structure to determine more effective and efficient means to achieve its SARA objectives.

There are strengths within the Department that provide some measure of operational control related to climate change concerns. For example, the referrals process provides DFO with the capability/process to screen human activities that could affect habitat. As another example, infrastructure such as the tidal gauge and freshwater networks are in place.

2.4 SAFETY AND ACCESSIBILITY OF WATERWAYS RISKS

INTRODUCTION

Risks related to the safety and accessibility of waterways are focused on the delivery of the priorities of the Canadian Coast Guard (CCG), Small Craft Harbours, and the Canadian Hydrographic Service. These three risks jeopardize DFO's ability to protect lives, facilitate marine commerce, support marine security and protect the aquatic environment against contamination from marine incidents. These risks also affect DFO infrastructure.

Safety and Accessibility of Waterways Risk Events

Risk 4: Emergency Response
There is a risk that climate change will jeopardize DFO's ability to provide acceptable levels of environmental response and search and rescue activities.

Risk 5: Infrastructure Damage
There is a risk that climate change will result in damage and the need for alterations to DFO vessels, coastal and Small Craft Harbour infrastructure.

Risk 6: Navigation and Accessibility
There is a risk that climate change will jeopardize DFO's ability to provide safe access to waterways.

The three risks in this category are less tightly inter-related than the risks in the previous category, and the risk factors differ for each of the risks. As such, the discussion of each risk includes a separate discussion of the associated risk factors, impacts and control capacity.

RISK 4: EMERGENCY RESPONSE

There is a risk that climate change will jeopardize DFO's ability to provide acceptable levels of environmental response and search and rescue activities.

The emphasis in this risk is on the potential for an increased incidence of marine incidents due to climate change factors, and the associated strain on CCG's capacity to respond. Both direct and indirect climate change risk factors are expected to have an impact on CCGs' workload.

First, increased severity and frequency of severe weather events, storm surges, and coastline changes due to sea level rise could lead to a rise in the number of emergency situations involving vessels in both the marine environment and freshwater systems. [redacted] to the inherent challenges to vessels in extreme weather, buoy dislocation and loss of mooring as a

result of severe storms can present significant navigation problems for both DFO and other vessels.

In the Arctic, an earlier ice break-up and a later freeze-up could allow more dangerous multi-year ice to be distributed in the shipping lanes. This would:

- increase the requirement (both the quantity and coverage) of ice reconnaissance activity;
- increase the pressure on the CCG icebreaker fleet to provide vessel escort operations; and,
- elevate the environmental and search rescue response profile for CCG.

Equally significant, however, is the risk associated with increased human activity and vessel traffic in the Arctic. Longer and warmer summer seasons and increased waterway access due to changing ice flows (e.g., the potential opening of the Northwest Passage), could significantly increase vessel traffic. Increases can be expected in commercial activity in the Arctic, such as mining, drilling, and fishing, and in the number of cruise ships and recreational boaters. An Arctic sea route would reduce the distance a vessel must travel between Europe and Asia from 12,600 nautical miles to 7,900 nautical miles, for example. Also vessel size restrictions and costs associated with transiting the Panama Canal would be removed, leading to extremely large vessels carrying more cargo at lower costs through the Arctic. This represents huge potential savings for shipping companies, and the pressure to take advantage of this is already growing.

Increased vessel traffic, combined with the fact that navigational charts are not current (particularly off the coast of Labrador and for the west coast of the Queen Charlotte Islands), increases the risk of marine incidents, ranging from vessel accidents and search and rescue operations, to bilge-dumping.

Furthermore, the increased vessel activity in Arctic passages that were historically closed could increase the CCG requirement to provide platform support for security and sovereignty enforcement activities.

The key concern is that DFO's capacity may become increasingly challenged due to an increase in climate-change related demands for response.

Impacts: Risk 4

Table 7 summarizes the undesirable impacts that could result from this risk.

Strategic Outcome	Potential Impact of Climate Change
Safe and Accessible Waterways	♦ Personal injury; loss of life ♦ Increased costs associated with maintaining DFO fleet, particularly in the North ♦ Increased costs associated with vessel design and modification to meet changing needs and higher operational requirements ♦ Increased charting requirements and costs for the Canadian Hydrographic Service in the Arctic ♦ Increased operational costs associated with SAR activities in the North ♦ Increased risk and costs for protection of sovereignty
Sustainable Fisheries and Aquaculture	♦ Depletion of fish stocks if DFO is unable to provide sovereignty platform support ♦ Reduced support for research activities, due to re-deployment of vessels to emergency response activities
Healthy and Productive Aquatic Ecosystem	♦ Pollution and environmental damage from marine incidents ♦ Clean-up costs from tanker spills, marine incidents, bilge-pumping ♦ Reduced support for research activities, due to re-deployment of vessels to emergency response activities

Table 7: Summary of Impacts Related to Risk 4 – Emergency Response

Current Departmental Capacity to Mitigate and Control: Risk 4

Climate change is expected to place increased resource demands on CCG's fleet, both vessels and crew, jeopardizing the Department's ability to sustain operational service levels. Specific example of CCG capacity issues include:

- CCG has no dedicated SAR support in the Arctic. Icebreakers, rather than dedicated SAR vessels, are currently providing any support that is required; and,
- The Department has only limited capacity to provide clean-up support for oil spills.

The CCG planning regime for operational sustainability is not seen to be robust enough to ensure that the organization is adequately prepared for the impacts that may stem from climate change. A more strategic focus and a long-term planning horizon are required to address climate change issues, but operational pressures, such as fleet recapitalization, tend to take precedence.

It should be noted that Budget 2005 plans to allocate $276 million over the next five years for the procurement, operation and maintenance of two offshore fishery research vessels and four midshore patrol vessels to support the conservation and protection of fisheries.

In addition, risk assessment participants noted that the regulations for tankers are becoming stricter, potentially reducing their vulnerability to more severe storms. On the other hand, it was also noted that the Northern Traffic Regulations for control of shipping are voluntary, unlike the mandatory regulations elsewhere.

Finally, the availability of accurate charts can reduce the likelihood of navigation incidents, particularly in the Arctic, but there is concern that the Canadian Hydrographic Service of the Science Sector will not have the capacity to respond to even greater charting requirements that may arise as a result of climate change. While the Northwest Passage and other areas of high economic activity are currently well charted, accurate charts are not always available for more remote areas and some areas of Newfoundland and Labrador and the Queen Charlottes. Arctic charts are sometimes based on data collected by ships of opportunity with little or no assurance of accuracy. Other data include widely spaced spot soundings taken through the ice that give only a minimal indication of the actual water depths, and can be misleading when used without an understanding of their reliability.

RISK 5: INFRASTRUCTURE DAMAGE

There is a risk that climate change will result in damage and the need for alterations to DFO vessels, coastal and Small Craft Harbour infrastructure.

DFO maintains considerable infrastructure to support its operational and scientific activities in both the marine and freshwater environments. Elements of the built infrastructure include, for example: harbours, wharves, bases, stations, buoys, slipways, buildings, labs, lighthouses, navigation aids, hatcheries and DFO aquaculture infrastructure.

Effects of climate change could cause direct physical damage to DFO's infrastructure, for example:

- Increased incidence of storm surges, extreme weather events and associated wave energy can directly damage infrastructure;
- Sea level rise in some regions (Nova Scotia and PEI, southeastern New Brunswick and Newfoundland, and the western Beaufort coast) can lead to the need to adjust infrastructure, and can exacerbate the effect of increased wave energy;
- Fluctuating water levels could increase the requirement to adjust wharves; and,
- Changing ice dynamics and permafrost degradation can affect built infrastructure in more northern locations.

Climate change can represent both proactive and reactive costs to DFO. For example, DFO can proactively design and put in place measures to protect its harbours and wharves from storm surges. However, there may also be reactive costs associated with repairing [redacted]

Impacts: Risk 5

Table 8 summarizes the undesirable impacts that could result from this risk.

Strategic Outcome	Potential Impact of Climate Change
Safe and Accessible Waterways	♦ Increased costs associated with designing, building, maintaining, repairing and adjusting infrastructure ♦ Increased cost associated with charting of adjustments to wharves and slipways ♦ Potential reputation and liability impacts for DFO as a result of damage to private vessels due to inadequate DFO infrastructure
Sustainable Fisheries and Aquaculture	♦ Lack of access by fishers to fish stocks, and associated economic and social impacts, due to damaged or unavailable harbour infrastructure
Healthy and Productive Aquatic Ecosystem	♦ Environmental pollution and habitat impacts related to structure failure, and construction and repair activity

Table 8: Summary of Impacts Related to Risk 5 – Infrastructure Damage

Current Departmental Capacity to Mitigate and Control: Risk 5

CCG must continually modify and adjust its infrastructure to respond to natural degradation, environmental conditions, and new engineering requirements. CCG can reduce the likelihood that infrastructure will sustain damage if it considers the impact of climate change on infrastructure when planning and designing new infrastructure, and maintaining and adjusting existing infrastructure.

The CCG planning regime for operational sustainability is not seen to be robust enough to address climate change challenges. A more strategic focus and a long-term planning horizon are required to address climate change issues, but operational pressures, such as fleet recapitalization, tend to take precedence.

Infrastructure planning that considers climate change will require a longer-term strategic perspective and may necessitate up-front investments in more robust infrastructure. As with Risk 4, the CCG planning regime for operational sustainability may not be robust enough to ensure that the longer-term infrastructure requirements are addressed.

Likewise, there is a concern that there may be budgetary or regulatory limitations on DFO's capacity to reactively address infrastructure damage in a timely fashion, and interim solutions may need to be applied.

Currently, strong inspection teams work hand in hand with PWGSC to react promptly to rectify infrastructure damage after storm. Harbour Authorities and Community Coastal Networks also react promptly when problems occur. However, an increased frequency of severe weather damage may strain resource allocations and result in degraded response times.

It should be noted that CCG has implemented a marine aids modernization project. There is some concern that initiatives as a result of this project (e.g., decreased buoy maintenance) may increase the susceptibility of certain aids to damage.

RISK 6: NAVIGATION AND ACCESSIBILITY

There is a risk that climate change will jeopardize DFO's ability to provide safe access to waterways.

Risk 6 deals with the impact that climate change could have on the Department's ability to provide access to Canadian waterways.

Sedimentation associated with changes in water circulation and lower water levels could alter navigation channels in the Great Lakes. Furthermore, more frequent changes to navigation channels would necessitate additional efforts for the Canadian Hydrographic Service to create new surveys and charts, and necessitate increased surveillance activity.

Storm surges and storms associated with high tides will increase the risk of debris damage to small crafts. This is a particular concern in British Columbia, in that beaches are covered with logging debris. This debris also can damage aquaculture sites, harbours, and infrastructure, and increase the costs for log salvage and infrastructure repair operations.

There is a relationship between Risks 4 and 6, in that a change in Arctic sea ice is a driver for both risks. Risk 6 focuses on impeded access, whereas aspects of increased access in the Arctic have been addressed in Risk 4. While melting sea ice in the Arctic could lead to increased vessel traffic (Risk 4), multi-year ice in Arctic shipping routes, and an increased incidence of transient ice in more southern waters, particularly in the Newfoundland and Labrador area, could impede vessel traffic (Risk 6).

Finally, DFO will need to be prepared to provide guidance and input, as the shipping industry adapts to new conditions. For example, the current trend in the St. Lawrence is towards larger vessels with bigger draft. Climate change may lead to a shift in this trend.

Impacts: Risk 6

Table 9 summarizes the undesirable impacts that could result from this risk.

Strategic Outcomes	Potential Impacts of Climate Change
Safe and Accessible Waterways	• Personal injury or loss of life due to incidents related to navigation • Damage to vessels due to incidents related to navigation • Blocked shipping lanes could jeopardize the flow of goods and materials • Increased surveillance costs • Increased charting requirements and costs for the Canadian Hydrographic Service, particularly in the Arctic • Increased channel dredging costs • Broader economic impact on communities associated with lack of access, including increased transportation costs
Sustainable Fisheries and Aquaculture	• Lack of access by fishers to fish stocks, and associated economic and social impacts
Healthy and Productive Aquatic Ecosystem	• Environmental pollution related to leaking contaminants from vessels due to navigation incidents • Physical impact on fish habitat

Table 9: Summary of Impacts Related to Risk 6 – Navigation and Accessibility

Current Departmental Capacity to Mitigate and Control: Risk 6

Risk assessment participants believe that DFO is reasonably well-prepared to deal with icebreaking activities to ensure access to waterways. However, the Department is less well-prepared to respond to access problems that are caused by sedimentation, and does not run dredging programs beyond the Detroit/St. Clair River under international agreement, in the St. Lawrence on a cost recovery basis, and in Small Craft Harbours' channels and basins. Once again, this is primarily a resource capacity issue.

3 RISK EXPOSURE ANALYSIS

Risk exposure is a function of the likelihood that a risk will materialize, and the severity of its impact on Departmental objectives. A third exposure factor, timeframe, provides an organization with additional information that needs to be considered when allocating resources to risk mitigation activities.

Workshop participants assigned values to the exposure attributes of likelihood, impact and timeframe for each of the six risks using voting technology. Participants considered the mitigating impact of the current control environment when voting. The criteria used to assign values to each of the attributes are included in Appendix A.

Figure 1 indicates the placement of each of the six risks, based on the consolidated responses of workshop participants for likelihood and impact.

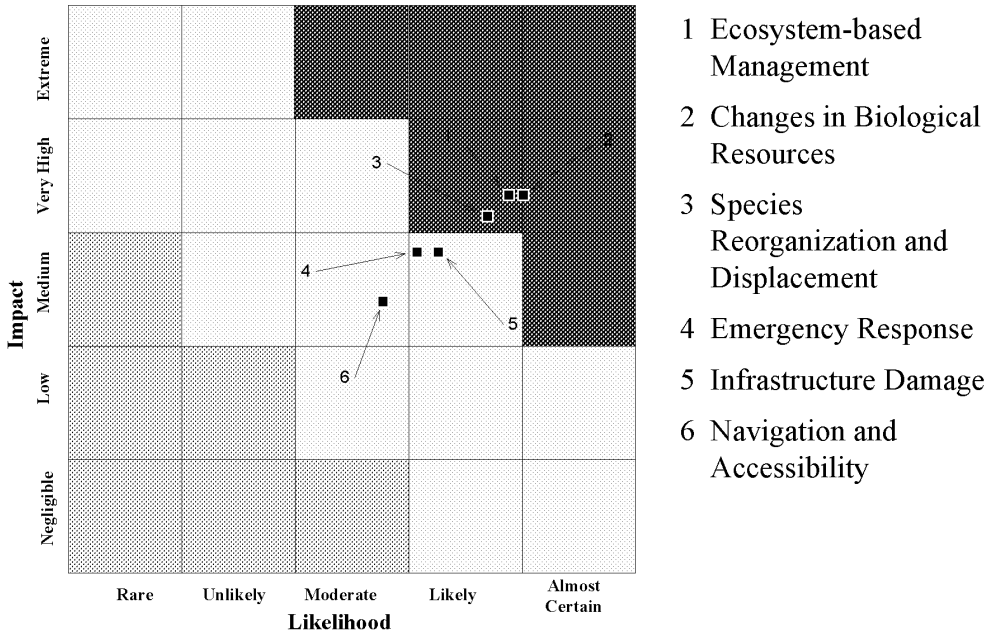

Figure 1: Consolidated Risk Exposure Grid

Based on all responses, the risks were ranked as follows:

Rank	Risk
1	Risk 2: Changes in Biological Resources There is a risk that climate change will jeopardize DFO's ability to manage and protect the abundance, distribution, and quality of harvested fisheries and aquaculture stocks.
2	Risk 1: Ecosystem-based Management There is a risk that climate change will jeopardize DFO's ability to meet its strategic and policy objectives related to oceans management, and the sustainable development and integrated management of resources in Canada's aquatic environment.
3	Risk 3: Species Reorganization and Displacement There is a risk that climate change will jeopardize DFO's ability to protect species diversity and species at risk.
4	Risk 5: Infrastructure Damage There is a risk that climate change will result in damage and the need for alterations to DFO vessels, coastal and Small Craft Harbour infrastructure.
5	Risk 4: Emergency Response There is a risk that climate change will jeopardize DFO's ability to provide acceptable levels of environmental response and search and rescue activities.
6	Risk 6: Navigation and Accessibility There is a risk that climate change will jeopardize DFO's ability to provide safe access to waterways.

Table10: Consolidated Rankings

Clearly, the three biological risks in the Ecosystem and Fisheries Management category were considered to present a greater exposure to the Department than the remaining risks that primarily affect CCG and Small Craft Harbours.

The rationale for the lower placement of Risks 4 through 6 may be related to the greater variability of the contributing factors for the biological risks. There is considerable uncertainty associated with the manner in which the direct and indirect risk factors could affect the aquatic ecosystems and fisheries. There may be greater certainty with the type of impact that climate change could have on the operational activities of CCG and Small Craft Harbours, and, as a result, a greater inherent capacity to plan.

The lower exposure rating for Risks 4 through 6 may also be related to the nature of the work conducted by CCG. As an emergency response organization, CCG may have more robust risk management and preparedness plans for dealing with contingency situations. Such

organizations are often better prepared to re-deploy resources to core mission critical priorities, such as search and rescue and emergency response. The mission critical priorities may continue to be met, but it may be at the expense of lesser priorities. This could have an impact on the objectives of Departmental priorities other than those of CCG. For example, resource pressures within CCG could result in reduced vessel support for scientific research activities.

Figure 2 provides an indication of the consolidated assessment of timeframe. Timeframe can provide management with an additional indicator for determining the priority of risks. Typically, risks with a shorter timeframe (i.e., near-term) present greater urgency for taking action. In this case, the three highest priority risks based on impact and likelihood (denoted by the red arrows) were also assigned a near-term timeframe.

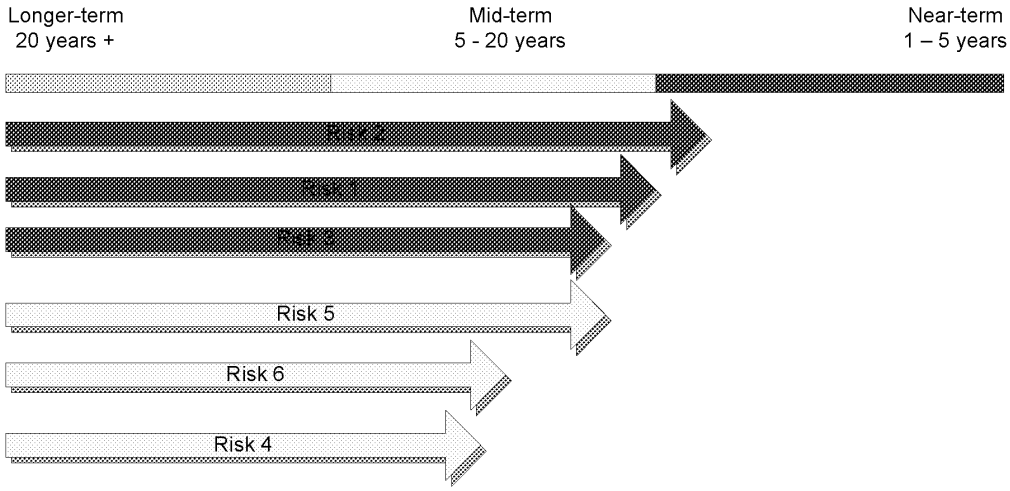

Figure 2: Consolidated Timeframe Results

4 RISK RESPONSE

4.1 INTRODUCTION

Based on feedback from Departmental participants in the risk assessment exercise, the degree of climate change risk exposure is such that action should be taken to respond to all six risks. The risk response approaches suggested in this section are directional in nature. If accepted, further development of detailed action plans will be required, including defined accountabilities, activities and dates.

4.2 ECOSYSTEM AND FISHERIES MANAGEMENT RISKS

The risks in this category are particularly significant to DFO, given the Department's priorities, strategic directions, and commitment to an ecosystem approach, based on precautionary decision-making in an environment of uncertainty. The following specific response options were identified.

Support and Enhance the Science Program

Ensure that the Science Program has the direction, capacity, and tools to support a better understanding of the potential impacts of climate change on ecosystems and fisheries:

- Plan science activities systematically to address issues incrementally;
- Identify and model appropriate climate change indicators and predictors that distinguish between climate change and climate variability, ensuring that the focus is on the cumulative effects of the direct and indirect risk factors;
- Enhance the monitoring program in the Arctic to leverage the fact that climate change impacts are likely to be the most dramatic and rapid in the Arctic;
- Enhance the capacity of the science, oceanography, and fisheries programs to support an ecosystem approach; and,
- Strengthen the rigor of stock assessments by incorporating environmental and climate change considerations on a regular basis.

Enhance Linkages

Position the Department to more effectively engage its key external stakeholders:

- The Department must better collaborate with and engage OGDs (e.g. Transport Canada, Environment Canada, Natural Resources Canada) on issues for which it has

the lead or can contribute, and develop more effective mechanisms for addressing risks for which control lies outside of DFO;

- Extend and enhance funding for the C-CIARN Fisheries Node, to build scientific knowledge related to the impacts of climate change on fisheries;
- The Northern Strategy (interdepartmental ADM committees) could be leveraged for climate change purposes and cross-related to interdepartmental science planning activities;
- Leverage the Federal Council (in Maritimes) to engage stakeholders on climate change issues; and,
- Leverage existing processes and the outreach elements of the Oceans Action Plan to more effectively communicate and address climate issues with key stakeholders, such as harvesters, and First Nations, folding integrated management into coastal, fisheries and habitat management. Stakeholders should be actively engaged to contribute information and be a part of any adaptive approaches.

Departmental Governance

Enhance the Department's ability to manage the horizontality of climate change across the Oceans Sector, Science Sector, and Fisheries and Aquaculture Management. Develop and institutionalize management structures to facilitate an integrated approach to identifying and priorities, addressing issues, and communicating information:

- DFO must move in real ways towards developing support mechanisms and applying integrated management. Entities such as the Science Policy Forum, can help to bridge the integration and communication gap; and,
- Establish an active national network of cross-sectoral working groups with linkages to the Departmental Management Committee (DMC) to coordinate and communicate monitoring results, and identify priorities for impact assessment research. Regular reporting to DMC would be an important element of the working group mandates.

  The Fraser River Watch Program is an example of the Science Sector working with Fisheries and Aquaculture Management to communicate results of monitoring. This program models and predicts river temperature regime for fish management and en-route salmon mortality.

  The Centre for Offshore Oil and Gas Environmental Research (COOGER) is an example of DFO science virtual centre of expertise that draws together departmental and external experts to target oil and gas science and manage horizontal issues. COOGER is essentially a virtual research network or centre of expertise that aims to address specific scientific questions in a nationally cohesive manner.

Finally, the National Centre on Arctic Aquatic Research Excellence (N-CAARE) is another example of a centre of expertise model.

Planning and Priorities

Incorporate climate change planning into the Departmental business planning cycle. Specific suggestions include:

- Building on the national working group concept, charge experts groups to develop, in consultation with managers, strategic proposals for targeted areas of research for submission into the business planning and priority setting process;
- Consider integrating strategic environmental assessments into the Departmental planning and policy development exercise. A strategic environmental assessment, a charter under the Canadian Environmental Assessment Act, involves reviewing policy, plan and program proposals to incorporate environmental considerations into the development of public policies;
- Incorporate the latest climate change information, including changes in the oceans or aquatic environment into the formal Departmental resource allocation processes, perhaps holding a resource allocation workshop focused on climate change; and,
- Incorporate into the SARA evaluation an assessment of the likelihood that an intervention will be successful, considering the impact of climate change risk to the species.

4.3 SAFETY AND ACCESSIBILITY OF WATERWAYS RISKS

The risks in this category, while assessed at a somewhat lower exposure than those in the Ecosystem and Fisheries Management category, can potentially seriously jeopardize the Department's objectives related to safe access to Canada's waterways.

Unless mitigated, the materialization of these risks could also undermine both the health of the aquatic ecosystems and the societal benefits associated with sustainable fisheries and aquaculture. For example, a degradation of surveillance to detect environmental compliance, such as bilge-pumping, could result in an increase of pollution and contaminants in the aquatic environment. Damaged infrastructure or inaccessible waterways could present challenges to fishers in accessing harvestable stocks.

The response options presented below are more focused than those for the Ecosystem and Fisheries Management risks. This may be partly related to the more operational nature of CCG's and Small Craft Harbour's objectives and activities. It may also be related to a somewhat less complex and more direct relationship between the climate change risk factors and the risk impacts. For example, unlike the complex relationship between various climate risk factors and a dynamic and multi-faceted ecosystem, the presence of dangerous multi-year sea ice in shipping channels has a clear and direct impact on Departmental resources. While

uncertainty remains regarding the extent and timing of climate change effects, there is little uncertainty regarding how it could affect DFO.

It is also important to note that a number of the response options suggested for risks in the Ecosystem and Fisheries Management category would, in fact, benefit all risks, including those in the Safety and Accessibility of Waterways risks. For example:

- An enhanced science program could provide CCG and Small Craft Harbours with valuable predictive information to support strategic planning, priority setting and resource allocation decisions;
- Incorporation of climate change planning into the Departmental business planning cycle would also ensure that CCG's and Small Craft Harbour's priorities and resource allocations considered the longer-term strategic needs driven by climate change; and,
- The establishment of climate change virtual networks of centres of expertise would also benefit the protection of Small Craft Harbours infrastructure.

Planning, Priorities and Resource Allocation

Incorporate the impact of climate change on CCG's platform, infrastructure and human resource requirements into the Departmental business planning cycle.

Specific suggestions pertinent primarily to Risk 4, Emergency Response, include:

- Stabilize funding and capacity to enhance CCG's ability and flexibility to respond as required to, for example, increased escort and search and rescue activity;
- Review service levels with a view to increase flexibility to respond;
- Pursue fleet recapitalization;
- Enhance surveillance activity (satellite and aerial) to detect environmental non-compliance (e.g., bilge pumping) in the Arctic. This will require coordination with OGDs (e.g. Transport Canada and Environment Canada);
- Enhance the spill-response capability for the Arctic to respond to potential increased traffic; and,
- Further augment the establishment of the Coast Guard auxiliary in the Arctic.

Specific response options for Risk 5, Infrastructure Damage, include both preventative and reactive measures:

- Pursue a proposal currently being prepared as part of the National Disaster Mitigation Strategy for Public Safety and Emergency Preparedness Canada, to seeks funding to assess storm surge risk areas relative to the location of harbours (preventative). This proposal addresses a preventative response measure, and includes the conduct of a cost-benefit analysis regarding the storm-proofing and/or the re-location of the Department's infrastructure; and,

- Consider the creation of a contingency fund to allow for rapid response to extreme events.

A specific response option that would mitigate both risk 4, Emergency Response, and Risk 6, Navigation and Accessibility, includes the allocation of funds and resources to hydrographic activities for the North and Newfoundland and Labrador.

Education

Enhance education and outreach programs, particularly in the North. Specifically, expand the outreach activities to educate mariners and marine insurance companies on navigation risks, perils and safety system availability.

Enhanced Regulations

Impose mandatory compliance to the northern traffic regulations for control of shipping (Transport Canada).

APPENDIX A STUDY METHODOLOGY

CONFIRM OBJECTIVES

The first activity confirmed the key relevant business priorities of DFO related to climate change. Business priorities are the natural starting point for any type of risk identification exercise, in that risk must always be considered in the context of the impact that it will have on those objectives. The objectives were based on the high level outcomes articulated as part of the Departmental Assessment and Alignment Project, as depicted in Figure 3.

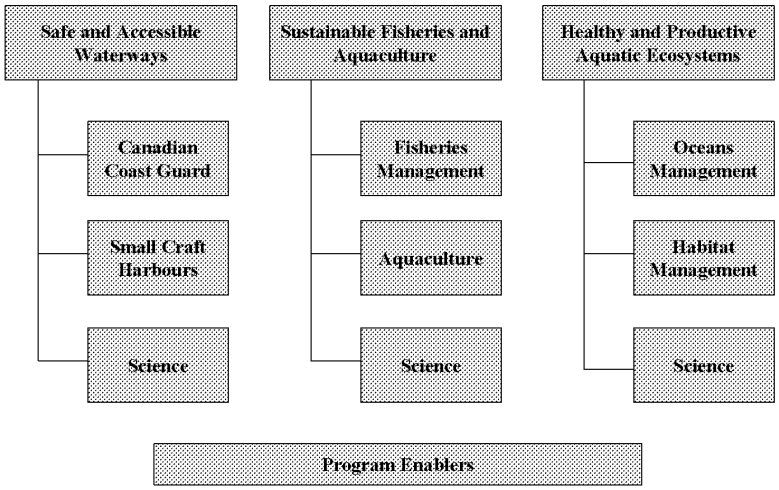

Figure 3: DFO Strategic Outcomes

IDENTIFY RISK FACTORS AND RISK EVENTS

Identification and assessment of risks followed a top-down first, then bottom-up, approach.

Risk Factor Analysis

Based on a review of relevant documentation, a risk profile analysis framework was developed, identifying the key risk factors related to climate change that would lead to risk events relevant to DFO.

The framework was used to guide a series of interviews with DFO stakeholders to further explore the risk factors and the types of risk events that could result. This top-down approach to identifying the potential risk events was useful in that it provided a necessary frame of reference for subsequent risk analysis.

Figure 4 illustrates the relationship among risk factors, risk events and the associated impacts, based on examples from this risk assessment.

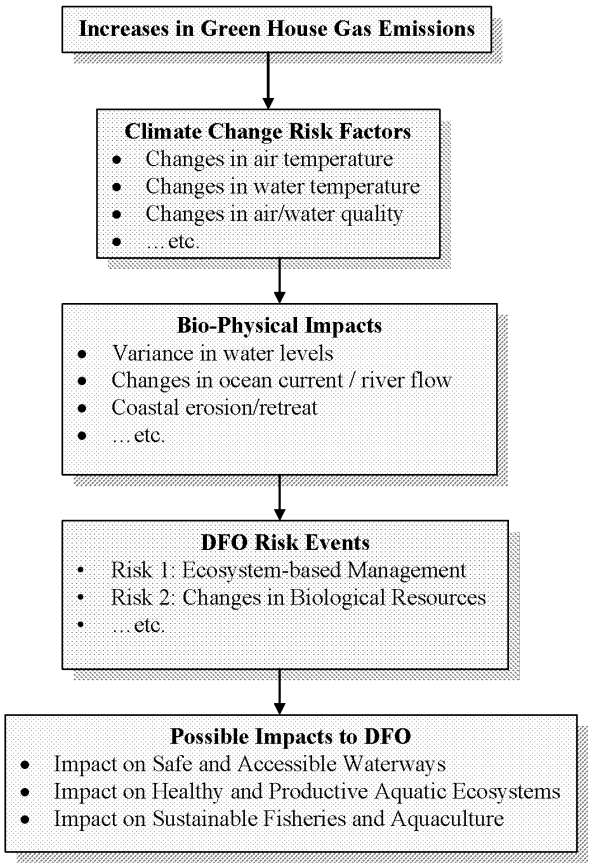

Figure 4: Examples of Risk Factors, Events, and Impacts

Confirm and Assess Risk Events

The list of potential risk events developed through documentation review and stakeholder interviews was then used as the starting point during a series of risk assessment workshops with representatives from all regions and sectors (the bottom-up approach). Four strategically located workshops representing all regions were conducted to gain a broad level of stakeholder input.

During the workshops, the potential risk events were used to initiate discussions of the relevance of each risk and the manner in which the risk could undermine the ability of the Department to achieve its objectives. The discussion of impact addressed the economic, social and environmental impacts in the context of the PAA objectives. Participants were asked to provide their regional and program perspectives of both the risk event and the current capacity, practices, and structures in place that could control or mitigate the risks.

Using voting technology, participants then rated the exposure for each of the risks, by assigning values for likelihood, impact, and timeframe, using pre-defined criteria as follows:

Likelihood Criteria

How likely is this risk event to occur, given current controls and mitigating measures?

Rare	This event may occur only in exceptional circumstances. It will occur less than 5% of the time.
Unlikely	This event could occur at some time. It will occur between 5% and 20% of the time.
Moderate	This event should occur at some time. It will occur between 21% and 59% of the time.
Likely	This event will probably occur in most circumstance. Will occur from 60% to 94% of the time.
Almost Certain	This event is expected to occur in most circumstances. Will occur 95% of the time.

Impact Criteria

What impact would this risk have on the ability of DFO to achieve its objectives, considering current controls and mitigating measures?

Negligible	An event, the consequences of which can be absorbed through normal activity.
Low	An event, the consequences of which can be absorbed but management effort is required to minimize the impact. The consequences could threaten the efficiency or effectiveness of some aspects of the operation, but would be dealt with internally.
Medium	A significant event which can be managed under normal circumstances by the department. The consequences could mean that the activity could be subject to significant review or changed ways of operation.
Very High	A critical event that with proper management can be endured by the department.
Extreme	A disaster with the potential to lead to permanent or long-term damage to the department's ability to achieve its objectives. The consequences could threaten the survival of not only the activity, but also the Department, possibly causing major problems for clients / public.

Timeframe

When will this risk materialize, or when should action be taken?

Long-term	20 years and over
Medium-term	Greater than 5 years, less than 20 years
Near-term	1 – 5 years

Participants were asked to consider the mitigating impact of the current controls when assigning ratings. This is referred to as the residual risk, or the level of risk exposure that remains after the controls have been applied.

ANALYZE AND REPORT INTERIM RESULTS

The results of the regional and program workshops were then consolidated and analyzed to gain a Departmental perspective of climate change risks. Analysis addressed:

- the risk's background and context, influencing factors, and drivers;
- potential impact on objectives;
- effectiveness of mitigating controls;
- resulting residual exposure expressed as a function of likelihood and impact; and,
- the relative timeframe for the risk (a qualitative assessment of when the risk can be expected to materialize and when action must be taken to mitigate the risk).

The findings were then documented in an Interim Report for distribution to key internal stakeholders prior to the conduct of a validation workshop.

VALIDATE RESULTS AND FINALIZE REPORT

A national validation workshop was conducted with representation from all regions and sectors. Workshop participants:

- provided a corporate and strategic perspective of the risk assessment results as documented in the Interim Report, reconciling or providing context for regional or sectoral deviations;
- discussed the current capacity of the organization to manage and control climate change risks, highlighting both strengths and potential gaps in control capacity; and,
- provided their perspectives on appropriate management response options to each of the risks.

Workshop results and post-workshop feedback from participants were consolidated and analyzed, prior to preparation of the final Climate Change Risk Assessment Report.

APPENDIX B DOCUMENTATION REVIEWED

ACIA. (2004). "Impacts of a Warming Climate: Arctic Climate Impact Assessment". Cambridge University Press.

Fisheries and Oceans Canada. (2000). "DFO Climate Variability and Change Impacts and Adaptation Research for Canada's Marine and Freshwater Fisheries – Summary, Program Framework, Workshop Proceedings, and Background Report ".

Fisheries and Oceans Canada. (2004-05). "Report on Plans and Priorities". http://www.dfo-mpo.gc.ca/publication_e.htm

Fisheries and Oceans Canada. (2005). "Fisheries and Oceans Canada Strategic Plan 2005-2010". Commnications Branch, Fisheries and Oceans Canada

Government of Canada. "Canada's Oceans Strategy" http://www.cos-soc.gc.ca/dir/cos-soc_e.asp

Johannes, Mark. R. S. "Past, Present and Future Perspectives of Impact and Adaptation Responses of Fish and Fisheries to Climate Variation and Change in the Eastern Pacific". Canadian Impacts and Adaptation Research Network: Fisheries Sector.

Natural Resources Canada. (2004). "Climate Change Impacts and Adaptation: A Canadian Perspective". http://adaptation.nrcan.gc.ca/perspective_e.asp

The Union of Concerned Scientists and the Ecological Society of America. (2003). "Confronting Climate Change in the Great L:akes Region. Impacts on our Communities and Ecosystems"

Vigod, Toby. Environmental Law and Policy Consulting. (2004). "The Need to Address the Impacts of Climate Change and Potential Liability Issues: A Preliminary Examination of Selected Federal Legislation".

APPENDIX C STUDY PARTICIPANTS

INITIAL INTERVIEWS

Individual	Region/ Program
Allyn Clarke	Maritimes/Research Scientist, Oceans Sciences Division
Carla Dale	Maritimes/A/Chief, Marine Policy
Jean Piuze	Quebec/Advisor to the RDG, Regional Director General's Office
John Karau	NCR/Director, Oceans Stewardship Branch
Kim Hyatt	Pacific/Research Scientist; Manager C-CIARN Fisheries
Kim Schmidt	NCR/Senior Policy /Program Advisor, Multi-species and Ecosystems, Oceans and Aquaculture Science Directorate
Lloyd Mackey	NCR/Senior Planning and Performance Analyst, Planning, Performance & Monitoring
Luke Crevier-McKenna	NCR/Policy Analyst, Strategic Priorities
Mark Burgham	NCR/Director, Aquaculture Policy, Aquaculture Management Directorate
Mark Johannes	Pacific/Research Scientist, Coordinator C-CIARN Fisheries
Marty Bergmann	Central and Arctic/Director, Arctic Science Program Development
Michel Lafleur	NCR/Director, Office of Environmental Coordination
Micheline Leduc	NCR/Director, Harbour Operations And Engineering
Pierre Pepin	Newfoundland and Labrador/Biomathematician, Biological and Physical Oceanography Section
Richard Dalpé	NCR/Chief, Policy Analysis, Strategic Priorities

REGIONAL WORKSHOPS

Region/Sector	Attendee	Program
Central/Arctic	Alan Kathan	Manager, Western Area, Small Craft Harbours
Central/Arctic	Allan Kristofferson	Fisheries Management Biologist, Resource Management & Aboriginal Affairs
Central/Arctic	Chris Baron	Program Leader, Mining Impacts, Environmental Science Division
Central/Arctic	Gary Stern	Research Scientist, Arctic Research Division
Central/Arctic	James Boraski	District Manager-Inuvik, Western Arctic Area
Central/Arctic	Jim Reist	Section Head, Arctic Fish Ecology/Assessment, Arctic Research Division
Central/Arctic	Marty Bergmann	Director, Arctic Science Program Development
Central/Arctic	Mike Stainton	Aquatic Chemist, Environmental Science
Central/Arctic	Robert Fudge	Science Program Coordinator, Regional Science
Central/Arctic	Steve Newton	Integrated Management Planner, Oceans
Central/Arctic	Dr. Robert Randall	Fish Habitat Scientist GLLFAS
Central/Arctic	Susan Doka	Research Scientist, Great Lakes Laboratory for Fisheries and Aquatic Sciences
Central/Arctic	Vera Williams	Statistical Analyst, Policy
Gulf	Daniel Caissie	Hydrological Engineer, Fish Habitat Research
Gulf	Josiane Massiéra	Analyst, Policy & Economics
Maritimes	Allyn Clarke	Research Scientist, Oceans Sciences Division
Maritimes	Bert Gauthier	Regional Environmental Coordinator, Corporate Services

Region/Sector	Attendee	Program
Maritimes	Carla Dale	A/Chief, Marine Policy
Maritimes	Dale Nicholson	A/Director Hydrography, Director's Office
Maritimes	Dannie Chipman	Engineering Project Officer, Engineering
Maritimes	Joe Arbour	Division Manager, Oceans and Coastal Management
Maritimes	Lexena Power	Business Services Officer, Canadian Coast Guard
Maritimes	René Lavoie	Manager, Invertebrate Fisheries Division, Science
Maritimes	Rick Young	Assistant Regional Director, Fisheries & Aquaculture Management
Maritimes - Gulf	Emilie LeBlanc	A/Special Projects and Training Coordinator, Small Craft Harbours
Nfld. & Labrador	Geoff Perry	Aquaculture Coordinator, Planning & Coordination
Nfld. & Labrador	Jim Helbig	Research Scientist/Senior Advisor, Oceans & Aquaculture Science
Nfld. & Labrador	Laura Park	Oceans Biologist, Oceans Management
Ottawa	Barbara Calvert	Analyst, National Fisheries Policy Framework
Ottawa	Barbara O'Connell	Service Standards Officer, Icebreaking
Ottawa	Carol Gibson	Senior Advisor, Program Policy & Regulatory Affairs
Ottawa	Claudette Raymond	Senior Policy and Program Advisor, Harbour Policy & Program Planning
Ottawa	Francois-Rene Dussault	Legal Counsel
Ottawa	Georgina Lloyd	Advisor, Oceans & Aquaculture Science Directorate
Ottawa	Jacque Lorquet	Director, Navigation Services

Region/Sector	Attendee	Program
Ottawa	Kelly Ann Fay	Analyst, Environmental Coordination
Ottawa	Ken Huffman	Senior Policy Advisor, Oceans Stewardship Branch
Ottawa	Lloyd Mackey	Senior Planning and Performance Analyst, Planning, Performance & Monitoring
Ottawa	Marc Clemens	Program Officer, Pacific Operations
Ottawa	Micheline Leduc	Director, Harbour Operations and Engineering
Ottawa	Paul Lyon	Policy Analyst, Aquaculture Management
Ottawa	Rose Gaigg	Strategic Planning Advisor, Strategic Planning, Fleet
Pacific	Adrian Rowland	Engineer, Small Craft Harbours
Pacific	Al von Finster	Senior Resource Restoration Biologist, Oceans, Habitat and Enhancement Branch
Pacific	Brian Pearce	Oceans, Habitat & Enhancement Branch
Pacific	Cory Paterson	Policy Advisor, Policy
Pacific	Don Radford	A/Director, Fisheries Management & Aquaculture
Pacific	Ed Woo	Chief, Oceans/Watershed Planning & Restoration Oceans, Habitat Enhancement Branch
Pacific	John Davis	Special Advisor to DM, SARA
Pacific	Kim Hyatt	Research Scientist; Manager C-CIARN Fisheries
Pacific	Mark Johannes	Research Scientist, Coordinator C-CIARN Fisheries
Pacific	Mary Hobbs	A/Director, Policy
Pacific	Robin Brown	Head, Oceans Sciences & Productivity Division
Pacific	Timber Whitehouse	Sockeye Program Head, Sockeye Program
Quebec	André Audet	Superintendent, Search & Rescue

Region/Sector	Attendee	Program
Quebec	Francine Dufour	Senior Analyst, Policy, Planning & Integration
Quebec	Jacques Lavigueur	Head of Users services, Small Craft Harbours
Quebec	Jean-Claude Therriault	Director, Ocean Science

NATIONAL VALIDATION WORKSHOP

Region/Sector	Attendee	Position
Central and Arctic	Bob Fudge	Science Program Coordinator, Science Director's Office
Gulf	Michel Audet	Regional Director, Policy and Economics Branch
Quebec	Jean Piuze	Special Counsellor, Director General's Office
Maritimes	Joe Arbour	Division Manager, Oceans and Coastal Management Division
Maritimes	John Loder	Head, Ocean Circulation Section, Oceans Sciences Division
Newfoundland	John Collins	Regional Director, Policy and Economics Branch
Pacific	John Davis	Special Advisor to the Deputy Minister, Species at Risk Act (SARA)
NCR Strategic Priorities and Planning	Danielle Labonté	Director General, Strategic Priorities and Planning
NCR Strategic Priorities and Planning	Richard Dalpé	Chief, Horizontal Policy, SPP
NCR Strategic Priorities and Planning	Luke Crevier-McKenna	Analyst, Horizontal Policy, SPP
NCR Science	Nicole Asselin	Senior Advisor, Policy and Planning Branch
NCR Science	Doug Bancroft	Director, Oceanography and Climate Branch, Oceans and Aquaculture Science Directorate
NCR Science	Kathleen Fischer	Director General, Policy, Planning and Coordination

Region/Sector	Attendee	Position
NCR Fisheries and Aquaculture Management	Stephen Watkinson	Staff Officer, Resource Management
NCR Canadian Coast Guard	David Jackson	Manager, Icebreaking Division
NCR Small Craft Harbours	François Bellehumeur	Senior Policy and Program Analyst, Harbour Policy and Program Planning
NCR Small Craft Harbours	Micheline Leduc	Director, Harbour Operations and Engineering
NCR Corporate Services	Michel Lafleur	Director, Office of Environmental Coordination
NCR Corporate Services	Kelly Ellis	Environmental Management Analyst, Office of Environmental Coordination
NCR Legal	François-René Dussault	Counsel, Legal Services
NCR Audit and Evaluation	John Lark	Project Manager, Audit and Evaluation

APPENDIX D REGIONAL RANKINGS

Table 11 indicates the averaged results of regional voting during the workshops, for Likelihood and Impact, based on the Figure 5 colour coding scheme. Note that the Winnipeg and Vancouver workshops did not include CCG representation. The Newfoundland, Gulf and Maritimes regions participated in the Halifax location session The Quebec region participated in the Ottawa workshop.

Location / Risk Event	Vancouver	Winnipeg	Halifax	Ottawa	All
Risk 1: Ecosystem Management					
Risk 2: Changes in Biological Resources					
Risk 3: Species Reorganization and Displacement					
Risk 4: Emergency Response					
Risk 5: Infrastructure					
Risk 6: Navigation and Accessibility					

Table 11: Risk Exposure by Workshop Location, Based on Likelihood and Impact

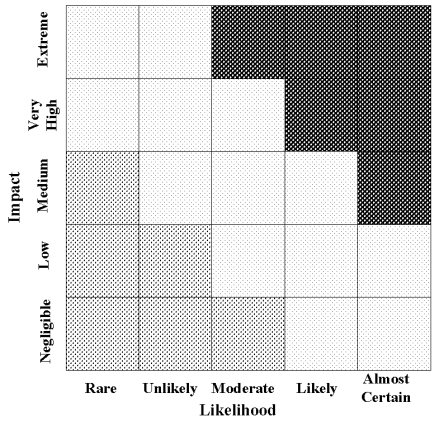

Figure 5: Risk Exposure Grid