Science Needs for the Tarium Niryutait Marine Protected Area: Workshop Report

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ABSTRACT
A workshop to identify priority science needs and programs to support management of the proposed Tarium Marine Protected Area (MPA) in the Beaufort Sea was held May 24–25, 2006. There were 20 participants, including community members, Canada/Inuvialuit Fisheries Joint Management Committee (FJMC) members and scientists, biologists and managers from three government departments. The workshop built on earlier workshops on habitat mapping and marine environmental quality, a Parks Canada initiative on northern ecosystem indicators, and ongoing beluga harvest monitoring and fisheries monitoring programs in the Mackenzie Delta.

This report presents a summary of the workshop, including the background information presented, the approach used and the results of the workshop discussions. Following the objectives-based approach to integrated management, four conceptual objectives were adopted by the workshop participants and 14 operational objectives were developed to cover the priority components of the conceptual objectives. Project proposals to support the objectives were developed for physical and chemical properties of the ecosystem, fish populations and fish habitat, belugas and their habitat, and the relationship between waterfowl, seabirds, and shorebirds and the aquatic components of the ecosystem.

Long-term ongoing costs to support the range of science needed to effectively manage the MPA and meet the conceptual ecosystem objectives would cost an additional $234,000 annually. However, to establish the meaningful indicators necessary, there are significant up-front costs in the five years before the ongoing program can be implemented. The five year total for operations and materials, equipment and vessel costs would be $4,538,000.

PREFACE

This report is based on a workshop held on May 24–25, 2006 in Leduc, AB and co-hosted by the Canada/Inuvialuit Fisheries Joint Management Committee (FJMC) and Fisheries and Oceans Canada (DFO). The workshop was planned and coordinated by G. Burton Ayles and Michael Papst.

Dr. Ayles is currently a Canada Member of the FJMC and was formerly a research scientist, and research director of the DFO. Dr. Papst is an Arctic research scientist in the Central and Arctic Region of the DFO.

The Fisheries Joint Management Committee (FJMC) Report Series was initiated in 1986 and reports were published sporadically in a variety of formats until 1998. Information on the earlier publications can be obtained directly from the FJMC office. The Series was re-initiated in 2003 and a common format established with concurrent publication on the FJMC website (WWW.FJMC.ca).

INTRODUCTION

In 1991, the Canada/Inuvialuit Fisheries Joint Management Committee (FJMC), Fisheries and Oceans Canada (DFO), and the Inuvialuit Game Council (IGC), concerned about possible future developments in an area of critical cultural and resource importance for the Inuvialuit, established the Beaufort Sea Beluga Management Plan (BSBMP) (FJMC 2001) (see Appendix 1 for a list of Acronyms). The purpose of the plan is to ensure the responsible and effective, long-term management of beluga whales and their habitat. The FJMC is responsible for the BSBMP.

In 1999, the FJMC, the Inuvialuit, DFO, the Department of Indian Affairs and Northern Development (DIAND) and the hydrocarbon industry agreed to collaborate on the development of integrated management planning for coastal and marine areas in the Inuvialuit Settlement Region (ISR). Out of this Beaufort Sea Integrated Management Planning Initiative (BSIMPI) has come a proposal to establish a Marine Protected Area (MPA) based on the BSBMP. Three areas of the Mackenzie Delta will comprise the Tarium Niryutait Marine Protected Area (MPA): Niaqunnaq (Shallow Bay), Kittigaryuit (Kugmallit Bay) and Okeevik (east Mackenzie Bay near Kendall and Pelly Islands).

The MPA will conserve and protect beluga whales in the Area and support the goals of the BSBMP. It will prohibit a number of activities in the Area:

- approaching, disturbing or interfering with beluga whales;
- disturbing, damaging, destroying or removal of any marine organism or its habitat;
- disturbing, damaging, destroying or removing any part of the seabed;
- depositing any substance in the area that might disturb or destroy whales or the ecosystem;
- traveling on open water.

There will be exemptions for a number of activities under certain circumstances and conditions, including Inuvialuit harvesting, community travel, commercial and sport fishing, scientific activities, boating and shipping, and emergency safety and security.

The MPA will be established under the Canada Oceans Act. An important component of the management plan for the MPA will be a plan for science activities to meet the management needs of the MPA.

In December 2005, DFO and FJMC agreed to develop and coordinate a workshop to develop a science program for the MPA management plan. The workshop was co-hosted by DFO and the FJMC on May 24–25, 2006. There were 20 participants, including community members, FJMC members and scientists, biologists and managers from three government departments (Appendix 2.). The purpose of the workshop was to identify priority science needs and programs to support management of the proposed Tarium Marine Protected Area. This report presents a summary of the workshop, including the background information presented, the approach used and results of the workshop discussions.

WORKSHOP BACKGROUND PRESENTATIONS

A series of background presentations on the status of the development of the MPA were delivered at the beginning of the workshop. Their purpose was to ensure that all participants were familiar with the progress to date and to provide the basis for the discussions that were to follow. The presentations included an overview of the DFO's approach to science to support MPAs and integrated oceans management followed by a summary of the natural history of the MPA, brief results of earlier workshops on habitat mapping, development of Marine Environmental Quality (MEQ) objectives, and northern marine monitoring by Parks Canada, and descriptions of two monitoring programs that are currently partly operating in the proposed MPA.

The Natural Environment of the MPA – Beth Thomson

This presentation summarized the general ecology of the MPA and recent scientific investigations in the Beaufort Sea. The ecological significance and current and potential stressors to the MPA ecosystem were discussed and recommendations made for directions for Beaufort Sea science. The justification and purpose of the MPA and the conservation objectives of the MPA and their relationship to science, both research and monitoring, were emphasized.

Habitat Mapping in the Beaufort Sea– Don Cobb

A Habitat Mapping Workshop (February 28–March 1, 2002), was held to provide the foundations for a strategic plan for habitat mapping in the Beaufort Sea. Oceans partners, clients and stakeholders in attendance at the workshop were directed to address objectives of user needs and priorities, identifying ongoing research which could link or contribute to the habitat mapping program and technology needs, logistics, and assessing funding requirements and sources. Breakout groups generated three maps showing priority areas for future habitat mapping.

As a result of the workshop, a collaborative, multi-disciplinary habitat-mapping program has been funded until 2008/09, and using the (Canadian Coast Guard Service) CCGS Nahidik as the main platform, various offshore and nearshore programs have been started. The focus of the work has been to provide biological/oceanographic and geohazards information, which will assist in decision making, planning of future hydrocarbon activities in the Beaufort Sea. The annual cruise plan reflects on the results of this workshop.

Marine Environmental Quality for the Beaufort Sea – Burton Ayles

An MEQ Workshop (October 28–29, 2003; Cobb et al. 2006) brought together knowledgeable participants from the communities of Tuktoyaktuk, Aklavik and Inuvik, co-management bodies, regulators, scientists, the petroleum industry and environmental-planning specialists. The goals of the workshop were to develop MEQ Objectives for the proposed MPA, identify possible MEQ indicators and develop a MEQ monitoring framework. General MEQ objectives were established for beluga and marine mammals, fish and fish habitat, the physical and chemical environment, and birds and other animals. A process (including the present workshop) was established for further refining conceptual objectives and developing usable indicators.

Parks Canada Arctic Coastal/Marine Ecosystem Initiatives – Marlow Pellatt

Under the National Ecological Integrity Monitoring and Reporting Initiative, Parks Canada is working to establish early warning systems to monitor condition of the coastal and marine environments in northern parks. The Parks Canada, Northern Bioregion Marine Monitoring Workshop (February 6, 2006) was held to develop a list of coastal-ecosystem monitoring measures for implementation. Opportunities for cooperation between the Parks Canada proposal and any proposed monitoring in the MPA were discussed. Ivvavik National Park, in particular, offers opportunities for collaborative work.

FJMC Beluga Monitoring Program – Andrea Hoyt

Since 1987, the FJMC Beluga Monitoring Program has collected data during the annual subsistence beluga harvest by Inuvialuit. The FJMC, through contract arrangements with local Hunters and Trappers Committees (HTCs), employs Inuvialuit whale monitors at the various whale camps around the region — Aklavik (Shingle Point & West Whitefish Station), Inuvik (East Whitefish Station and Kendall Island), Tuktoyaktuk (Hendrickson Island and Tuktoyaktuk Harbour), and Paulatuk (various whaling camps around Darnley Bay). This hunter-based monitoring program records most beluga harvested annually by subsistence whalers from the ISR, but whales are sometimes taken before or after the whale monitor is in place. As a result, attempts are made to record whales taken outside the period of this program's operation, as well as the occasional harvest of whales in Holman and Sachs Harbour. Monitors collect a variety of information including: 1) details on the hunt and the harvester (i.e. community of residence, number of whales struck/lost/landed); 2) whale gender; 3) body colouration and presence of scarring; 4) body measurements, including total length, fluke width, flipper width and more recently maximum girth and breast blubber thickness; 5) stomach contents; and 6) female reproductive status (i.e. presence of calf and/or foetus, lactation). Since 2000, monitors have also kept track of aircraft traffic over and around whale camps during the whaling season and filed incident reports for any cases where harvesters or whales were disturbed by overflights. In past years, FJMC monitors have also supported DFO research by assisting in beluga sample collection for contaminants, disease, and reproductive status.

Tariuq (Ocean) Community-Based Monitoring Program – Don Pittman

The Tariuq Monitoring Program is a community-based initiative sponsored by DFO and undertaken in partnership with the Inuvik, Aklavik, and Tuktoyaktuk HTCs and the Ehdiitat Renewable Resource Council. Tariuq was designed to provide baseline data related to MEQ in the Mackenzie Delta and nearshore Beaufort Sea. It was also designed to obtain information on subsistence fisheries. The program was meant to contribute to the understanding of how changes in the environment affect marine life, and to help identify environmental changes triggered by industrial activity or climate change. Data have been collected since 2001.

Tariuq has built a solid base from which to evolve. In addition to collecting fisheries data from remote locations, Tariuq has strengthened relationships between DFO and its co-management partners and has helped foster environmental stewardship within the ISR.

Since Tariuq has very much been a "learn by doing" process, but there are lessons learned that potentially have broader implications for community-based monitoring initiatives. Thus DFO will be more involved in the future, from greater monitor education and training through being in the field during monitoring. DFO will also revamp the Tariuq program objectives and structure, and adapt the program indicators as MEQ indicators and ecosystem objectives become articulated and community concerns evolve. Tariuq will also build linkages with other monitoring and research programs.

APPROACH TO THE DEVELOPMENT OF SCIENCE PROPOSALS

This workshop was specifically organized to support the draft Management Plan of the MPA (DFO 2005) and guidelines developed by DFO for the establishment of ecosystem objectives (DFO 2004a), and to identify ecologically significant areas (DFO 2004b).

After the background presentations the workshop returned to a specific review of the objectives, principles of the management plans, the key activities that will affect the MPA (Appendix 3) and the definitions of conceptual objectives and operational objectives (DFO 2004a). Participants were then divided into four breakout groups to discuss in more detail priority science needs and programs to support the management of the proposed Tarium MPA.

The MEQ workshop established general objectives for beluga and marine mammals, fish and fish habitat, the physical and chemical environment, and birds and other animals (Appendix 3.). The general objectives were used in this workshop to structure the breakout groups and initiate discussions. Participants were asked to consider the already identified MEQ objectives, add further objectives if necessary and then select priority objectives for more detailed development into conceptual objectives and usable indicators.

A full spectrum of management decision-making is required in a complex estuarine environment system such as the Mackenzie Delta/nearshore Beaufort Sea, as is a full spectrum of new knowledge acquisition. In this workshop, discussions were structured to ensure that all the elements of a comprehensive, integrated, aquatic-science plan for the MPA were considered. A model developed by the Westwater Institute, University of British Columbia(Appendix 3.), was used to describe acquisition of knowledge and understanding (research) to support management decision making for the MPA (Dorcey and Hall 1981). Research needs (acquisition of knowledge and understanding) were identified and described under five categories viz., Inventory, Monitoring, Desk Analysis, Experimental Management and Experimental Research. It was emphasized that both scientific knowledge and traditional or local knowledge are valid and both should be considered in the development of proposals.

A template was developed to focus the breakout group discussions, to ensure that all the necessary elements were addressed and to facilitate comparisons between proposals for participants to follow (Appendix 3, Appendix 4.). Elements of the template included a program description, community participation, linkage to other programs, objectives and costs.

Proposals were developed in breakout groups and the entire group reconvened in plenary to discuss gaps and overlaps, and then returned to breakout groups to finalize the proposals. Final proposals were prepared by the breakout group rapporteurs immediately following the workshop, reviewed by breakout-group participants and then submitted to the workshop conveners for final rewriting and incorporation into this report.

RESULTS

Ecosystem Objectives and Proposals

Following the objectives-based approach to integrated management of the Tarium Niryutait MPA (DFO 2001), four conceptual objectives were adopted by the workshop participants and 11 operational objectives were developed to cover the priority components of the conceptual objectives.

The conceptual objectives are:

I. to conserve the physical and chemical properties of the Tarium Niryutait MPA ecosystem;
II. to conserve enough of the fish populations and habitat to maintain the natural resilience of the Tarium Niryutait MPA ecosystem;
III. to conserve a healthy population of belugas and the integrity of the ecosystem in Tarium Niryutait MPA ecosystem; and
IV. to conserve the waterfowl, seabird and shorebird components of the Tarium Niryutait MPA ecosystem and surrounding area to maintain the trophic structure and the relationship between these birds and aquatic components of the ecosystem.

Despite considerable survey and exploratory work related to oil and gas exploration in the 1970s and 1980s, our understanding of aquatic ecosystems in the Mackenzie Delta and Beaufort Sea lags significantly behind our knowledge of ecosystems in the nearshore Pacific and Atlantic coasts. An even poorer understanding of aquatic ecosystems exists in the proposed Tarium Niryutait than in the surrounding Beaufort Sea. To establish meaningful indicators to allow us to meet the conceptual ecosystem objectives the participants determined a need for a number of specifically designed projects over a five-year period before ongoing monitoring and research can be effectively implemented. The breakout groups described a total of 13 integrated proposals necessary to adequately address the operational objectives. This section summarizes the proposals for each objective, and Table 1 is an overall summary of the cost estimates of the proposals. The proposals are detailed in Appendix 4.

I. MPA Conceptual Objective: To conserve the physical and chemical properties of the Tarium Niryutait MPA ecosystem.

Operational Objective: To maintain the natural range of variability of physical oceanography (temperature, salinity, suspended sediments, currents, water chemistry, etc.) within the MPA by developing a baseline range of physical and chemical variables and monitoring for changes outside of that range.

Project PC 1: Measuring and modelling physical oceanography and sediment dynamics within the MPA.
The three areas of the Mackenzie Delta that comprise the MPA exist at the interface between fresh and salt water and the movement and mixing of water masses; the associated chemicals and nutrients are critical defining characteristics. Some work has been undertaken to understand large-scale oceanography of the southern Beaufort Sea, but little research has focussed on the coastal oceanography of the shallow nearshore regions within the Mackenzie Estuary Ecologically and Biologically Significant Area (EBSA). Biota utilizing the MPA for at least some phase of their seasonal life cycle may respond positively or negatively to changes in physical oceanography resulting from influences outside the MPA (e.g. changes to the flow regime of the Mackenzie River caused by climate change or human activities within the watershed).

The proposed program will undertake collection of basic physical and chemical oceanographic data that are crucial for understanding the dynamics of water, sediment and chemical constituents at the interface between the Mackenzie River and the Beaufort Sea. Instruments will be deployed to measure the following variables: waves, currents, temperature, salinity, suspended sediment, nutrients, bedload, oxygen and others as determined. The resulting data will be used to help understand critical processes and to validate coastal ocean models. A modeling component of the program will be essential to extrapolate the measurements in both space and time.

Operational Objective: To maintain the natural range of variability of the morphology of the seafloor and sediment composition by conducting a benthic habitat mapping program of the three areas comprising the MPA to establish a baseline and then repeating the program in the future (>10 years).
Project PC 2: Benthic habitat mapping of the MPA.
The shape of the seabed (morphology) including its large-scale shape (bathymetry) and seabed material are critical underpinnings for the marine ecosystem within and around the three areas comprising the MPA. Bathymetric surveys were undertaken in the Delta in the 1970s and 1980s by the Canadian Hydrographic Service. The very shallow nature of the outer Delta means there are parts of the region that are not well covered. Also, the seabed in this area is dynamic, so the older surveys probably do not reflect the present-day detailed bathymetry. The older surveys did not necessarily capture all features of interest for habitat or ecosystem characterization and smaller-scale features such as gas vents, sand waves and seabed roughness, were not captured in navigation surveys. New methods have been developed in recent years to map seabed and lakebed habitat.

Mapping of seabed materials is also required to characterize the nature of the physical habitat. Sampling surveys have been undertaken within and adjacent to the MPA since the 1970s in support of government and industry mapping programs and environmental assessments. These data are useful but generally sparse. Ideally, a smart sampling program is guided by a general understanding of the seabed morphology and sediment dynamics in an area. Seabed morphological maps and associated sidescan images are used to target sampling to specific areas of interest. Seabed photography may also be

used to capture visual images of the seabed and surface-dwelling flora and fauna during the winter when sediment turbulence is at a minimum.

Operational Objective: To understand the relationship between ice processes and specific characteristics of key species (e.g. timing of beluga return and overwintering of fish species).

Project PC 3: Sea-ice dynamics within the MPA.

The extent, thickness and timing of freezeup and breakup are unique characteristics of Arctic marine habitats. Sea ice controls the energy of waves and currents, heat and light and physical access to the Mackenzie Estuary and the MPA. Sea ice was studied in the nearshore and offshore regions were during the 1970s and 1980s by industry and government to try to understand how it may affect oil and gas exploration and development operations. Studies have recommenced with the latest round of exploration. Recent advances in the interpretation of synthetic aperture data imagery from satellites and a range of new polar orbiting optical and radar satellites have assisted in these new studies. We now have a reasonable understanding of the distribution of bottomfast ice (ice that freezes to the seabed) in parts of the MPA and how that affects overflow and breakup. Satellite imagery will be used to monitor the progress of freeze up and breakup; new airborne sensors mounted on helicopters can be used to measure ice thickness very rapidly. The United States Minerals Management Service is about to release the results of a study on the development of landfast ice in the Beaufort Sea that includes a portion of the Mackenzie Bay area including part of the MPA. This study, and the techniques developed, will be extended to the remainder of the MPA (mainly Kugmallit Bay). These new data and techniques will be used to develop a landfast sea-ice climatology for the Mackenzie Estuary detailing the spatial and temporal variability of important events such as freezeup, landfast ice evolution, bottomfast ice development, timing of overflow and breakup.

Operational Objective: To determine rates of change and coastal processes (erosion, permafrost degradation) by monitoring in cooperation with community members.

Project PC-4: Coastal erosion hazards (e.g. to community and industry infrastructure) and contaminant release to the MPA.

The Beaufort Sea coast is dominated by erosion and landward migration of spits and barriers as a result of naturally occurring sea-level rise. Climate-change-induced acceleration of sea-level rise and increasing length of the open-water season combined with warming air temperatures are factors that will act to increase erosion. The land areas adjacent to the MPA are already prone to erosion, with rates at one location exceeding 20 m per year, although typical rates are 2–5 m per year. Low-lying spits and barriers are subjected to periodic washover during high-water events associated with storm surges that, in most cases, results in landward migration of the spit or barrier. Community infrastructure (whaling and fishing camps) and potential industrial infrastructure (e.g. pipeline landing sites, gas plants, drilling facilities, etc.) built in these areas are vulnerable to erosion and flooding hazards.

Naturally occurring chemicals like hydrocarbons, mercury, carbon dioxide and methane are buried and stable within permafrost soils. Erosion of these soils will release the

associated chemical compounds into the receiving waters and the atmosphere. This release is not expected to be a major source of contaminants, but the actual contribution of these materials is not known. Coastal monitoring sites will be identified, based on air photo analysis and community consultations, and local monitors will be trained to monitor the sites using a combination of photos and rudimentary surveying during periods of community occupation of sites. This monitoring will be combined with high-resolution satellite imagery. Representative permafrost types (e.g. tundra, delta, lake basin, etc.) will be sampled for potential contaminants of concern.

Operational Objective: To conserve water quality and sediment quality in the MPA by developing a baseline understanding of contaminants in water and sediment within the MPA, and ensuring that levels resulting from human activities do not exceed naturally occurring levels.

Project PC-5: Understanding natural and human sources of contaminants (e.g. mercury, polyaromatic hydrocarbons [PAH]) in the MPA

Contaminants introduced from long-range sources could accumulate within sediments of the MPA, and make their way into the food web. For example PAHs are known to seep into the Mackenzie River from natural sources. Mercury is introduced to the Mackenzie River as a result of permafrost degradation. Local sources of contaminants from human activities could also contribute to the contamination of sediments within the MPA. Concerns about the levels of contaminants within beluga and fish, effects on the health of fisheries resources, and the use of these marine resources for subsistence food sources require an understanding of contaminants in the MPA. This program will involve seasonal sampling of water, suspended sediment and substrates within the MPA, which would provide data for understanding the seasonal (floods, etc.) contribution of contaminants to the MPA. Sampling design would be stratified to ensure different zones of potential accumulation are adequately covered.

II. MPA Conceptual Objective: To conserve sufficient the fish populations and habitat to maintain natural resilience of the Tarium Niryutait ecosystem.

Operational Objective: To maintain fish communities, species and populations in the MPA and surrounding EBSA within bounds of natural variability.

Project F 1: Inventory and assessment of fish assemblages in the MPA.

Fish communities in the MPA can be influenced by many of the key activities that will affect the MPA, in particular climate change, hydrocarbon exploration and development, pollution, and cumulative effects of developments on the Mackenzie River. There is a general understanding of what fish species occur in the MPAs, but the data are limited and sampling has been done mostly in the summer. The importance of the MPA ecosystem to the ecology of the fish species that have been caught in the area is not well understood, and the relationship between the fish species using the MPA and beluga biology is not known. Fishers have often observed beluga chasing schools of fish in the area, and it has been assumed some feeding occurs. A better understanding of fish communities and habitat within the MPA and their temporal and geographic variability is an important component in conserving the MPA ecosystem.

The first step in this program would be an inventory to provide a list of fish assemblages associated with the MPA ecosystem. This step would begin with a desk analysis of existing information to be followed by a year-round target field program to address knowledge gaps. The field project would be community based and would use local fishers and fish monitors to collect data. The second step in the program would be the establishment of an ongoing community-based monitoring program using local fishers to collect fish samples and environmental data. Every five years there will be a more intensive assessment involving community fishers and DFO scientists.

Project F 2: *Ecosystem indicator fish species/fish community properties identification project.*
Fish communities in the MPA can be influenced by many of the key activities that will affect the MPA, in particular climate change, hydrocarbon exploration and development, pollution and cumulative effects of developments on the Mackenzie River. The growth, condition, and population structure of indictor species can be used to detect changes in the ecosystem. The use of indicator species or fish community properties can provide a focus for monitoring program activities and provide a way to integrate ecosystem research activities within ecosystems.

This project will involve two steps (1) the identification of candidate indicator species and an experimental or pilot stage to test the feasibility of using the candidate species to assess the MPA ecosystem. This first step would involve the development of a small working group of fishers and a DFO scientist. Using a combination of traditional knowledge (TK) and scientific knowledge, the working group would identify possible candidate species and develop ecological profiles for each one. (2) a pilot project to test the feasibility of using an indicator species in the MPA. The project(s) would include community fishers and a DFO scientist. After this pilot project the selected indicator species would be integrated into monitoring program F1.

Project F 3: Fish health monitoring program.
The health of fish species can be influenced by many of the activities that will affect the MPA, in particular hydrocarbon exploration and development, pollution, and cumulative effects of developments on the Mackenzie River. Understanding the current health of fish species within the MPA ecosystem can provide an ecosystem-based method of monitoring the health and possible impacts of activities on the MPA ecosystem. Basic indicators, such as the presence and frequency of occurrence of fish diseases and parasites, occurrences of marks and tumours, and qualitative indices of fish condition like condition of flesh or body shape, are sensitive to both, physical and biological changes in the ecosystem.

The first step in this program would be a desk exercise involving scientific experts and community fishers to assess possible indicators and to review other studies that have used condition indices. Based on this analysis, a pilot project would be introduced involving both scientific field collections and community monitors. Indicators of fish biota health and condition would be selected after a three year trial period and integrated into on-going fisheries monitoring program F1 and indicator species program F2.

Operational Objective: To maintain the trophic structure in the MPA so that fish communities can play their historical role in the food web.

Project F 4: Trophic structure and diversity in the MPA.

The trophic structure of the MPA can be influenced by many of the activities that will affect the MPA, in particular climate change, hydrocarbon exploration and development, pollution and cumulative effects of developments on the Mackenzie River. There is a need to understand and monitor the trophic structure with the MPA marine ecosystem to protect the ecosystem of the MPA. Identification of ecologically dependent species within the MPA ecosystem and the development of monitoring programs to assess trophic-level balance requires the identification of key species (or fish community properties) and some measure of their normal range of abundance.

This program will involve three stages program that build on the present Tariuq program. The first step would be an assessment of our current knowledge of the trophic structure of the MPA ecosystem and evaluation of possible methods of assessing the health and stability of the trophic structure. This step would include an evaluation of the Tariuq program. The second step would be a three-year field study to address knowledge gaps and to collect information required to test various approaches (models). The final step in the program would be to redesign and revitalize an expanded community-based Tariuq program.

III. Conceptual Objective: To conserve a healthy population of belugas and the integrity of the ecosystem in Tarium Niryutait MPA

Operational Objective: To maintain the spatial and temporal variability, both within and between seasons, of the use of the Mackenzie estuary by beluga.

Project MM 1: An assessment of the spatial and temporal use of the Tarium Niryutait MPA by beluga.

Beluga movement patterns and habitat use can be influenced by many of the key activities that will affect the MPA, including hydrocarbon exploration and development, air and marine transport, tourism, climate change and pollution. Existing research on the use of the estuary by marine mammals (particularly belugas) includes aerial surveys, satellite tagging and TK. Beluga whales distribute themselves among the three main bays and tend to congregate in specific "hotspots" in the area but the reasons for those congregations are not understood. Establishing patterns of congregations and use of an area and correlating that information with habitat data and geomorphology to determine features and characteristics of the physical environment in these "hot spots" will allow the development of guidelines and regulations to protect the whales from disturbance. Better understanding of natural variability will lead to the development of MEQ indicators based on migration patterns.

This study will establish patterns of distribution between years, including micro-movements and length of time the whales are using an area. This analysis will be correlated to habitat data and geomorphology to determine features and characteristics of the physical environment in these "hotspots". The first step in this program will be to establish the current state of understanding of beluga distributions within particular areas and the relationship to other elements within an ecosystem, including food distribution,

salinity, temperature and sediment. Further studies would involve fieldwork by scientists and community members to investigate one or two hotspots in a program integrated with aspects of the physical and chemical oceanography studies. Further studies would focus on development and use of a less invasive tracking device than current satellite tags, which would allow researchers to focus on the short period of time belugas are in the estuary. Further tagging studies would be required to understand the patterns of migrations within leads in the ice in the Beaufort Sea in spring (before whales go to the estuary).

Operational Objective: To maintain the health and well-being of the beluga population by sampling, measuring and enumerating beluga whales taken in the harvest in the Mackenzie estuary.

Project MM 2: Health and well-being of the beluga population and of individuals.

Climate change, hydrocarbon developments, and airborne pollutants are potential threats to the health of individual beluga and the beluga population. The FJMC beluga monitoring program has been in place for over 25 years and serves a multitude of goals, including monitoring of the harvest, and is built upon the principle that harvesters themselves are involved in the science and management of the beluga population. The program formalizes management and science at a local level.

The proposed program will build on the ongoing program to address MPA objectives and principles by providing data for the development of MEQ indicators that will allow the MPA management agency to better manage the MPA and influence external activities beyond MPA boundaries. This multi-part program will include (1) hunter collection of various information and samples from harvested belugas, including size, gender, thickness of blubber (an indicator of general health) and reproductive status for use in genetic stock identification and screening for diseases; (2) ongoing monitoring of mercury and organochlorines as well as other key contaminants; (3) monitoring and analyses of fatty acid and isotopes to better understand beluga feeding habits; and (4) an aerial stock assessment.

Operational Objective: To maintain the beluga population of the MPA within its normal range of distribution by determining the zone of influence of single and cumulative sources of underwater noise disturbances in the MPA.

Project MM 3: Effects of noise disturbances on beluga whales.

There are important vessel traffic corridors that will run through and adjacent to the MPAs, and commercial vessel traffic is important and growing in the Mackenzie Delta and the Beaufort Sea. There are also numerous other noise sources that impact marine mammal movements and behaviour.

Experimental research has provided good understanding of the audible ranges of cetaceans. Given the existing activities that are occurring in and around the MPA, there is a good understanding of the sound sources that might influence beluga behaviour. This program will address MPA objectives and principles by providing data to manage the MPA and external activities. The program will link changes to activities that may be occurring in and around the MPA, specifically large-vessel traffic.

Sound levels from a variety of contemporary sound sources in the MPA would be measured under a range of water depths and substrate types. Models would be prepared

to estimate the zone of detectability of noises by beluga whales in the estuary. This project would include groundtruthing to verify impacts of noise on whales in this environment. The project would also include an assessment of extant knowledge, measurement of ambient noise in the MPA environment, establishment of a data-logging system, and ongoing community based monitoring on noise levels in the MPA.

IV. Conceptual Objective: To conserve the waterfowl, seabird and shorebird components of the MPA and surrounding area to maintain the trophic structure and the relationship between these birds and aquatic components of the MPA ecosystem.

Operational Objective: To maintain the historic relationship between waterfowl, seabirds and shorebirds and the aquatic ecosystem.

Project B 1: Food-web interactions between seabirds and shorebirds and aquatic biota including fish and benthos.

A diverse assemblage of avifauna uses portions or the periphery of the MPA. Local knowledge indicates that waterfowl and shorebirds may have significant impacts on aquatic biota of the MPA. There has been a significant amount of TK and scientific knowledge acquired about birds in the Kendall Island Bird Sanctuary and in the EBSA surrounding the MPA, but the relationship between fish and benthic-feeding birds and their impacts on fish populations is unknown in this area. Changes in bird populations outside of natural variability may have significant implications for other components of the MPA ecosystem. For example, of the over 100 species of birds that use the Sanctuary at least three (Eskimo Curlew, the Ivory Gull and Ross's Gull), as identified under the Species at Risk Act (SARA) depend in whole or in part on aquatic resources for sustenance.

An initial desk analysis will determine: (1) percentage of fish/benthos eating birds that use the MPA,; (2) total numbers; (3) total consumption of fish and benthos; (4) species consumed; (5) energy transfer between ecosystem components; (6) contaminant transfers between trophic levels; (7) time of arrival of sea-ice birds; and (8) other related scientific and TK related to fish/bird interrelationships. The desk analysis would also provide an assessment of the potential of waterfowl and/or shore birds to be indicators of the health of the aquatic ecosystem.

Results of the desk study could lead to future projects such as: (1) effects of changing climates on bird populations; (2) determination of contaminant loads; (3) use of the MPA shoreline by waterfowl and shorebirds; (4) bird behaviour associated with various disturbance levels; (5) understanding predator/prey relationships (e.g. seabirds/waterfowl/fish); and (6) determination of habitat use by birds of the MPA.

Budget Summary

Operating, equipment and vessel costs for science proposals that address management objectives of the Tarium Niryutait MPA are detailed in the individual proposals in Appendix 4 and summarized in Table 1. Current operating dollars being expended by the FJMC and DFO in or adjacent to the MPA on a continuing basis total $150,000 for beluga harvest monitoring and for the Tariuq monitoring program. It is assumed that

these programs will continue in a modified form. Long-term ongoing costs to support the range of science needed to effectively manage the MPA and meet the conceptual ecosystem objectives are an additional $234,000 annually. Of this total, $218,000 would be required for annual monitoring and other studies. An additional $80,000 is required to address longer-term (every five years) monitoring. However, there are significant upfront costs to establish meaningful indicators in the five years before the ongoing program can be implemented. The five-year total for O&M, equipment and vessel costs is $4,538,000.

Table 1. Budget requirements (as of October 2006) for science proposals to address the management objectives of the Tarium Niryutait Marine Protected Area.

		Current O&M	New O&M/ Annual	New O&M/ every 5 yrs	New O&M/ one time 5 yr total	Equipment Total	Annual vessel days	Annual vessel costs	Total new 5-year costs	New annual ongoing after 5 y
PC-1	Measure and model oceanography and sediment		$0	$0	$585,000	$120,000	4	$68,000	$773,000	$0
PC-2	Benthic habitat mapping		$0	$0	$775,000		10	$170,000	$945,000	$0
PC-3	Sea-ice dynamics		$0	$0	$225,000				$225,000	$0
PC-4	Coastal erosion hazards		$15,000	$0	$130,000	$30,000			$235,000	$15,000
PC-5	Contaminants		$35,000	$0	$300,000				$475,000	$35,000
F-1	Inventory and assessment of fish		$5,000	$30,000	$200,000	$10,000			$265,000	$11,000
F-2	Ecosystem indicator development		$8,000	$20,000	$120,000				$180,000	$12,000
F-3	Fish health monitoring		$15,000	$10,000	$100,000				$185,000	$17,000
F-4	Trophic structure and diversity	$100,000	$20,000	$20,000	$190,000	$10,000			$320,000	$24,000
MM-1	Assessment of beluga use of MPA		$0	$0	$115,000	$50,000		$100,000	$265,000	$0
MM-2	Beluga health	$50,000	$105,000	$0	$0	$0		$0	$525,000	$105,000
MM-3	Effects of noise		$15,000	$0	$65,000				$140,000	$15,000
B-1	Foodweb interactions between birds and fish				$25,000				$25,000	$0
	TOTAL	**$150,000**	**$218,000**	**$80,000**	**$2,830,000**	**$220,000**	**$14**	**$338,000**	**$4,558,000**	**$234,000**

CONCLUSIONS

The four conceptual ecosystem objectives, supporting operational objectives and specific science proposals developed at this workshop, are the most recent steps in a series of actions that will lead to a comprehensive science program to support the overall management plan of the proposed Tarium Niryutait MPA. Consistent with the co-management focus of the management plan and the emphasis on community support and involvement, most of the projects will involve community input at various levels from incorporation of traditional and local knowledge in program design, to field assistance, to responsibility for long term-monitoring.

We have emphasized the limits to understanding of the aquatic ecosystem of the MPA, but previous studies have provided a baseline for these proposals. Few of the proposals identify a need for inventories or surveys, which indicates that at least we know what is there. However, our knowledge of temporal, biological and spatial variability of populations and habitats is insufficient.

Ten of the 13 proposed projects will result in the establishment of monitoring programs (half of them community led), but these monitoring programs will need to be preceded by desk analyses and experimental management or research before we can establish the specific ecosystem indicators required to meet the operational and conceptual ecosystem objectives.

It should be emphasized that the proposals presented here are integrated and all need to proceed if the ecosystem objectives are to be achieved. For example, the proposal to assess spatial and temporal use of the MPA by beluga (MM1) will rely on three of the physical/chemical proposals: (1) measuring and modeling physical oceanography and sediment dynamics will contribute background environmental information, particularly water temperatures, salinity and sediment load in relation to movements of beluga (PC 1); (2) benthic habitat mapping will provide the bottom habitat information (PC 2); and (3) understanding the linkage between sea ice and arrival of marine mammals requires the ice and water information for baseline environmental conditions (PC 3).

We recognize that the total five-year cost of the proposed work is significant, and funding at the full level is not immediately available. However, a number of the projects have proposed work meetings/workshops that could be completed quickly with relatively minor costs. These initial studies are necessary to set the stage for the more intensive field work that would follow. In most cases, we envision work meetings of five to eight specialists who would develop specific potential indicators and identify natural variability of those indicators. Such specialized meetings are called for in the marine mammal, fish and aquatic environment components. Assembling background information or desk analysis is also called for in a number of projects. Assessments from those analyses would also help to set the stage for future work.

This workshop was directed primarily in support of the management of the proposed MPA but this MPA would be part of the Beaufort Sea Large Ocean Management Area (LOMA) (Muir 2006) and any research and monitoring would contribute to the

management of the LOMA, which will take place through the Beaufort Sea Regional Coordination Committee[1]. This MPA initiative could be seen as a case study for establishing ecosystem objectives for LOMAs.

[1] The Beaufort Sea Regional Coordination Committee is a high-level inter-governmental committee currently being established by DFO.

ACKNOWLEDGEMENTS
We thank the people listed in Appendix 2 for participation in the workshop. In particular, we thank the presenters listed in the text, and Andrea Hoyt, Don Cobb and Michael Papst who coordinated the preparation of the project proposals in the breakout groups. We also thank David Rosenberg for technical editing of this report. The FJMC and the DFO shared in the provision of financial support for the workshop.

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APPENDIX 1: LIST OF ACRONYMS

BSBMP	Beaufort Sea Beluga Management Plan
BSIMPI	Beaufort Sea Integrated Management Planning Initiative
CCGS	Canadian Coast Guard Service
DFO	Department of Fisheries and Oceans, Canada
DIAND	Department of Indian Affairs and Northern Development
EBSA	Ecologically and Biologically Sensitive Area
EISC	Environmental Impact Screening Committee
FJMC	Canada/Inuvialuit Fisheries Joint Management Committee
HTC	Hunters and Trappers Committee
IGC	Inuvialuit Game Council
ISR	Inuvialuit Settlement Region
LOMA	Large Ocean Management Area
MEQ	Marine Environmental Quality
MPA	Marine Protected Area
NGO	Nongovernmental Organization
PAH	Poly Aromatic Hydrocarbon
SARA	Species at Risk Act
TK	Traditional Knowledge

APPENDIX 2: WORKSHOP PARTICIPANTS

Tarium Niryutait MPA Science Needs Workshop
Leduc, Alberta
May 24–25, 2006
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APPENDIX 3: WORKSHOP AGENDA AND STRUCTURE

MPA Science Needs Workshop
Edmonton, Alberta
May 24-25, 2006
Workshop Agenda

Conveners/coordinators: Burton Ayles and Michael Papst

Participants (total 19)**:**

- FJMC and ISR – Bob Bell, Max Kotokak, Lawrence Amos, Burton Ayles, Andrea Hoyt, Richard Binder, Ronnie Gruben.
- DFO Central & Arctic Region – Mike Papst, Don Pittman, Lois Harwood, Don Cobb, Erin Hiebert, Sam Stephenson, Beth Thomson, Adrian Paylor, Beth Pechter, Cal Wenghofer, Bill Williams (unable to attend).
- Others – Ed McLean, Marlow Pellatt (Parks Canada), Steve Solomon (NRCan).

Workshop Schedule:

Wednesday May 24, 2006

- **Day 1 AM Background Presentations**
  - 9:00 Introduction to workshop – B. Ayles and M. Papst
  - 9:15 Science to support MPAs, and Integrated Oceans Management for Sustainable Development – Mike Papst
  - 9:35 The natural environment of the MPA - Beth Thomson
  - 9:55 Recent Workshop Results
    - Habitat mapping in the Beaufort - D. Cobb
    - MEQ priorities for the Beaufort - B. Ayles
    - Parks Canada Arctic Coastal/Marine Ecosystems – Marlow Pellatt
  - 10:30 Coffee Break
  - 10:45 Current DFO/FJMC Monitoring Programs in or near the MPA.
    - Tariuq Monitoring Program – Don Pittman
    - Beluga monitoring program – Andrea Hoyt
  - 11:15 Discussion of Principles for Community Involvement and for Science
  - 12:00 Lunch
- **Day 1 PM Program Development**
  - 13:00 Discussion and Agreement on Areas for Program Development
  - 13:45 Breakout into Smaller Groups to Further Develop Specific Program Components.
  - 16:30 End for day
- **Day 2 AM Program Development**
  - 9:00 Group Update on Progress on Program Development
  - 9:45 Return to Smaller Groups to Continue Program Development
  - 12:00 Lunch
- **Day 2 PM Finalization of Framework, Schedule and Costs for Science Needs for MPA**
  - 13:00 Group Update on Final Program Development
  - 14:00 Discussion of Program Priorities, Framework, Schedule and Costs

16:00 Wrap-up and Next Steps

WORKSHOP STRUCTURE – MPA OBJECTIVES THAT RELATE TO THIS WORKSHOP

After the background presentations, the workshop returned to a specific review of the objectives, principles of the management plans and the key activities that would affect the MPA. The Tarium Niryutait MPA Conservation Objectives are:

- to support the goals of the Beaufort Sea Beluga Management Plan and the Inuvialuit Final Agreement:
- to maintain a thriving population of beluga whales and beluga habitat in the Beaufort Sea; and
- to provide for optimum sustainable harvest of beluga whales by the Inuvialuit within the MPA.

To achieve these overall conservation objectives the Plan identified 10 Management Objectives. The five management objectives specifically related to scientific support include:

- Objective 2. Developing an annual or multi-year plan with key elements including: monitoring program priorities; a research plan and protocol;
- Objective 4. Advising, approving and evaluating the monitoring of ecosystem-based management and MEQ within the MPA;
- Objective 5. Developing and communicating any research protocols and guidelines for research topics and methodologies; and
- Objectives 6, and 7. Communicating and providing clarity for accidents and spills, air and marine transport, ice roads and other activities.

The management plan outlines principles developed for the management of the MPA:

- ensure the Inuvialuit and communities are fully engaged and that their support is obtained in all phases of implementation of the Management Plan;
- ensure regulations and guidelines are enforced in a fair and equitable manner;
- use traditional knowledge, local knowledge and scientific knowledge to manage the MPA;
- apply the principles of ecosystem-based adaptive management for decision making in the MPA; and
- ensure ongoing communication with Inuvialuit, communities, government, industry, nongovernmental organizations (NGOs) and the public.

The Key Activities that will affect the MPA include:

- hydrocarbon exploration and development;
- air and marine transportation and ice roads;
- tourism activities;
- reporting of accidents and spill response;
- ecosystem-based management and monitoring;
- education , public awareness and outreach;

WORKSHOP STRUCTURE – MEQ OBJECTIVES

The MEQ workshop established general objectives for beluga and marine mammals, fish and fish habitat, the physical and chemical environment, and birds and other animals. The workshop objectives were used to structure the present workshop breakout groups and initiate discussions. Participants were asked to consider the already identified MEQ objectives, add further objectives if necessary and then select priority objectives for more detailed development into conceptual objectives and development of usable indicators.

The following initial MEQ objectives were considered by the breakout groups:

Beluga and marine mammals

- maintain beluga health (population and individual);
- ensure levels of disturbance are low;
- maintain socializing, calving, feeding, etc. unchanged;
- maintain important spawning events;
- maintain moulting habitat;
- maintain whale feeding habitat;
- maintain mercury levels below sage level;
- maintain organo-halogens below a safe level;
- understand changes in relation to pack ice;
- understand distributions in relation to climate change;
- maintain incidence of colon cancer below a safe level; and
- maintain incidence of diseases below safe level.

Fish and fish habitat

- ensure population and community structure (species, age, size, condition, etc.); remains within natural range for important subsistence harvesting species (cisco, char, broad whitefish, coney and others) and species valuable to beluga (cisco herring);
- ensure historical timing and route of spawning – feeding migrations;
- ensure adequate supply of fish-food organisms within natural range of variability; and
- ensure fish usability with contaminants at or below current levels and ensure palatability.

Physical and chemical parameters

- maintain salinity within natural range;
- minimize adverse sea-floor alterations;
- prevent changes to rates of coastal erosion beyond historic rates;
- contaminants in sediments in water not to exceed safe level;
- maintain airborne noise below levels safe to beluga;
- maintain pH levels in sediment at or below target levels; and

- minimize impacts to ice thickness, ice breakup and freeze up due to human activities.

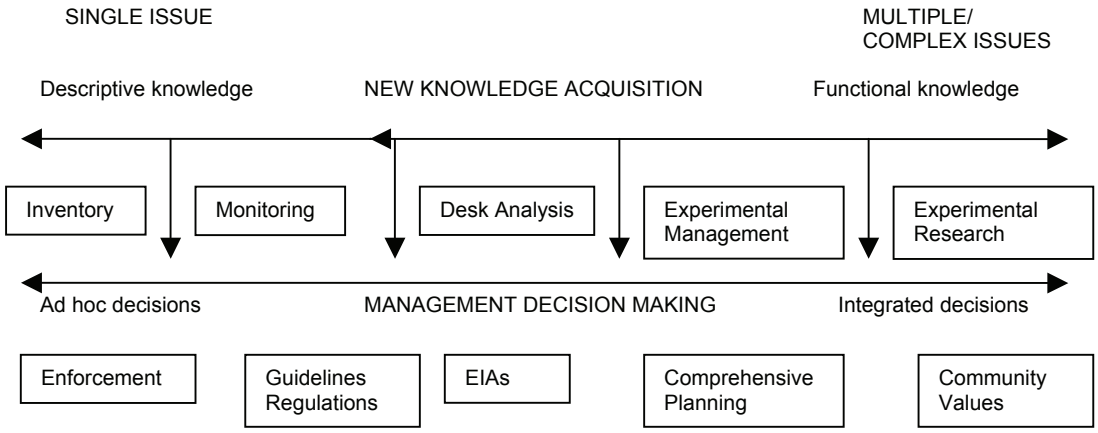
Birds and other animals

- maintain healthy and stable populations of waterfowl and shorebirds and their habitat;
- maintain status of MPA by understanding effects of climate change on bird and animal survival and productivity;
- maintain migration patterns and habitat use within long-term patterns
- maintain contaminant levels at acceptable concentrations;
- maintain water quality and waterfowl habitat at present levels;
- establish threshold of acceptable footprint size;
- ensure access by tourism is restricted during important times e.g. nesting, harvesting; and
- develop a management decision-making continuum

WORKSHOP STURCTURE – SCIENCE – MANAGEMENT LINKAGE

The link between science and management actions needed to be explicitly addressed in the science proposals, so the discussions were structured to ensure that all the elements of a comprehensive, integrated aquatic science plan for the MPA were considered (i.e. not just monitoring and not just experimental research). A model (Fig. 1), developed by the Westwater Institute, University of British Columbia, was used to describe acquisition of knowledge and understanding (research) to support management decision making for the MPA (Dorcey and Hall 1981). This model was developed for the Fraser River estuary but can be applied to environmental research in general as a conceptual view of how different kinds of research contribute to management. Issues related to aquatic environments range from simple/single issues to multiple/complex issues. Management decision making is a continuum from *ad hoc* decisions to integrated decisions, from enforcement to comprehensive planning to changes in community values. Similarly, the acquisition of new knowledge can be seen as a continuum, from simple data collection to comprehensive understanding. New knowledge and information contribute to management decision making along those continua. A full spectrum of management decision-making and new knowledge acquisition, are required in a complex estuarine environment system such as the Mackenzie Delta/nearshore Beaufort Sea.

Figure 1. A model for the acquisition of aquatic science and technology to support management decision making in the proposed Tarium Niryutait Marine Protected Area. (adapted from Dorcey and Hall 1981)



We identified and described research needs (acquisition of knowledge and understanding) under five categories viz., Inventory, Monitoring, Desk Analysis, Experimental Management[2] and Experimental Research. It should be emphasized that both scientific knowledge and TK are valid and both can be captured in the model.

The following activities are related to the five knowledge categories;

- Inventory: a one time gillnet and/or trapping survey of marine fish in the MPA; a count of the number of birds of different species nesting in the bird sanctuary; an aerial survey of the beluga use of the MPA over a summer; determination of mercury levels in fish in a particular area;
- Monitoring: ongoing records of numbers of beluga harvested in the MPA and body measurements (e.g. sex, size, fat levels, reproductive condition etc.) of individual animals; the Inuvialuit Harvest Study; daily, weekly and monthly records of water levels in the Mackenzie over many years or decades; decadal observations of changes in shorelines along the Beaufort Coast;
- Desk Analysis: the environmental, traditional knowledge and economic analyses prepared for the MPA; the preparation of Community Conservation plans;
- Experimental Management: studies of the impact on beluga movements of vessel traffic through the MPA; determination of the effects of dredging on bottom fauna in the MPA; responses of seals to drilling activity.

[2] Dorcey and Hall (1981) use the term "Experimental Management" to describe knowledge gathering that that involves designing an experiment that enables an hypothesis to be tested by the implementation of a management decision.

- Experimental Research: Development of techniques to monitor whale behaviour using satellite tags. Development of methods to distinguish between genetic stocks of whitefish that migrate through the MPA.

The following activities are related to the management categories presented in the model:

- Enforcement: fish wastage charges; charges to tourists for harassing whales;
- Guidelines/regulations: HTC beluga bylaws; Beluga Management Plan; MPA Regulations;.
- EIAs: Mackenzie Gas Pipeline review; Environmental Impact Screening Committee (EISC) review of development projects and recommendations;
- Comprehensive Planning: Community Conservation Plans; Land Use Planning; and
- Community Values: signing of comprehensive land settlements, southerners' acceptance of Inuvialuit rights to hunt whales.

WORKSHOP STUCTURE - DESCRIPTION OF PROPOSALS

A template was developed to focus the breakout group discussions, to ensure that all the necessary elements were addressed and to facilitate comparisons between proposals. Participants followed the template in developing proposals. The proposals are detailed in Appendix 4. Elements of the template included:

- project number and title;
- ecosystem component;
- knowledge continuum;
- context including relation to MPA objectives;
- program outline;
- equipment and infrastructure support requirements;
- participation in the program including community participation;
- linkage to other programs;
- linkage to LOMA;
- cost estimate; and
- contacts.

APPENDIX 4: DETAILS OF PROPOSALS

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

PC 1	Measuring and Modelling Physical Oceanography and sediment dynamics within the MPA

MPA Conceptual Objective (marine mammal communities, fish and fish habitat. physical and chemical environment, waterfowl, shorebirds and other animals)

To conserve the physical and chemical properties of the Marine Protected Area

Operational Objective (Objective for this project to support MPA conceptual objective)

To maintain the natural range of variability of physical oceanography (temperature, salinity, suspended sediments, currents, water chemistry, etc.) within the MPA by developing a baseline range of and monitoring for changes outside of that range.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Monitoring, Experimental Research, Desk Analysis

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

The three areas of the Mackenzie Delta that make up the MPA areas exist at the interface between fresh and salt water and the movement and mixing of water masses and the associated chemicals and nutrients are critical defining characteristics. Some work has been undertaken to understand large scale oceanography of the southern Beaufort Sea, but little research has focussed on the coastal oceanography of the shallow nearshore regions within the Mackenzie Estuary EBSA Biota utilizing the MPA for at least some phase of their seasonal life cycle, may respond positively or negatively to changes in the physical oceanography resulting from influences outside the MPA (e.g. changes to the flow regime of the Mackenzie River caused by climate change or human activities within the watershed).

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.)

The proposed program will undertake data collection of basic physical and chemical oceanographic parameters that are crucial for understanding the dynamics of water, sediment and chemical constituents at the interface between the Mackenzie River and the Beaufort Sea. These data will be used to help understand critical processes and as validation into coastal ocean models. The modeling component of the program is essential in order to extrapolate the measurements in both space and time. A series of

instrument deployments will be undertaken and include the following parameters: Waves, Currents, Temperature, Salinity, Suspended sediment, Nutrients, Bedload, Oxygen, and others as determined.

Instruments will be deployed in arrays across the inner shelf to look are gradients in physical forcing. Remotely sensed data (including wind scatterometer, ocean colour, Landsat, etc) will be used to help define the context for the nearshore measurements and derive boundary conditions. The project will depend on the presence of offshore wave and water level data from other projects (e.g. IOS program by Humfrey Melling). Offshore waves may also be available from models being developed under PERD (Swail). River parameters are dependent upon data from Environment Canada.

Modeling will need to address coupling between river and ocean. Existing public domain models such as the Princeton Ocean Model will be employed.

Potential Indicators

There are a number of potential indicators of aquatic health that might be considered. They include the following: Suspended sediment concentrations, Salinity, Temperature, Wind/water level, Oxygen. The normal range in the areas would need to be established before specific levels for management action could be identified

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Equipment and infrastructure support: Water and current meters, Optical backscatter sensors or acoustic Doppler current meters, Water level/oxygen, temperature sensors, Ship support (instrument deployment and recovery), Mooring design and development.

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

Participation in program: NRCan (Geological Survey of Canada, Canada Centre for Remote Sensing, DFO, Environment Canada.

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

MM1. This project would contribute background environmental information to the MM1 beluga project, specifically: water temperature, salinity and sediment load in relation to movements of beluga into and out of the MPA.

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single	

			round and interval)	
Current O&M Support (identify source)				
New O&M funding required		$585,000		$250,000 Data analysis Equipment rental and insurance
New equipment funding required		$120,000		
Vessel days and costs (identify type of vessel)		4 days $210,000		

Contact (names of individuals who prepared this proposal or should be involved)

To be determined.

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

PC 2	Benthic habitat mapping of MPA.

MPA Conceptual Objective (Marine mammal communities, fish and fish habitat. physical and chemical environment, Waterfowl, shorebirds and other animals)

To conserve the physical and chemical properties of the Marine Protected Area

Operational Objective (Objective for this project to support MPA conceptual objective)

To maintain the morphology of the seafloor and sediment composition within the range of natural variability by conducting a benthic habitat mapping program of the three MPA areas to establish a baseline and then repeating it in the future (>10years).

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Monitoring, Experimental Research, Desk Analysis

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

The shape of the seabed (morphology) including its large scale shape (bathymetry) and seabed material are critical underpinnings for the marine ecosystem within and around the MPAs. Bathymetric surveys were undertaken in all of the MPAs in the 1970s and 1980s by the hydrographic survey. Due to the very shallow nature of the outer delta, there are parts of the region that are not well covered and because the seabed in this area is dynamic, the older surveys probably do not reflect the present day detailed bathymetry. We know for example, that the navigation channel through Kugmallit Bay has been dredged once and it is likely that natural deposition from the river could cause problem in the future, especially in the s-bends area. In addition, the older surveys were based on line spacings of 100 m to 500 m and therefore do not necessary capture all features of interest for habitat or ecosystem characterization. Smaller scale features such as gas vents, sand waves and seabed roughness will not be captured in the navigation surveys. New methods have been developed in recent years to map seabed and lakebed habitat using “swath” techniques that essentially paint the seabed with low energy echosounders to permit development of full coverage maps of the seabed morphology. The “multibeam” techniques that are used in the offshore waters to map ice scours and artificial islands are only efficient in water depths of more than 5 m. However, other methods (sweep or inerferometric sidescan can be utilised in shallower depths.

Mapping of the seabed materials is the other aspect of seabed mapping that is required to characterize the nature of the physical habitat. Sampling surveys have been undertaken within and adjacent to the MPAs since the 1970s in support of government and industry mapping programs and environmental assessments. These data are useful, but generally

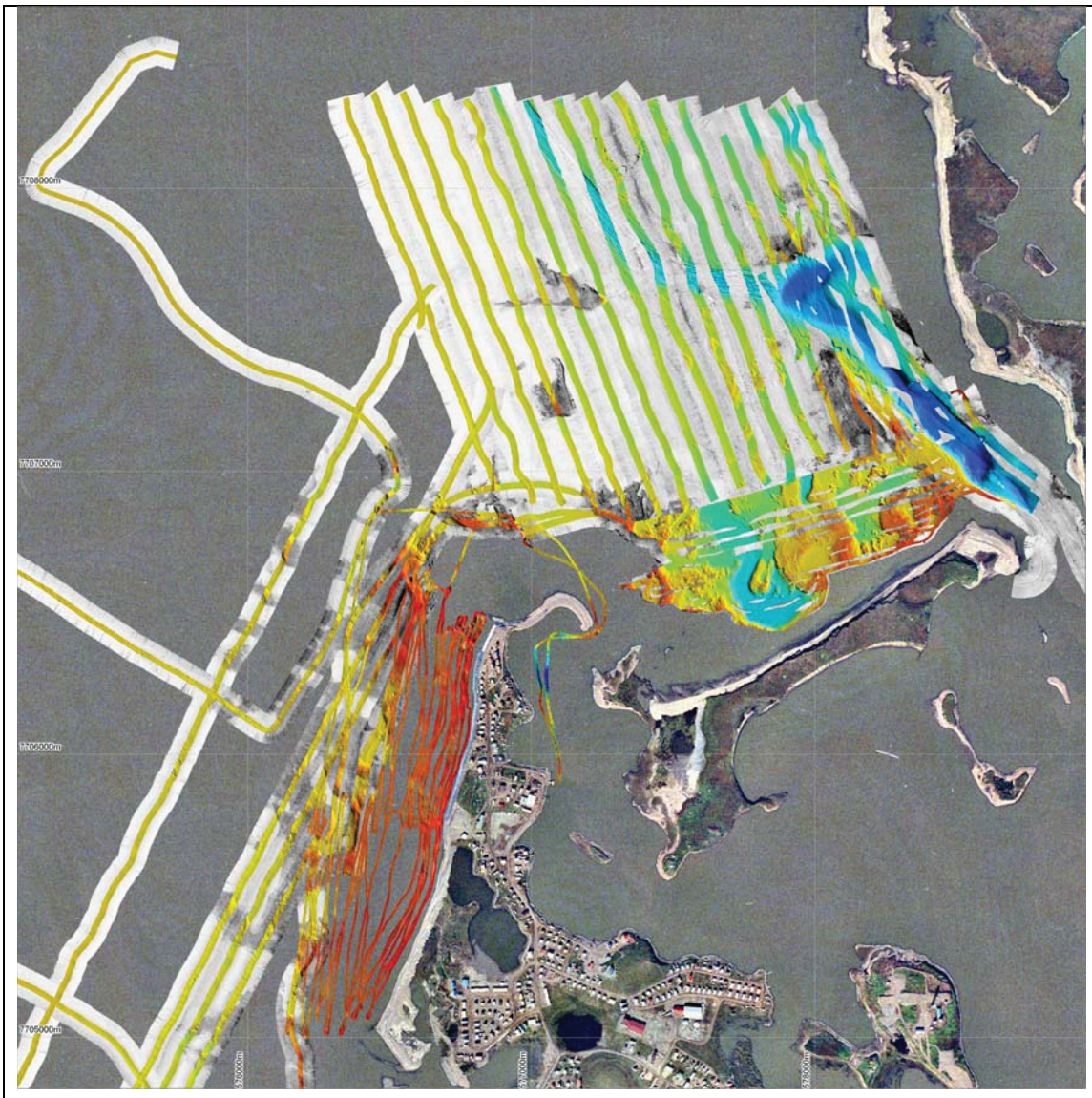
sparse. Ideally, a smart sampling program should be guided by a general understanding of seabed morphology and sediment dynamics in an area. Seabed morphological maps and associated sidescan images should be used to target sampling to specific areas of interest. Seabed mapping in most parts of the world is complemented by seabed photography. The waters in the MPAs are extremely turbid, however, it may be possible to capture visual images of the seabed and surface-dwelling fauna during the winter when turbulence is at a minimum.

Physical mapping of the habitat is one pillar of seabed mapping, the other is identifying and mapping the flora and fauna that characterize the seabed surface and shallow subsurface. A combination of targeted sampling and seabed photography is employed to accomplish this task.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.)

This program would proceed in five steps as follows:

1. Compile all available bathymetry, sediment and biological sampling data for the MPAs and immediately adjacent areas.
2. Plan morphology surveys – it is highly unlikely that we will be able to acquire complete bathymetric coverage of the entire area of each MPA using existing technologies, therefore an optimal survey strategy for each MPA must be developed so that areas of greatest concern or interest are mapped as thoroughly as possible. A combination of partial bathymetric coverage plus full sidescan coverage is the most efficient approach (see Tuk example).
3. Undertake surveys – rough estimate of 10-20 survey days per MPA for full coverage sidescan plus partial bathymetry
4. Analyse data
5. Produce maps



Potential Indicators

There are a number of potential indicators that might be considered. Grain size distribution from grab samples at representative sites and changes in abundance and diversity of benthic community at representative sites are examples that need to be developed further.

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Could use government assets or contract Inuvialuit business (IEG-Aquatics joint venture) to acquire morphology and sidescan data (Tuk data acquired by IEG-Aquatics). The Kendall and Kugmallit Bay areas can be done using small vessels supported by camps on

shore. The Shallow Bay area may require offshore vessel e.g. Nahidik, support for safety of crews and equipment. Sampling can be done in summer or winter. Sea bed photography can only be attempted in winter from the sea ice.

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

NRCan would lead this project. DFO, and FJMC and private contractors would also participate.

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

PC1. This project would directly support the project which would then link to the ecosystem modeling project B1. Trophic interactions between benthic habitat and sea birds MM1. Relationships between beluga use of different substrates within the MPA This project would provide the bottom habitat information, which the B1 and MM1 projects would depend upon.

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single round and interval)	
Current O&M Support (identify source)				
New O&M funding required		$775,000		$375,000 Contracts for data acquisition and/or purchase
New equipment funding required				
Vessel days and costs (identify type of vessel)		10 days $170,000 Nahidik		

Contact (names of individuals who prepared this proposal or should be involved)

To be determined.

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

PC 3	Sea-ice dynamics within the MPAs.

MPA Conceptual Objective (Marine mammal communities, fish and fish habitat. physical and chemical environment, Waterfowl, shorebirds and other animals)

To conserve the physical and chemical properties of the Marine Protected Area

Operational Objective (Objective for this project to support MPA conceptual objective)

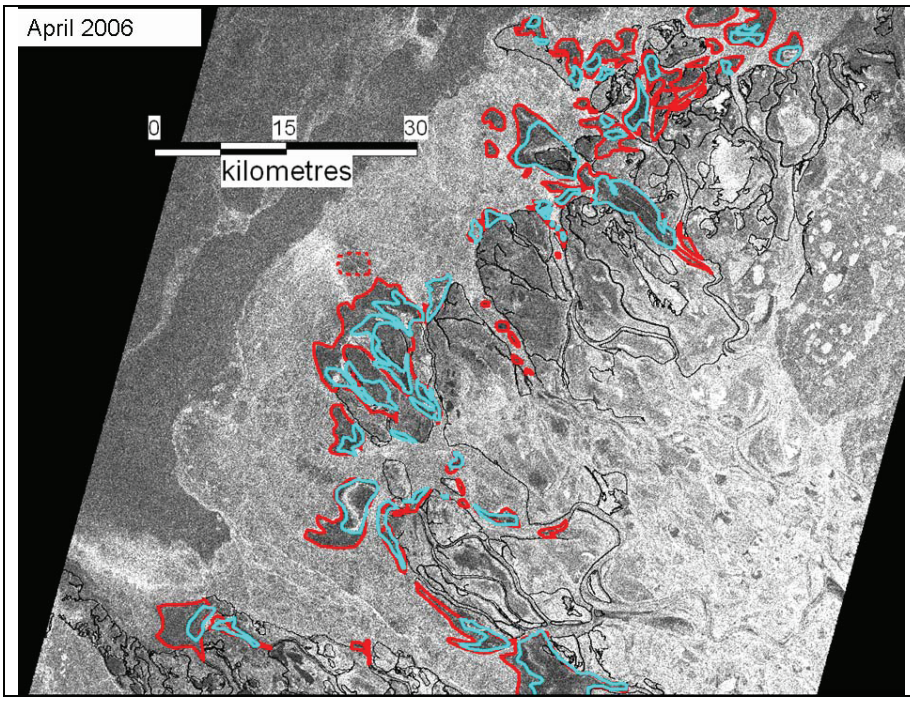
To understand the relationship between ice processes and specific characteristics of key species (e.g. timing of beluga return, and overwintering of fish species).

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Monitoring, Desk Analysis

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

The extent, thickness and timing of freezeup and breakup are unique characteristics of Arctic marine habitats. Sea ice controls the energy due to waves and currents, heat and light and physical access to the Mackenzie Estuary and the MPAs. Studies of sea ice in the nearshore and offshore regions were undertaken during the 1970s and 1980s by industry and government to try to understand how it may affect oil and gas exploration and development operations. Studies have recommenced with the latest round of exploration. Recent advances in the interpretation of synthetic aperture data imagery from satellites and a range of new polar orbiting optical and SAR satellites have assisted in these new studies. We now have a reasonable understanding for the distribution of bottomfast ice (ice that freezes to the seabed) in parts of the MPAs and how that affects overflow and breakup (see figure). We can use satellite imagery to monitor the progress of freeze up and breakup as well and new airborne sensors mounted on helicopters can be used to measure ice thickness very rapidly. In addition, the Minerals Management Service (MMS) Alaska Branch is a bout to release the results of a study on the development of landfast ice in the Beaufort Sea that includes a portion of the Mackenzie Bay area including parts of the MPAs. This study and the techniques developed could be extended to the remainder of the Delta MPAs (mainly Kugmallit Bay). These new data and techniques can be used to develop a landfast sea ice climatology for the Mackenzie Estuary and associated MPAs detailing the spatial and temporal variability of important events such as freeze-up, landfast ice evolution, bottomfast ice development, timing of overflow and breakup.



Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.)

This project will proceed with in the following stages

1. compile and summarize existing data
2. consult with community and biologists regarding import events and characteristics that need to be mapped.
3. Acquire satellite imagery and undertake analysis
4. validation of satellite interpretations
5. database development and map productions

Potential Indicators

There are a number of indicators that should be considered. They include timing of various events (ice on, ice off,) and timing of overflow and breakup.

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

This project would be lead by NRCan (GSC, CCRS), and would involve the Canadian Ice Service, DFO

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

B1. linkage between sea ice and arrival of birds and their use of the MPAs and MM1. linkage between sea ice and arrival of marine mammals would require the ice and water information for base environmental conditions

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single round and interval)	
Current O&M Support (identify source)				
New O&M funding required		$225,000		post-doc plus imagery purchase and travel Part of the O&M work could be done under contract
New equipment funding required				
Vessel days and costs (identify type of vessel)				

Contact (names of individuals who prepared this proposal or should be involved)

To be determined.

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

PC 4	Coastal erosion hazards (e.g. community and industry infrastructure) and contaminant release to the MPAs

MPA Conceptual Objective (Marine mammal communities, fish and fish habitat. physical and chemical environment, Waterfowl, shorebirds and other animals)

To conserve the physical and chemical properties of the Marine Protected

Operational Objective (Objective for this project to support MPA conceptual objective)

To determine rates of change of coastal processes (erosion, permafrost degradation) by monitoring in cooperation with community members.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Monitoring, desk analysis

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

The Beaufort Sea coast is dominated by erosion and landward migration of spits and barriers as a result of naturally occurring sea level rise. Climate change induced acceleration of sea level rise and increasing length of open water season combined with warming air temperatures are factors that will act to increase erosion and transgression. The land areas adjacent to the MPAs are already prone to erosion with rates in one location exceeding 20 m per year, although typical rates are 2-5 m per year. Low lying spits and barriers (like Shingle Point are subjected to periodic washover during high water events associated with storm surges that, in most cases, results in landward migration of the spit or barrier. These surges are also associated with flooding of low lying delta and low tundra surfaces. Community infrastructure (whaling and fishing camps) and potential industrial infrastructure (e.g. pipeline landing sites, gas plants, drilling facilities, etc.) built in these areas are vulnerable to erosion and flooding hazards. Naturally occurring chemicals like hydrocarbons, mercury, carbon dioxide and methane are buried and stabilize within permafrost soils. Erosion of these soils will release the associated chemical compounds into the receiving waters and the atmosphere. While this is not expected to be a major source of contaminants, the actual contribution of these materials is not known.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.)

This project would proceed as follows:

1. Complete historical erosion mapping of MPAs – Air photo and satellite analysis (Kugmallit and Kendall nearly complete, Shallow Bay – only Shingle Point is done).
2. Identify locations of concern based on air photo analysis and community consultations.
3. Establish coastal monitoring sites and train local monitors – use combination of photos and rudimentary surveying during periods of community occupation of sites plus high resolution satellite imagery.
4. Sample representative permafrost types (e.g. tundra, delta, lake basin, etc.) for chemical analysis of potential contaminants of concern.

Potential Indicators

The rate of coastal erosion would be the primary indicator employed.

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Digital cameras, Tape measures, Surveying equipment, Transport to sites.

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

NRCan (Geological Survey of Canada, Canada Centre for Remote Sensing, DFO (Inuvik Field Office), Environment Canada (contaminants?),
The Inuvialuit partner would assume responsibility for community based monitoring of coastal erosion. .

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

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Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single round and interval)	
Current O&M Support (identify source)				
New O&M funding required (exclude contract)	$15,000	$130,000		15K Ongoing coastal monitoring

				30K image rectification digitization & measurement
New equipment funding required		$30,000		Cameras, survey gear
Vessel days and costs (identify type of vessel)				

Contact (names of individuals who prepared this proposal or should be involved)

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Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

PC 5	Understanding natural and human sources of contaminants (e.g. mercury, PAH) in the MPA

MPA Conceptual Objective (Marine mammal communities, fish and fish habitat. physical and chemical environment, Waterfowl, shorebirds and other animals)

To conserve the physical and chemical properties of the Marine Protected Area

Operational Objective (Objective for this project to support MPA conceptual objective)

To conserve water quality and sediment quality in the MPA by developing a baseline understanding of contaminants within the water, and sediment within the MPA, and ensuring that levels resulting from human activities does not result in levels above those naturally occurring.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Survey, Monitoring, Experimental Research, Desk Analysis

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

Contaminants introduced from long-range sources could accumulate within sediments of the MPA, and make their way into the food web. For example PAH's are known to seep into the Mackenzie River from natural sources. Mercury is introduced to the Mackenzie River as a result of permafrost degradation. Local sources of contaminants from human activities could also contribute to the contamination of sediments within the MPA. Concerns about the levels of contaminants within beluga and fish require an understanding of contaminants in the MPA.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.)

The program will involve seasonal sampling of water, suspended sediment and substrates within the MPA, this would provide data for understanding the seasonal (floods, etc.) contribution of contaminants to the MPA. Sampling design would be stratified in order to ensure different zones of potential accumulation are adequately covered.

Potential Indicators

Levels of contaminants in suspended sediment in water and in substrates (cores…retrospective historical) would be the primary indicators

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Equipment and infrastructure support: Water sampling equipment (pumps, filtering devices etc.), sediment coring devices, small boats/launches.

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

Participation in program: NRCan would lead, DFO and Environment Canada would participate.

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

B1. Sources and pathways of contaminants to seabirds using the MPA. MM2. Linking health of the beluga to contaminant sources (even if not currently an issue), but with changes in the uses of the region. Both projects would depend on this project for an understanding of what was happening to the biota

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single round and interval)	
Current O&M Support (identify source)				
New O&M funding required (exclude contract)	$35,000 added s. Solomon Oct 11	$300,000		50K chemical analyses
New equipment funding required				
Vessel days and costs (identify type of vessel)				

Contact (names of individuals who prepared this proposal or should be involved)

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Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

F 1	Inventory and assessment of fish assemblages in MPA

MPA Conceptual Objective

To conserve enough of the fish populations and habitat so as to maintain the natural resilience of the Tarium Niryutait ecosystem.

Operational Objective

To maintain fish communities, species and populations in the MPA and surrounding EBSA within bounds of natural variability.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Desk Analysis, Inventory, Monitoring

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

Fish communities in the MPA can be influenced by many of the key activities that will affect the MPA in particular climate change, hydrocarbon exploration and development, pollution and cumulative effects of developments on the Mackenzie River.
Although there is a general understanding of what fish species occur in the MPAs, the data is limited and sampling has been done mostly in the summer. The importance of the MPA ecosystem to the ecology of the fish species that have been caught in the area is not well understood and the relationship of the fish species utilizing the MPA and beluga biology is not known. Fishers have reported that beluga are often observed chasing schools of fish in the area, and it has been assumed some feeding may occur. Having a better understanding of the fish communities and habitat within the MPA and their temporal and geographic variability is an important component in conserving the MPA ecosystem.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.)

The hypothesis is that fish communities of the MPA will be affected by developments in the Mackenzie Basin and elsewhere.

1. Inventory and assembly of existing information

The first step in this program would be an inventory project to provide a list of fish assemblages associated with the MPA ecosystem. This step would begin with desk analysis of existing information, followed by a target field program; year round to address knowledge gaps. The field project would be a community based project using

local fishers and fish monitors to collect data. The project would focus on identifying fish assemblages (who is there), what habitat they are associated with (link to physical oceanography and chemistry); not an abundance study (density).

2. Establishment of ongoing community based monitoring

The second step in the program would be the establishment of an ongoing community based monitoring program employing local fishers to collect fish samples and environmental data (see linkage to fish projects 3 and 4). There will be a need to have a intensive assessment possibly every 5 years involving community fishers and DFO scientists.

Indictors (identify ecosystem indicators associated with the project)

Fish and fish habitat diversity for the MPA will be defined in step 1 and used to monitor the MPA ecosystem in step two.

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Most of the fishing equipment required to conduct the inventory and boats to access the site already exist. There may be a requirement of a limited purchase of instruments to support environmental measurements (temperature and salinity) and some support for processing data.

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

The program would be a joint DFO/FJMC effort utilizing community fishers and working through HTCs. The current program costing assumes that DFO and FJMC will deliver this program. Because this project is similar to projects being planned by Parks Canada for similar ecosystems in the region collaboration with Parks Canada would be beneficial.

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

A strong linkage is anticipated between this project and the physical oceanographic and water chemistry programs PC 1 and PC 2. There will be some linkage of this program with fish project F 2 which involves the identification of environmental indicator species and there may be limited linkages to ongoing DFO/FJMC projects. This project would also provide input to project B 1 Food web interactions with sea birds and shorebirds and the aquatic biota including fish and benthos. Please note there is limited subsistence fishing in parts of the MPA so there will be a need for some level of program specific sampling.

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single	

			round and interval)	
Current O&M Support (identify source)	-			
New O&M funding required	5k	200K	Possible 5 year assessment survey 30k	Year 1 – 100k Year 2 – 100k 3 – year first cycle total – 205k
New equipment funding required	0			
Vessel days and costs (identify type of vessel)	N/A			

Contact (names of individuals who prepared this proposal or should be involved)

To be determined

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

F 2	Ecosystem indicator fish species identification project

MPA Conceptual Objective

To conserve enough of the fish populations and habitat so as to maintain the natural resilience of the Tarium Niryutait ecosystem.

Operational Objective

To maintain fish communities, species and populations in the MPA and surrounding EBSA within bounds of natural variability.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Desk Analysis, Experimental management, Monitoring

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

Fish communities in the MPA can be influenced by many of the key activities that will affect the MPA in particular climate change, hydrocarbon exploration and development, pollution and cumulative effects of developments on the Mackenzie River.
Fish species that are resident in an ecosystem for a significant part of their life history can be indicators of the overall health of an ecosystem. The growth, health (condition) and population structure of indictor species can be used to detect changes in the ecosystem. Use of indicators species can provide a focus for monitoring program activities and provide a way to integrate ecosystem research activities within ecosystems.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.)

This project will involve two steps; the identification of candidate indicator species and an experimental or pilot stage to test the feasibility of using the candidate species to assess the ecosystem of the MPA.

Step 1 Selection of candidate species

This step would involve the development of a small working group of fishers and scientist. Using a combination of traditional and scientific knowledge the working group would identify possible candidate species. Ecological profiles for each candidate species would be developed using data from the literature and traditional knowledge.

Step 2 Experimental testing of indicator species approach

This step would be a pilot project to test the feasibility of using a indicator species in the MPA. The project(s) would include community fishers and DFO scientist. After this pilot

project the results and recommendations would be presented to the MPA management board.

Step 3 Integration into community monitoring program

If an indicator species is selected the sampling for this species would be integrated into the monitoring program F1. Only the on going cost specific to the assessment of the indicator would be part of this program after year 3.

Indictors (identify ecosystem indicators associated with the project)

This project is specifically designed to develop and refine indicators of ecosystem health

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Most of the fishing equipment required to conduct the inventory and boats to access the site already exist. There may be a requirement of a limited purchase of instruments to support environmental measurements (temperature and salinity) and some support for processing data.

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

The program would be a joint DFO/FJMC effort utilizing community fishers and working through HTCs. The current program costing assumes that DFO and FJMC will deliver this program except for some contract costs associated with the facilitation of the working group for identifying the indicator species. Because this project is similar to projects being planned by Parks Canada for similar ecosystems in the region collaboration with Parks Canada would be beneficial.

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

F2 and F1 are strongly linked once the indicator species have been identified and the pilot assessment completed.

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single round and interval)	
Current O&M Support (identify source)	-			
New O&M funding required	8K	120k	20k	Ongoing 8k indicator

				specific sampling and data analysis Year 1 – 30k selection stage Year 2 & 3 – 35k Pilot project Periodic intensive evaluation of indicator (every 8 years) 20 K for facilitation of working group process
Vessel days and costs (identify type of vessel)	N/A			

Contact (names of individuals who prepared this proposal or should be involved)

To be determined.

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

F 3	Fish biota condition monitoring program

MPA Conceptual Objective

To conserve enough of the fish populations and habitat so as to maintain the natural resilience of the Tarium Niryutait ecosystem.

Operational Objective

To maintain fish communities, species and populations within bounds of natural variability.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Desk Analysis, Experimental management, Monitoring

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

The health of fish species can be influenced by many of the activities that will affect the MPA in particular hydrocarbon exploration and development, pollution and cumulative effects of developments on the Mackenzie River.
Understanding the current health of fish species within the MPA ecosystem can provide a ecosystem based method of monitoring the health and possible impacts of activities of the MPA ecosystem as a whole. Basic indicators such as the presence and frequency of occurrence of fish diseases and parasites; occurrences of marks and tumours; qualitative indexes of fish condition like condition of flesh or body shape; can be used to assess the overall health of the ecosystem. These indicators are sensitive to both, physical and biological changes in the ecosystem. If tested and periodically examined at a refined scale these indexes can be used by fisher monitors.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.)

The hypothesis is that the health of individual fish in the MPA can be used as an indicator of the overall health of the ecosystem.

1. Identification of potential indicators

The first step in this program would be a desk exercise involving scientific experts and community fishers to assess possible indicators and to review other studies that have employed condition indices.

2. Pilot project

Based on this analysis a pilot project would be introduced involving both scientific field

collections and community monitors. The project would consider the experiences of the Borderlands Ecological Knowledge Cooperative program and the Parks Canada environmental incident wildlife card programs.

3. Evaluation and integration with ongoing monitoring

After a three year trial period indicators of fish biota health and condition would be selected and integrated into the on going fisheries monitoring program F1 and the indicator species program F2.

Indictors (identify ecosystem indicators associated with the project)

Fish condition indictors would be identified at the end of the program and would be integrated into the MPA ecosystem monitoring program.

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Most of the fishing equipment required to conduct the inventory and boats to access the site already exist. There may be a requirement of a limited purchase of instruments to support environmental measurements (temperature and salinity) and some support for processing data.

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

The program would be a joint DFO/FJMC effort utilizing community fishers and working through HTCs. The current program costing assumes that DFO and FJMC will deliver this program. Because this project is similar to projects being planned by Parks Canada for similar ecosystems in the region collaboration with Parks Canada would be beneficial.

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

A strong linkage is anticipated between this project and the physical oceanographic and water chemistry programs. There will be some linkage of this program with fish project F2 which involves the identification of environmental indicator species and there may be limited linkages to ongoing DFO/FJMC projects.

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single round and	

			interval)	
Current O&M Support (identify source)	-			
New O&M funding required	15k	100K	Possible 5 year assessment of indicator approach 10k	Ongoing 15k added to F1 Year 1 – 50k work of indicator group and first year of testing. Year 2 & 3 – 25k /year test collection program integrated into other work.
New equipment funding required	0			
Vessel days and costs (identify type of vessel)	N/A			

Contact (names of individuals who prepared this proposal or should be involved)

To be determined.

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

F 4	Trophic structure and diversity in MPA

MPA Conceptual Objective

To conserve enough of the fish populations and habitat so as to maintain the natural resilience of the Tarium Niryutait ecosystem.

Operational Objective

To maintain the trophic structure in the MPA so that fish communities, can play their historical role in the food web.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Desk Analysis, Experimental Research, Monitoring

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

The trophic structure of the MPA can be influenced by many of the activities that will affect the MPA in particular climate change, hydrocarbon exploration and development, pollution and cumulative effects of developments on the Mackenzie River.
In order to protect the ecosystem of the MPA there is a need to understand and monitor the trophic structure with the MPAs marine ecosystem. Identification of ecologically dependent species within in the MPA ecosystem and the development of monitoring programs to assess tropic level balance requires the identification of key species and some measure of their normal range of abundance.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.)

The hypothesis is that the trophic structure of the MPA will be affected by developments in the Mackenzie Basin and elsewhere.
This would be a three stage program that will build on the present Tariuq program .

1. Assessment of knowledge of trophic structure

The first step in this program would be an assessment of our current knowledge of the trophic structure of the MPA ecosystem and evaluation of possible methods of assessing the health and stability of the trophic structure. This would include an evaluation of the Tariuq program and may involve the use of an ecosystem based model. The focus of this stage would be defining the trophic structure not a detailed taxonomic assessment of the MPA ecosystem. The project would likely involve a partnership with University researchers.

2. Field studies to evaluate approaches
The second step in this program would involve field studies to address knowledge gaps and to collect information required to test various approaches (models). It is estimated that this would take three years.

3. Redesign of Tariuq
The third phase of the program would involve initiating a redesign and of the existing community based Tariuq program.

Indictors (identify ecosystem indicators associated with the project)

Indicators of tropic structure might include: condition of key predator species; percent of prey species in diet; diversity of food species; biomass of key size ranges of pray species (zooplankton).

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Most of the fishing equipment required to conduct the field studies and boats to access the site already exist. There may be a requirement of a limited purchase of analysis for diet and stable isotopes.

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

The program would be a joint DFO/FJMC effort utilizing community fishers and working through HTCs. The current program costing assumes that DFO and FJMC will deliver this program. Because this project is similar to projects being planned by Parks Canada for similar ecosystems in the region collaboration with Parks Canada would be beneficial.

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

A strong linkage is anticipated between this project and the physical oceanographic and water chemistry program PC 1 Measuring and Modelling Physical Oceanography and sediment dynamics within the MPA and PC 2 Benthic habitat mapping of MPA. There will be some linkage of this program with fish project F2 which involves the identification of environmental indicator species and there may be limited linkages to ongoing DFO/FJMC projects. This project would also provide input to project B 1 Food web interactions with sea birds and shorebirds and the aquatic biota including fish and benthos.

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single round and interval)	

Current O&M Support (identify source)	- 100k			Integration with Tariuq program
New O&M funding required	20K	190K	20K	Ongoing – 20k supplement to Tariuq program.3 – year 190k Year 1 – 70k design phase and first year of evaluation Year 2 & 3 – 60k field assessment and collection of data Possible 5 year assessment survey 20k
New equipment funding required	0			
Vessel days and costs (identify type of vessel)	N/A			

Contact (names of individuals who prepared this proposal or should be involved)

To be determined.

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

MM 1	An assessment of the spatial and temporal use of the Tarium Niryutait Marine Protected Area by beluga

MPA Conceptual Objective (Marine mammal communities, fish and fish habitat. physical and chemical environment, waterfowl, shorebirds and other animals)

To conserve a healthy population of belugas and the integrity of the ecosystem in Tarium Niryutait Marine Protected Area

Operational Objective (Objective for this project to support MPA conceptual objective)

To maintain the spatial and temporal variability, both within and between seasons, of the use of the Mackenzie estuary by beluga.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Inventory and desk analysis

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

Beluga movement patterns and habitat use can be influenced by many of the key activities that will affect the MPA including hydrocarbon exploration and development, air and marine transport, tourism, climate change and pollution.
Existing research on the use of the estuary by marine mammals (particularly belugas) includes aerial surveys, satellite tagging, and traditional knowledge. Beluga whales distribute themselves among the three main bays, and tend to congregate in specific "hot spots" in the area but the reasons for those congregations are not understood.
Establishing patterns of congregations and use of an area and correlating that information with habitat data and geomorphology to determine features and characteristics of the physical environment in these "hot spots" will allow the development of guidelines and regulations to protect the whales from disturbance. Better understanding the natural variability will lead to the development of MEQ indicators based on migration patterns.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.

The hypothesis is that the migrations and distribution of beluga into, within, and out of, the MPA is in response to environmental conditions within the MPAs and within the larger area of the Beaufort Sea LOMA and beyond.
This study will establish patterns of distribution between years, including micro-movements and length of time the whales are using an area. This analysis will be

correlated to habitat data and geomorphology to determine features and characteristics of the physical environment in these "hot spots".
This program would proceed in several steps as follows:

1. Establish current state of understanding of beluga distributions within particular areas and the relationship to other elements within an ecosystem including food distribution, salinity, temperature and sediment. One time study desk analysis 15K.
2. This evaluation of existing data could lead to further study of beluga use of the estuary. Specifically his would involve field work by scientists and community members to investigate one or two hotspots. It would be integrated with aspects of the physical and chemical oceanography study. Field study 25K.
3. Development and use of a less invasive tracking devise than current satellite tags that would focus on a shorter period of time, while belugas are in the estuary. This would allow a more detailed look at some of the areas that whales tend to use. It would necessitate separate projects of:
    a. tagging development 50K and
    b. experimental application of tags in estuary 75K .
4. Further tagging studies would be required to understand the patterns of migrations within in the leads in the ice in the Beaufort Sea in spring (before whales go to estuary). This study would be based on an IPY icebreaker 100K.

Possible Indicators

Better understanding the natural variability will lead to the development of MEQ indicators based on migration patterns including stability of the harvest; harvester success ratio; continuing beluga use of "preferred habitat".

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Access to survey and satellite tagging databases and industry bathymetry and other databases, GIS analyst

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

DFO: technical
Contract to private GIS contractor
HTC s and individuals would be involved for their local knowledge and the field studies of distribution and migration patterns.
FJMC: data teased out of monitoring reports

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

This project would link closely with three of the Physical-Chemical projects

PC 1 Measuring and modelling physical oceanography and sediment dynamics within the MPA would contribute background environmental information particularly water temperatures and salinity and sediment load in relation to movements of beluga into and out of the MPA. PC 2 Benthic habitat mapping of MPAs, which would then link to the ecosystem modeling project. It would provide the bottom habitat information which the MM1 project would depend. PC-3 Sea-ice dynamics within the MPAs Understanding the linkage between sea ice and arrival of marine mammals would require the ice and water information for base environmental conditions

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single round and interval)	
Current O&M Support (identify source)				
New O&M funding required			$15K $25K $75K	Desk analysis Field study Tagging study
New equipment funding required			$50K	Tag development
Vessel days and costs (identify type of vessel)			$100K	Offshore tagging

Contact (names of individuals who prepared this proposal or should be involved)

This project was prepared by Lois Harwood, Andrea Hoyt, Richard Binder, Lawrence Amos, Cal Wenghofer. Those involved should be: Lois Harwood, DFO (survey data); Pierre Richard, DFO (tagging data); Shell Canada (bathymetry); Steve Solomon, NRCAN (substrate data); the Tuk, Inuvik, and Aklavik HTCs (interpretation and reviewing the maps); and FJMC (technical and TK support)

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25

Project Number and Title

MM 2	Health and well-being of beluga individuals and populations

MPA Conceptual Objective (Marine mammal communities, fish and fish habitat. physical and chemical environment, waterfowl, shorebirds and other animals)

To conserve a healthy population of belugas and the integrity of the ecosystem in Tarium Niryutait Marine Protected Area

Operational Objective (Objective for this project to support MPA conceptual objective)

To maintain the health and well-being of the beluga population by sampling, measuring, and enumerating beluga whales taken in the harvest in the Mackenzie estuary.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Monitoring, desk analysis, and experimental management

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

Potential threats to he health of individual beluga and the beluga population include many of the key activities both regionally and world wide that will affect the MPA and the Beaufort Sea LOMA. They include: climate change, hydrocarbon developments, air borne and air borne pollutants amongst others

The FJMC beluga monitoring program has been in place for over 25 years and serves a multitude of goals including monitoring the harvest, and is built upon the principle that harvesters themselves are involved in the science and management of the beluga population, and formalises management and science at a local level. The current program assesses health of individuals and the beluga population, through collection of specific samples for contaminants, disease, reproduction, and body condition.

The proposed program will build on the ongoing program to address the MPA objectives and principles by providing data for the development of MEQ indicators that will allow the MPA management agency to better manage the MPA and influence external activities beyond the MPA boundaries.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.

This is a multipart program that will build on the present FJMC, hunter based, beluga monitoring program. The hypothesis is that basic biological and population parameters of beluga will respond to stressors on the environment and the population and thus are indicators of the health of the MPA and LOMA ecosystems.

The program will include:

1. Beluga Monitoring Program Hunters collect various information and samples from harvested belugas, including size, gender, thickness of blubber (indicator of general health) and reproductive status. These samples go toward various studies and also for genetic stock identification and screening for diseases, primarily looking at serum for evidence of exposure to viruses. 60K Ongoing FJMC a base
2. Stock Assessment: DFO 35K
3. Contaminants: This component would involve ongoing monitoring of mercury and organochlorines as well as other key contaminants. DFO 45K

DFO Fatty acid and isotope analysis. Fatty acids and isotopes would be evaluated in an examination of beluga feeding habits. The intent would be to gain an understanding of how changes in marine productivity and availability of prey impact the diet (and health and reproduction) of beluga whales: what is causing the decrease in blubber thickness in marine mammals. 25K

Possible Indicators

The beluga monitoring program provides a number of parameters that can be used to monitor MEQ in the MPA and in the Beaufort Sea LOMA They include variations in size and composition of harvest, incidence of diseases, health/condition features (e.g. fat content).

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

DFO: Harwood (35K), Loseto/Stern (45K)
DFO: Fatty acid and isotope analysis (25K)

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

Aklavik, Inuvik, and Tuk HTCs and FJMC for the community based beluga monitoring program.
Lois Harwood
John Reynolds (looking at fatty acid profiles of marine mammals) - MOTE

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

The fatty acid analysis will allow researchers to better understand what belugas are eating and where belugas are feeding.

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single round and	

			interval)	
Current O&M Support (identify source)	50K			Beluga monitoring
New O&M funding required	35K 45K 25K			Stock Asst: Contaminants: Fatty acid and isotope analysis
New equipment funding required				
Vessel days and costs (identify type of vessel)				

Contact (names of individuals who prepared this proposal or should be involved)

This project was prepared by Lois Harwood, Andrea Hoyt, Richard Binder, Lawrence Amos, Cal Wenghofer. Those involved should be: Lois Harwood (DFO) – beluga sampling and assessment, John Reynolds (MOTE), Gary Stern/Lisa Loseto (DFO) – contaminants and fatty acids, Kevin Bill (FJMC) and ISR HTCs - beluga monitoring program field program

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

MM 3	Effects of noise disturbances on beluga whales.

MPA Conceptual Objective (Marine mammal communities, fish and fish habitat. physical and chemical environment, waterfowl, shorebirds and other animals)

To conserve a healthy population of belugas and the integrity of the ecosystem in Tarium Niryutait Marine Protected Area

Operational Objective (Objective for this project to support MPA conceptual objective)

To maintain the beluga population of the MPA within its normal range of distribution by determining the zone of influence of single and cumulative sources of underwater noise disturbances in the MPA.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Monitoring, desk analysis, and experimental management

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

There are important vessel traffic corridors that will run through and adjacent to the MPAs and commercial vessel traffic is important and growing in the Mackenzie Delta and the Beaufort Sea. There are also numerous other noise sources which have been shown to impact on marine mammal movements and behaviour.
A1977 study reviewed sound attenuation in the Mackenzie estuary. Through experimental research, there is also currently good understanding of the audible ranges of cetaceans. Given the existing activities that are occurring in and around the MPA, we have a good understating of the sound sources that might influence beluga behaviour. This program addresses the MPA objectives and principles by providing data to better allow us to manage the MPA and external activities and will link changes to activities that may be occurring in and around the MPA specifically large vessel traffic.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research.

The hypothesis is that certain levels and types of sound have the potential to effect the natural migration and movement patterns of beluga whales in the MPA. In this study the source levels from a variety of contemporary sound sources in the MPA would be measured under a range of water depths and substrate types. Data models would be prepared to estimate the zone of detectability of noises for beluga whales in the estuary.

This project would include ground-truthing to verify impacts of noise on whales in this environment. The project would also include measuring ambient and extant noise in the MPA environment with hydrophones and a data logging system.
This program would proceed as follows

1. First would be a desk study, which will correlate beluga noise detection limits against known noise sources and geomorphology/habitat assessment to determine noise attenuation, and to map the zones of influence. The study would include GIS mapping, modeling and analysis. 25K
2. Following this would be a research program to assess contemporary sources of noise levels in the MPA and to ground truth beluga responses in comparison to studies elsewhere. 40K
3. Ongoing monitoring of noise levels in MPA. Activities that may create sound impacts include dredging for shipping lanes, recreational boating, barges, aircraft (fixed wing and helicopters), drilling programs, pipeline maintenance activities including pigging. This would be a community run program. 15K annually (5 year initial study then periodically)

Possible Indicators

Potential indicators include noise levels at critical points in the MPA (as relates to marine mammal behaviour).

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

Equipment needed: GIS, hydrophones with dataloggers

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

DFO, Alaska, HTC members/fishers/hunters, FJMC, industry, and environmental consultants with expertise in sound propagation and attenuation. The long term monitoring would be a community/government joint program

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

Link to industry activities
Harvesters and beluga monitors would be involved in collaborative delivery This project could be expanded to include exposure to noise offshore, where the noise propagation would be expected to be greater.

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single	

			round and interval)	
Current O&M Support (identify source)				
New O&M funding required (exclude contract)	15K		25K 40K	Desk analysis Field study Sound monitoring
New equipment funding required				
Vessel days and costs (identify type of vessel)				

Contact (names of individuals who prepared this proposal or should be involved)

This project was prepared by Lois Harwood, Andrea Hoyt, Richard Binder, Lawrence Amos, Cal Wenghofer. Those involved should be Lois Harwood (DFO); Charles Green (USA), LGL (acoustics), Jasco, and Aquatics Environmental (all consultants); HTCs/FJMC (behavioural studies and monitoring).

Tarium Niryutait Marine Protected Area
Description of Science Needed to Support the Management Plan
Workshop, May 24-25, 2006-05-16

Project Number and Title

B 1	Food web interactions between waterfowl/sea birds/shorebirds and aquatic biota including fish and benthos

MPA Conceptual Objective (Marine mammal communities, fish and fish habitat. physical and chemical environment, Waterfowl, shorebirds and other animals)

To conserve the waterfowl, seabird, and shorebird components of the MPA and surrounding area in order to maintain the trophic structure and the relationship between these birds and the aquatic components of the ecosystem.

Operational Objective (Objective for this project to support MPA conceptual objective)

To maintain the historic relationship between waterfowl, seabirds, and shorebirds and the aquatic ecosystem.

Knowledge Continuum (Inventory, Monitoring, Desk Analysis, Experimental management, Experimental Research)

Desk analysis

Context (Narrative description of the context including an assessment of the current state of knowledge, threats or issues related to the component, and how this initiative would relate to the management principles and objectives of the MPA).

A diverse assemblage of avifauna use portions or the periphery of the MPA. Local knowledge indicates that waterfowl, seabirds, and shorebirds may play a significant role in the MPA ecosystem. There has been significant amount of traditional and scientific knowledge acquired about birds in the Kendall Island Bird Sanctuary and in the area surrounding the MPA but the relationships between fish and avifauna are unknown in this area. Changes in the bird populations outside of traditional variability may have significant implications for other components of the MPA ecosystem. For example of the 100^{+} bird species that use the Sanctuary, three have been identified under SARA (Eskimo Curlew, the Ivory Gull and the Ross's Gull) which depend in whole or in part on aquatic resources for sustenance.

Program Outline (Narrative description of the proposed program to include the hypothesis(es) to be tested or question to be answered, methods to be used including sample and data repositories, equipment/facilities required, and timelines for completion of the research. Program is to be described at three different levels viz. Level I Basic program or minimum needed to support the management plan, Level II Expanded basic program and Level III Full program to address all issues.)

Hypothesis – Waterfowl, seabirds and shorebirds make significant use of the MPA. The proposed project is an initial desk analysis of existing data to determine: percentage of fish/benthos eating birds that utilize the MPA, total numbers, their total consumption of fish and benthos, species consumed, energy transfer between ecosystem components,

contaminant transfers between trophic levels, time of arrival of migratory species, and other related scientific and traditional knowledge related to fish/bird interrelationships. The desk analysis would also provide an assessment of potential use of waterfowl, seabirds, and/or shore birds as indicators for the health of the aquatic ecosystem. Confirmation or rejection of the above hypothesis could lead to future knowledge acquisition activities including monitoring, further desk analysis, experimental research etc. Examples of projects that might be considered include: effects of changing climates on bird populations in the MPA and surrounding area; community based bird observations (e.g. date of first arrival, date of last bird in fall, new species, breeding success, egg quality); determination of contaminant loads in birds; use of the MPA shoreline by waterfowl, seabirds and shorebirds; bird behaviour associated with various disturbance (noise, dredging,) levels; understanding predator/prey relationships (e.g. seabirds/waterfowl/fish, grizzlies/bird eggs); determination of habitat use of MPA by birds; and effects of oil spills on birds.

Indicators

There are a number of potential indicators of aquatic health that might be provided by waterfowl, seabirds and/or shorebirds. Examples include breeding success, contaminant levels in eggs, prey composition etc. The desk analysis would provide a first level scan of potential indicators for further specific development for the MPA.

Equipment and Infrastructure support requirements (to include the nature of analytical equipment, field equipment and vessels needed including estimate of time, place and season for the work)

This is a desk analysis no specific equipment or infrastructure would be required.

Participation in the Program (Narrative description of agencies and expertise that would lead and support the program e.g. DFO, FJMC, HTC members, Parks Canada, fishers/hunters, tourist operators, expertise from outside the region etc. In particular community based monitoring/participation should be described)

This would be a cooperative study carried out primarily by a contractor or university faculty member and overseen by DFO and CWS scientists and the MPA management body.

Linkage to Other Programs (Identify other numbers and titles from this exercise and other programs operated by FJMC, DFO, or other agencies and briefly describe synergies and dependencies)

Within the proposed MPA science plan this project would be supported by the physical chemical projects (PC 2 benthic mapping, PC 3 ice dynamics, PC 5 contaminants) and the fish and fish habitat projects (F 1 Inventory and assessment of fish assemblages in the MPA and F 3 Trophic structure and diversity the MPA).
This project would depend heavily on CWS input to identify sources of information and kinds of information that would be collected. Specific DFO fisheries input would be required from fish population/feeding specialists, contaminant specialists. Input from the Inuvialuit Joint Secretariat and the NWT WMAC would also be necessary. Specific

programs/agencies operating in the ISR such as the Arctic Borderlands Coop and the Aurora Research Institute would also benefit the study.

Cost Estimate

	Annual Ongoing	3-5 Year (total)	Periodic (costs for single round and interval)	
Current O&M Support (identify source)	None in DFO or FJMC			
New O&M funding required		$25000		One time study then re-evaluated. University faculty or contractor
New equipment funding required	None			
Vessel days and costs (identify type of vessel)	None			

Contact (names of individuals who prepared this proposal or should be involved)

CWS would be the project authority. Individuals from CWS that might be involved could be Paul Latour (CWS and WMAC?) and Lynne Dickson (CWS). This proposal was prepared by Beth Thomson (DFO), Sam Stephenson (DFO), Max Kotokak (FJMC), Burton Ayles (FJMC)