# Marine Environmental Quality Workshop Report

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# Marine Environmental Quality
# Workshop Report

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**ABSTRACT**
On October 28-29, 2003, a workshop was held in Inuvik to discuss the concepts of the ecosystem approach to Oceans Management, and begin the process of developing Marine Environmental Quality objectives for the proposed Marine Protected Area in the Beaufort Sea. The workshop brought together knowledgeable participants from the communities of Tuktoyaktuk, Aklavik and Inuvik, co-management bodies, regulators, scientists, the petroleum industry and environmental planning specialists (See Appendix 1). This mix of participants was important to ensure all aspects (traditional, scientific and local knowledge) of the marine environment were integrated into the discussion.

This report provides a summary of the consultation workshop to begin the development of MEQ objectives for the proposed MPA. A short background paper is provided to place the proposed MPA in the context of the Beaufort Sea ecosystem; this paper will be expanded and published in an upcoming FJMC report. Four break-out groups discussed concerns and issues with: beluga and marine mammals, physical/chemical, fish and fish habitat and birds and other animals, then discussed possible indicators that could be monitored, and finally suggested objectives that would be further developed as MEQ objectives in subsequent meetings involving technical experts.

**PREFACE**

This report is based on a workshop held October 28-29, 2003 in Inuvik, NT. The workshop was planned and held cooperatively by Fisheries and Oceans Canada and the Fisheries Joint Management Committee. This report was prepared for the Fisheries Joint Management Committee (FJMC), Joint Secretariat - Inuvialuit Renewable Resources Committees, P.O. Box 2120, Inuvik, NT, XOE OTO. Burton Ayles, Member of the FJMC, reviewed the draft document.

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That 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

With the implementation of Canada's *Oceans Act* in 1997, Fisheries and Oceans Canada became the federal government agency tasked to lead and facilitate the Integrated Planning of Canada's Coastal waters. In the spirit of co-management, and respecting the Inuvialuit Final Agreement, the Beaufort Sea Integrated Management Planning Initiative (BSIMPI) was formed with a Senior Management Committee and Working Group. The BSIMPI working group has been assessing the need for, and feasibility of, a Marine Protected Area in the Beluga 1(a) zone of the Beaufort Sea since 2001. Ecological, socio-economic and technical feasibility assessments were undertaken and assessed as required by the Marine Protected Areas framework document (DFO, 1999). After extensive consultations with communities and community organizations, government agencies and industry to determine the level of support for a Marine Protected Area, the working group recommended to senior management committee that a Marine Protected Area be established within the Beaufort Sea Beluga Management Zone 1(a)s. The senior management committee requested the development of a management plan before a formal request would be made to establish the MPA.

The MPA management plan discusses the development of MEQ objectives for the MPA. The development of MEQ objectives can start with very broad statements on what important environmental components of the MPA should be conserved or maintained. These broad objectives are a reflection of the larger ecosystem within which the proposed MPA is situated. Once the broad objectives are established, they can be more exactly defined to include statements with specific thresholds or targets, and indicators selected for the purpose of monitoring. Monitoring consists of observing or measuring indicators, and over time provides a means of knowing whether the MEQ objectives for the MPA are being met.

The development of MEQ objectives is reflective of Canada's *Oceans Act* principle of ecosystem-based management of activities in the marine environment. The planning of any human activity in the marine environment should consider impacts on the whole ecosystem.

As a first step in a series of consultations with a broad stakeholder group on the development of MEQ objectives for the proposed MPA, a workshop was co-hosted by DFO and Fisheries Joint Management Committee (FJMC) October 28-29, 2003. This report presents a summary of the workshop, discusses the approach used for the workshop, results of the workshop, and explains the next steps in the process. For those with a broader interest in the Beaufort Sea, a backgrounder paper was prepared for the workshop, and it discusses the proposed MPA and MEQ in the context of the Beaufort Sea.

## WORKSHOP BACKGROUNDER

Canada's *Oceans Act* was passed in 1997. It directs that integrated management should be undertaken to ensure the sustainable use and health of marine ecosystems. One aspect of this broad objective is the development of an effective planning process. Such a process will identify social, cultural, environmental and economic values, thus providing a solid basis for the development of management plans. In 1999 the Inuvialuit, the Department of Fisheries and Oceans and industry agreed to collaborate in the development of integrated management planning for marine and coastal areas in the Inuvialuit Settlement Region. This agreement is called the Beaufort Sea Integrated Management Planning Initiative (BSIMPI). Under BSIMPI the Senior Management Committee (SMC) seeks to guide initiatives related to the development of a management planning process for ocean-related activities in the Beaufort Sea. The SMC also formed a Working Group to implement effective collaboration on Oceans management initiatives. The first major task assigned to the Working Group was to evaluate a proposal for the establishment of a pilot Marine Protected Area (MPA) in the Inuvialuit Settlement Region. The primary objectives of this proposed MPA would be to conserve and protect important subsistence beluga whale and anadromous fisheries.

The area selected for consideration as a MPA was consistent with the areas zoned as 1(a) in the Beaufort Sea Beluga Management Plan (BSBMP). The BSBMP was developed and implemented to ensure sustainable beluga management in a manner reflective of the Inuvialuit Final Agreement (IFA). Of the five zones defined by the BSBMP, Zone 1(a) affords the highest level of protection. The process for evaluating the merits of an area proposed for consideration as a MPA under the *Oceans Act* is outlined in the *National Framework for Establishing and Managing Marine Protected Areas* (DFO 1999). Part of the evaluation process includes the completion of 3 assessments: a Socio-economic Assessment; an Ecological Assessment; and a Technical Assessment. According to the *National Framework* the Technical Assessment provides an overview of the proposed MPA from the point of view of the level of public and stakeholder support for the establishment of the MPA; management related issues including those of co-management and management resources; appropriate boundaries and adjacent uses. Accordingly, these topics form the basis of this document. Results of this Technical Assessment indicate that the area of interest, namely the BSBMP Zone 1(a), could feasibly be designated a MPA under the *Oceans Act*. Public and stakeholder support for the proposed MPA is sufficient to warrant continuation of the evaluation process. Existing co-management arrangements including BSIMPI and the Fisheries Joint Management Committee (FJMC) have the capacity to provide some managerial support for the proposed MPA, but would likely need additional resources, or collaborative efforts, to manage the proposed MPA comprehensively. Modifications to the boundary of the proposed MPA may be necessary if alternative measures for dealing with existing significant discovery licenses are not acceptable to the license holders.

### *Beaufort Sea Beluga Management Plan*

In 1988 the Beaufort Sea Beluga Management Plan (Fisheries Joint Management Committee, 2001, Amended third printing) was developed by community Hunter and

Trapper Committees, Fisheries Joint Management Committee and DFO. The plan creates beluga management zones and related guidelines for the Beaufort Sea. Three near shore areas within the Mackenzie outer delta/estuary referred to as Zone 1(a), are important habitat for the beluga and also represent areas of importance for beluga harvesting.

Zone 1(a) areas are defined as traditional harvesting/whale concentration areas. These areas are shallow (generally less than 2m), warm brackish, and highly turbid (FJMC 2001). The westernmost area, Shallow Bay, is the primary harvesting area for Inuvialuit from Aklavik. The Kendall Island or east Mackenzie Bay area in the central Delta is the primary harvesting area for Inuvialuit from Inuvik. The Kugmallit Bay area on the east side of the Mackenzie Delta is the primary harvesting area for Inuvialuit from Tuktoyaktuk.

The three areas include about 1,800 square kilometers from the shore to a maximum water depth of approximately 8 m. The plan recommends that the three Beluga Management Plan Zone 1(a) areas should be treated as if protected.

***Marine Protected Areas (MPA)***

The *Oceans Act* authorizes the Minister of Fisheries and Oceans to lead the development of a national Oceans Strategy guided by the principles of sustainable development, the precautionary approach, and integrated management. Three programs are identified in the Act to assist with meeting these principles: integrated management planning; marine protected areas; and marine environmental quality.

The FJMC requested that DFO undertake an assessment of the Act to determine whether it could be applied in a fashion that would be complementary to the Inuvialuit Final Agreement in establishing a Marine Protected Area (MPA) for the Beluga Management Plans' Zone 1(a) areas. Following this legal assessment, further discussions were held between DFO, the FJMC, Inuvialuit, industry and other government agencies; the Beaufort Sea Integrated Management Planning Initiative (BSIMPI) was formed to coordinate further work on the merits of designating the Zone 1(a) areas as one Beaufort Sea Marine Protected Area (MPA).

Section 35 (1) of the *Oceans Act* states that: A marine protected area is an area of the sea that forms part of the internal waters of Canada, the territorial sea of Canada or the exclusive economic zone of Canada and has been designated under this section for special protection for one or more of the following reasons:

1. the conservation and protection of commercial and non-commercial fishery resources, including marine mammals, and their habitats;
2. the conservation and protection of endangered or threatened marine species, and their habitats;
3. the conservation and protection of unique habitats;
4. the conservation and protection of marine areas of high biodiversity or biological productivity; and,
5. the conservation and protection of any other marine resource or habitat as is necessary to fulfil the mandate of the Minister.

### *Beaufort Sea Integrated Management Planning Initiative (BSIMPI)*

BSIMPI's overall objective is to facilitate integrated management planning for the marine and coastal areas of the Inuvialuit Settlement Region. BSIMPI is a partnership among the Inuvialuit, government and industry. There are three components to BSIMPI, the Senior Management Committee, the Working Group, and the Secretariat. The Working Group has an independent chairperson, and the Secretariat is provided by DFO.
The evaluation of the proposed Beaufort Sea MPA has included completion of technical, socio-economic, non-renewable resource, ecological, and multiple account assessments. As well, an extensive consultation process is underway with communities in the Inuvialuit Settlement Region, government agencies and interested industry stakeholders. Traditional Ecological Knowledge was incorporated into the ecological assessment under the guidance of an Inuvialuit TEK advisory committee.

Based on the feedback from the consultation process and information from the assessments, the Senior Management Committee accepted the Working Group's recommendation that they work towards designation of the Zone 1(a) areas as a MPA under Canada's *Oceans Act*. This process will involve ongoing consultation with communities and stakeholders.

### *Marine Environmental Quality (MEQ)*

Marine Environmental Quality (MEQ) is a statement of the overall health of the marine ecosystem, all the parts and how they are functioning. It considers such things as animals and plants, and how they interact with each other and the environment. It relies on traditional and scientific knowledge as a source of information. An assessment of the overall health of the marine ecosystem is necessary in order to evaluate the success of management plans in maintaining marine health. MEQ is one of three cooperative programs under Canada's *Oceans Act* (1997), Integrated Management and Marine Protected Areas are the others.

Monitoring is one of the key components of a MEQ program. It is intended to assess and monitor the marine environment, particularly in areas subject to planning for integrated ocean management and marine protected areas. For example, the Tariuq (Ocean) Monitoring Program, developed in conjunction with communities around the Beaufort Sea is combining scientific disciplines. Under this program, community-based monitors sample fish populations, and fish health such as contaminants and vitamins are assessed. This program combines traditional ecological knowledge and community-based monitoring.

Should the MPA be designated, monitoring in support of the MPA will consist of a combination of community-based and scientific monitoring programs, and partnerships with agencies with ongoing monitoring programs.

## APPROACH TO DEVELOP MEQ OBJECTIVES

The following summarizes the goals of the workshop:

- Goal #1: Consult Communities on MEQ for the proposed MPA.
- Goal #2: Development of MEQ Objectives for the proposed MPA.
- Goal #3: Identification of MEQ Indicators for the proposed MPA.
- Goal #4: Development of MEQ Monitoring Framework for the proposed MPA.

There are a number of approaches possible for setting MEQ objectives, as outlined in the schematic in Fig. 1. One approach (also called the "top down" approach) begins with high level ecosystem objectives, which are broad narrative statements with no measurable targets or limits, and working down (called "unpacking") to more specific objectives, with measurable targets or limits for which indicators can be chosen and monitored. Because there was a wide range of knowledge about ecosystem principles and theories present at the meeting, by starting with the top down approach, we were concerned that we would not be able to focus sufficiently to reach our objective in two days. We concluded that a more meaningful approach would be to discuss issues, threats or things that are likely to impact the proposed MPA, and from there discuss things that could be monitored (indicators) and then attempt to set some objectives (the "bottom-up" approach). In the two days of the workshop, we knew that for many objectives, actual targets, indicators and monitoring ideas would not likely be completed. So, we decided to focus on making sure participants understood the approach, had a full discussion of issues, threats that were important from their perspective, and came away with a few narrative "meeting statements" that could then be further refined into MEQ objectives.

We decided on four categories to establish break-out groups, selected in part because they represented parts of the ecosystem which would likely be represented within the MPA. Also they were broad enough so that based on the collective expertise at the workshop, we anticipated that we could have meaningful discussions on possible threats and issues pertinent to the proposed MPA.

Participants were assigned to one of four breakout groups:

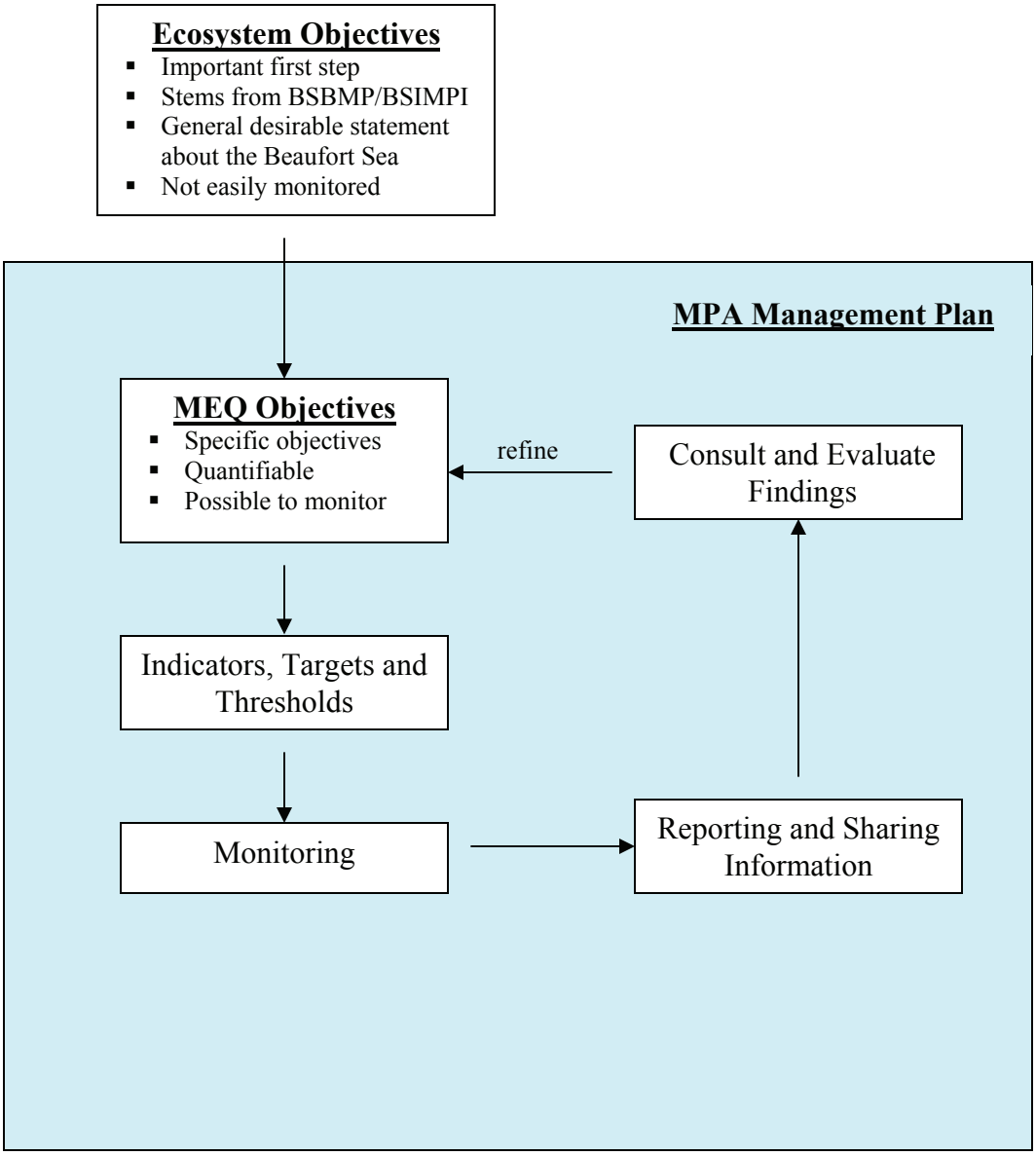
1. Beluga and Marine Mammals
2. Physical/Chemical Environment
3. Fish and Fish Habitat
4. Birds and other animals

Each breakout group began with a brain-storming session on types of stressors or issues of concern to members of that group. The next step consisted of a discussion on types of indicators that could be monitored to address the stressors or issues of concern. The list of potential indicators is very large, but given the constraints of working in harsh, remote environments, where monitoring programs can easily become cost prohibitive, we decided to test the relevance of the indicator against the list of stressors. Thus an indicator was considered useful if it was feasible, relevant in relation to the issues, but also relevant to the coastal communities and managers involved in the proposed MPA. Thus, by adopting the approach of discussing issues of concern, followed by discussions

around indicators that were relevant to address these concerns, it went a long way towards the working group taking the next step of developing a set of "meeting statements" (loosely termed MEQ objective for the purposes of this workshop) that could then be further refined with thresholds, targets, etc. by technical experts.

We felt that this approach, although not as linear as it might have been if a top-down approach had been taken, was the most effective means of reaching some meeting statements which had relevance to the participants of the workshop. The meeting statements can be tracked back to the indicator and stressor, thus when the technical experts move to the next step of developing thresholds and targets and MEQ objectives, they will have the contextual meaning behind each statement. Moreover, it was valuable to assess each of the indicators as to their relevance to addressing each issue, their practicability and meaningfulness to coastal community participants and managers.

**Figure 1: Schematic showing how MEQ Objectives fit into the proposed MPA Management Plan**



**RESULTS**

As discussed earlier in the Approach Section, our focus for this meeting was to have a full discussion with all the participants about marine stressors/issues and indicators and then to come away with meeting statements that could be later refined into MEQ Objectives. The final meeting statements as compiled by the facilitators are summarized below as per their respective groups.

***Note:*** "XX and YY" – Values to be determined by a future specialist group

**A. Beluga and marine mammals:**

1. Maintain the health of beluga – population and individuals;
2. Ensure levels of disturbance of marine mammals are low (aircraft and boats);
3. Maintain ecological processes (socializing, calving, feeding) in unchanged state;
4. Maintain important spawning events in east channel and Kugmallit Bay;
5. Maintain physical habitat important to whales moulting;
6. Maintain whale feeding habitat undisturbed;
7. Maintain mercury concentration in beluga below a safe level as established by technical experts;
8. Maintain organo-halogens below a safe level established by technical experts;
9. Understand changes in position, extent of pack ice at average levels;
10. Understand how animal sightings and distributions inform us about changes in climate and how animals adapt;
11. Maintain tissue incidence of colon cancer in marine mammals below a safe level of incidence established by technical experts; and
12. Maintain incidence of Brucella and other diseases in beluga, seals, below a safe level of incidence established by technical experts.

This working group had a discussion around importance of marine mammals to their cultures. Although strictly speaking these are socio-economic objectives, we felt it was valuable to capture these statements for future work. Value to communities placed on the above meeting statements included:

- Beluga are safe to eat;
- Enough beluga to eat;
- Beluga can be hunted; and
- A thriving beluga population.

**B. Fish and Fish Habitat:**

1. Ensure population and community structure (species, size, age, fecundity, condition, sex ratio) remains within a natural range of all species with emphasis on <u>important subsistence harvesting species</u> (cisco, char, broad whitefish, coney list to be completed) and <u>species valuable to beluga for food</u> (cisco herring);
2. Ensure historical timing and route of spawning/feeding migrations;
3. Ensure adequate supply of fish food organisms within natural range of variability; and
4. Ensure fish usability with contaminant levels at or below current levels, and ensure palatability (taste and texture) <u>to the satisfaction of traditional harvesters</u>.

As with the previous group, fish have a cultural importance to the Inuvialuit. The underlined statements are of socio-economic relevance, however we felt it important to capture these components for future reference, and to show the connectivity between the cultural and environmental components.

**C. Physical/Chemical:**

1. To maintain salinity within natural range during the ice-on period;
2. Minimize adverse sea floor alterations (bathymetry and sediment distribution etc.) within the proposed MPA caused by human activities;
3. Prevent changes to rates of coastal erosion beyond natural historic/current rates;
4. Contaminants in sediments and water not to exceed safe levels as determined by technical specialists;
5. Maintain airborne noise below levels that would significantly affect beluga behaviour (may need to have separate objective for inwater noise, and differences in background noise and short outbursts);
6. Maintain PAH levels in sediment at or below the lower of (1) existing levels or (2) some target as established by technical experts;
7. Minimize impacts in ice thickness, ice breakup, freeze up due to human activities.

**D. Birds and other Animals:**

1. Maintain healthy and stable populations of waterfowl and shorebirds and their habitat within the MPA;
2. Maintain the status of the MPA as currently exists by understanding the effects of climate change on bird and animal survival and productivity;
3. Migration pattern and habitat use and local abundance/diversity should not vary from long-term patterns;
4. Maintain contaminant levels in birds at an acceptable concentration;
5. Maintain water quality and waterfowl habitat at present levels: if negative change occurs, action to remedy change should be initiated;
6. Establish threshold of acceptable footprint size (e.g. 1% affected area limit in Kendall Island Bird Sanctuary) as established by specialists; and
7. Ensure access by tourism is restricted during important times (e.g. nesting, harvesting) through co-management.

## CONCLUSIONS

This workshop was successful for a number of reasons. It allowed traditional and scientific knowledge experts to exchange information about the Beaufort Sea, to discuss stressors/issues and indicators in the marine environment, to identify gaps in the knowledge and finally to set Marine Environmental Quality priorities for future research initiatives. The workshop was a first step towards developing MEQ Objectives for the proposed Marine Protected Area and that this ongoing collaboration between communities and scientists will result in a better understanding of the Beaufort Sea ecosystem. The workshop was challenging for a number or reasons. More time for the meeting, or a fuller discussion prior to forming break-out groups may have helped clarify

some of the concepts. Many participants were exposed to some of the concepts and terminology of the ecosystem approach for the first time, and they should be acknowledged for persisting and maintaining their focus. We hope that by reading the attached background papers, and reflecting on the discussions, that the participants will have a fuller understanding of the programs related to the proposed MPA. When we gather again in future meetings, the time and hard work spent at this workshop will pay dividends.

**NEXT STEPS**

Once the draft list of meeting statements is confirmed with the communities, there will be a series of workshops to further refine them into MEQ objectives. A workshop of technical experts will discuss possible indicators, the suitability of existing knowledge, available historic data, and work towards the development of the indicators to fit into an eventual monitoring program. Once this is completed, there will be a follow-up set of discussions with the communities to explain how the objectives, indicators and monitoring will contribute to an understanding of whether the MPA is meeting it's conservation objectives. Ongoing meetings and workshops will provide communities a chance to assess the monitoring results and evaluate whether changes to the management plan are required to better meet the objectives.

**ACKNOWLEDGEMENTS**

This workshop was a collaborative effort between Fisheries and Oceans Canada – Oceans Programs, and the Fisheries Joint Management Committee. Dr. Burton Ayles – FJMC facilitated the workshop. Break-out groups were facilitated by Kevin Bill, Lloyd Binder, Doug Chiperzak and Kelly Cott. All those who assisted in organizing the meeting, note-taking and other logistics are thanked. We thank Mr. Steve Newton for his assistance in the preparation of this report.

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**Documents are available from:*

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**APPENDIX 2: SUMMARY OF DAY ONE DISCUSSION ON STRESSORS/IMPACTS, INDICATORS TO BE TESTED FOR RELEVANCE, AND SUGGESTED MEETING STATEMENTS (MEQ OBJECTIVES) RELATED TO THE INDICATORS.**

***Note:*** "XX and YY" – Values to be determined by a future specialist group

| Stressors / Impacts | Indicators / Monitoring | MEQ Objectives |
|---|---|---|
| ***Group #1: Birds and Other Animals*** | | |
| Chronic Oil Spills<br><br>Climate Change<br><br>Noise (e.g. boats, construction, etc)<br><br>Increased hunting<br><br>Garbage<br><br>Air and water contaminants<br><br>Hydro-electric development<br><br>Tourism<br><br>Shipping<br><br>Dredging<br><br>New Permanent Structures | Monitor bird habitat and populations for:<br>▪ Sensitivity (e.g. geese during fall migration most affected by disturbance; birds further up the food chain affected by contaminants)<br>▪ Quality<br>▪ Migration patterns<br>▪ Change – utilize local/traditional knowledge of populations based on numbers returning to nesting colonies (e.g. Banks Island)<br>▪ Contaminants – determine trends and changes in concentration levels (e.g. heavy metals, PCBs, POPs in young-of-the-year birds (Red Throated Loons and Arctic Terns). Also, PAH levels in water and in sediments (to account for substances coming down river which may not be visible)<br>▪ Productivity – hatching and fledging success<br>▪ Exotic and invasive species<br><br>Monitor mink and fox for:<br>▪ timing and quality of fur (e.g. mink turns red within 1 week of sun)<br><br>Monitor tourism activities by restricting:<br>▪ access to certain areas during certain important times (e.g. important harvesting or nesting times).<br>▪ # of tourists visiting in area<br>▪ # of outfitting companies in area | To maintain healthy and stable population of waterfowl and shorebirds and their habitat within the MPA.<br><br>To maintain the status of the MPA as currently exists by understanding the effect of climate change on bird and animal survival and productivity. |

| | | |
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| | Suggestions:<br>▪ Monitoring should be done by local people incorporating local/traditional knowledge (hunters reporting to their HTC and involvement in programs like Arctic Borderland project).<br>▪ There needs to be a program developed to manage data collected by local people to integrate it with scientific results (e.g. Arctic Borderlands)<br>▪ Parks Canada keeps records of sightings made by people during the year ("Wildlife Card Database".<br>▪ CWS program (1985-90) could be re-initiated to re-establish baseline and build in as one component of a monitoring program.<br>▪ Hunters could be given kits to collect samples of birds when they are out doing regular hunting. | |
| ***Group #2 Physical / Chemical Group*** | | |
| Climate Change | Monitor changes in weather, including:<br>▪ Wind speed, precipitation, storm strength/frequency.<br><br>Monitor changes in ice conditions, including:<br>▪ Timing freeze-up/ breakup, Ice thickness, pack ice position, ice movement, shorefast ice.<br><br>Monitor changes in circulation patterns, including:<br>▪ Depth of current, change in tide, speed.<br><br>Monitor changes in water, including:<br>▪ Salinity, volume, speed, colour<br><br>Monitor changes in sediments and benthos | To collect baseline information from which indications of climate change could be identified. Climate change could modify conditions within the MPA so that they are no longer favourable.<br><br>To minimize adverse bathymetric alterations within the MPA caused by human activities.<br><br>To maintain salinity within the natural range during the ice-on period.<br><br>To prevent changes to rates of coastal erosion beyond the natural current/historic rates. |
| Dam building upstream on the Mackenzie River has potential to | Monitor dam related changes, including: | To prevent contaminant levels from exceeding a level to be |

| | | |
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| modify water conditions which could result in conditions that are not suitable for the wildlife species. | ▪ Water volume<br>▪ Sediments<br>▪ Contaminants<br>▪ Erosion<br>▪ Temperature<br>▪ Change in flow patterns/ flooding<br>▪ hydrology | determined by a future specialist group. |
| Dredging in open water<br><br>Trenching in the winter | Monitor level of disturbance, including:<br>▪ Ice scouring, frequency, turbidity, vessel noise, suspended particles, sedimentation, bathymetry, coastal erosion.<br><br>Monitor animals and habitat, including:<br>▪ Use, behaviour, populations.<br><br>Monitor contaminants, including:<br>▪ Presence, particle size, TSS (total suspended solids) | To minimize the impact of dredging and trenching in the MPA.<br><br>To establish thresholds of acceptable dredging and trenching footprint size (e.g. 1% affected area limit in KIBS). |
| ***Group #3 Beluga and Marine Mammals*** | | |
| Contaminants:<br>▪ Current-use compounds (PDB's) are now increasing in Arctic food chain.<br>▪ Uncontrolled use of Scotch Guard, Flame retardants;<br>▪ Air-borne pollution to Arctic;<br>▪ Bioaccumulation in biota.<br>▪ Brucella can infect beluga, seals, causing disease in humans | Monitor the impacts and indicators of contaminants, including:<br>▪ disease<br>▪ behaviour<br>▪ body condition<br>▪ Reproduction measures<br>▪ organo-halogens concentration in tissue of marine mammals<br>▪ Contaminants in milk<br><br>Monitor the incidence of Brucella, viruses, in beluga and seals. | To maintain health of beluga (population and individuals)<br><br>To maintain incidence of Brucella in beluga, seals, below a level to be determined by a future specialist group.<br><br>To maintain organo-halogens concentrations below a level to be determined by a future specialist group. |
| Tourism:<br>▪ Air traffic, especially low flights<br>▪ Boat traffic (e.g. Cruise ships affect ice leads) | Monitor tourism disturbance, including:<br>▪ Whale monitor reports for beluga hunting (e.g. flight times/locations)<br>▪ Borderlands co-op on-going monitoring (modify for low flights)<br>▪ Herschel Ranger log books record flights. Currently, hunter complaints are phoned in, (ad-hoc) mostly dealing w seals, whales. | To ensure levels of disturbance of marine mammals are low<br><br>To maintain ecological processes (socializing, calving feeding,) in unchanged state |

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| Dredging:<br>▪ Dredge spoils deposited in water.<br>▪ Remobilization of contaminants in sediments<br>▪ Impacts on beluga rubbing substrates | Monitor levels of mercury and other contaminants in the water.<br><br>Identify distribution of rubbing areas (TEK, sea-bed mapping) | To minimize the impact of dredging and trenching in the MPA.<br><br>To maintain physical habitat important to whales moulting |
| Disruption of bowhead in Shingle Point area | Monitor occurrences of bowhead along Yukon coast | To maintain whale habitat undisturbed |
| Climate change:<br>▪ Warming increases mercury release from soil and increased methylation.<br>▪ Less ice cover, more open water, more bromine released to air from water, more Hg from atmosphere deposited in water.<br>▪ Effects on ice floe, which in turn affects harvesting, animal behaviour and distribution | Monitor mercury concentration in the water.<br><br>Monitor forest fire frequency<br><br>Monitor permafrost melting<br><br>Monitor ice distribution, including:<br>▪ Breakup<br>▪ Extent of pack ice<br><br>Monitor abnormal changes in behaviour of animals | To maintain mercury concentration in beluga below a level to be determined by a future specialist group.<br><br>To understand changes in position, extent of pack ice at average levels<br><br>To understand how animal sightings and distributions inform us about changes in climate and how animals adapt |
| Oil in the environment taken up and metabolized by marine mammals causing colon cancer:<br>▪ Spills<br>▪ Drilling mud spills<br>▪ Feeder lines rupture releasing gas and light oils | Monitor the incidence of colon cancer (as base-line monitoring) prior to oil contamination.<br><br>Monitor the effects of oil on marine mammals, including:<br>▪ reproductive effects (not sure what these are).<br>▪ Change in growth (asymptotic length)<br>▪ Age of maturity<br>▪ Calving intervals<br>▪ Calf survival<br>▪ Pregnancy rates | To maintain tissue incidence of colon cancer in biota below a level to be determined by a future specialist group. |
| Seismic exploration:<br>▪ ship traffic, air traffic, dredging, underwater noise) | Monitor impacts of seismic exploration | To minimize the impact of seismic on the MPA |
| ***Group #4 Fish and Other Animals*** | | |
| Lack of baseline fish data | Evaluate harvesting studies results.<br><br>Monitor index gillnetting (e.g. Tariuq community based monitoring)<br><br>Evaluate other sampling methods<br><br>Monitor sport and subsistence fisheries | To ensure fish population and community structure (species, size, age, fecundity, condition, sex ratio) remain within a natural range of all species with emphasis on important subsistence harvesting species (cisco, char, broad whitefish, coney list to be completed) and species valuable to beluga for food (cisco herring). |

| | | |
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| | Comment:<br>▪ research on health of cisco (disease/parasites.<br>▪ Research on relationship between beluga and bird feeding and fish species abundance<br>▪ Research on basic biology of fish species<br>▪ Community based monitoring (e.g.Tariuq) | To ascertain the historical timing and route of spawning/feeding migrations. |
| Contaminants | Monitor contaminant levels and impacts on fish<br><br>Monitor key life history parameters e.g. gonad size, and reproductive potential.<br><br>Monitor the taste, texture of fish<br><br>Monitor range of fish types e.g. bullheads (sedentary), BWfish (important food) arctic cisco (blue herring), char (dolly varden) (migratory) | To ensure fish usability with contaminant levels at or below current levels, and ensure palatability (taste and texture) to the satisfaction of traditional harvesters. |
| Dredging:<br>▪ Smothering of blue herring eggs in early July | Monitor density of larval fish in Kugmallit Bay<br><br>Use science and TEK to document extent and duration of fish spawning in east channel and Kugmallit bay. | To maintain important spawning events in east channel and Kugmallit bay unharmed. |

## APPENDIX 3: WORKSHOP AGENDA

**Day 1**

| | |
|---|---|
| 9:00-9:15 | Welcome (ISR Coordinator), Opening Prayer (elder), Comments by SMC member. |
| 9:15-9:45 | Purpose of Workshop (workshop facilitator - Burton Ayles) |
| 9:45-10:00 | Why an MPA and MEQ objectives (Hal Mills/Don Cobb) |
| 10:00-10:15 | Coffee |
| 10:15-10:55 | The proposed MPA as part of the ecosystem of the SE Beaufort Sea (Jack Mathias) |
| 11:00-11:30 | Inuvialuit perspectives of the SE Beaufort and the proposed MPA (TBA) |
| 11:30-11:45 | Questions or comments on presentations |
| 11:45-12:00 | Agenda for afternoon – Setting MEQ Objectives for the proposed MPA (Burton Ayles) |
| 12:00 – 1:00 | Lunch (provided) |
| 1:00 – 1:15 | Plenary – B. Ayles |

**Review/Agreement on Proposed Broad Ecosystem Objectives which have resulted from discussions by BSIMPI, and which help support the Specific Goals of the Beaufort Sea Beluga Management Plan. From this list, we will now begin to develop more specific MEQ objectives for the proposed MPA**

Specific Goals of Beaufort Sea Beluga Management Plan (FJMC, 2001)

1. To maintain a thriving population of beluga in the Beaufort Sea.
2. To provide for optimum sustainable harvest of beluga by Inuvialuit.

Broad Ecosystem Objectives which support the BSBMP:

1. To protect beluga and their habitat within the proposed MPA.
2. To protect biodiversity of important marine and anadromous fish stocks and other plants and animals within the proposed MPA.
3. To protect the biological productivity of important marine and anadromous fish and other plants and animals within the proposed MPA.
4. To maintain the quality of the marine environment within the proposed MPA.

1:15 – 1:30 Plenary – B. Ayles
**Review of the process for the afternoon sessions**

1:30 – 4:15 Breakout Sessions

**Session purpose:**

- Discuss what things might impact on the health (e.g. beluga, fish etc.) of the proposed MPA.
- Discuss indicators to monitor the health of the proposed MPA.
- Develop MEQ objectives for the proposed MPA which are more specific than the four broad objectives (above).

**Details of Plans for Breakout Groups**

There will be four breakout groups

1. Beluga and Marine Mammals
2. Physical/Chemical Environment
3. Fish and Fish Habitat
4. Birds and other animals

(People will be assigned to groups, but are free to move if they feel more comfortable).

**What are we going to do:**

Each group will address the following in reference to the proposed MPA:

- Discuss and develop a list of possible impacts related to their category.
- Prepare a short statement of effect of impact on their category (i.e why do we need to monitor).
- Discuss and list indicators of the effect of impact which could be monitored for their category.
- Develop an MEQ objective which the indicator would address.

This can be viewed in a matrix format as follows:

| Group | Impact on your group | Statement of effects | What to monitor (indicator) | MEQ objective |
|---|---|---|---|---|
| Beluga and Marine Mammals | | | | |
| Physical/Chemical | | | | |
| Fish and Fish Habitat | | | | |
| Birds and Other Animals | | | | |

4:15 – 4:30 Plenary
Brief report by rapporteurs on progress in first day.

**Day 2. October 29**

Note: the agenda for day 2 will evolve depending upon the progress from day 1.

9:00-9:30 Breakout groups reconvene:
review summaries prepared by rapporteurs/facilitators and establish priorities for monitoring. (Note: If the previous day's work has not been completed by all groups this session may be extended to allow them to complete.

9:30-10:30 Plenary – Reports from rapporteurs on results from the sessions. Priority indicators, suggested MEQ objective, and rationale for monitoring indicator. 15 min each

11:00-11:20 Don Cobb Report summarizing current monitoring programs and setting the scene for the next session

11:20-11:30 Burton Ayles – Instructions for next session

In the second breakout session the same groups will consider the proposed indicators further in terms of the following:

- Ongoing or extension of ongoing program (agency monitoring)
- Community involvement
- Cost effectiveness (high, low, practicality)
- Time Scale (daily, annual, every 5 years, etc.)
- Protocols (do they exist or need to be developed)
- Information gaps.

11:30 – 12:00 Breakout groups

12:00 – 1:00 lunch (provided)

1:00 – 2:00 Breakout Groups continue
At the end of this session we will have a list of indicators with a clear rationale for each and an assessment of each against various criteria above. These indicators should provide the necessary input for focused technical expert groups to draft more detailed targets, thresholds, etc.

2:00 – 3:00 Report back and group discussion on MEQ objectives.

3:00 – 3:30 Wrap up, summary and next steps (Burton Ayles).

## APPENDIX 4: LETTER OF INVITATION

To whom it may concern,

**Re: Invitation to participate in setting Marine Environmental Quality objectives for proposed Marine Protected Area in the Beaufort Sea**

On behalf of the Beaufort Sea Integrated Management Planning Initiative Working Group and the Fisheries Joint Management Committee, you are invited to participate in setting marine environmental quality (MEQ) objectives for the proposed MPA in the Beaufort Sea. This workshop will occur from October 28-29 at the Midnight Sun Recreation Centre in Inuvik. Attached is some background material and a draft agenda.

We have sent you this invitation because you have special knowledge which will be of great value in setting these marine environmental quality objectives, and in defining indicators and monitoring in the MPA once it is established. The marine environmental objectives selected at this workshop will contribute to the broader management plan for the Marine Protected Area.

We would appreciate a response whether you or an alternate from your agency plan to attend the workshop before October 3, 2003. If you have any questions please call/email/fax to the addresses below, or contact Gina Elliott @ (867) 777-7504. We look forward to seeing you in Inuvik in October.

Sincerely,

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## APPENDIX 5: THE PROPOSED MPA AND MEQ IN THE CONTEXT OF THE BEAUFORT SEA

**J. Mathias**
**Fisheries & Oceans Canada**

### The Proposed MPA

The world's largest summering stock of beluga whales congregates in the Beaufort Sea. The Beaufort Sea Beluga Management Plan aims to protect these beluga populations, their habitat and traditional harvesting by the Inuvialuit. The areas afforded maximum protection under the Plan are designated Zone 1a areas and defined as 'Traditional Harvesting/Concentration Areas'. The three Zone 1a areas, namely Shallow Bay, Kugmallit Bay, and the vicinity of Kendall Island, together comprise approximately 1,742 square kilometres of mostly shallow (less than 2 m), warm brackish and highly turbid waters at the head of the Mackenzie Delta.

The Zone 1a areas are currently an Area of Interest (AOI) under consideration as a marine protected area (MPA) under the Oceans Act. As part of the MPA candidacy process specified in the National Framework for Establishing and Managing Marine Protected Areas, the Beaufort Sea Integrated Management Planning Initiative (BSIMPI) Working Group initiated assessments of the ecological (North South 2002), social, cultural and economic environment (Kavik-AXYS, 2003) of the proposed MPA, as well as of the technical merits of the proposal."(Elliott 2002). The BSIMPI Senior Management Committee has endorsed proceeding towards MPA status.

The National Framework for Establishing and Managing Marine Protected Areas (Canada DFO, 1999) stipulates that a management plan shall be developed for the MPA. The management plan will provide details on how the MPA will be managed, including the social and environmental objectives for the MPA. This paper deals with the environmental objectives.

### The ecosystem context of the proposed MPA

An ecosystem can be defined as "Any unit that includes all of the organisms (i.e., the community) in a given area interacting with the physical environment so that a flow of energy leads to a clearly defined trophic structure, biotic diversity, and material cycles (i.e. exchange of material between living and non-living parts) within the system." (Odum, in Cunningham et al. 1994). Appendix 1 provides further comment on the definition for 'ecosystem' as well as on other terms related to marine environmental quality.

***Mackenzie Estuary Ecosystem Scale:*** Marine ecosystems exist at a variety of spatial scales often nested one inside another. Generally ecosystem properties at a larger scale influence ecosystems at a smaller scale. For example the proposed MPA is a part of the

Mackenzie Estuary ecosystem (Fig. 1), characterized as a mixture of marine water from the Beaufort Sea and by the freshwater influence of the Mackenzie River.

At the estuary scale the main influences on the proposed MPA come from the Mackenzie river itself; its freshwater—and the nutrients, sediments, heat and contaminants it carries, and from industrial activities arising from oil and gas development. Figure 1 indicates the extent of marine and air traffic related to oil exploration on the Beaufort shelf in 1985.

***Beaufort Shelf Ecosystem:*** The estuarine ecosystem is itself contained within the Beaufort Shelf ecosystem (Fig. 2) that includes the continental shelf from Banks Island in the east to Point Barrow, Alaska in the west. The Beaufort Shelf ecosystem is characterized by a receding ice edge in spring and open water in the summer, providing higher productivity than the adjacent Canada Basin ecosystem to the north, but lower productivity than the Mackenzie River Estuarine ecosystem. The primary productivity of the shelf ecosystem is thought to be enhanced further by upwelling of colder, nutrient-rich water from below the edge of the continental shelf, caused by shelf currents flowing over the breaks in the continental shelf at Amundsen Gulf and at the Mackenzie Canyon.

A narrow band of brackish water lies along the whole southern coast of the Beaufort Sea. It originates from freshwater outflow of the Mackenzie and other coastal rivers and combines with easterly-flowing, low salinity water originating from the Bering Sea, providing a corridor for the migratory movements of anadromous fish species along the coast. The corridor is continuous with the Mackenzie River through the Shallow Bay and Kugmallit Bay so migrating fish pass through these parts of the proposed MPA as they move in and out of the River during spring and fall (Fig.2).

Upwelling occurs on the Beaufort Shelf where there are major discontinuities in the sea-bed such as at Cape Bathurst and at the Mackenzie Canyon near Herschel Island, and along fronts between water masses of differing temperature or salinity. Upwelling, detected by satellite as signatures of water colour, chlorophyll a fluorescence and/or temperature, is associated with elevated Chlorophyll levels that indicate high productivity. Satellite images have also shown that important congregations of bowheads occur in upwelling areas. Such areas are known for high zooplankton abundance (Borstad, 1985).

***Beaufort Sea Ecosystem:*** Viewed from an even larger perspective the Beaufort Shelf ecosystem is seen to be a part of the larger Beaufort Sea, outlined in Figure 3. At this scale, several large scale elements come into focus that impact upon the proposed MPA. For example, this scale emphasizes the impact of the Mackenzie River drainage basin upon the estuary, the Beaufort Shelf and even the Beaufort Sea. Also apparent is the extent of the pack ice which is important to the well-being of polar bears and the ringed seals on which they feed. A third element that comes into focus at this scale is the migration route of beluga and bowhead whales into the Beaufort Sea. It emphasizes the linkage between the Beaufort and the Bering Seas, and reminds us that contaminants and disease that may be detected in beluga tissues from the Beaufort Sea do not necessarily originate there.

***Arctic Ocean Ecosystem:*** Finally, at the largest ecosystem scale, the Arctic Ocean scale, the importance of the Arctic Ocean drainage basin and the Beaufort Gyre can be appreciated (Fig. 4). The Arctic Ocean is a land-locked sea in which the area of the land drainage basins exceeds the area of the Ocean itself. This is in contrast to the rest of the world oceans where land drainage area are is only about a third of the area of the oceans. The Beaufort Gyre is a counter-clockwise circulation of the top 50 m water layer of the ocean, which 'traps' surface water, delaying its exit from the Arctic Ocean by as much as 5 years longer than surface water over the north pole for example. In this way it acts as a concentrating mechanism for contaminants dissolved in surface ocean water, which have been carried to the Arctic and deposited on the ice by global atmospheric circulation patterns. These contaminants, originating far beyond the Arctic Ocean, nevertheless impact the biota of the Mackenzie River Estuary ecosystem and the proposed MPA within it.

**Measuring the Health of Ecosystems.**

People in the Arctic rely heavily on marine ecosystems to provide an abundance of wildlife, fish and marine mammals. Everyone can agree that they want to maintain a healthy marine environment, but how can this be assured? It can be done by setting specific objectives for the quality of the marine ecosystem, and then choosing measurements that indicate whether or not the objectives are being met. If objectives are not met because of the way people use the ecosystem, then use patterns must be modified. There are many examples from around the world and in Canada to guide the choice of good indicators of marine environmental quality. The first step in choosing one is to decide upon the general health objectives for the marine ecosystem. The second step is to choose a more operational objective (MEQ Objective) that can be monitored and that will show the state of ecosystem health. A third step is to define a measurable indicator that measures the MEQ objective. The last step is to identify a threshold level of the indicator that will tell us when human use must be modified. Table 1 shows these steps, explains them, and provides examples.

**Table 1. Steps for Setting Environmental Monitoring Objectives**

| Steps | Terminology | Explanation | Example |
|---|---|---|---|
| 1. Set objective for health of marine ecosystem | **Ecosystem Objective** | A general condition desirable for health of the ecosystem (qualitative) | Ecosystem Objective = **To maintain a thriving population of beluga in the Beaufort Sea** |
| 2. Set measurable objective for health of marine ecosystem | **Marine Environmental Quality Objective** | Specific objective for a marine ecosystem that can be measured (quantitative) as one of the components of a MPA management plan | MEQ Objective = **Maintain the beluga population in the proposed MPA at its historical levels** |
| 3. Choose measurement for the | **Indicator** | A measurement that indicates whether the MEQ Objective is being | Indicator = **Numbers of beluga** |

| | | | |
|---|---|---|---|
| MEQ objective | | met | **returning** |
| 4. Choose a desirable level for the indicator | **Threshold** level | If the numbers of beluga fall below the historical range, then management action is taken. | Threshold level = **Historical data needed for "normal range"** |

If we were to consider a snow machine to be like an ecosystem, then our ecosystem objective would be "to maintain the snow machine in good running condition". But to maintain the machine in "good running condition" there are a number of more operational objectives we can think of, for example, "maintain sufficient fuel", or "ensure headlight is working". These would be like MEQ objectives. Monitoring is the systematic tracking of an indicator to determine whether it is changing. Monitoring an indicator means measuring that indicator over the long term to see how it changes in relation to some threshold level. The threshold level signals when management action should be taken. For example, the rider of a snow machine monitors the gas gauge (indicator) to see where it is in relation to the EMPTY sign (threshold). When the indicator reaches the threshold, he takes management action and 'fills up the tank'.

An ecosystem Objective describes a general condition for a large marine ecosystem such as the Beaufort Sea as in Table 1. However in order to be measurable and monitored as part of a MPA management plan the objective must be made more specific. In this form it is called a MEQ (Marine Environmental Quality) objective.

MEQ objectives refer to some condition of the environment and not to human or industrial activities. They are always tied to a particular marine ecosystem and a specific management plan. If the plan has legal authority then the MEQ objectives within the plan have greater weight than otherwise. Even then, in most cases MEQ objectives will be non-regulatory and will only provide direction for the management of human activity. The value of an MEQ objective lies in its service for management purposes. MPA management plans that contain MEQ objectives can call for corrective action once an MEQ threshold level has been exceeded for that specific ecosystem. Since MEQ objectives linked to specific ecosystems can be measured, and are monitored for management purposes, they are an ideal means for reporting on the state of the marine environment and for defining the management system.

In some cases a threshold level that triggers management action does not make sense for an indicator. For example, suppose the objective for ecosystem health were to maintain the position of the summer pack ice edge within its historical range. There are two problems with defining a threshold for this objective. First, the threshold is not a single value, but a range within which we want the ice edge to vary from year to year. Secondly, there may be no management action that can be taken if the ice edge distribution begins to move outside its long term range. Nevertheless, this indicator is still worth monitoring, because it helps us to understand the extent of global climate change, which may have a strong impact on other indicators we are measuring.

In other cases, it may not be possible to specify an indicator at all. For example, an important indicator for the proposed MPA would be the population size of western Arctic beluga whales. For a number of reasons we cannot measure this parameter with accuracy, and it is impossible to set a threshold. Nevertheless it is still worth monitoring an index of the relative abundance of whales in the MPA. Subsistence hunters have a general idea of the density of whales in the Mackenzie Estuary from year to year. The trend in the relative abundance of whales over 10 or 15 years will indicate whether the whales continue to use the estuary, and other measures may inform us about the health of the beluga population.

**MEQ Guidelines and Standards**

MEQ objectives describe "desirable" conditions for ecosystems, and associated indicators and threshold levels signal when management action is required to meet MEQ objectives. However what will steer management actions so that MEQ objectives are met? There are two types of guidance: MEQ Guidelines and MEQ Standards. Guidelines are process documents or 'best practices' procedures that when followed, reduce the ecosystem impacts of specific industrial sectors or human activities. MEQ guidelines or criteria provide supplementary direction and guidance to ensure that an MEQ objective can be attained.

Enforceable MEQ standards could be prescribed as a regulation to meet a MEQ objective under the Oceans Act. However, in most instances this would be unlikely to happen because other federal or provincial legislation has traditionally been the mechanism for making and enforcing regulations to protect the marine environment. It is far more likely that DFO would work with other regulatory agencies to ensure that they enforce legislation relevant to MEQ objectives in management plans, rather than to set new MEQ standards. Nevertheless, where regulatory legislation does not exist, Oceans Act MEQ standards could be used to introduce an enforceable standard (e.g. an MEQ standard to protect marine mammals from excessive noise disturbance within an MPA if MEQ objectives in the management plan are not being met).

**Ecosystem Objectives Applied to the Proposed MPA**

In defining broad ecosystem objectives for the proposed MPA it is useful to examine the goals of Beaufort Sea Beluga Management Plan (FJMC, 2001). The first goal:

***"To maintain a thriving population of beluga in the Beaufort Sea"***

provides a useful vision to guide some of the MEQ objectives for the proposed MPA. The second goal:

***"To provide for optimum sustainable harvest of beluga by Inuvialuit"***

will be included in the management plan for the proposed MPA as an important socio-economic objective, but not as an ecosystem objective, because it addresses the social and economic concerns but not the ecosystem directly. In support of the Beaufort Sea

Beluga Management Plan the BSIMPI Working Group listed the following objectives which do address the ecosystem in the proposed MPA:

1. ***To protect beluga and an important part of its habitat.***
2. ***To protect Marine Environmental Quality within the MPA***
3. ***To protect biodiversity and biological productivity within the MPA.***

These objectives can provide a valuable framework for MEQ monitoring. They could be considered as ecosystem objectives, as shown in Table 2, column 1. The second column of Table 2 suggests how MEQ objectives could be used to make the ecosystem objectives more specific. The third column of Table 2 provides indicators that could be monitored to see whether the MEQ objectives are being met.

**Table 2. A Framework for Monitoring in the proposed Marine Protected Area**

| Ecosystem Objectives | MEQ Objectives | Indicators |
|---|---|---|
| Protect **beluga** of the Mackenzie Delta (Estuary) | Maintain the beluga population in the estuary at its historical levels | Numbers of beluga returning |
| | Maintain the health of beluga whales | Tissue concentration of contaminants<br>Incidence of disease |
| Protect part of the **beluga habitat** in the Mackenzie Delta (Estuary) | Ensure that the estuary habitat remains suitable for beluga | Indicators of disturbance of beluga; avoidance, fleeing |
| Protect the **biological Diversity** within the proposed MPA | Maintain species and relative numbers of anadromous fish at historical levels | Number of species; relative numbers of each fish species; food diversity |
| Protect the **Biological Productivity** within the proposed MPA | Maintain the density of anadromous fish species at historical levels | Catch per unit effort, size, growth of each species<br>Success of juvenile birds fed with marine fish |
| Maintain the **quality of the marine environment** within the proposed MPA | Conserve shoreline structure | Coastal erosion |
| | Maintain water physical properties within historical levels | • Ice cover distribution<br>• Tides, waves, fetch, currents<br>• Stratification<br>• Temperature<br>• Underwater noise<br>• Terrestrial/ watershed inputs of organics, sediment |

| Table 2. A Framework for Monitoring in the proposed Marine Protected Area | | |
|---|---|---|
| **Ecosystem Objectives** | **MEQ Objectives** | **Indicators** |
| | Maintain water quality within historical levels | Salinity<br>Nutrients<br>Contaminants<br>dissolved gases |
| | Maintain biota quality within recommended levels | Contaminant loads<br>• POP's<br>• PAH's<br>• Heavy metals<br>• Bioaccumulation<br>Health of animals |

To choose useful indicators, we must consider five questions:

1. How will the indicator be used in managing marine resources?
2. Is it technically and logistically feasible to measure the indicator?
3. Can the indicator be measured with accuracy and precision?
4. Is there a history of information to tell us what the normal status for the indicator is?
5. What is the cost of monitoring, and is it already being done?

These questions can probably be answered by a combination of traditional ecological knowledge and scientific knowledge, and the 'Workshop on MEQ Objectives for the proposed MPA' will provide a venue to bring this information together.

## The Usefulness of Ecosystem Indicators in the Western Arctic

Many ecological factors that affect the proposed MPA and its resources originate from beyond its boundaries. These factors include: climate change, long range transport of atmospheric pollutants, long range transport of water-borne contaminants and nutrients (ocean circulation, Mackenzie River), and hydrology changes associated with potential upstream hydroelectric development. As well, fishery stocks, beluga, bowhead, polar bears and ringed seals are subject to harvest outside the proposed MPA and because of their migratory nature, are potentially exposed to contaminants outside it. Polar bears and seals, though they move through the proposed MPA, depend heavily upon the distribution of sea ice, which is affected by climate at the global scale. For this reason, some indicators of ecosystem health within the proposed MPA will have to be measured outside the MPA. A good example would be the monitoring of the annual pack ice position by satellite imagery.

Some indicators don't seem to be very important to people, yet they may be very sensitive indicators of marine productivity, upon which people depend. For example, the success of seabirds in raising their young on islands in the Pacific Ocean bears little outward relation to the success of commercial fisheries there. Yet it has been shown that fledgling success is closely related to the abundance of forage fish in offshore waters, and it is much easier to measure the birds than to estimate abundance of these small food fish that support the commercial species. In a similar way, the fledgling success of birds that eat marine fish might be used in the Beaufort Sea to measure the productivity of forage fish from year to year. Forage fish are thought to be important for the well-being of beluga and anadromous fish that feed along the coast.

Many indicators of ecosystem health in the proposed MPA are affected by large-scale oceanographic and atmospheric climate events. For these indicators, there is not likely to be a clear, simple management action that could be taken to correct matters if the indicator varied beyond its historical range. In some cases even the historical range on an indicator may be unknown. Nevertheless, it remains important to monitor these indicators in order to interpret changes that are likely to occur in the proposed MPA. Where no historical record exists for an indicator the monitoring will provide one, given a long-term commitment to measurement. If the marine protected area were designated, its management plan could institutionalize the monitoring of indicators to show change in the marine ecosystem of the western Arctic. 'State-of-the Ocean' reporting of these indicators might be used by a variety of agencies to make adjustment to resource management plans.

## APPENDIX 1: SOME MEQ DEFINITIONS

***Ecosystem:***

Ecosystem is a broad concept that can be approached from many different perspectives, but two common themes running throughout most definitions are that both organic (biotic) and non-organic (abiotic) components must be considered, and that interactions among the different components, including humans, have to be considered. A useful current view is that ecosystems exist at all scales and within any chosen boundaries; the ecosystem is thus a function of the objectives of the study or exercise. Ecosystem boundaries are usually based on physical features, which are the framework for the biological life and the ecosystem as a whole.

*"Any unit that includes all of the organisms (i.e., the community) in a given area interacting with the physical environment so that a flow of energy leads to a clearly defined trophic structure, biotic diversity, and material cycles (i.e. exchange of material between living and non-living parts) within the system."* (Odum, in Cunningham et al. 1994)

***Ecosystem approach:***

An ecosystem approach is usually a synonym for an integrated or holistic approach to ecosystem management. It recognizes the complexity of ecosystems and the interconnections among component parts.

*"An ecosystem approach involves comprehensive and holistic consideration and assessment of the state of the environment. This approach recognizes the complexity of ecosystems and the interconnections among component parts, and acknowledges that people are part of ecosystems." (modified from Environment Canada, 1996)*

***Ecosystem-based management:***

Ecosystem-based management is synonymous with applying an ecosystem approach to management. Ecosystem-based management does not imply an attempt to manage ecosystems by humans, but rather to manage human impacts on ecosystems.

*"The management of human activities so that ecosystems, their structure, function, composition, and the physical, chemical and biological processes that shaped them, continue at appropriate temporal and spatial scales." (Canadian Biodiversity Strategy, Environment Canada, 1995)*

***Ecosystem Health:***

Ecosystem health is viewed as a state of ecosystem well-being which implies that ecosystem structure and function are maintained over time, such that the ecosystem is sustainable. Ecosystem health is thus a state or condition of the ecosystem which is closely linked to sustainability and integrity, the latter being essential ingredients to realize healthy conditions. This agrees with the following definition, from Lehman and Tilman (2000):

*"Ecosystem health is the capacity for self-maintenance, for resistance to stress and for resilience following degradation. What is actually maintained is a set of essential components and rates of energy transfer between components. Diversity can be viewed as one essential element of ecosystem health and productivity."*

***Ecosystem Integrity:***

Ecosystem integrity, also referred to as ecological integrity, has a number of definitions. The concept of ecological integrity is closely linked to that of ecosystem health, with the view that a number of key states (components, properties and processes) must be intact for an ecosystem to persist in a stable state, or more appropriately within limits of natural fluctuations.

*"ecological integrity means, with respect to a park, a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes." – from Canada National Parks Act 2002)*

***Ecosystem Objective:***

Ecosystem objectives (ecosystem-based management objectives) are set for aspects of marine ecosystem structure and function (productivity, key species, sensitive habitats etc.) which should not be compromised. They describe a desired physical, chemical or biological condition of the ecosystem or of one of its constituents that must be maintained over time. They may also be expressed as limits, where an ecosystem condition should be avoided. Surpassing these limits will trigger management actions.

Ecosystem objectives may be set at various levels of detail (conceptual objectives generally establish desired conditions; measurable objectives are designed to allow for monitoring, and operational objectives relate to concrete implementation measures). Ecosystem objectives will be set for Large Ocean Management Areas.

***Marine Environmental Quality:***

Marine environmental quality: *"... is an overall expression of the structure and function of the marine ecosystem taking into account the biological community and natural physiographic, geographic and climatic factors as well as physical and chemical conditions including those resulting from human activities."* (Skjoldal, 1999)

***Marine environmental quality guideline:***

The terms MEQ guideline and criteria are similar and often used interchangeably. An MEQ guideline or criteria is a numerical value or narrative statement for physical, chemical or biological characteristics of water, biota, soil, or sediment that must be respected to protect and maintain healthy marine ecosystems.

MEQ guidelines or criteria are linked to a particular MEQ objective to enhance the implementation of the objective. MEQ objectives, guidelines or criteria are all narrative or numeric statements about ecosystem structure and function intended to influence human activities (i.e. they are non-regulatory). However, MEQ objectives are always tied to a specific Integrated Management or Marine Protected Area plan - while MEQ guidelines or criteria may be plan specific or may apply broadly to areas outside of an IM/MPA plan. MEQ objectives will tend to focus on describing "desirable" conditions for ecosystems, while MEQ guidelines or criteria focus on controlling the ecosystem impacts of specific industrial sectors or human activities. MEQ guidelines or criteria provide additional direction (guidance) to ensure that an MEQ objective can be attained.

***Marine environmental quality objective:***

A numerical value or narrative statement describing a desired condition for a given ecosystem, taking into account ecological characteristics. MEQ objectives are set with the long-term preservation of marine ecosystem structure and function in mind. MEQ objectives can be derived from broader assessment information such as ecosystem objectives. MEQ objectives are always tied to specific IM or MPA management plans and have the same legal authority as the plans.

***Marine environmental quality standard:***

A legally enforceable numerical limit or narrative statement, such as in a regulation, statute, contract, or legally binding document, that has been adapted from an MEQ objective (or rarely, an MEQ guideline or criteria). MEQ standards or requirements are created as regulations under the *Oceans Act.*

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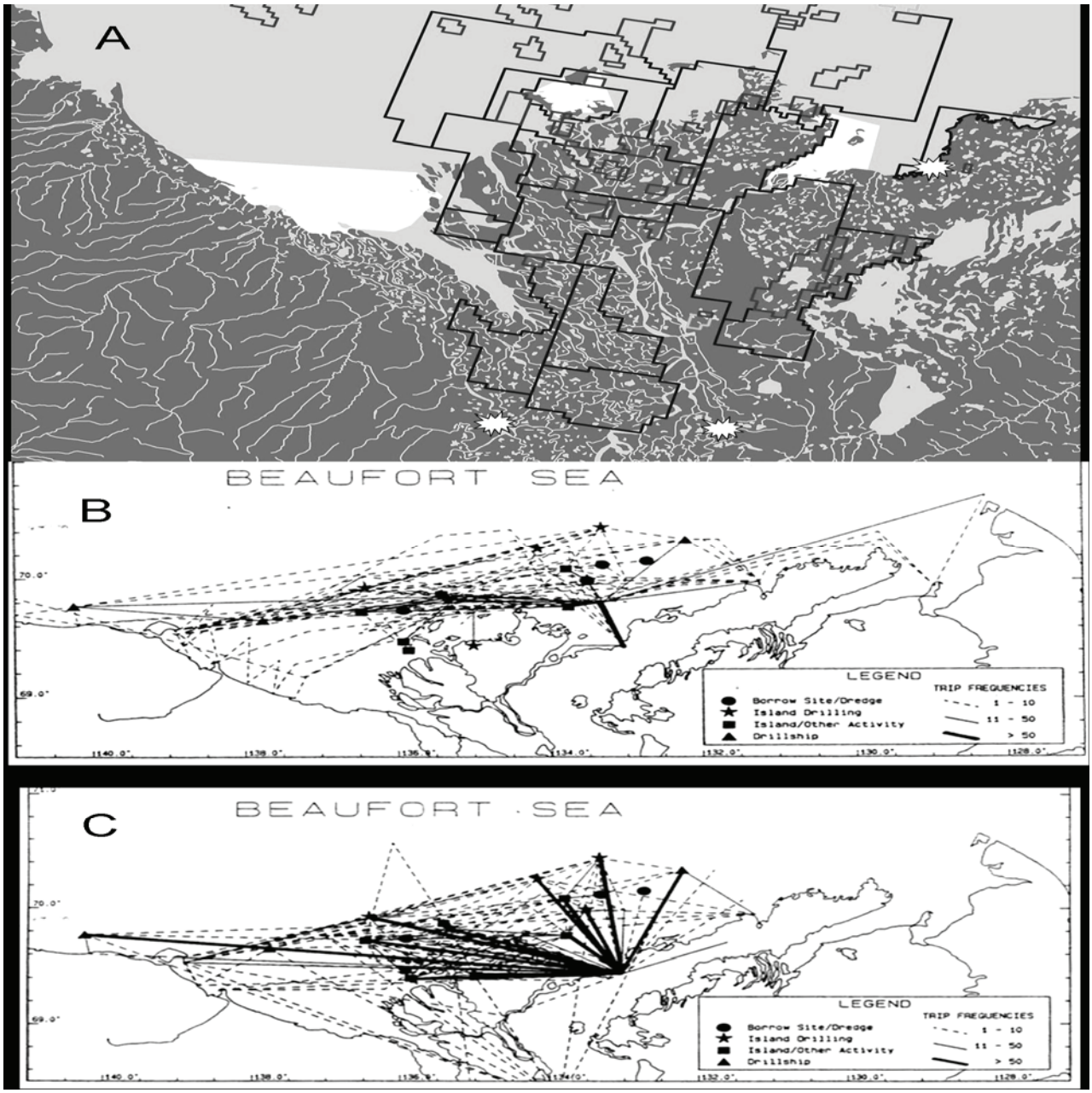


Figure 1. Mackenzie Estuary.

A. Oil and gas exploration lease and significant discovery licences are shown in dark lines, MPA areas of interest are shown in white shading; Shallow Bay to the west, Kugmallit Bay to the east, and Kendall Island marine area in the centre. Stars indicate major towns of Aklavik, Inuvik and Tuktoyaktuk.

B. Extent of vessel traffic out of Tuktoyaktuk associated with oil and gas exploration between August 1 and September 10, 1985.

C. Helicopter traffic out of Tuktoyaktuk and Inuvik for the same period and purpose.

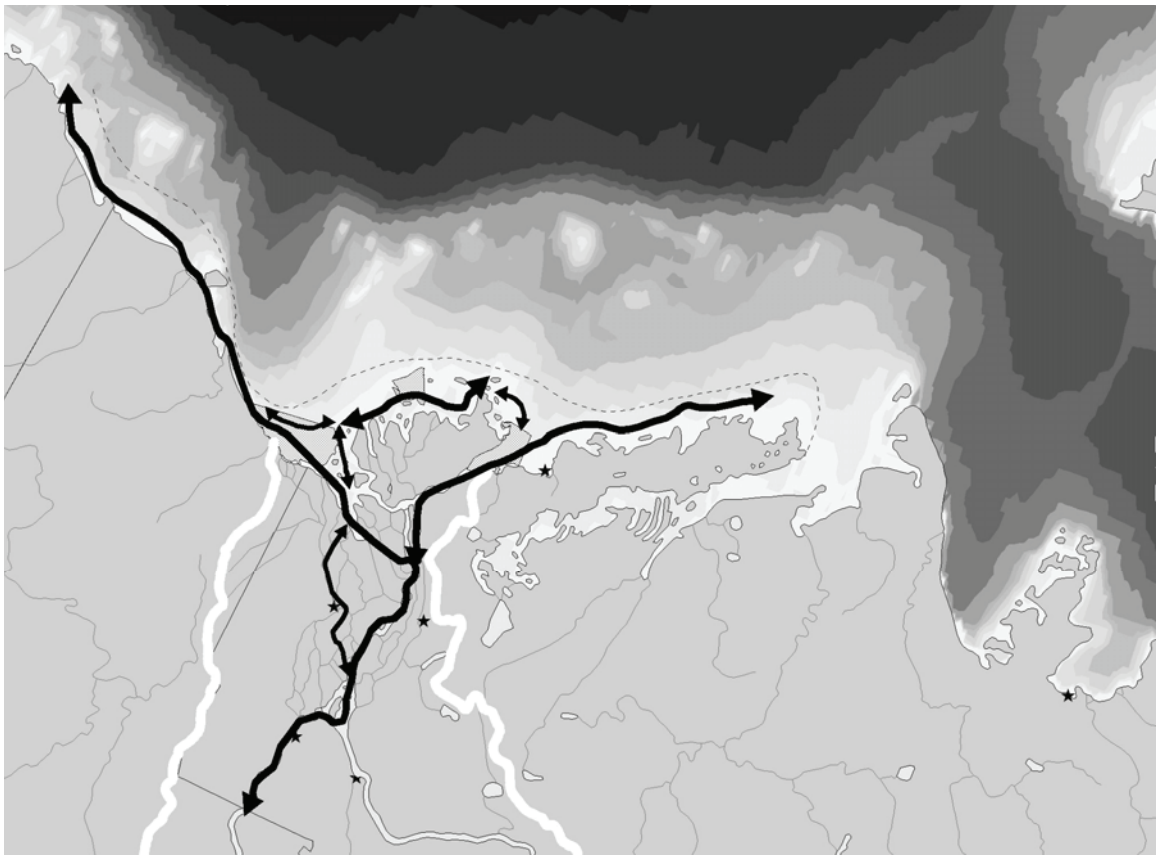

Figure 2. Beaufort Shelf.

Proposed MPA shown as speckled areas. Black arrows show generalized movements of anadromous fish through proposed MPA (after Craig, 1984). Broken line indicates approximate outer limit of low-salinity coastal water (<20 ppm, after Wacasey, 1975). White line shows limit of Mackenzie River drainage basin.

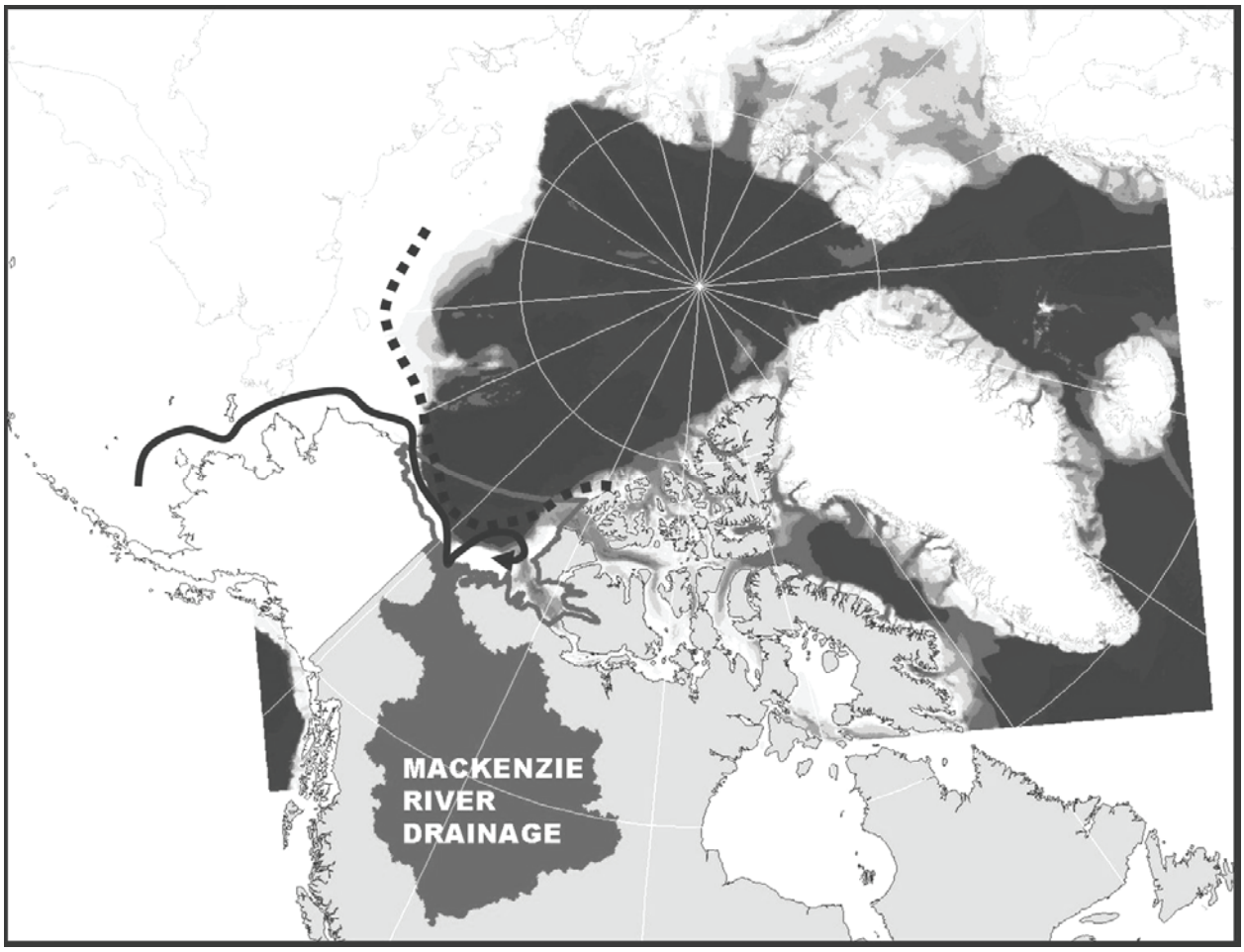


Figure 3. Beaufort Sea.

Beaufort Sea, Amundsen Gulf and Mackenzie River drainage basin discussed in this paper. Black solid line with arrow indicates approximate migration route of beluga whales in spring. Black broken line illustrates approximate extent of pack ice in summer.

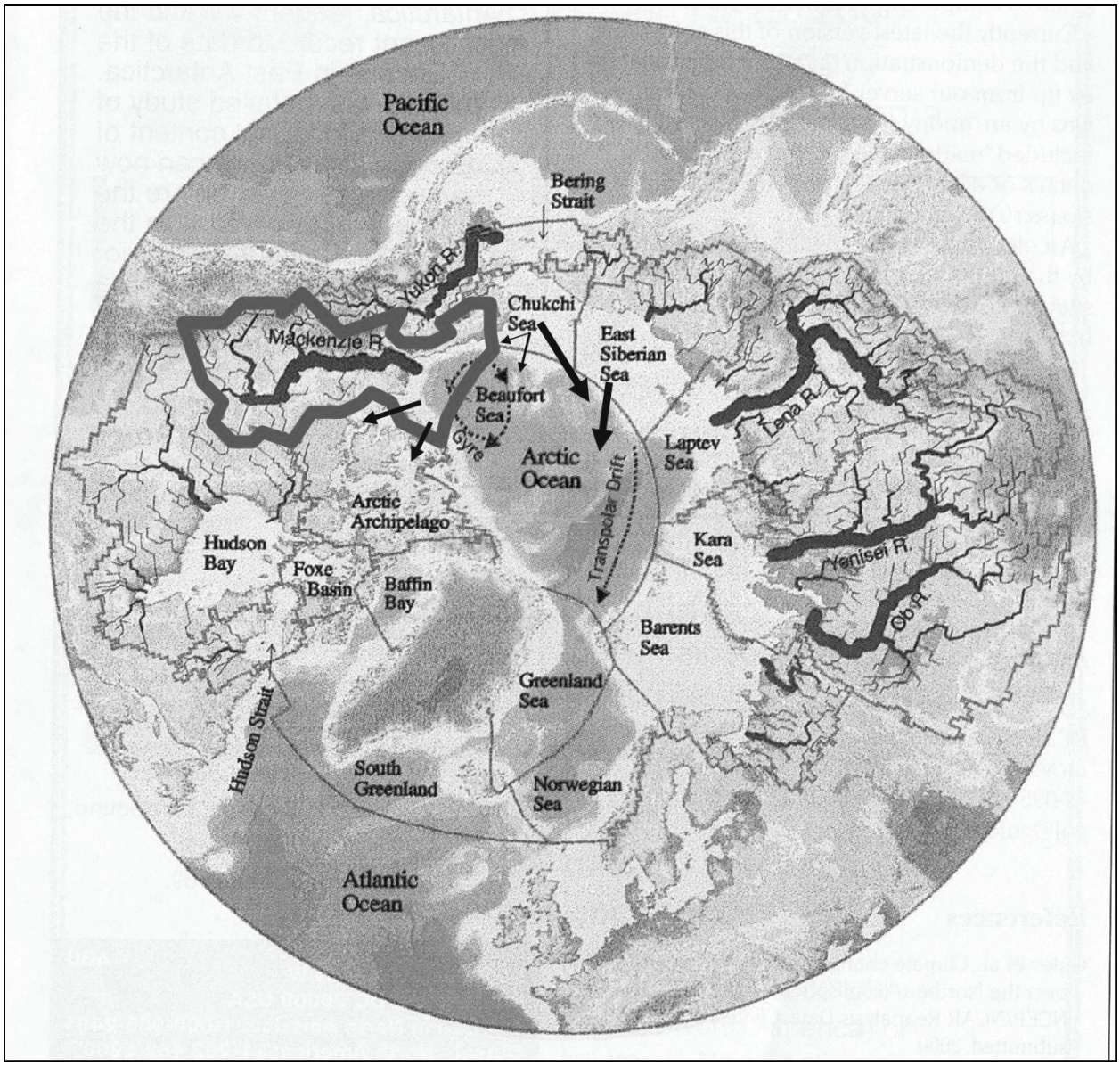


Figure 4. Polar view of the Arctic Ocean showing extent of freshwater drainage basins for the Arctic Ocean, and the extent of the regional seas. The Mackenzie River drainage basin is outlined top left. Arrows indicate approximate movement of surface water as it relates to the Beaufort Sea.