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Information to support the re-assessment of ecologically and biologically significant areas (EBSAs) in the Beaufort Sea Large Ocean Management Area

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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TABLE OF CONTENTS

ABSTRACT

The identification of ecologically and biologically significant areas (EBSAs) is an important tool for highlighting areas that have particularly high ecological or biological importance for the overall ecosystem. This in turn facilitates a greater-than-usual degree of risk aversion in the management of activities within such areas. A series of scientific and community workshops were conducted between 2006 and 2007 to identify EBSAs in the Beaufort Sea Large Ocean Management Area (LOMA). They resulted in 20 EBSAs being identified in the LOMA. At the request of the Beaufort Sea Partnership Ecosystem Working Group, Fisheries and Oceans Canada (DFO) agreed to conduct a regional Canadian Science Advisory Secretariat (CSAS) science peer review meeting to re-evaluate the EBSAs in the Beaufort Sea LOMA using the National Evaluation Framework for EBSAs. The re-evaluation was based on a compiled list of publications and information, the guidance available from past experiences, and the nationally identified lessons learned. A total of 24 candidate EBSAs were assessed. For each candidate EBSA, the Valued Ecosystem Components (VECs) were identified based on their importance to ecosystem function and structure; not economic importance. Using the National Evaluation Framework for EBSAs, the three main dimensions of uniqueness, aggregation and fitness consequences were ranked to give an overall level of confidence in the data supporting each EBSA. The meeting concluded 18 areas within the LOMA met the criteria to be considered EBSAs. In the future, these EBSAs should be re-assessed as more information becomes available.

Renseignements à l'appui de la réévaluation des zones d'importance écologique et biologique (ZIEB) dans la zone étendue de gestion des océans de la mer de Beaufort

RÉSUMÉ

La désignation des zones d'importance écologique et biologique (ZIEB) est un outil important pour mettre en évidence des zones qui présentent une importance écologique et biologique particulièrement élevée pour l'ensemble de l'écosystème. Cette désignation permet en retour un degré de prévention des risques supérieur à la normale dans la gestion des activités se déroulant dans ces zones. Une série d'ateliers scientifiques et communautaires ont eu lieu entre 2006 et 2007 pour désigner les ZIEB dans la zone étendue de gestion des océans (ZEGO) de la mer de Beaufort. De ces ateliers a découlé la désignation de 20 ZIEB dans la ZEGO. À la demande du groupe de gestion écosystémique du Partenariat de la mer de Beaufort, Pêches et Océans Canada (MPO) a accepté d'effectuer un examen scientifique par les pairs coordonnée par le Secrétariat canadien de consultation scientifique (SCCS) à l'échelle régionale pour réévaluer les ZIEB dans la ZEGO de la mer de Beaufort à l'aide du cadre d'évaluation nationale des ZIEB. La réévaluation se fondait sur une liste compilée de publications et de renseignements, de directives émanant des expériences antérieures, ainsi que de leçons retenues à l'échelle nationale. Au total, 24 ZIEB candidats ont été évaluées. Pour chacune des ZIEB candidats, les composantes valorisées de l'écosystème (CVE) ont été déterminées en fonction non pas de leur importance économique, mais de leur importance pour la fonction et la structure de l’écosystème. À l'aide du cadre d'évaluation nationale des ZIEB, les trois principaux aspects étudiés (unicité, concentration et conséquences sur la valeur adaptative) ont été classés pour donner un niveau global de confiance envers les données à l'appui de chacune des ZIEB. Les participants à la réunion ont conclu que 18 zones dans la ZEGO répondaient aux critères de désignation des ZIEB. Á l’avenir, ces ZIEB devraient être évaluées au fur et à mesure que l'on obtient de nouveaux renseignements.

INTRODUCTION

Canada's *Oceans Act* (1996), enacted in 1997, authorizes Fisheries and Oceans Canada (DFO) to provide enhanced protection to areas of the oceans and coasts that are ecologically or biologically significant (DFO 2004). The identification of ecologically and biologically significant areas (EBSAs) in Canada's Arctic marine waters is an important step towards a more comprehensive management approach for the Arctic marine environment. This is of particular significance given the increased interest in renewable and non-renewable resource exploration and development, and marine transportation throughout the Canadian Arctic. Moreover, the potential threats that these human activities pose to the environment are heightened with the threat of a rapidly changing climate. The identification of EBSAs is based on sound knowledge and defensible methods and is considered an important tool for calling attention to areas that have particularly high ecological or biological significance. This in turn facilitates a greater-than-usual degree of risk aversion in the management of activities within such areas.

The Beaufort Sea Large Ocean Management Area (LOMA) Ecosystem Overview and Assessment Report (EOAR) (Cobb et al. 2008) contained the results of a series of scientific and community workshops conducted between 2006 and 2007 to identify EBSAs in the Beaufort Sea (Paulic et al. 2009). These original EBSAs were identified based on published literature, expert opinion and local/traditional knowledge. Since then, major government and academic Arctic research projects within the Beaufort Sea (e.g., ArcticNet, Canadian Arctic Shelf Exchange Studies (CASES), Northern Coastal Marine Studies (CCGS *Nahidik*), International Polar Year-Circumpolar Flaw Lead System Study (IPY-CFL), Beaufort Sea Regional Environmental Assessment (BREA) have resulted in substantial new scientific information. It is anticipated that the knowledge resulting from recent scientific endeavors will contribute to an update of the original EBSAs. Moreover, DFO held a national science advisory meeting to identify lessons learned in applying the EBSA criteria and identifying EBSAs across Canada (DFO 2011a). Following this meeting and based on the conclusions and advice, another advisory meeting was held to identify EBSAs in remaining areas of the Canadian Arctic where they had not yet been identified (DFO 2011b). The lack of comprehensive data remains a challenge for the identification of EBSAs in the Arctic region when compared to other Canadian marine waters, but the long-term plan is to revisit EBSA advice periodically to ensure the best available information is available for management and decision-making in the Arctic.

At the request of the Beaufort Sea Partnership Ecosystem Working Group, DFO agreed to conduct a regional Canadian Science Advisory Secretariat (CSAS) peer review meeting to re-evaluate EBSAs in the Beaufort Sea LOMA. This re-evaluation included the modification of the original EBSA boundaries and/or the removal/addition of new EBSAs to produce a revised list of EBSAs. Furthermore, for each revised EBSA, the Valued Ecosystem Components (VECs) were identified. This report provides the results of a recent literature review (from 2004 to present), and evaluation of candidate EBSAs in the Beaufort Sea.

BACKGROUND

The identification of EBSAs in Canadian marine waters uses nationally accepted DFO EBSA criteria as it was defined during a 2004 national CSAS meeting (DFO 2004). Three main dimensions (Uniqueness, Aggregation, and Fitness Consequences) and two secondary dimensions (Resilience and Naturalness) were agreed upon to evaluate and identify sites (DFO 2004). The DFO (2004) report provides guidance on how to interpret and apply the dimensions in an ecosystem context. Since this time, and as part of the lessons learned national science advisory meeting, it has been concluded that although important, the two secondary dimensions

were extremely difficult concepts to rank and in many cases were not attempted (DFO 2011a). It was recognized that as part of an Ecosystem Approach, the use of resilience and naturalness should be considered in the context of EBSA prioritization and potential future development (i.e., future risk assessments; DFO 2011a).

A number of criteria have been established by various groups to identify ecologically and biologically important/sensitive areas (e.g., Convention on Biological Diversity, International Union for Conservation of Nature, International Maritime Organization). The criteria for identification are similar and have been compared. The results of the comparison suggest that the criteria are not different, rather the information and evaluation is packaged and presented in different formats (Figure 1). Since all other EBSA identification processes within Canada have used the nationally accepted DFO criteria in the past, this exercise will do the same.

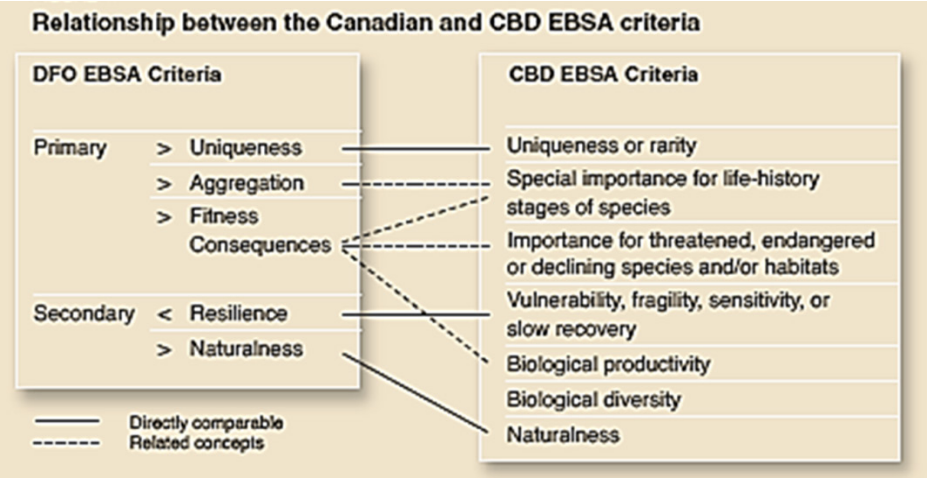

Figure 1. Relationship between the Canadian and Convention on Biological Diversity EBSA criteria (taken from Smith et al. 2009).

PAST BEAUFORT SEA EBSA IDENTIFICATION PROCESS

A required component of the Beaufort Sea EOAR (Cobb et al. 2008), was the identification of EBSAs. This was the first attempt at conducting an EBSA identification process in the Canadian Arctic, and thus it was anticipated that there would be many challenges with introducing a new concept to a broad cross-section of parties. In order to do this efficiently, a number of workshops and consultation meetings were held in 2006 and 2007 with the scientific community, co-management partners, local community members (i.e., six Inuvialuit Settlement Region communities), and federal and territorial government departments (Paulic et al. 2009). The workshops were designed to: discuss the general concepts behind the process of selecting EBSAs; consider its application in the Beaufort Sea; and conduct the EBSA process for the first time in the Canadian Arctic.

Candidate areas were chosen at these meetings based on the best available scientific knowledge, and on local and traditional knowledge. During the science workshop, experts identified ten areas as potential EBSAs, while during the community workshop (which included other federal and territorial government departments) participants identified 15 areas (Paulic et al. 2009). The science community identified large areas while the community workshop identified areas that were more focused. The community workshop also identified more EBSAs because the knowledge used at the meeting was not restricted to scientific data and publications. When the two lists were merged, a number of commonalities were identified (Figure 2). This made the merging of the two lists relatively simple and resulted in a total of 21

candidate areas for the Beaufort Sea LOMA. These candidate areas were then assessed using the National Evaluation Framework for EBSAs (DFO 2004). The outcome of assessing candidate EBSAs against the framework resulted in the identification of 20 EBSAs, with one candidate area being rejected (Paulic et al. 2009).

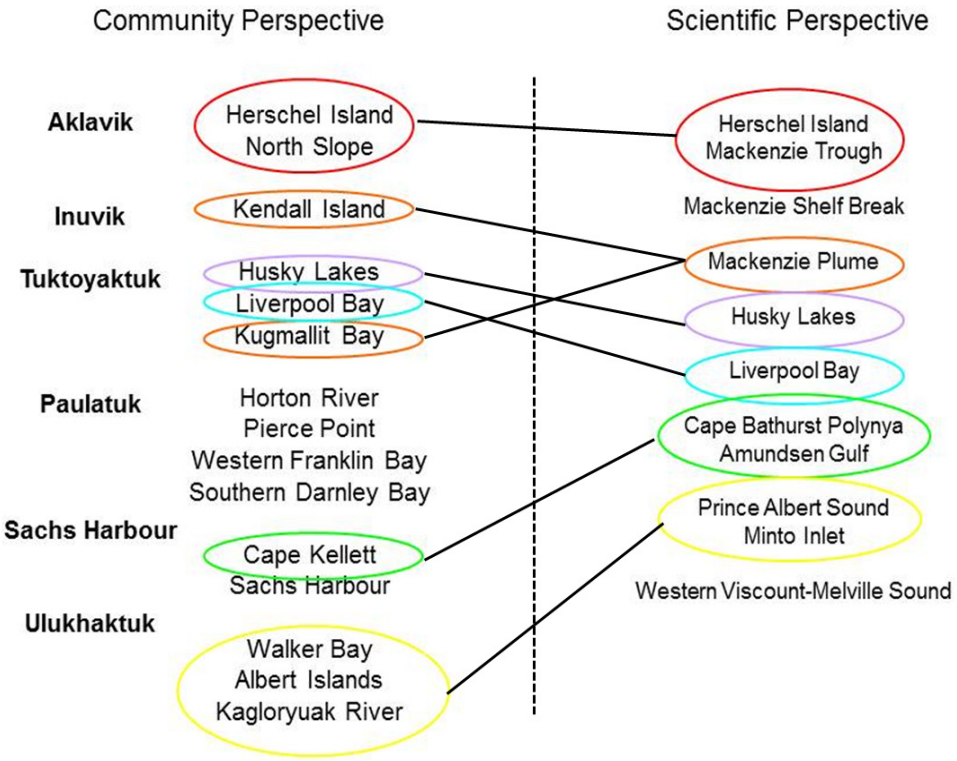

Figure 2. Comparison of EBSAs identified during the Community Workshop and those identified during the Science workshop (taken from Paulic et al. 2009).

During the original Arctic EBSA evaluation process there were a number of areas that were understood to be ecologically and biologically important, but for which there was limited scientific data specific to the Beaufort Sea. For example, features such as shelf breaks, and areas of topographic divergence, are known from the scientific literature to be globally important upwelling areas (e.g., Jacobs and Comiso 1989). For this reason, participants inferred the importance of the Beaufort Shelf Break as an area of upwelling and importance in the absence of data and research. In addition, incidental records for areas used by species, species groups, or unique or rarely occurring ecosystem components, were deemed 'data deficient' because of the lack of focused research (Figure 3).

It was recognized early on that a number of other issues complicated the identification of EBSAs in the Beaufort Sea. The ice cover in the Beaufort Sea LOMA is extremely variable on an annual and inter-annual basis, greatly affecting biodiversity and productivity at any given point in time (Carmack and Macdonald 2002). For example, in the Mackenzie Estuary, towards the end of winter, landfast ice extends to a maximum thickness of 2 m and its outer boundary is defined by a stamukhi (or rubble ice field). Further offshore, past the stamukhi, lies a region of intermittently open water, and finally an area of freely drifting polar pack ice. The ice cover during the winter months is important for arctic animals that rely heavily on ice to hunt, migrate, or reproduce. April and May are characterized by a rapid melt in ice cover, which allows sunlight to penetrate the water column, increasing primary production which attracts higher trophic order animals to the area. By late summer landfast ice has completely disappeared, however, the duration of

open water in nearshore areas is brief and by October ice begins to reform (Carmack and Macdonald 2002). Since ice is a dynamic feature of the Beaufort Sea LOMA, not only is the spatial distribution of VECs continuously changing throughout the year, but it is also quite difficult to delineate static EBSA boundaries.

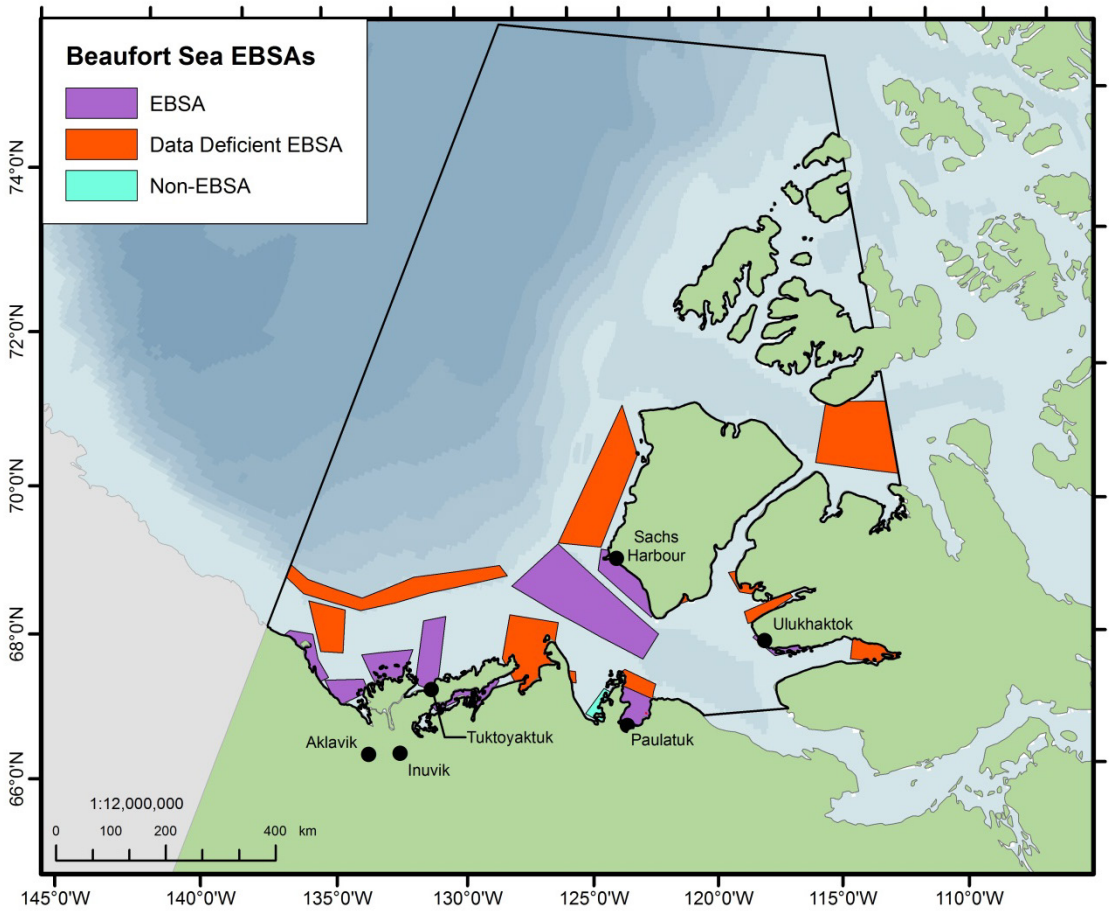

Figure 3. The original 20 EBSAs developed in the Beaufort Sea LOMA (LOMA delineated by a solid black line). One area (light blue) did not meet the criteria for an EBSA. These areas were evaluated according to the DFO (2004) criteria.

To complicate matters further, climate change has caused, and will continue to cause, significant shifts in annual ice patterns (Galley et al. 2009). In a study by Meier et al. (2007), decreasing trends in sea ice extent in the Beaufort Sea were observed in August and September, from 1979-2006. In the southwestern Beaufort Sea, the formation of landfast ice occurs a week later than it did in 1997 (Mahoney et al. 2007). Global warming is an ongoing phenomenon and therefore it will be imperative to re-evaluate EBSAs in the Beaufort Sea LOMA to reflect change.

The use of traditional and local knowledge for areas that have not been studied extensively has been typically used in past EBSA exercises (Paulic et al. 2009). Many local community members can readily identify areas that are important to their community for traditional harvesting activities or areas that were heavily used because of relative ease of access from the community, however these reasons may not necessarily fit any of the criteria for the establishment of an EBSA. In addition, the scale by which local communities tend to evaluate

EBSAs are not necessarily from the LOMA scale, in which case significance may be elevated inaccurately. Awareness and communication can help to alleviate this often difficult concept in EBSA identification, as it often can be an issue when interpreting the results of very focused local research projects and results.

Finally, there are many areas within the Beaufort Sea LOMA where there is a complete lack of data and local knowledge, specifically the vast offshore expanse and much of what we do know has resulted from studies of rather short duration, usually conducted during a few weeks in the ice-free season. At the time of the original EBSA process, it was recognized that these gaps were slowly being filled by a number of new scientific initiatives related to the changing Arctic climate and/or support for hydrocarbon exploration and development. It was recognized that the new findings from these studies would contribute to a future re-evaluation of original EBSAs in the Beaufort Sea LOMA. Furthermore, it was also noted that several contributions from Environment Canada, Canadian Wildlife Service and information collected during a DFO Oceans Division community tour (Hartwig 2009) were received after completion of the first report (Paulic et al. 2009). This valuable information, along with other individual suggestions has been incorporated into this re-evaluation.

PAST CANADIAN ARCTIC EBSA IDENTIFICATION PROCESS

In response to increasing requests from the international community for Canada to identify and provide information on areas that are important in the Arctic marine ecosystem, DFO Science sector was asked in 2011 to provide advice in support of the identification and prioritization of EBSAs within each of the Canadian Arctic marine biogeographic regions (DFO 2011b). During the exercise to identify EBSAs for the entire eastern Arctic, the Beaufort Sea EBSAs (Paulic et al. 2009) and the Foxe Basin EBSAs (DFO 2010) were not re-evaluated at the advisory meeting (DFO 2011b). The scale by which each EBSA exercise took place (entire Arctic region vs. LOMA vs. northern Foxe Basin) would have likely influenced;

1) the amount of information and detail that could be included in each exercise;
2) the relative ranking of each dimension and;
3) the degree of which important areas are grouped to create fewer, larger EBSAs, rather than smaller, more defined EBSAs.

METHODS

A literature review of relevant publications since 2004 was conducted on a number of search engines (e.g., Google Scholar, the Web of Science, and the DFO library “WAVES” site). Search words included those that covered several geographic locations within the Beaufort Sea (e.g., place names), key marine taxonomic group by scientific discipline, processes and features that are dominant drivers of ecosystem structure and function within the Beaufort Sea and major research project titles. From this populated list of publications, papers that provided either a regional perspective comparing different locations within the Beaufort Sea, or provided supporting evidence that suggested an area met one or more of the EBSA criteria, were used as supporting literature for the evaluation. This however, was not likely a complete and exhaustive list of publications, as many of the recent International Polar Year (IPY) and ArcticNet publications were continuing to show up as this document was being drafted. Additionally, it should be noted that no attempt was made to access industry reports, even though there are some large studies currently underway as part of their participation in a number of regulatory processes.

In addition to the general literature review, experts in benthic systems from the Université du Québec à Rimouski contributed a short paper to provide advice on benthic systems based on their best available knowledge. Results from the compilation of data for advice in this evaluation can be found in the Appendix, where the authors attempt to provide advice from all available historical and most recent data on macro- and megabenthic diversity, and on benthic ecosystem functions. For the purposes of this report macro- and megabenthos refer to seabed invertebrate fauna >0.5mm; demersal fishes are not considered. Macrobenthos include mostly infaunal organisms collected using a box corer or grab, while megabenthos represent mostly large epifaunal organisms visible in seabed images and/or sampled with towed gear (e.g., Agassiz trawl). Macro- and megabenthic diversity measures presented in this document are total taxa richness at each station and total density at each station (ind. m^{-2}). Taxa represent species or the lowest possible taxon. Benthic ecosystem functions can be measured in several ways (Danovaro et al. 2010). Remineralization of organic matter by benthic communities release carbon and nutrients from the sediments back into the water column (benthic boundary fluxes) and therefore is a function related to many processes in the water column. Here, we use results on multiple benthic boundary fluxes (oxygen, nitrate, phosphate, silicic acid) to define areas of important benthic functions in the southeastern Beaufort Sea.

Although this evaluation process used a number of publications from local communities in the Beaufort Sea LOMA (e.g., Hartwig 2009, Community of Paulatuk et al. 2008), information from the traditional knowledge of Aboriginal peoples in the North is incomplete. This knowledge is critical to the success of a full and complete EBSA identification process, particularly for areas that are remote and not often visited by researchers. Their observations can add important information with respect to seasonal changes in habitat and species use where literature and scientific data tend to be restricted. The inclusion of traditional or local knowledge in the EBSA process was considered a valid contribution (DFO 2011a).

RATIONALE FOR EBSA IDENTIFICATION AND EVALUATION

Based on the compiled list of publications and information, a re-evaluation of the original EBSAs was conducted using the National Evaluation Framework (DFO 2004), the guidance available from past experiences (DFO 2010; 2011b) and the nationally identified lessons learned (DFO 2011a). For this evaluation, only the three main dimensions of uniqueness, aggregation and fitness consequences were applied and ranked based on a subjective score of high, medium or low. The secondary dimensions were removed for this evaluation based on past experiences with these criteria and the associated difficulty with ranking (Paulic et al. 2009; DFO 2011a; DFO 2011b).

During this re-evaluation, and when EBSA processes were discussed at both the national and regional level, it was apparent that physical/oceanographic features were the most easily used features to identify an EBSA. For example, most marine animals carry out important stages of their life cycles near areas that are typically associated with higher productivity or concentrate lower trophic levels (i.e., match-mismatch theory) and are relatively consistent or stable in their presence. For this reason, large feeding aggregations tend to correspond to these relatively unique physical/oceanographic features (e.g., zones of upwelling, polynyas, shelf breaks).

The ranking and evaluation of the uniqueness criteria is extremely sensitive to scale (i.e., local, regional, national and global). An area was deemed to have met the dimension of uniqueness if it met the criteria definition and was unique based on the scale of the LOMA. For the dimensions of aggregation and fitness consequences, the ranking was based on the relative importance of an area to aggregating animals or the functions (e.g., feeding, reproduction, nursery) that contribute to the fitness consequences of the animals. If the area under consideration met the high or medium score, then it was considered an EBSA.

Where there was not sufficient recent knowledge to remove or change boundaries of an original EBSA, no attempt was made to do so other than to more accurately map the boundaries based on available bathymetry or the identified EBSA feature (e.g., ice data). VECs were identified for each candidate EBSA based on their importance to ecosystem function and structure; not economic importance (e.g., subsistence use).

The level of confidence in the data supporting an area as an EBSA is often considered valuable information and can provide the context to which an area is identified. For each EBSA and/or VEC a level of certainty in the data and knowledge was provided (Table 1).

Table 1. Description of confidence levels (level of knowledge; source of data), modified from Chan et al. (2011).

Level of Confidence	**Description**
Very Low	Little or no scientific information; no supporting data
Low	Limited scientific information; circumstantial evidence, some first hand, unsystematic observations
Moderate	Moderate level of scientific information; first hand, unsystematic observations
High	Substantial scientific information; expert opinion
Very High	Extensive scientific/systematic information; peer-reviewed data sources/information

There are a number of examples that can explain why the level of confidence in data would be ranked very low or low:

1) a complete absence of or severely limited amount of data, information or knowledge (e.g., offshore and remote areas, inaccessibility due to cost or safety);
2) irregular and/or inconsistent collection of data (e.g., data collection based on a study in the 1970s with no recent information for the area);
3) irregular and/or inconsistent use of the area (e.g., local people only visit the area occasionally or it was a historically used site) and;
4) research projects and site visits only capture a single point in time (i.e., days, weeks) which may not accurately represent the typical or ‘normal’ state or the area and will not always capture significant events.

In these situations, where there is limited or incomplete knowledge the precautionary approach is applied and the area may be identified as an EBSA. In these cases, the information should be used with the appropriate caution, and the area in question may require further study for validation prior to a management action or decision. Further to this, many areas in the Arctic are in a continual state of flux due to climate change. This will further impact our level of confidence in many areas.

ASSESSMENT OF CANDIDATE BEAUFORT SEA EBSAS

Based on a synthesis of recent publications and discussions with scientists conducting work in the Beaufort Sea, 24 candidate EBSAs were identified and became the basis for this re-evaluation (Figure 4; Table 2).

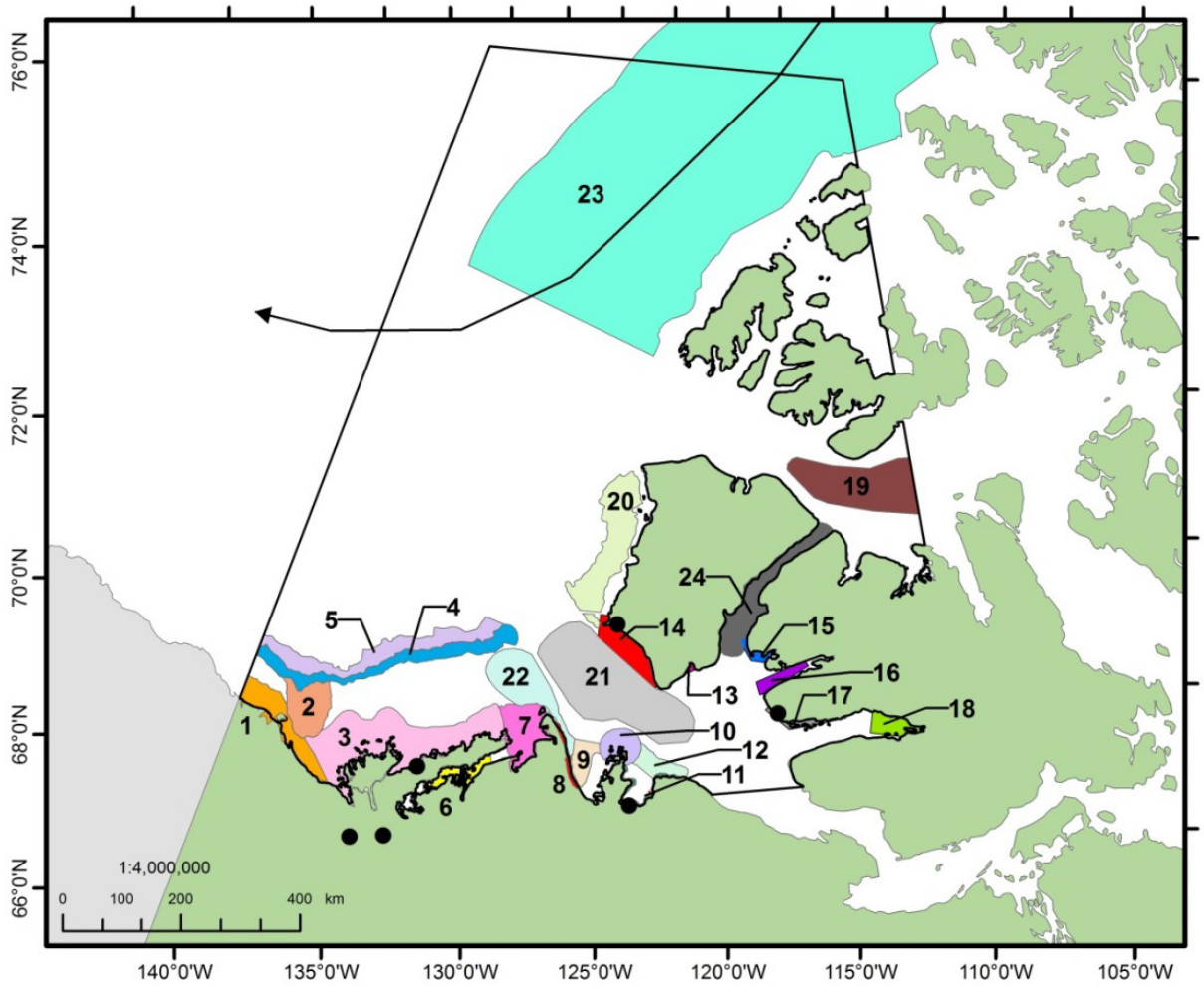

Figure 4. Candidate EBSAs within the Beaufort Sea LOMA (solid black line) that were evaluated using the National Evaluation Framework (DFO 2004). Each number represents a candidate EBSA. EBSA names can be found in Table 2. The arrow marks the Beaufort Gyre.

Table 2. Summary of candidate EBSAs based on a literature review and expert knowledge in comparison with the original EBSAs (Paulic et al. 2009).

	Candidate EBSA	Comparison with original EBSAs
1	Herschel Island/Yukon North Slope	Original EBSA, boundaries modified based on bathymetry
2	Mackenzie Trough	Original EBSA, boundaries modified based on bathymetry
3	Mackenzie Estuary and Nearshore Beaufort Shelf	Boundaries expanded to include other EBSAs (Shallow Bay, Beluga Bay, Kugmallit Corridor) and entire habitat feature.
4	Beaufort Shelf Break	Original EBSA. Northern boundary follows the 500 m depth contour
5	Beaufort Shelf Slope	NEW
6	Husky Lakes	Original EBSA with boundaries unchanged
7	Liverpool Bay	Original EBSA with northern boundary modified to follow the 20 m depth contour
8	Horton River	Original EBSA with offshore boundary modified to follow 20 m depth contour
9	Franklin Bay	NEW
10	Cape Parry	NEW
11	Nearshore Darnley Bay	Original EBSA (Hornaday River), boundaries modified based on bathymetry
12	Offshore Darnley Bay	Original EBSA (Pearce Point), boundaries modified based on bathymetry and sea-ice
13	DeSalis Bay	Original EBSA
14	Thesiger Bay	Original EBSA
15	Walker Bay	Original EBSA
16	Minto Inlet/Kuujjua River	Original EBSA (Minto Inlet)
17	Albert Islands/Safety Channel	Original EBSA
18	Kagloryuak River	Original EBSA, boundaries modified based on bathymetry
19	Viscount Melville Sound	Original EBSA, boundaries modified based on bathymetry
20	Banks Island Flaw Lead	Original EBSA, boundaries modified based on bathymetry
21	Cape Bathurst Polynya	Original EBSA, boundaries modified based on bathymetry and sea-ice data
22	Cape Bathurst/Ballie Island	NEW
23	Beaufort Gyre/Multi-year Pack Ice	NEW
24	Prince of Wales Strait	NEW

1. HERSCHEL ISLAND/YUKON NORTH SLOPE

The EBSA is characterized by a relatively steep slope, roughly 50 km (east) to 100 km (west) offshore of the Yukon coast. From the coastline it is approximately 60 m in depth. The EBSA's eastern-most point is a straight line extending from the tip of the Mackenzie Canyon to the

shoreline. At the east, the EBSA borders the Mackenzie Estuary and nearshore Beaufort Shelf EBSAs, then further west follows the border of the Mackenzie Trough EBSA at the 60 m depth contour, roughly 50 km offshore. West of Hershel Island, the outer border of the EBSA follows the 60 m depth contour and therefore widens to a distance of 100 km offshore. The EBSA ends to the west at the Canada/US border, however the ecological and/or biological features in most cases extend beyond Canadian waters.

The coast along the Yukon North Slope provides a narrow band (<10 m isobath) of freshwater, with relatively steep bathymetry into marine waters, which when combined with wind events can result in topographically enhanced upwelling. This area is used as a feeding and migration route to and from coastal river systems by at least seven anadromous fish species, including: Arctic Cisco (*Coregonus autumnalis*), Least Cisco (*Coregonus sardinella*), Rainbow Smelt (*Osmerus mordax*), Arctic Char (*Salvelinus alpinus*), Broad Whitefish (*Coregonus nasus*), Lake Whitefish (*Coregonus clupeaformis*), and Inconnu (*Stenodus leucichthys*) (Bond and Erickson 1989). At least eight marine fish species make use of this region, entering dilute coastal waters in summer and then migrating back to deep oceanic waters in winter (Bond and Erickson 1989, Niemi et al. 2012).

Dolly Varden Char (*Salvelinus malma*) migrate annually from summer marine feeding grounds off the Yukon North Slope along the coastal waters (< 20 m) to overwintering and spawning grounds in a number of streams (e.g., Rat and Big Fish rivers) along the Yukon North Slope. The species is currently considered to be depleted in the Rat and Big Fish rivers, and is listed as a species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2010).

Harwood et al. (2010) report moderate feeding aggregations of Bowhead Whales (*Balaena mysticetus*) in August along the slope. Traditional knowledge confirms that historic feeding by Bowhead Whales has occurred along the coastline (Hartwig 2009). Asselin et al. (2011) reported moderate use by Beluga (*Delphinapterus leucas*) which feed in the same area. Ringed Seal (*Phoca hispida*) use the area for late summer feeding during their fall migration from the Beaufort Sea to their wintering grounds (Harwood and Stirling 1992, Harwood et al. 2012). In addition to feeding, traditional knowledge reports Ringed Seal pupping along the Yukon North Slope in winter (Hartwig 2009). The areas identified include King Point, Herschel Island, Komakuk Beach, and other areas where an abundance of fish is available.

The only known nesting site for Black Guillemots (*Cepphus grylle*) in the western Arctic is on Herschel Island, although this is a man-made habitat. The birds frequent the adjacent marine waters for feeding (Eckert et al. 2006). The coastline also contains important Polar Bear (*Ursus maritimus*) denning areas and feeding areas for females emerging from dens (Stirling and Andriashek 1992, Environment Canada unpublished data, Pilfold et al. 2012).

VECS: Upwelling, anadromous fish feeding and migration corridor, Dolly Varden Char, Polar Bear, Bowhead Whale, Beluga, Ringed Seal, Black Guillemot

Confidence:

Very High: Peer-review data sources exist for the bathymetry and upwelling events as well as the feeding and migration corridor for anadromous fishes. Habitat use by Black Guillemots has been well documented for the area.

High: There are peer-reviewed articles that document the importance of area for Bowhead Whales, Beluga, Ringed Seal and Polar Bear.

2. MACKENZIE TROUGH

The Mackenzie Trough is a unique bathymetric feature within the Beaufort Sea LOMA, with depths ranging from 50-300 m, and subsequent upwelling events. Williams et al. (2006) reported that the cross shelf canyon provides enhanced shelf-break exchange via upwelling, which is caused by wind and ice driven ocean surface stress. Upwelling events are associated with wind in the short ice-free season and ice motion in winter. The trough is a conduit for deeper nutrient rich water to the shelf, and these conditions facilitate dense aggregations of Arctic Cod (*Boreogadus saida*) within two bands of water, 0–50 m and 150–200 m (Crawford et al. 2012). The trough is found to receive seven times greater annual deposition than along the shelf (O'Brien et al. 2006). Williams et al. (2006) estimate that the focusing of waters from >150 m results in an annual net upwelling and flux of nitrate, phosphate and silicate to the head of the trough. Conlan et al. (2008) report on average high macrofaunal density in this EBSA, with comparable taxonomic diversity (Clarke and Warwick 1995) at similar depth in the Cape Bathurst and the Beaufort Shelf EBSAs. A recent review of data collected in this region (V. Roy, H. Link and P. Archambault, UQAR, unpubl. data) found also high macrobenthic taxa richness and moderate macrobenthic density. Also, sites with high oxygen uptake and silicic acid and phosphate release were identified within this EBSA (Link 2012).

Moderate Bowhead Whale feeding aggregations have been observed during past aerial surveys (Harwood et al. 2010). Asselin et al. (2011) reported spring Beluga concentrations along the Mackenzie Trough slope which are presumably feeding on deep water Arctic Cod. A similar pattern of use may exist for at least a portion of tagged summer Beluga (Barber et al. 2001). Walkusz et al. (2010) reported maximum zooplankton biomass in oceanic waters at deep water stations of the Mackenzie Trough; this is three and twelve times greater than the diffuse plume waters (mixed freshwater and oceanic) along the shelf. Due to the complex dynamics of the Mackenzie River plume, plume waters are often observed hundreds of kilometers offshore; in this case, zooplankton diversity was greatest at the interface with plume and ocean water. This was a similar case for larval fish (Wong et al. 2013) where diversity was highest at the diffuse plume water interface, and biomass was highest in oceanic waters.

The region is also considered important seasonal habitat for Polar Bears (Durner et al. 2004) and an important feeding area for females emerging from their dens along the Canadian mainland (Stirling and Andriashek 1992).

VECS: Upwelling, Arctic Cod, macrobenthic taxa richness and density , benthic ecosystem functions, primary producers (phyto- and zooplankton), larval fishes, Polar Bear, Bowhead Whale, Beluga

Confidence:

Very High: The trough feature and associated upwelling features are well documented and the trough as a bathymetric feature within the LOMA is unique in terms of its relative size to other troughs on the Beaufort Shelf.

High: Aggregations of primary and benthic producers, benthic functions and Arctic Cod are documented in published literature as well as the use of the area by marine mammals.

3. MACKENZIE ESTUARY AND NEARSHORE BEAUFORT SHELF

The Mackenzie Estuary and nearshore Beaufort Shelf is a highly dynamic marine environment. The region is dominated by large freshwater inputs from the Mackenzie River which are modified by wind driven events that can intrude oceanic water onto the shelf (Carmack and Macdonald 2002). The candidate EBSA is covered by landfast ice for much of the year and in winter a stamukhi zone forms. Over the course of the winter, discharge from the Mackenzie

Estuary builds up behind the stamukhi zone to form a large freshened water mass under-ice (Lake Herlieux). This is considered a unique feature of the Canadian Arctic (Carmack and Macdonald 2002), and is one of several large river estuarine environments of this scale globally (Walkusz et al. 2010). Water masses on the Beaufort Shelf have been described in summer as consisting of three highly dynamic but different zones defined as: dense plume waters, diffuse plume waters and oceanic waters (Walkusz et al. 2010, Paulic and Papst 2012, Wong et al. 2013). These dynamics create a unique environment supporting a mix of marine and estuarine fauna, including high macrobenthic density and moderate taxa richness (Walkusz et al. 2010, Majewski et al. 2006, Conlan et al. 2008, V. Roy, H. Link and P. Archambault, ,UQAR, unpubl. data). Also, sites with high oxygen and nitrate uptake, and silicic acid and phosphate release were identified within this EBSA (Renaud et al. 2007a, Link 2012).

An important nursery area (i.e., hot spot) for larval fish has been identified (Sareault 2009, Paulic and Papst 2012, Wong et al. 2013) in the northeastern boundary of this candidate EBSA. It is hypothesized that a number of marine species spawn in the offshore marine waters, but gain energy and thermal advantage in the warm, nutrient rich plume waters.

Periodic upwelling of nutrient rich Pacific water via the Kugmallit Canyon enhances shelf productivity (Williams et al. 2008). Anadromous fish migrate seasonally through the Mackenzie Estuary between spawning rivers within the Mackenzie River watershed and overwintering locations along the coastal lake and river systems. A number of coastal and sea birds are also abundant within the shallow coastal waters along the entire northern coastline and along the Beaufort Shelf (>20 m), north of the Tuktoyaktuk Peninsula for staging, moulting and feeding (Dickson and Gilchrist 2002, Mallory and Fontaine 2004). The EBSA is also an important feeding area for female Polar Bears emerging from dens (Stirling and Andriashek 1992, Environment Canada unpublished data) and other bears from the southern Beaufort Sea Polar Bear population (Durner et al. 2004, Pilfold et al. 2012).

Large numbers of the Eastern Beaufort Sea Beluga aggregate annually in the shallow estuarine waters, for a number of possible reasons such as thermal advantage, moulting, feeding, avoidance of predators or socialization (Richard et al. 2001, Loseto et al. 2008). In the original EBSA exercise, three regions were distinguished as EBSAs, Shallow Bay, Kugmallit corridor and Beluga Bay; portions of these original EBSAs have since been designated as part of the Tarium Niryutait Marine Protected Area under the *Oceans Act*. The Mackenzie River is the main physical driver for the Mackenzie Estuary and is considered a unique ecosystem and is important for a number of VECs, therefore, several of the original EBSAs have been combined into a single candidate EBSA.

VECS: Freshwater Plume, feeding and migratory corridor for anadromous fishes, macrobenthic taxa richness and density, benthic ecosystem functions, zooplankton and marine larval fishes, marine fish, Beluga, coastal and sea birds, Polar Bears

Confidence:

Very High: This area is probably one of the most well studied areas, aside from the Cape Bathurst polynya, in the LOMA. The existence and dynamics of the freshwater plume and use of the area by anadromous fishes is well documented, however, the dynamics of the oceanography are very difficult to map. Aggregations of primary and benthic producers, benthic functions are also well documented in published literature.

High: Aggregations (summer habitat use) and health of Beluga, coastal and sea birds and Polar Bear are documented in published literature.

Moderate: Distribution and assemblages of larval fish are based on recent data, however, further analysis of early data from the Northern Oil and Gas Action Program is still required.

4. BEAUFORT SHELF BREAK

The Beaufort Shelf break runs the length of the continental shelf of the Beaufort Sea and is the boundary between the continental shelf and the much steeper continental slope. The shelf break occurs at between 60–100 m depth. Continental shelf breaks are known around the world to be an important marine ecosystem driver since the topography usually induces upwelling events that can bring nutrient rich, deep oceanic waters onto the shelf resulting in enhanced primary productivity within the photic zone (Carmack et al. 2004). Upwelling along the shelf break is further enhanced in the Beaufort Sea at the Mackenzie and Kugmallit troughs (Williams et al. 2006, 2008).

A recent review of data collected in this region (V. Roy, H. Link and P. Archambault, UQAR, unpubl. data) found that sample sites in the Beaufort Shelf break EBSA had high macrobenthic taxa richness and moderate megabenthic richness.

VECS: Upwelling, enhanced primary productivity, macro- and megabenthic taxa richness

Confidence:

High: It is documented that oceanographic upwelling events occur along the Shelf break.

Low: Primary production, benthic and fish data are limited for this EBSA.

5. BEAUFORT SHELF SLOPE

The shelf slope is a unique feature where the Beaufort Sea floor descends steeply between 100 and 1000 m. Until recently little was known about the ecology of this vast area, however recent sampling has revealed it supports a unique Canadian Beaufort Sea fauna (A. Majewski, pers. comm.). Recent sampling off the shelf (depths between 200–1500 m) collected a greater diversity of large invertebrates (e.g., crabs, shrimps, gelatinous pelagic invertebrates) than on the Beaufort Shelf, as well a narrow band of Atlantic origin waters between 200–400 m which supported dense aggregations of Arctic Cod (A. Majewski, pers. comm.). V. Roy, H. Link and P. Archambault, UQAR, (unpubl. data) found that sample sites in this EBSA had moderate macrobenthic taxa richness. Some Beaufort Sea Polar Bears move offshore to use the pack ice along the slope during summer (Durner et al. 2004). Asselin et al. (2011) reported Beluga using the shelf slope during spring, likely to feed on Arctic Cod.

VECS: Marine fishes, Arctic Cod, macrobenthic taxa richness, Polar Bear, Beluga

Confidence:

High: The Beaufort Shelf slope is the largest feature of its kind in the Beaufort Sea LOMA.

Low: Scientific research and data along the Beaufort slope is limited, however, recent sampling and future publications will help to reveal new information and knowledge of the area. This is a region of the Beaufort Sea LOMA where local/traditional knowledge is very limited.

6. HUSKY LAKES

No new scientific information has been added to this candidate EBSA. Husky Lakes is a unique estuary, with strong tidal flows in the ‘fingers’ and narrows which enhances vertical mixing of nutrients into surface waters. Due to the unique configuration and combination of fresh and estuarine waters, it supports 14 species of freshwater and estuarine or migratory fishes, including Lake Trout (*Salvelinus namaycush*), Inconnu (*Stenodus leucichthys*), and Broad Whitefish (*Coregonus nasus*) (Harwood 2003). The area is also identified as an important feeding area for migratory marine birds such as Common Merganser (*Mergus merganser*) and Brant (*Branta bernicla*) (Mallory and Fontaine 2004). Beluga and Ringed Seal use the outer

Husky Lakes area for feeding. TEK supports the importance of Husky Lakes for a number of fish, Beluga and Ringed Seal (Hartwig 2009).

VECS: Tidal mixing, estuary, Lake Trout, Marine/estuarine/freshwater fishes, Beluga, Ringed Seal, coastal and sea birds

Confidence:

High: The unique physical oceanography of the region is well known and documented. The marine environment of the Husky Lakes is protected from development by the Government of Northwest Territories. This EBSA is used by local community members and traditional/local knowledge is available.

Moderate: Fish assemblage and distribution is fairly well documented. Life history information on Lake Trout is also relatively available.

Low: No dedicated studies have been conducted on Beluga and seals.

7. LIVERPOOL BAY

The area within Liverpool Bay and out to the 50 m depth contour was identified as ecologically and biologically significant by both science and local communities during the original EBSA identification process (Paulic et al. 2009). The upwelling tides produce enhanced productivity. Liverpool Bay (including Baillie Island) was considered a candidate EBSA based on a high ranking for uniqueness of sea birds, and a medium ranking for marine mammals (Bowhead Whale and seals). A high diversity of productive communities, kelp beds, clams and other invertebrates were identified in this area. A wide variety of marine fish species are both known to spawn in Liverpool Bay and include Saffron Cod (*Eleginus gracilis*), Pacific Herring (*Clupea pallasi*), and rarer species such as the Blackline Prickleback (*Lumpenus mackayi*). Communities report high use by Pacific Herring, presumably for spawning (Hartwig 2009). Local/traditional knowledge has indicated that Ringed and Bearded seals use the area for feeding, migration and general use, while Bowhead Whale feed and migrate through Liverpool Bay (Hartwig 2009). There was no new literature available that would suggest any change to the rational of this candidate EBSA, however with the naming of a candidate EBSA off Cape Bathurst; the northern boundary has been reduced to the 20 m contour. This area is also identified as important seasonal habitat for Polar Bears (Durner et al. 2004, Pilfold et al. 2012).

VECS: Marine fishes, Saffron Cod, Ringed and Bearded seals, coastal and sea birds, kelp and clam beds, Blackline Prickleback, Polar Bear

Confidence:

High: The unique physical oceanography of the region is well known and documented. The marine environment of the Husky Lakes is protected from development by the Government of Northwest Territories. This EBSA is used by local community members and traditional/local knowledge is available.

Moderate: Fish assemblage and distribution is documented.

Low: No dedicated studies have been conducted on Bearded Seals or Ringed Seals. Some local/traditional knowledge on invertebrate communities and kelp and clam beds have been provided.

8. HORTON RIVER

The area off the Horton River was considered a candidate EBSA due to its importance for marine feeding by Arctic Char off the mouth of the river. This area has a smaller population of

Arctic Char relative to other populations identified within EBSAs in the Beaufort Sea. The importance of primary productivity in the Franklin Bay region has been demonstrated as high by Ban et al. (2006). Some infrequent observations of Beluga and Bowhead Whale feeding aggregations have been made by community members when ice conditions have allowed (Hartwig 2009), however, this area is not frequented regularly by locals.

VECS: Arctic Char feeding and migratory corridor, primary production

Confidence:

Low: Although some studies have been conducted in this EBSA, they are limited. The significance of this EBSA relative to other areas is based on local/traditional knowledge.

9. FRANKLIN BAY

New information that contributes to the addition of Franklin Bay to the list of candidate EBSAs in the Beaufort Sea are the large aggregations of Arctic Cod that were identified from December to March (Benoit et al. 2008). Arctic Cod were found to use the deep waters between 125 to 250 m depth in the west/central part of Franklin Bay. This coincides with the lower Pacific halocline waters. Benoit et al. (2008) suggested that Arctic Cod use this band of water for temperature preference and avoidance from predators, making it an area of high significance as a seasonal refugium and for fitness consequences. The importance of Franklin Bay for Arctic Cod is supported by Geoffrey et al. (2011), who reported similar results in the Amundsen Gulf.

Benoit et al. (2008) also suggest that Ringed Seal can access the upper layers of cod populations in Franklin Bay for feeding. In addition to the Ringed Seal feeding, Asselin et al. (2011) reported diving behaviour by Beluga at the ice-edge of Franklin Bay. The presence of Arctic Cod would also provide a rationale for spring use of these waters by Beluga for feeding. The enhanced primary productivity in Franklin Bay relative to other parts of the Beaufort Sea has been documented by Darnis et al. 2008. Conlan et al. (2008) reports that on average macrobenthic taxonomic diversity (Clarke and Warwick 1995) was highest in this area while the macrobenthic density was considered high. This bay was intensively studied during the CASES project (Renaud et al. 2007a, b) and revisited during the IPY-CFL program (Link et al. 2011). Both studies report benthic carbon and nutrient (nitrate, silicic acid) remineralization higher than in the surrounding Amundsen Gulf (Link 2012).

Franklin Bay has been identified as an important feeding area for female Polar Bears and their cubs emerging from terrestrial dens (Environment Canada unpubl. data; Pilfold et al. 2012).

VECS: Arctic Cod, Beluga, Ringed Seal, primary production, macrobenthic taxonomic diversity and density, benthic ecosystem functions, Polar Bear

Confidence:

High: Aggregations of primary and benthic producers and benthic functions are documented in published literature.

Moderate: Although some studies have been conducted in this area, they are limited. The significance of this EBSA relative to other areas for Arctic Cod is based on a limited number of studies and on acoustic data with limited sampling to ground truth the acoustic results. Results for Beluga, Ringed Seal and primary production are also limited.

DARNLEY BAY AREA OF INTEREST ASSESSMENT

The next three candidate EBSAs result from a recent assessment of the original two Darnley Bay EBSAs, the Hornaday River and Pearce Point. Pursuant to the *Oceans Act* (1996) designation of a Marine Protected Area cannot be made until an assessment of an Area of

Interest (AOI) has been undertaken. The request to consider areas within Darnley Bay for marine protection under the *Oceans Act* triggered this assessment (DFO 2011c). The result of a detailed examination of existing scientific and traditional knowledge resulted in three AOIs recommended for consideration as MPAs; the Cape Parry Offshore Marine Feeding Habitat, Darnley Bay Nearshore Migration and Feeding Corridor, and the Darnley Bay Offshore Ice-edge Habitat. These three areas met at least one of the criteria for consideration as an EBSA, therefore they are considered in this re-evaluation.

10. CAPE PARRY

The marine habitat adjacent to Cape Parry is considered to be a productive area as a result of currents, tides and bathymetry and related potential upwelling as well (Mundy et al. 2009, DFO 2011c). The sea-ice/polynya water interface creates key habitat for feeding by Polar Bear (Durner et al. 2004, Pilfold et al. 2012), Ringed Seal and Bearded Seal in late fall to early spring. The bathymetry and oceanographic conditions also create concentrated areas of prey for Beluga and Bowhead Whale. Sea ducks use the ice-edge as an important staging area. The offshore and nearshore marine feeding habitat supports a unique seabird nesting area for Thick-billed Murres (*Uria lomvia*) and Black Guillemots of the Cape Parry Migratory Bird Sanctuary (Mallory and Fontaine 2004). King Eider (*Somateria spectabilis)* and Common Eider (*Somateria mollissima*use) use the marine waters as a staging and moulting area. Asselin et al. (2011) reported a high abundance of Beluga in the spring along the coast of Cape Parry, these Beluga are thought to feed on Arctic Cod, which aggregate in waters of about 125–250 m depth (Benoit et al. 2008).

VECs: Seabirds (Thick-billed Murres, Black Guillemots) and migratory birds, King Eider and Common Eider, Polar Bear, Ringed Seal, Beluga and Bowhead Whale, Arctic Cod, benthos, ice-edge organisms and phytoplankton that benefit from enhanced productivity.

Confidence:

High: A Migratory Bird Sanctuary exists at Cape Parry and there is sufficient data and traditional/local knowledge to support the use of the EBSA by birds.

Moderate: The link between the foraging birds and marine productivity (primary, secondary, forage fishes, etc.) has been inferred based on other Arctic publication. Ice data is available from the Canadian Sea Ice Service, but is limited in the details (i.e., ice type).

Low: There are no recent detailed bathymetric data for the area. Very few studies on primary production and fish surveys have been conducted in the area.

11. NEARSHORE DARNLEY BAY

Freshwater flow from the Hornaday and Brock rivers create a band of relatively warm, freshened waters along the east and west coast of Darnley Bay offshore to about 10 m in depth (DFO 2011c). This habitat is critical for acclimatization of anadromous Arctic Char as they migrate between the freshwater and the marine environment annually, where they do most of their feeding. Capelin (*Mallotus villosus*) are considered to be abundant in the offshore water near Pearce Point, and may be a very important food source for the sea-run char. Arctic Char can also utilize the freshened portion of the water column further offshore (up to 20 m depth contour) under favorable meteorological and oceanographic conditions. The area from just north of Bennett Point to the area just east of Pearce Point (where tagged Arctic Char have been captured), was selected as ecologically and biologically important to sea-run Arctic Char (DFO 2011c). Kelp beds, which are rare in the Beaufort Sea LOMA have been reported in Argo Bay and along the coastline of Parry Peninsula, and could provide important structural habitat

for fish. Kelp in the area has not been sampled and the extent of kelp in Darnley Bay has not been assessed, so it is uncertain to what extent this is unique or in sufficient abundance to provide structural habitat.

VECS: Arctic Char feeding and migratory corridor, Capelin, kelp

Confidence:

Very High: Arctic Char from the Hornaday and Brock rivers make sea-run migrations along the coastal waters of Darnley Bay annually following ice-breakup. This habitat is considered critical for their survival. The exact extent of use of the suggested boundary along the coast of the bay is not known; however they are known to occur at least to Pearce Point (north eastern boundary extent). The community of Paulatuk has developed a Char Management Plan for the Hornaday River and regular monitoring of the fishery is conducted and reviewed.

Low: No studies on Capelin or kelp have been conducted in this area; information is based on observation and traditional/local knowledge.

12. OFFSHORE DARNLEY BAY

The third area evaluated as an AOI in DFO (2011c) was the Darnley Bay offshore ice-edge habitat between Pearce Point and Cape Parry. This area is part of the Amundsen Gulf flaw lead, and is considered a productive area offshore of Darnley and Franklin bays during late winter and spring. Favorable winds along the ice-edge can cause aggregations of prey and predators such as zooplankton, Arctic Cod, Bowhead Whale, Beluga, seabirds and Polar Bear (Durner et al. 2004). The boundary of this candidate EBSA is dynamic due to high inter-annual variation. A decision on the boundary was made based on the best approximation of the location of the fast-ice edge (DFO 2011c).

VECS: Marine mammal foraging, primary production, seabird foraging, Arctic Cod, primary/secondary productivity

Confidence:

Low: Although some studies have been conducted in this EBSA, they are limited. The ice-edge environment is known to be highly productive particularly if conditions persist for favorable upwelling at the edge. This is based on one study in the EBSA and other publications which reference sea ice-edge habitat is used as a proxy.

13. DESALIS BAY

Located on the southern shore of Banks Island, this area was identified in the Sachs Harbour Community Conservation Plan (Community of Sachs Harbour et al. 2008) as an important ecological area. Although not as heavily used by marine fauna as other areas in the Beaufort Sea, it is considered a moderately important Beluga area, with whales visiting the bay during their migrations between Amundsen Gulf and Viscount Melville Sound (Richard et al. 2001). The area has been designated under the Beaufort Sea Beluga Management Plan (FJMC 2001) as zone 1B, an area of existing or potential harvest. Oceanic upwelling provides conditions suitable to support Bowhead Whale feeding aggregations. Important Ringed Seal habitat was also identified by the Community of Sachs Harbour et al. (2008). Sea-run Arctic Char from the DeSalis River feed in the waters of the bay. Northern Beaufort Sea Polar Bears have been captured and released around DeSalis Bay (Stirling et al. 2007), and denning along the coastline has been identified (Mercier et al. 1995).

VECS: Arctic Char feeding and migratory corridor, Beluga, Bowhead Whale, Ringed Seal

Confidence:

Low: There have been no population studies of marine VECs in this EBSA, however, satellite tagging of marine mammals shows an affinity to the area on repeated years. Although some studies have been conducted in this EBSA, they are limited. The significance of this EBSA relative to other areas is based on local/traditional knowledge and the Beluga Management Plan zoning.

14. THESIGER BAY

On the west shore of Banks Island, this candidate EBSA extends offshore from Cape Kellett to Cape Lambton and includes the local harbour. The coastal area is important for sea-run Arctic Char from Sachs River, Reddi Lake and Kellett River (Community of Sachs Harbour et al. 2008). The offshore area is close to the ice-edge formed annually by the polynya and extensive flawlead system. Sites sampled within this EBSA have high silicic acid remineralization, phosphate and nitrate fluxes (Link 2012). Traditional knowledge has documented use of the area by Beluga and Bowhead Whales for migration, as well as for feeding (Hartwig 2009). Migrating tagged Bowhead Whales have been reported to use the outer areas of the bay over the past several years (Heide-Jørgensen et al. 2012). Polar Bear of the Northern Beaufort Sea population frequent the coastline (denning) along the Thesiger Bay EBSA in high numbers (Durner et al. 2004; Pilfold et al. 2012; Sterling et al. 2007). This area is also an important feeding area for females emerging from dens (Stirling and Andriashek 1992; Environment Canada unpubl. data). Diversity of invertebrates is high along the coastline of Sachs Harbour (Siferd 2001). Brant, King Eider and Long-tailed Ducks (*Clangula hyemalisuse*) frequent the marine waters.

VECS: Arctic Char feeding and migratory corridor, Beluga, Bowhead Whale, benthic ecosystem functions, Polar Bear, Pacific Brant, King Eider, Long-tailed Duck

Confidence:

Moderate: Some studies have been conducted in this EBSA. The significance of this EBSA relative to other areas is based on local/traditional knowledge.

15. WALKER BAY

Walker Bay is historically the original location of the Hudson's Bay Company trading post on Victoria Island (Community of Ulukhaktok et al. 2008). The candidate EBSA is situated on the west coast of Victoria Island, and was identified by Science and the community of Ulukhaktok as important for Arctic Char and Ringed Seal. The area of freshwater and saltwater mixing creates a small coastal estuary that supports Arctic Char marine feeding aggregation and fitness consequences, however the extent and relevance to the stock is unknown. The stock is small, localized and there is relatively no recent scientific data for this stock. In addition to Arctic Char, the bay is relatively secluded and is therefore considered prime breeding habitat for Ringed Seal, however, the use of seals in this area is not quantified and the significance of the habitat for the overall Ringed Seal population in the Beaufort Sea is relatively low compared to other areas in the Beaufort Sea LOMA. This area is identified by Durner et al. (2009) as important seasonal habitat for Polar Bears.

The Community of Ulukhaktok et al. (2008) suggests that shellfish in Walker Bay are important and significant in the area. They also support the development of a management plan for shellfish in Walker Bay.

VECS: Arctic Char feeding and migratory corridor, Ringed Seal, Polar Bear

Confidence:

Low: Although some studies have been conducted in this EBSA, they are limited. The significance of this EBSA relative to other areas is based on local/traditional knowledge.

16. MINTO INLET/KUUJJUA RIVER

The coastline, south of the Kuujjua River, to Cape Ptarmigan is an area of freshwater and saltwater mixing and is an important feeding and migration area for Kuujjua River Arctic Char. Similar to Walker Bay this area was also identified as important seasonal habitat by Durner et al. (2009). Traditional knowledge holders have also identified Arctic Cod and Pacific Herring use in Minto Inlet. Ringed Seal, Bowhead Whale and Beluga also make infrequent use of Minto Inlet based on local observations (Hartwig 2009).

VECS: Arctic Char feeding and migratory corridor, Ringed Seal, Polar Bear

Confidence:

Moderate: Although some studies have been conducted in this EBSA, they are limited. The significance of this EBSA relative to other areas is based on local/traditional knowledge.

17. ALBERT ISLANDS/SAFETY CHANNEL

This area is located just south of Ulukhaktok, and includes waters around Queen and Jack bays and the Albert Islands. This area was identified by science and the community as an important area. The combination of islands and channel bathymetry create mixing of freshwater and marine water, often creating flaw leads. Arctic Char and Capelin abound here, and Arctic Cod have been reported. A high diversity of macro-invertebrates, including clams, mussels, jellyfish, starfish, crabs, sea urchins, not common to the southern Beaufort Sea, exist along the rocky bottom and clear waters of this coastline. Ringed Seal aggregate in this area to feed and breed. Rare occurrences of Wolffish (*Anarhichas* spp.), Pacific Walrus (*Odobenus rosmarus divergens*) and Killer Whale (*Orcinus orca*) have been reported here (Paulic et al. 2009, Hartwig 2009). Beluga and Bowhead Whale feeding has been reported in this area (Hartwig 2009). This area is highly unique for its diversity of marine fauna. Long-tailed Duck, Brant and eiders also use this area for feeding and staging.

VECS: Arctic Char feeding and migratory corridor, High diversity of marine invertebrates, Ringed Seal, Bird feeding and staging

Confidence:

Moderate: Although some studies have been conducted in this EBSA on Arctic Char, marine invertebrates and Birds there have been few peer reviewed sources of information. The significance these VECs relative to other areas is based on local/traditional knowledge.

Very High: A long-term community-based Ringed Seal monitoring program has been running at this site recently from 1992 to present but is a continuation of an earlier monitoring program that started in 1971-1981. There are numerous peer-reviewed sources available.

18. KAGLORYUAK RIVER

This candidate EBSA is located in the eastern portion of Prince Albert Sound, and includes waters off of Kuuk and Kagloryuak Rivers. It was identified by both science and local community members. This coastal estuary provides a mixing zone for freshwater and marine water. Traditional knowledge holders have identified this area as an important feeding and migratory corridor for sea-run Arctic Char. It is also an important area for Bearded Seal (*Erignathus*

barbatus) pupping and feeding (Hartwig 2009). Some use by Polar Bear for feeding is reported for this part of Prince Albert Sound, however it is considered a data poor area for Polar Bear.

The Kagloryuak River valley is among the richest areas on Victoria Island in terms of diversity and abundance of bird life (Cornish and Dickson 1996). An estimated 2–3% of the western Canadian Arctic population of King Eider nest in the Kagloryuak River Valley Key Terrestrial Site, occurring there in higher densities than anywhere else in the western Canadian Arctic (Dickson et al. 1997).

VECS: Arctic Char feeding and migratory corridor, Bearded Seal, Seabirds

Confidence:

High: The key terrestrial site for Birds in the area subsequently has provided a number of scientific data and information on the use of the marine area by birds.

Moderate: The Arctic Char rivers in this EBSA have been studied in past under DFO stock assessment practices.

Very Low: Although some studies have been conducted in this EBSA for Bearded Seals, they are limited. The significance of this EBSA for Bearded Seals relative to other areas is based on local/traditional knowledge.

19. VISCOUNT MELVILLE SOUND

This area is receiving increasing attention by scientists as an important area. Tagged Beluga and Ringed Seal have been reported conducting deep dives in the area (Richard et al. 2001, Loseto et al. 2006, Lois Harwood pers. comm., DFO Yellowknife, NT), suggesting that they are feeding. More recently, tagged Bowhead Whales have also been found to use the area (Heide-Jørgensen et al. 2012).

The Viscount Melville Polar Bear subpopulation is small relative to other subpopulations, estimated at 215 ± 58, which is based on simulations from parameters measured in 1993 (Taylor et al. 2002). The EBSA is considered a seasonally important area (Taylor et al. 2001).

VECS: Beluga, Polar Bear

Confidence:

Low: Although some studies/observations have been made in this EBSA, they are limited. The significance of this EBSA relative to other areas is based on limited tagging data and boat-based observation for Beluga.

20. BANKS ISLAND FLAW LEAD

The Banks Island Flaw lead on the west coast of Banks Island provides important habitat for a variety of fauna. Beluga utilize the area in the spring on their way from wintering grounds en route to the Southern Beaufort Sea (Asselin et al. 2011), and also during summers when large male Beluga migrate to Viscount Melville Sound (Richard et al. 2001). Typical of many other Arctic flaw leads, productivity is enhanced along the ice-edge. Northern Beaufort Sea Polar Bear are abundant along the flaw lead (Durner et al. 2004; Pilfold et al. 2012; Stirling et al. 2007). The coastal areas are important for Polar Bear denning and the marine area is important for female Polar Bears emerging from their dens (Stirling and Andriashek 1992). Marine birds, with high densities of King Eider, use the flaw lead and coastline (Mallory and Fontaine 2004). Bowhead Whales migrate through the Banks Island Flaw lead on their migration to Viscount Melville Sound (Heide-Jørgensen et al. 2012). Local traditional knowledge also supports this area as important Bearded Seal habitat.

VECS: Marine mammal foraging and migration, Seabirds, primary production, Polar Bear

Confidence:

High: There is substantial scientific and traditional/local knowledge available for habitat use in this area.

21. CAPE BATHURST POLYNYA

The Cape Bathurst Polynya is located at the western entrance of the Amundsen Gulf, and has a spatially-variable boundary due to the intense annual and seasonal environmental variability in the area. The variability in sea-ice dynamics, extensive periods of open water, and the resultant productivity in the Amundsen Gulf, makes it one of the most important North American polynyas, and as such, has been an important focal point for ArcticNet and IPY research programs (Barber et al. 2010, Galley et al. 2008). Arrigo and Van Dijken (2004) describe the processes contributing to enhanced phytoplankton productivity in the polynya. This EBSA has moderate megabenthic taxa richness for the region (V. Roy, H. Link and P. Archambault, UQAR, unpubl. data) with comparable macrobenthic taxonomic diversity (Clarke and Warwick 1995) and density to the southwestern Beaufort Shelf region at similar depth (Conlan et al. 2008). Results of benthic remineralization indicate high biological activity, releasing nutrients from the sediments particularly at the western entrance of Amundsen Gulf (Renaud et al. 2007a, Link et al. 2011, Link 2012, Link et al. 2013).The polynya is important to Arctic Cod, as an area of aggregation, in deep and warm Atlantic waters (Geoffrey et al. 2011), and as an important nursery ground (Lafrance 2009). Marine birds utilize the polynya for feeding and staging. Polar Bear of both the southern and northern Beaufort Sea populations utilize the Cape Bathurst Polynya (Durner et al. 2004; Pilfold et al. 2012; Stirling et al. 2007) for feeding. Beluga also utilize the area in spring after their return to the Beaufort Sea (Asselin et al. 2011).

VECs: lower pelagic trophic levels (phytoplankton, zooplankton), megabenthic taxa richness, macrobenthic density, benthic ecosystem functions, Arctic Cod, marine birds, Beluga, Polar Bear

Confidence:

Very High: This candidate EBSA is well studied. The physical drivers (e.g., polynya, ice-edge) that create favorable conditions for complex food web dynamics and ecosystem structure and function are critical for the species that utilize the area. Aggregations of primary and benthic producers and benthic functions are documented in published literature.

22. CAPE BATHURST/BALLIE ISLAND

The area to the north and north-west of Cape Bathurst has a unique combination of bathymetry and oceanography that create strong wind-driven upwelling events which bring cold, Pacific-derived water to the surface (Williams and Carmack 2008). The resulting productivity supports dense zooplankton populations (Walkusz et al. 2012) and some of the most diverse and abundant benthic macrofaunal communities in the Canadian Beaufort Sea (Conlan et al. 2008). A recent review of data collected in this region (V. Roy, H. Link and P. Archambault, UQAR, unpubl. data) found also high macro- and megabenthic taxa richness and density. Benthic remineralization indicates high biological activity releasing nutrients from the sediments (Renaud et al. 2007a, Link et al. 2011, Link 2012, Link et al. 2013).

In late summer, Bowhead Whales aggregate near Cape Bathurst and feed intensively on dense zooplankton communities (Harwood et al. 2010, Walkusz et al. 2012). Important staging areas for Common Eider, King Eider and Long-tailed Duck are found within the Cape Bathurst EBSA (Dickson and Gilchrist 2002). Ringed Seal feeding aggregations have been reported north of

Tuktoyaktuk Peninsula, in the area of the Cape Bathurst EBSA (Harwood and Stirling 1992). These aggregations are variable depending upon ice conditions, but in most years were considered high. The seals aggregating in this region of the Beaufort Sea have been shown to be feeding on large concentrations of *Mysis* spp.

This area is considered to be important seasonal habitat for Polar Bears (Durner et al. 2004; Pilfold et al. 2012).

VECs: planktonic organisms, macro- and megabenthic taxa richness and density, benthic ecosystem functions, Bowhead Whale, Beluga, Common Eider, King Eider and Long-tailed Duck, Ringed Seal, Polar Bear.

Confidence:

Very High: The physical and oceanographic features that drive upwelling and create enhanced productivity in the area are well documented. Aggregations of primary and benthic producers and benthic functions are documented in published literature.

Very High: The aggregation of marine mammals and seabirds is well documented.

23. BEAUFORT GYRE/MULTI-YEAR PACK ICE

Since the Beaufort Sea LOMA extends up into the Arctic Basin biogeographic region, part of this region was assessed in the Arctic EBSA process (DFO 2011b). The Beaufort Gyre and multi-year pack ice are the physical features that dominate the region. The Beaufort Gyre is a large anticyclonic gyre in the southern Canada Basin of the Arctic Ocean that contains a globally significant accumulation of freshwater from the North American and Eurasian arctic rivers (from DFO 2011b). It is unique in this respect; and the release of freshwater from the gyre through the Canadian Arctic Archipelago and Fram Strait is of international interest due to its impact on the oceanography of the Canadian Arctic Archipelago and Greenland and Labrador seas.

The dramatic decline in Arctic summer ice coverage over the last few decades demonstrates that this EBSA is where the thick multi-year ice will persist longest in the Canadian Arctic. This makes this feature internationally unique within the Canadian Arctic and globally. Additionally, little is known about the fauna that reside in the Arctic Basin, however there are likely a number of taxonomic species/groups that are unique both to the Beaufort Sea LOMA and the Canadian Arctic. Northern and Southern Beaufort Sea Polar Bears use this candidate EBSA and it is considered an important summer refugium and potential denning area (Durner et al. 2009).

VECS: Beaufort Gyre, Multi-year pack ice, Under ice-fauna, Polar Bear.

Confidence:

Very High: Peer-review data sources exist for the Beaufort Gyre and the multi-year pack ice, however, the location as to the boundary of the EBSA is variable and difficult to distinguish

Very Low: The diversity and importance of under-ice fauna is not well documented.

High: There are peer-reviewed articles that document the importance of multi-year ice as seasonal refugium for both the northern and southern Beaufort Sea Polar Bear populations.

24. PRINCE OF WALES STRAIT

The narrow strait between Banks Island and Victoria Island is ice covered for the majority of the year, however it has been shown to be an important migration route for Beluga (Richard et al. 2001), Ringed Seal (Lois Harwood pers. comm., DFO Yellowknife, NT), and Bowhead Whale (Heide-Jørgensen et al. 2012). There have been no directed studies of this region, however,

local community members from Sachs Harbour and Ulukhaktok do access the area to harvest irregularly (Community of Sachs Harbour et al. 2008; Community of Ulukhaktok et al. 2008). A recent review of data collected in this region (V. Roy, H. Link and P. Archambault, UQAR, unpubl. data) found moderate megabenthic taxa richness within this EBSA.

VECs: Marine Mammal migration corridor, Beluga, Bowhead Whale, megabenthic taxa richness, Ringed Seal

Confidence:

Low: The marine mammal telemetry studies had a low sample size of animals. There is a potential that Prince of Wales Strait is an important route for migrating marine mammals from the Beaufort Sea to Viscount Melville Sound, it appears that the relative importance of Viscount Melville to marine mammals will be key to understanding the importance of access to the area.

CONCLUSIONS

During the November 2012 Science peer review meeting, the 24 candidate EBSAs were refined and/or amalgamated to create 18 EBSAs in the Beaufort Sea LOMA (Table 3).

*Table 3. Summary of the final EBSAs from the November 2012 advisory meeting in comparison to the candidate EBSAs evaluated during the meeting. * denotes when revision to the boundaries were made but no significant changes were made to the rationale for the EBSA.*

Final EBSAs	Candidate EBSAs
Yukon North Slope*	Herschel Island/Yukon North Slope
Mackenzie Trough*	Mackenzie Trough
Mackenzie Estuary and Nearshore Beaufort Shelf	Shallow Bay
	Beluga Bay
	Kugmallit Corridor (nearshore portion)
Beaufort Shelf Break and Slope*	Beaufort Shelf Break
Kugmallit Canyon	Kugmallit Corridor (offshore portion)
Husky Lakes	Husky Lakes
Cape Bathurst/Ballie Island	Liverpool Bay (northeastern portion)
	Cape Bathurst Polynya
Liverpool Bay*	Liverpool Bay (southern portion)
Horton River*	Horton River
Cape Bathurst Polynya*	Cape Bathurst Polynya

Final EBSAs	Candidate EBSAs
	Thesiger Bay (southern portion)
Western Banks Island	Banks Island Flaw Lead
	Thesiger Bay (Sachs Harbour)
DeSalis Bay*	DeSalis Bay
Diamond Jenness	Walker Bay
	Albert Islands/Safety Channel
	Minto Inlet
	Kagloryuak River
Southern Amundsen Gulf	Pearce Point
Darnley Bay Nearshore Migration and Feeding Corridor	Hornaday River
Viscount Melville Sound*	Viscount Melville Sound
Arctic Basin Multi-year Pack Ice	–
Archipelago Multi-year Pack Ice	–

Using the National Evaluation Framework for EBSAs, the three main dimensions of uniqueness, aggregation and fitness consequences were assessed. The classification system modified from Chan et al. (2012) was used to evaluate data quality and uncertainty and provide a level of confidence in the data supporting each EBSA. In addition, a description was added for those ecosystem components in the EBSAs that are seasonally variable to help managers. Species occurring in each EBSA that have been assessed as at risk of extinction by COSEWIC or are listed under the *Species at Risk Act* were also noted. Details are provided in the science advisory report (DFO 2014).

Due to the variable nature of multi-year pack ice, a more appropriate method is needed to define EBSA boundaries.

Whether all or which specific river systems in the LOMA supporting Arctic Char warrant EBSA designation was discussed but not resolved. Further evaluation is warranted.

As more information becomes available, EBSAs in the Beaufort Sea LOMA should continue to be re-evaluated. In particular, more information is needed from the Canadian Ice Service to better map the boundaries of the Southern Amundsen Gulf EBSA. More information is also needed detailing the importance of underwater pingos in the Mackenzie Estuary and Nearshore Beaufort Shelf EBSA, upwelling events in the DeSalis Bay EBSA and physical oceanographic properties of the Prince of Wales Strait. Lastly, in order to assess areas of ecological significance and uniqueness for the Beaufort Sea, information on the importance of kelp beds in general and more specifically for the Liverpool Bay and Nearshore Darnley Bay EBSAs are

needed. It is important to also note that there are many areas within the LOMA that have not been extensively visited and are not identified as EBSAs, caution should be taken in the event of any future proposed activity.

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PERSONAL COMMUNICATION

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APPENDIX

Identification of Macro- and Megabenthic Ecologically and Biologically Significant Areas (EBSAs) in the Beaufort Sea Large Ocean Management Area (LOMA): A Working Paper on benthic systems for the CSAS meeting November 20-22, 2012.

Information Sources and Limitations

The information included here is limited primarily by the accessibility of datasets and the willingness of researchers to share datasets. Unfortunately, many datasets were not accessible and could not be included in the present document (see Archambault et al. 2010 for a discussion on data sharing). Nevertheless, our benthic review compiles data from several sources and different years (1971 to 2011). The distribution of macro- and megabenthic taxa richness and density were mapped with ArcGIS 9.3.1 with color bins defined by the Jenks iterative method which minimizes within class difference and maximizes between class differences (Jenks and Caspall 1971). In the case of close site locations, the dot with the largest value was mapped on top.

Macrobenthos (155 stations included)

Historical macrobenthic data in the southeastern Beaufort Sea from 1971-1975 were collected as part of a multidisciplinary program of the Biological Oceanography Section of the Arctic Biological Station (Wacasey et al. 1977). Macrobenthic data from recent Arctic programs include: Arctic Net-IOL 2009, ArcticNet-BP 2010 and ArcticNet-BP/IOL 2011. Macrobenthic data were also obtained during the Canadian Arctic Shelf Exchange Study (CASES) in 2003-2004, but was not available to be included here (see data in Conlan et al. 2008).

Megabenthos (82 stations included)

Megabenthic community diversity has been studied in the Canadian Arctic only recently (from 2007-2011; IPY-CFL, ArcticNet-BP/IOL and ArcticNet-CHONe programs (Roy, unpubl. data)). To our knowledge no data, scientific publications and/or Canadian governmental reports exist on extended megabenthic diversity surveys in the southeastern Beaufort Sea (see Chapman and Kostylev 2008).

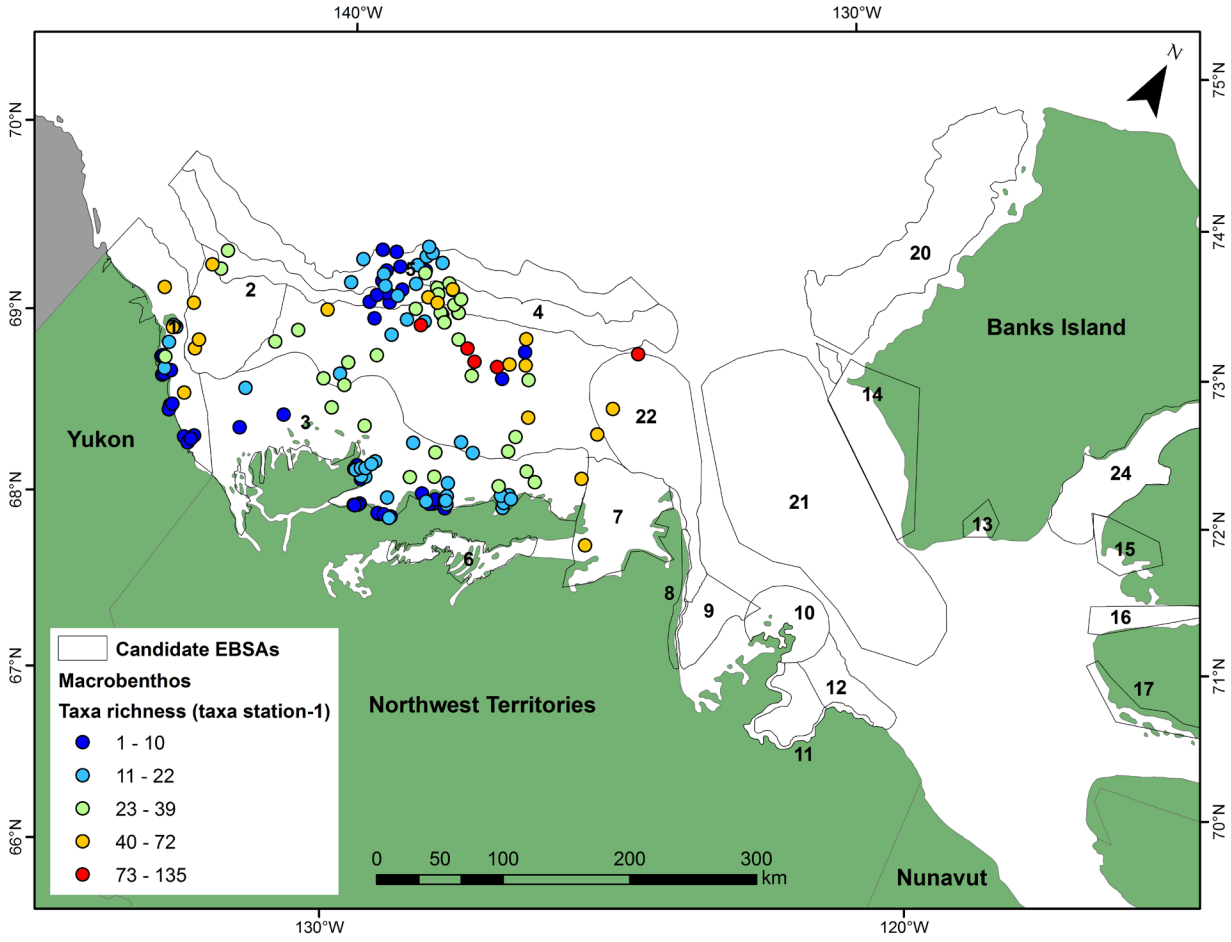
Benthic Ecosystem Functions as Indicated by Benthic Remineralization and Fluxes (25 stations included)

Data on benthic carbon remineralization (oxygen fluxes) in the Beaufort Sea LOMA has been published from the CASES campaign (2003-2004) in the Beaufort Sea (Renaud et al. 2007a,b). Data on multiple fluxes (oxygen, nitrate, nitrite, ammonium, phosphate, silicic acid) was obtained during the CFL (2007-2008) as well as the Malina and ArcticNet-CHONe campaigns (2009) from the Mackenzie Shelf, the Amundsen Gulf and Viscount-Melville Sound (Link et al. 2011, Darnis et al. 2012, Link 2012, Link et al. 2013). Further details on methods used to determine benthic remineralization of carbon and nutrients can be found in Kenchington et al. (2011) and Link et al. (2013).

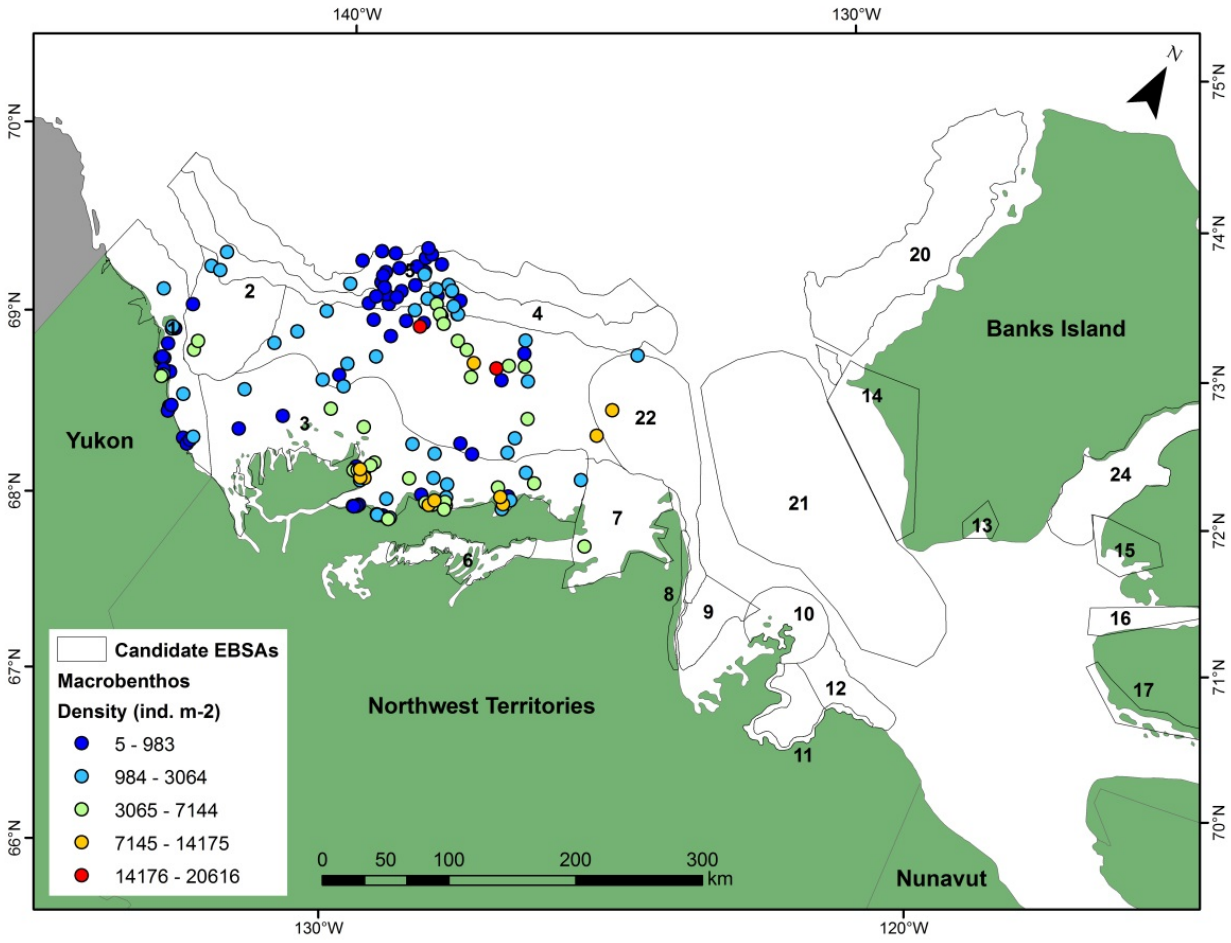
Results of Taxa Richness and Density Data

Macro and megabenthic community data on taxa richness (number of taxa) and density (ind. m^2) are presented in Appendix Figures 1-4. Based on the results in Figures 1-4 and with respect to areas regarded as moderate to high, benthic information was incorporated into each EBSA rational and/or identified VEC in this Research Document. Based on the results it was advised to extent the Mackenzie Estuary and Nearshore Beaufort Shelf and/or Beaufort Shelf break, and the Cape Bathurst/Ballie Island EBSAs in order to incorporate sites that indicated high taxa richness and/or density. This advice was considered during the meeting and rather

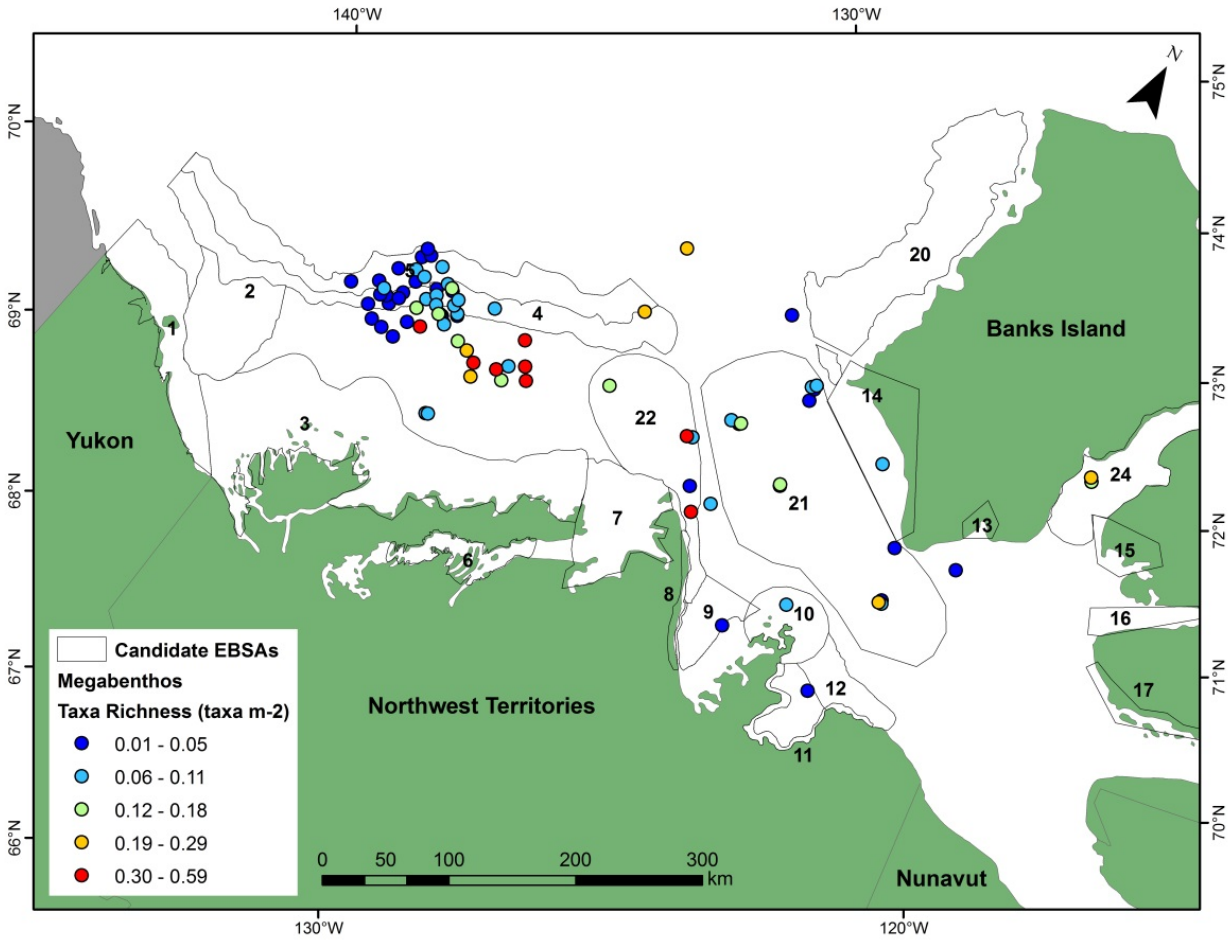
than extend existing EBSA boundaries, rational for a new EBSA was considered, the Kugmallit Canyon EBSA (see DFO 2014).



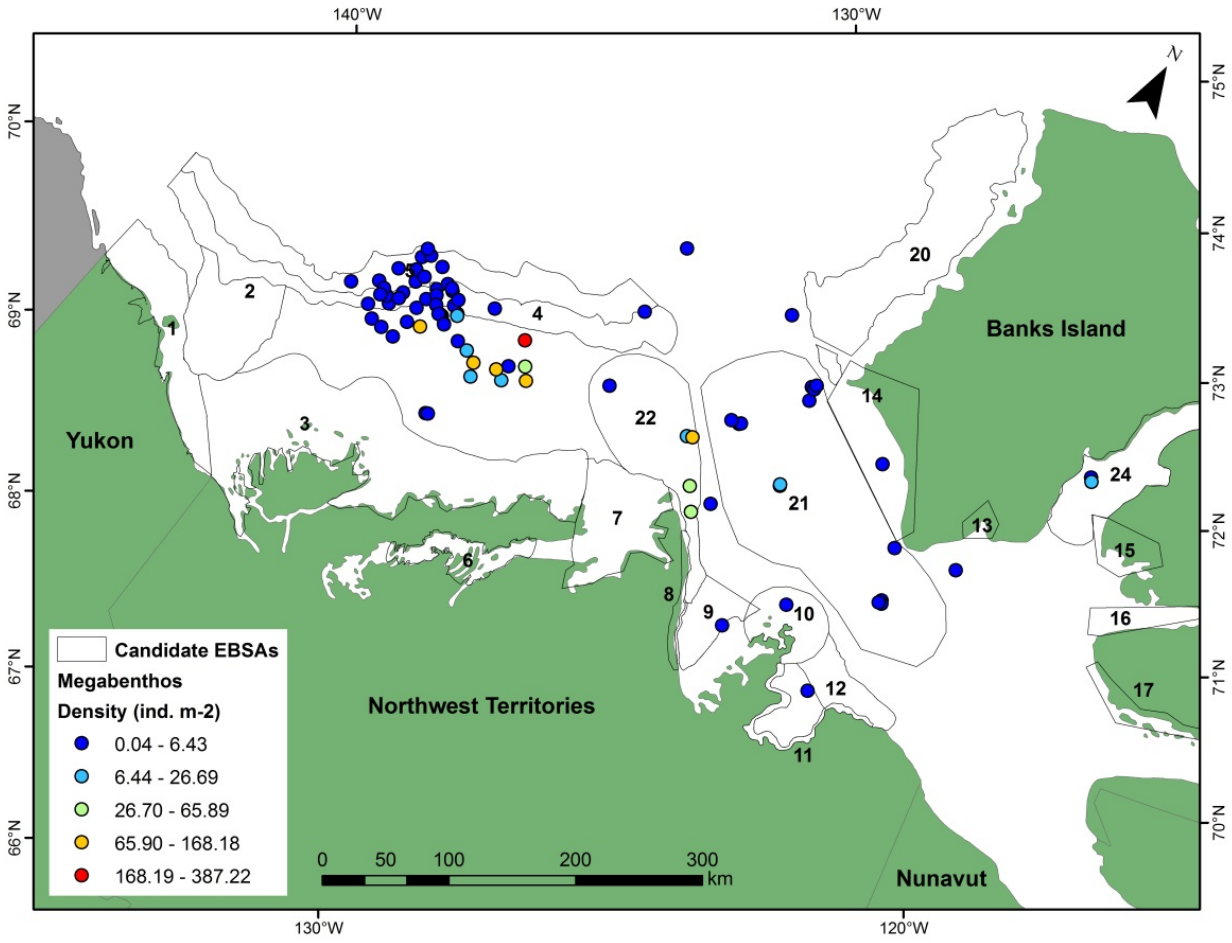
Appendix Figure 1. Macrobenthic taxa richness for 155 stations (number of taxa station^{-1}) in the Beaufort Sea LOMA. Each point represents one sampling event (station). Polygons and numbers represent the candidate EBSAs within the Beaufort Sea LOMA (solid black line) that were evaluated using the National Evaluation Framework (DFO 2004). EBSA names can be found in Table 2.



Appendix Figure 2. Macrobenthic density for 155 stations (ind. m^{-2}) in the Beaufort Sea LOMA. Each point represents one sampling event (station). Polygons and numbers represent the candidate EBSAs within the Beaufort Sea LOMA (solid black line) that were evaluated using the National Evaluation Framework (DFO 2004). EBSA names can be found in Table 2.



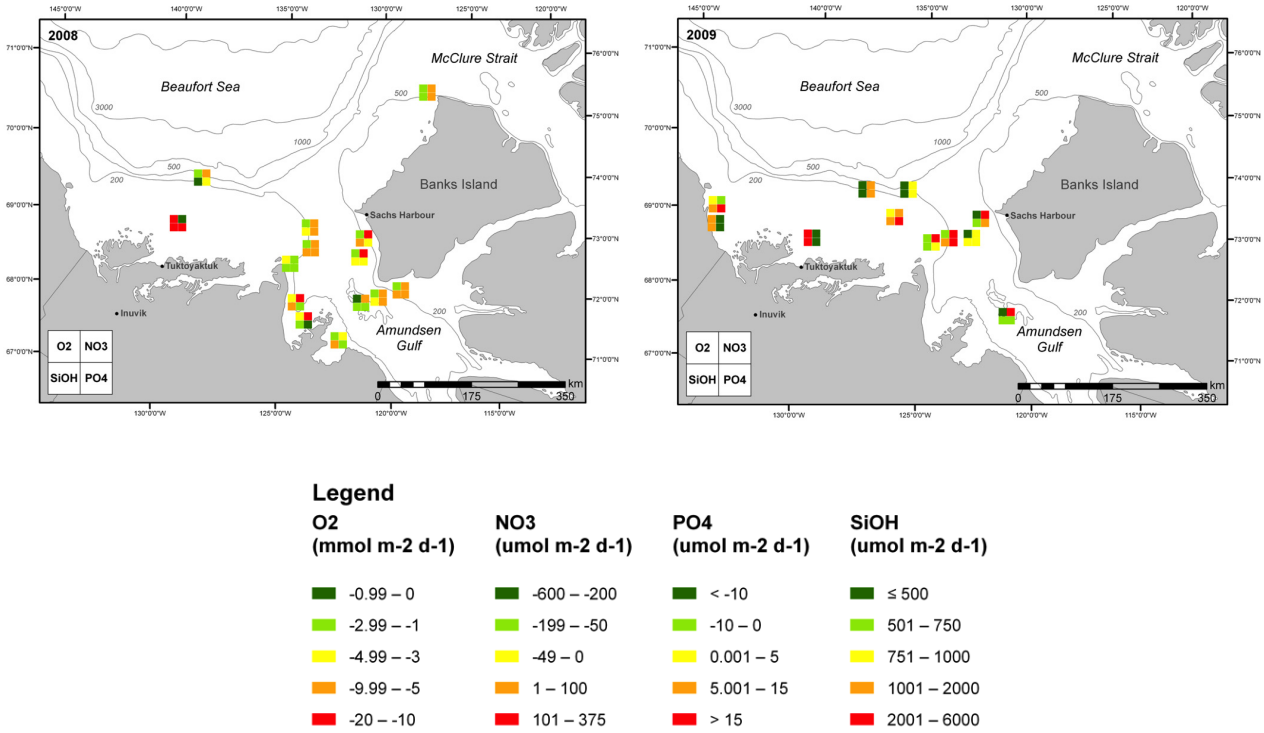
Appendix Figure 3. Megabenthic taxa richness for 82 stations (number of taxa m^{-2}) in Beaufort Sea LOMA. Each point represents one sampling event (station). Polygons and numbers represent the candidate EBSAs within the Beaufort Sea LOMA (solid black line) that were evaluated using the National Evaluation Framework (DFO 2004). EBSA names can be found in Table 2.



Appendix Figure 4. Megabenthic density for 82 stations (ind. m^{-2}) in Beaufort Sea LOMA. Each point represents one sampling event (station). Polygons and numbers represent the candidate EBSAs within the Beaufort Sea LOMA (solid black line) that were evaluated using the National Evaluation Framework (DFO 2004). EBSA names can be found in Table 2.

Summary

This working document presents an updated and integrated description of sites with moderate to high macro- and megabenthic diversity (taxa richness and density) and benthic ecosystem functions (carbon and nutrient remineralization) known to date in the Beaufort Sea LOMA (Figure 5). We recommend integrating these nine benthic EBSAs described into the report on the re-evaluation of EBSAs in the Beaufort Sea LOMA. Most benthic EBSAs presented here have been identified in the previous assessment of Beaufort Sea EBSAs to very similar extents (Paulic et al. 2009), but additional and newly considered benthic data implies to add a few EBSAs and to redefine borders and areas. Nine candidate EBSAs are of particular importance concerning benthic systems (Table 1).



Appendix Figure 5. Benthic remineralization in the southeastern Beaufort Sea in 2008 (14 stations) and 2009 (11 stations). Fluxes from the sediment to the water column of oxygen (O2), nitrate (NO3), silicic acid (SiOH) and phosphate (PO4) are presented. Modified after data published in Kenchington et al. (2011) and Darnis et al. (2012). See legend for rates and color codings. Figure from Link (2012).

*Appendix Table 1. Nine Ecologically and Biologically Significant Areas (EBSA) in the Beaufort Sea Large Ocean Management Area (LOMA) that are of particular importance concerning benthic systems. The * denotes where a boundary change is suggested in order to capture the feature identified within that EBSA.*

Candidate EBSA	Moderate to High Benthic Taxa Richness and/or Density	High Benthic Ecosystem Functions
Mackenzie Trough	X	X
Mackenzie Estuary and Nearshore Beaufort Shelf*	X	X
Beaufort Shelf break*	X	
Beaufort Slope	X	
Franklin Bay	X[a]	X
Thesiger Bay		X
Cape Bathurst Polynya	X	X
Cape Bathurst/Ballie Island*	X	X
Prince of Wales Strait	X	
TOTAL	8	6

[a] high macrobenthic taxonomic diversity and density, as reported by Conlan et al. 2008