The Arctic Marine Workshop

Freshwater Institute
Winnipeg, Manitoba
February 16-17, 2010

S.A. Stephenson and L. Hartwig

Fisheries and Oceans Canada
Oceans Programs Division
Freshwater Institute
Central and Arctic Region
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ABSTRACT

Stephenson, S.A., and L. Hartwig. 2010. The Arctic Marine Workshop: Freshwater Institute, Winnipeg, Manitoba, February 16-17, 2010. Can. Manuscript Rep. Fish. Aquat. Sci. 2934: vi+67p.

The Arctic Marine Workshop organized by the Oceans Programs Division of Fisheries and Oceans Canada was held to bring together expert knowledge about Arctic fauna, including marine mammals, fish, marine invertebrates, seabirds and polar bears, and their distribution in the marine environment. The objective of the workshop was to update the results of a similar workshop held in 1994 by identifying areas of overlapping use, and therefore, areas of High Biological Importance (HBI) to wildlife. Additionally, areas of current and proposed industrial and commercial activities were also identified so that participants could see where the areas of HBI might be adversely affected by anthropogenic activities. It was thought that having this information presented in one forum could assist further research initiatives, provide information for a planned Arctic marine protected area network, help inform regulators and provide a lasting “snapshot” of wildlife distribution prior to expected climatic changes.

Nineteen areas of HBI were identified by overlapping areas of high productivity and greatest use by individual species and species groups. While many of these areas corresponded well with those identified in 1994, due to the methodology used, the areas identified in 2010 were generally more restricted in size. In addition, due to an increase in knowledge and the inclusion of several species, some new areas were identified as biologically important.

Although there has been a substantial increase in our understanding of the distribution of wildlife in the Arctic and the relative importance and use of specific areas since 1994, there are still several areas, notably the Sverdrup and Arctic basins, where, for a number of reasons, little biological information is available. As Canada moves towards establishing a network of marine protected areas in the Arctic, these areas will require additional research. However, the issues that have traditionally kept researchers out of these areas remain essentially unchanged and present a continued challenge.

Key Words: Northwest Territories, Nunavut, Bowhead Whale, Beluga Whale, Narwhal, Killer Whale, Walrus, seal, fish, Polar Bear, seabird, polynya, productivity, Beaufort Sea, Hudson Bay, Lancaster Sound, Baffin Bay, Davis Strait, High Biological Importance.

RÉSUMÉ

Stephenson, S.A. et L. Hartwig. 2010. *The Arctic Marine Workshop,* Institut des eaux douces, Winnipeg (Manitoba), 16-17 février 2010. Can. Manuscript Rep. Fish. Aquat. Sci. 2934 : vi+66p.

Le Arctic Marine Workshop (*Atelier sur l’écosystème marin de l’Arctique*), organisé par la Division des programmes sur les océans de Pêches et Océans Canada a eu lieu dans le but de réunir les connaissances des experts sur les espèces de la faune arctique, notamment les mammifères marins, les poissons, les invertébrés marins, les oiseaux de mer et les ours polaires, ainsi que sur la répartition de ces espèces dans le milieu marin. L'objectif de l’atelier était de mettre à jour les résultats d'un atelier semblable, tenu en 1994, et ce, par la détermination des aires sur lesquelles

les utilisations se chevauchent qui sont, par conséquent, des zones de grande importance biologique pour la faune. En outre, on a également déterminé les aires où se déroulent actuellement des activités industrielles et commerciales, ou les aires où l'on propose que se déroulent de telles activités, afin que les participants puissent voir où les activités anthropiques pourraient nuire aux zones de grande importance biologique. On a cru que le fait de présenter les informations ci-dessus dans le cadre d'un seul forum pourrait aider à réaliser d'autres initiatives de recherche, fournir de l'information quant aux plans pour un réseau d'aires marines protégées dans l'Arctique, informer ceux qui sont chargés de la réglementation et fournir un « instantané » durable de la répartition de la faune, avant que les changements climatiques prévus ne se produisent.

Dix-neuf zones de grande importance biologique ont été déterminées en superposant les aires de grande productivité et les aires les plus utilisées par des espèces individuelles et des groupes d'espèces. Même si bon nombre de ces aires correspondaient bien à celles déterminées en 1994, en raison de la méthodologie utilisée, les aires déterminées en 2010 étaient plus restreintes en général. De plus, en raison des connaissances accrues et de l'inclusion de plusieurs espèces, certaines nouvelles aires ont été qualifiées de grande importance biologique.

Bien que nous comprenions beaucoup mieux la répartition de la faune dans l'Arctique, ainsi que l'importance et l'utilisation relatives de certaines aires en particulier depuis 1994, il y a toujours plusieurs aires, notamment le bassin de Sverdrup et le bassin arctique où, pour un certain nombre de raisons, il existe peu d'information biologique. À mesure que le Canada progressera dans l'établissement d'un réseau d'aires marines protégées dans l'Arctique, ces aires nécessiteront davantage de recherche. Cependant, pour l'essentiel, les problèmes qui ont par le passé maintenu les chercheurs à l'extérieur de ces aires restent inchangés et représentent un défi continu.

Mots clés : Territoires du Nord-Ouest, Nunavut, baleine boréale, béluga, narval, épaulard, morse, phoque, poisson, ours polaire, oiseau de mer, polynie, productivité, mer de Beaufort, baie d'Hudson, détroit de Lancaster, baie de Baffin, détroit de Davis, grande importance biologique.

ᐅᓂᒃᑳᓕᐊᑦ ᐃᓗᓕᖏᑦ

ᓱᑏᕙᓐᓴᓐ, ᓴ.ᐊ., ᐊᒻᒪ ᓚ. Hᐋᑦᐅᐃᒡ. 2010. ᑲᑎᒪᓂᐅᓚᐅᖅᑐᖅ ᐅᑭᐅᖅᑕᖅᑑᑉ ᐃᒪᖓᓂᒃ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ: ᐃᒥᕐᒥᒃ ᖃᐅᔨᓴᕐᕕ, ᐅᐊᓂᐱᒡ, ᒫᓂᑑᕝᕙ, ᕖᕝᐊᕈ 16-ᒥᑦ 17–ᒨᑦ, 2010. Can. Manuscript Rep. Fish. Aquat. Sci. 2934: vi+66p.

ᐅᑭᐅᖅᑕᖅᑑᐃᒪᖓᓂᒃ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᑲᑎᒪᔾᔪᑕᐅᓚᐅᖅᐳᖅ ᒐᕙᒪᑐᕐᑲᒃᑯᑦ ᐃᒪᕐᒥᐅᑕᓕᕆᔮᒃᑯᖏᑕ ᐃᒪᕐᒥ ᑕᕆᐅᕐᒥ ᖃᐅᔨᓴᖅᑎᖏᓐᓄᑦ ᑕᒻᑯᐊᓗ ᑲᑎᒪᑎᑕᐅᓪᓗᑎᒃ ᖃᐅᔨᒪᔪᕐᔪᐊᑦ ᑕᒻᑯᓂᖓ ᐅᑭᐅᖅᑕᖅᑑᑉ ᐆᒪᔪᕐᑯᑎᖏᓐᓂᒃ, ᐱᖃᓯᐅᑎᓪᓗᒋ ᐳᐃᔩᑦ, ᐃᖃᓗᐃᑦ, ᑕᕆᐅᑉ ᕐᑯᐱᕐᕈᖏᑦ, ᑎᖕᒥᐊᑦ ᐊᒻᒪᓗ ᓇᓄᐃᑦ, ᐊᒻᒪᓗ ᐃᓂᒋᕙᔪᒃᑕᖏᓐᓂᒃ ᑕᒫᓂ ᑕᕆᐅᕐᒥ. ᑕᒪᓐᓇ ᑲᑎᒪᓂᐅᓚᐅᖅᑐᖅ ᑐᓴᕆᐊᒃᑲᓂᕈᑕᐅᔪᓐᓇᕐᓗᓂ ᐋᖅᑭᒃᓱᖅᑕᐅᓯᒪᓚᐅᖅᐳᖅ ᐱᓕᕆᐊᖑᓯᒪᓕᖅᑐᓂᒃ ᑕᐃᒪᓐᖓᓂᑦ ᑕᒪᑐᒪ ᖃᐅᔨᓴᕐᓂᐅᑉ ᐃᒪᕐᒥᒃ ᑲᑎᒪᓂᐅᓚᐅᖅᑐᒥᑦ 1994–ᒥ ᓇᓗᓇᐃᖅᓯᓇᓱᒃᑎᓪᓗᒋᑦ ᖃᐅᔨᓴᕐᓂᐅᕐᑲᑦᑕᖅᑐᑦ ᐊᔾᔨᒌᖕᓂᒃ ᐱᓕᕆᓂᖏᓐᓂᒃ, ᑕᒪᒃᑯᓂᖓ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᔪᓂ ᓇᔪᖅᑕᐅᒐᔪᖕᓂᖏᑦ ᐆᒪᔪᓄᑦ. ᐊᒻᒪᑦᑕᐅᖅ, ᑕᒪᒃᑯᓂᖓ ᐅᕐᑲᐅᓯᕐᑲᓚᐅᓇᙳᑦ ᑭᓪᓕᓕᐅᖅᑕᐅᓯᒪᔪᓂᒃ ᐅᖅᓱᐊᓗᒃᓯᐅᕐᓂᕐᒧᑦ ᐊᒻᒪ ᐅᔭᕋᖕᓂᐊᕐᓂᕐᒧᑦ ᐊᒻᒪ ᐊᓯᖏᓐᓂᒃ ᐆᓇᐅᔭᓕᐅᕈᑕᐅᓇᓱᒃᑐᓂᒃ ᑖᒃᑯᐊ ᑲᑎᒪᔪᑦ ᖃᐅᔨᕚᓪᓕᕈᓐᓇᕐᑯᓪᓗᒋᑦ ᖃᓄᖅ ᑕᒪᒃᑯᐊ ᐱᓕᕆᐊᖑᔪᓄᑦ ᐊᑦᑐᖅᑕᐅᓂᖅᑲᓂᖏᓐᓂᒃ ᐆᒪᔪᐃᑦ ᓇᔪᒐᔾᔭᑦᑕᖏᓐᓂᒃ. ᑕᒪᓐᓇ ᑲᑎᒪᖅᑲᑦᑲᓂᐅᔪᖅ ᐃᓱᒪᒋᔭᐅᓚᐅᖅᐳᖅ ᑐᓴᐅᒪᖅᑲᑦᑕᐅᑎᔾᔪᑎᑦᑎᐊᕙᐅᕐᑯᓪᓗᒍ ᐊᑕᐅᓯᕐᒥ ᑲᑎᕝᕕᖅᑲᕐᓗᑎᒃ ᑕᒻᑯᐊ ᖃᐅᔨᓴᖅᑏᑦ ᐱᓕᕆᐊᖏᑦ ᐱᕚᓪᓕᕈᓐᓇᕐᑯᓪᓗᒋᑦ, ᑐᑦᑕᕐᕕᐅᓗᓂᓗ ᑐᓴᐅᒪᔭᐅᔭᕆᐊᖅᑲᖅᑐᓂᒃ ᐃᒪᕐᒥᐅᑕᓂᒃ ᐊᑦᑐᐃᓂᖅᑲᕈᓇᖅᑐᓂᒃ ᓴᐳᒥᕙᐅᓇᓱᒃᑐᓂᑦ,

ᐃᑲᔫᑎᖃᑦᑎᐊᕈᓐᓇᖁᓪᓗᒋᓪᓗ ᖃᐅᔨᓴᕐᓂᐅᔪᑦ ᒪᓕᒐᓕᐅᕐᓂᕐᒧᑦ ᐊᒻᒪ ᑕᒪᒃᑯᐊ ᐆᒪᔪᖃᖅᑲᓪᓚᕆᐊᓗᐃᑦ ᖃᓄᐃᓕᖓᓂᖏᑦ ᓇᓗᓇᐃᑦᑎᐊᕈᓐᓇᖁᓪᓗᒋᑦ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᑎᓪᓗᒍ ᓯᓚ ᖃᓄᖅ ᐊᓯᕈᖅᐸᓪᓕᐊᓂᖓ ᖃᐅᔨᒪᔭᐅᓂᐊᕐᒪᑦ.

19-ᖑᔦᑦ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᔪᑦ ᐆᒪᔪᖃᖅᑲᓪᓚᕆᐊᓗᐃᑦ ᑭᓪᓕᓐᖑᐊᖏᒍᑦ ᐊᑕᖃᑖᖏᓐᖏᑦ ᐆᒪᔫᑦ ᓇᔪᖅᑎᒋᕗᒃᑕᖏᓐᓄᑦ ᐆᒪᔫᑦ ᐊᔾᔨᒌᓐᖏᑦᑐᓄᑦ ᐊᒻᒪ ᐊᔾᔨᒌᓪᓕᖕᓄᑦ ᓱᕐᓗ ᑎᖕᒥᐊᑦ, ᐳᐃᔩᑦ, ᑕᒪᒃᑯᐊᒐᓚᐃᑦ. ᑕᒪᒃᑯᐊ ᑭᓪᓕᓐᖑᐊᖏᑦ ᐆᒪᔫᑦ ᓇᔪᖅᑕᐅᒐᔪᒃᑐᑦ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᓚᐅᖅᑐᑦ ᒪᓕᑦᑎᐊᕐᓂᖃᓚᐅᖅᑑᒐᓗᐊᑦ 1994-ᒥ ᑐᓴᐅᒪᓚᐅᖅᑕᑦᑎᓐᓂᒃ, ᖃᐅᔨᓴᕈᑎᒋᔭᖏᓐᓂᒃ ᐱᔾᔪᑕᐅᓪᓗᑎᒃ, ᑕᒪᒃᑯᐊ ᑭᓪᓕᓐᖑᐊᓕᐊᖑᓚᐅᖅᑐᑦ 2010-ᒥ ᒥᑭᓐᓂᖅᓴᐅᓂᐅᓴᑐᐃᓐᓇᖅᐳᑦ. ᐊᒻᒪᑦᑕᐅᖅ, ᖃᐅᔨᒪᓂᕆᔭᕗᑦ ᐱᕙᓪᓕᐊᑎᓪᓗᒍ ᐊᒻᒪ ᐃᓚᓕᐅᔾᔨᑲᓐᓂᕐᓂᕗᑦ ᐆᒪᔪᓂᒃ ᐊᓯᖏᓐᓂᒃ, ᓇᓗᓇᐃᖅᓯᓚᐅᕆᕗᒍᑦ ᐆᒪᔫᑦ ᓇᔪᖅᑕᐅᒐᔪᖃᑦᑕᖅᑐᓂᒃ ᑕᐃᑉᓯᒪᓂᓂ.

ᑕᕝᕙ ᖃᐅᔨᒪᓂᕆᔭᕗᑦ ᐊᖏᓪᓕᕚᓪᓕᖅᓯᒪᒐᓗᐊᖅᑎᓪᓗᒍ ᐆᒪᔨᐃᑦ ᐃᓂᒋᕙᒃᑕᖏᓐᓂᒃ ᐅᑭᐅᖅᑕᖅᑐᒥ ᐊᒻᒪ ᑕᒪᒃᑯᐊ ᓇᓄᐃᑦ ᐱᒻᒪᕆᐅᓂᖏᓐᓂᒃ ᑕᐃᒪᓐᖓᓂᑦ 1994-ᒥᓂᑦ, ᑭᓯᐊᓂᓕ ᑕᕝᕙ ᓯᓚ ᖃᐅᔨᓴᖅᓯᒪᓐᖏᑕᔦᑦ ᐊᒥᓲᔦᑦ ᓯᓚ, ᐱᓗᐊᖅᑐᒥᒃ ᖁᑦᑎᖕᓂᖅᐸᑦ ᕿᑭᖅᑕᐃᑦ ᓴᓐᓂᕈᑎᖏᑦ ᐊᒻᒪ ᐊᓯᖏᑦ, ᐊᔾᔨᒌᓐᖏᑦᑐᓂᒃ ᐱᔾᔪᑎᖃᖅᑐᑎᒃ, ᖃᐅᔨᒪᔭᐅᓗᐊᓐᖏᒻᒪᑕ ᐆᒪᔪᖃᕐᓂᖏᑦ ᑕᐅᕝᕙᒃᑯᐊ. ᑲᓇᑕ ᓴᖅᑭᑦᑎᕙᓪᓕᐊᓂᐊᖅᑎᓪᓗᒍ ᐃᒪᕐᒥᐅᑕᓂᒃ ᓴᐳᒻᒥᔭᐅᕕᐅᔪᓂᒃ ᐅᑭᐅᖅᑕᖅᑐᒥ, ᑕᒪᒃᑯᐊ ᑭᓪᓕᓐᖑᐊᓕᐅᖅᑕᐅᕙᓪᓕᐊᔪᑦ ᖃᐅᔨᓴᖅᑕᐅᔭᕆᐊᖃᕐᓂᐊᖅᐳᑦ ᐋᖅᑭᒃᐸᓪᓕᐊᑎᓪᓗᒋᑦ. ᑭᓯᐊᓂᑦᑕᐅᖅ, ᑕᒪᒃᑯᐊ ᐊᕝᕙᐊᕈᑕᐅᖃᑦᑕᖅᓯᒪᔪᑦ ᖃᐅᔨᓇᓱᖕᓂᕐᒧᑦ ᑕᐅᕙᑦᑐᒥᖓ ᓱᓕ ᐊᓯᔾᔨᓗᐊᖅᓯᒪᓐᖏᒻᒪᑕ ᐊᒻᒪᓗ ᒫᓐᓇᒧᑦ ᓱᓕ ᐊᕝᕙᐊᕈᑕᐅᖕᒪᑕ.

ᐅᖃᐅᑏᑦ ᓇᓗᓇᐃᖅᑕᐅᒋᐊᒃᑲᓐᓂᖅᓯᒪᔪᑦ: ᓄᓇᑦᓯᐊᖅ, ᓄᓇᕗᑦ, ᐊᕐᕕᖅ, ᕿᓚᓗᒐᖅ - ᖃᑯᖅᑕᑦ ᐊᒻᒪ ᐊᓪᓚᓐᖑᐊᑦ, ᐋᕐᓗᖅ, ᐊᐃᕙᖅ, ᓇᑦᑎᖅ, ᐃᖃᓗᒃ, ᓇᓄᖅ, ᑎᖕᒥᐊᑦ, ᓯᑯᓯᐃᑦᑐᖅ, ᐱᕗᓪᓕᐊᑦᑎᐊᕐᓂᖅ, ᐃᓅᕙᐊᓗᐃᑦ ᐃᒪᖓᑦ, ᑕᓯᐅᔭᕐᔪᐊᖅ, ᑕᓪᓗᕈᑎ, ᕿᑭᖅᑖᓘᑉ ᓴᓐᓂᕈᑎᐊ, ᐆᒪᔫᑦ ᓇᔪᖅᑕᐅᒐᔪᒃᑐᖅ.

INTRODUCTION

The 2010 Arctic Marine Workshop was held with several purposes in mind. Although the first Arctic Marine Workshop (Parks Canada, 1995) held in 1994 resulted in a report that has served multiple uses over the past 15 years, the effects of climate change and the collection of new information on a number of species since that time suggested that an update was warranted. Parks Canada initiated the first workshop to help identify possible areas for protection under their National Marine Conservation Area program while also realizing that the information would prove valuable to a number of other users. As a recent example of this, the Oceans Programs Division of Fisheries and Oceans Canada (DFO) used the maps from the 1994 workshop during its' earliest discussions with Nunavut organizations when given approval for proceeding with a Marine Protected Area (MPA) in the territory. Since an *Oceans Act* MPA can only be created within an area already identified as an Ecologically and Biologically Significant Area (EBSA) as determined by DFO Science (DFO, 2004) and because the determination of such areas had not yet been carried out in Nunavut, the Oceans Programs Division was placed in a position of not having a defensible starting point from which to suggest a potential location for an MPA. The 1994 workshop report was used to select three areas identified as having "high diversity". These areas were then presented to the Nunavut Regional Inuit Associations as candidate areas from which the location of a potential MPA could be selected.

Another primary purpose for holding the 2010 workshop was to respond to Canada's responsibility to develop a national network of marine protected areas by 2012. The results of this workshop will provide the data necessary to develop the Arctic component of this network. The DFO is the lead on the national network initiative although Environment Canada and Parks Canada, as well as territories and land claim groups, will be involved in Arctic network creation. The workshop provided the means to gather the most current scientific information on species distribution across the Arctic. The results from this workshop may therefore be used in future consultations with Arctic residents so that Inuit may provide feedback on these results and any proposed MPA locations.

Pre-Workshop Activities

Prior to the workshop, researchers were contacted and asked if they could provide distributional information on their species or species group of study in the form of electronic GIS (Geographic Information System) shapefiles. When these data were unavailable, electronic maps were created by digitizing the distributional information provided (usually paper maps). The result was the creation of a series of electronic maps of Arctic faunal distribution prepared on similar base maps that could be overlain in any combination to show geographic areas of overlapping use. In addition to the species discussed in 1994, information on several other species or species groups was sought to help increase the usefulness of the workshop. The workshop technique of using a researcher's knowledge of a species or species group to help identify spatially important areas is similar to the "expert" opinion method used to define EBSAs (*i.e.*, DFO, 2004).

Several people were also contacted prior to the workshop and asked if they could present information on current and proposed anthropogenic activities in the Arctic. The rationale was that having these activities presented would allow participants to understand what activities might threaten areas of biological interest or use of an area by a particular species when the two overlapped. Presentations were requested on oil and gas activity, shipping and major commercial or industrial projects (*e.g.*, the location of proposed mines or possible ports) underway or planned for the Arctic.

While there is some “spot” information available on the distribution of many species throughout the Arctic, this workshop intended to document only information for those species that have been repeatedly and intentionally surveyed in some systematic manner. Data on species observed infrequently or taken incidentally during surveys for other species (*e.g.*, some whale and many fish species) could not be considered complete and therefore was not considered for this workshop. The reason for this was because it was unknown if the available records for these species represented their entire Arctic distribution, key areas of use or only infrequent, extra-limital presence. Including this type of incomplete information would have had no real benefit to this workshop. Future workshops may have more complete information on additional species worthy of presentation. Therefore, when areas of biological importance are discussed, they are in the context of those species or species groups discussed at this workshop that have been well studied and are often harvested commercially or for subsistence purposes. These species remain, by and large, the same suite of vertebrate species discussed in 1994.

By definition, because a particular geographic area is used by a species or species group, these areas must be important at some level, whether it be for feeding, reproduction or some other purpose. When numerous species use the same area, even if at different times of the year or for a different purpose, that area becomes more important than areas that fewer species use. The loss of these areas used by multiple species would have a greater overall effect than the loss of an area used by only a single species. However, to say that, as an example, six species using an area makes that area six times as important an area as a nearby area frequented by only one species is an oversimplification if for no other reason than the area could represent critical habitat required by a single species for a significant part of its’ life history. Prendergast *et al.* (1993) noted that overlaps in distribution are typically few for a great many species simply because different species have different ecological requirements. Therefore, to some extent, we should be surprised to see many overlaps in space among a large number of diverse Arctic species within a small area. It is more probable to see larger areas of overlapping use by fewer species.

The Mapping Process

It should first be noted that lines had to be drawn somewhere to illustrate distribution. These lines were carefully placed by researchers with the belief that all lines should be interpreted as approximate representations of edges of distribution which may change on a somewhat regular basis. While we considered “blurring” the edges of lines to illustrate this edge effect, we decided that this advisory note was more useful and that solid lines ultimately made comparing the distribution of species easier and the areas identified more distinct.

The figure legends do not always provide enough information to properly interpret the maps. Users are advised to refer to the associated text to ensure they are using maps appropriately.

While no geographic limit was specified, the majority of presenters confined their distribution maps to Canadian waters. Therefore, although in many cases there is knowledge of the distribution of a species outside Canadian waters, many maps do not show this. Because it should properly be experts from Greenland, as an example, that present distributional information about marine mammals in Greenland waters, researchers who chose to limit their presentation on distribution to Canadian waters is not a shortcoming in their presentation.

The distribution of some species is very well known while the distribution of others is still somewhat poorly understood, especially in specific areas. The result is that some participants were able to describe species distribution based on well known, detailed summer and winter areas of occupancy while the distribution of other species were best suited to terminology that favoured terms relating to density in an area. When possible, we decided that migratory species that remained in the Arctic year round were best described by maps illustrating their common summer and winter range. For other species we used the terms common, uncommon and rare to describe their abundance within geographic areas. For some species groups, like some fish and seabirds, it is understood that their distribution in an area is only for a portion of the year and at other times they are completely absent.

The distribution of large, well studied marine mammals is presented on individual maps. Multiple species of seabirds and fish are shown on one map indicating overlapping use of an area. These composite species maps were created because producing multiple maps for species in which the distribution of individual species is limited would have potentially resulted in numerous maps of a value no greater than that produced by a map which grouped these species. Combining closely related species with somewhat similar life histories and needs (*e.g.*, nesting habitat, feeding areas) seemed a more viable approach when the species utilized similar areas for the same purpose. The area is identified as important, but the details as to the exact species present are absent. It was the identification of areas that were most often used by species groups during portions of their life that was deemed to be of greatest value to this workshop, not necessarily the absolute number of species using them or the "why".

Some presenters did not originally identify the entire range of a species and in some cases, rarely used areas or areas in which the species is absent were not noted. However, because all presenters were allowed the opportunity to revise their maps in order to address these issues or questions raised at the workshop, we encouraged them to identify all of these areas when making revisions. We feel that this has created more useful maps and allows for a greater degree of comparison among species. Areas marked as "absent" on the maps generally indicate that, despite extensive survey work and Traditional Knowledge, the species is unlikely to be found in the area. Individual strays are, however, always possible.

This workshop may have been one of the last to document the distribution of several wildlife species before climate change begins to have a major impact on their distribution. There is already some evidence suggesting that changes in sea ice conditions have altered the distribution of species such as Killer Whale (*Orcinus orca*) and Polar Bear (*Ursus maritimus*) both spatially and temporally. Minimally then, the workshop will, to the best of our knowledge, be a snapshot of marine faunal distribution up to 2009-10.

Similar to the 1994 workshop and in keeping with DFO regions, the "Arctic" referred to those marine waters from the Alaskan border at 141^{o} west to the Greenland border in the east, included Hudson and James bays, and extended south to the northern tip of Labrador (Fig. 1).

Workshop Methods

The first day of the workshop was dedicated primarily to having information presented on the life history and distribution of species and species groups by participants who had prepared the distribution maps. The second day of the workshop was spent on the remaining species presentations, presentations on proposed or current industrial and commercial activities in the Arctic and general discussion (Appendix 1).

Following a brief introduction as to why this workshop was being held, including a summary of why the original 1994 workshop had been held and how it had been used over the years, presentations were made by individual researchers or spokespersons (Appendix 2).

THE PRESENTATIONS

Biological Information

Seals

<u>Ringed Seal</u>

Ringed Seal (*Pusa hispida*) are common throughout the Canadian Arctic at all times of the year as illustrated in Figure 2. The map highlights areas of high density pupping habitat that is used during the ice covered season. The data used to create the map are primarily derived from surveys of Ringed Seal that indicate higher densities of seals up to 15 km offshore along the east Baffin coast. This corresponds to the limit of landfast ice, which provides stable habitat for dens and birth lairs. In the high Arctic, the limit of landfast ice was used to delimit the high density area. Within this area, some areas will have higher or lower densities as, for example, complex shorelines provide more denning habitat than simple coastlines. Offshore breeding does occur, but in most cases it is assumed to be sub-adults that cannot secure territories in high quality habitat. Baffin Bay was surveyed in the 1990s and the high numbers of Ringed Seal observed showed that sub-adults and juveniles were largely restricted to less stable ice further offshore. Within Hudson Bay and Foxe Basin, 1 km offshore was used to delimit the area of high density based on surveys conducted in recent years north of Arviat (northwest Hudson Bay).

Changes in this map from the 1994 map are slight as most of the data were available in 1992 and, except in Hudson Bay, little survey work has been carried out since that time. Some "hot spot" areas in the 1994 map were inferred from Polar Bear density (E. Richardson, Environment Canada, pers. comm.) and while these areas have been omitted from this map, there is no reason to suspect that they are not still present. Ringed Seal are generalists and are probably doing better than some other Arctic species hence the priority for survey work has been low.

<u>Harbour Seal</u>

The Arctic distribution of Harbour Seal (*Phoca vitulina*) is best known in western Hudson Bay where telemetry work has suggested that the 50 m contour line can be used to delimit their distribution. This contour was extrapolated for the rest of their known distribution to plot the map (Fig. 3). Harbour Seal occur at low density in the areas indicated and in many areas it is unknown if they are year-round residents or only seasonal visitors. Past researchers have suggested that Harbour Seal once had a larger distribution, reaching as far north as Admiralty Inlet and even Ellesmere Island. However, the Nunavut Wildlife Harvest study report does not indicate that Harbour Seal were ever harvested above the east Baffin area. Unlike Ringed Seal, Harbour Seal do not maintain breathing holes in the ice and they are therefore limited as to where they can exist due to the need for open water access during the ice covered months.

It has been suggested that their habit of hauling out on land at traditional locations and the higher quality of their pelts led to the extirpation of Harbour Seal from some areas (pre-1950s). Modification of the flow regimes of large rivers that reduce the amount of open water in the winter may also impact Harbour Seal distribution. As an example, Inuit hunters indicate that, compared to the past, Harbour Seal are rarely observed or harvested in James Bay and in the Belcher Islands. Conversely, climate change may result in more areas of open water during the winter, which could lead to higher population numbers in some areas. To date, there has not been an increase in the proportion of Harbour Seal harvested from the Arviat area, but this may be a result of hunter preference rather than an indication of a stable population size.

Not indicated on the map are the small inland populations of Harbour Seal that live in lakes of northern Quebec (*e.g.*, Seal Lakes).

Bearded Seal

The Arctic distribution of Bearded Seal (*Erignathus barbatus*) is not well studied, perhaps because they appear to be present in low densities throughout most of the Arctic. Pre-1992 reports and more recent harvest returns suggest that higher densities of Bearded Seal may occur in northern Hudson Bay and Foxe Basin than in other areas. However, it should be noted that the work involved in harvesting Bearded Seal has less of a payoff than in the past and therefore harvest returns should be interpreted with caution. Based on foraging ecology, the 250 m contour line has been used to delineate the area that Bearded Seal are commonly observed in. Rare or absent areas indicate where water depths are greater than 250 m, but occasional records of Bearded Seal from these areas do exist. During the ice-covered season, Bearded Seal are typically associated with moving pack ice, open water leads and polynyas. There may be some winter concentration of animals in these areas although little is known in this regard.

The overall distribution of Bearded Seal has not changed significantly since 1994 (Fig. 4). However, while the 1994 map suggested that Lancaster Sound was an area of high density, we have removed this designation although it may be an important winter area. Bearded Seal can maintain breathing holes in ice but seem to prefer to winter in areas where this is not necessary, thus they could be excluded from areas of the central high Arctic and from areas of landfast ice during the winter months.

Harp Seal

In recent years the population of Harp Seal (*Pagophilus groenlandica*) has increased from an estimated 2 million animals in the 1970s to an estimated 6 million animals. This increase, in conjunction with reductions in ice cover, has meant that Harp Seal have expanded further into the central Arctic, Hudson Bay and Foxe Basin than ever before. The boundaries on the map for the species represent the known extent of Harp Seal summer occurrences with little modification from the 1994 distribution (Fig. 5). The abundance of Harp Seal within these areas is variable both spatially and temporally. For example, very large summer aggregations have been observed in Admiralty Inlet (northern Baffin Island). For the ice covered (winter) months, Harp Seal move to pack ice in Davis Strait and areas farther south. The location of the whelping patch (area where seals congregate to give birth) has not changed although its exact location shifts on an annual basis in response to ice conditions.

Hooded Seal

Hooded Seal (*Crystophora cristata*) are deep water feeders and therefore their open water distribution is indicated as being most of Baffin Bay where they have access to these preferred depths. During the ice covered season, Hooded Seal move to areas of pack ice in southern Davis Strait and farther south. The shape and location of the whelping patch, as with Harp Seal, is marked somewhat arbitrarily and likely shifts with ice conditions from year to year.

For Hooded Seal there is only a limited amount of information available to update the distribution maps from 1994. The 200 m contour line has been used to delimit the distributional boundary as research has indicated that most foraging occurs in waters deeper than this (Fig. 6). Distribution gaps that appear along the east coast of Baffin Island are indicative of waters shallower than preferred depths and represent the contour lines in the area. Regions of suitable depth that occur in the central Arctic were omitted as Hooded Seal are rarely encountered in these areas. However, younger Hooded Seal explore widely and they have been occasionally reported from many areas of the Arctic.

Walrus

The map of known Walrus (*Odobenus rosmarus*) distribution has not changed much since 1994. The distribution reported here is based on Inuit Traditional Knowledge and research that has been carried out over the past 15 years. Perhaps the biggest change is the recently confirmed knowledge of the connection/migration corridor between Canada and Greenland based on the movement of a couple of Walrus tagged in Greenland (Fig. 7).

Research has been carried out in the high Arctic in the past five years with the last two years of work being based out of Resolute. Intensive surveys have been flown along all of south Devon Island, up Ellesmere Island to Alexander Fiord, all of Jones Sound, and around Cornwallis and Bathurst islands. Some of the main Walrus haul out sites are located in the fiords in the high Arctic. Tagging was carried out in the Jones Sound area from 2002-2005. However, community residents currently don’t want any tagging done due to concern over immobilisation issues and this issue is not yet resolved.

Surveys were carried out around Iqaluit and up to Qikiqtarjuaq from 2006-2008. There were some new haul out sites discovered and the use of some older ones verified. Work included boat surveys with Canadian Coast Guard of haul out sites in 2006 and a survey with Greenland in 2007 around Qikiqtarjuaq. Biopsy samples have been collected at some haul out sites and a few tags have been applied. One tagged Walrus was later killed in Greenland. Future work will be directed towards northern Foxe Basin and the collection of biopsy samples when possible.

Little is known about population numbers at this time. Stocks appear to be stable and there have been no significant changes in abundance. It is known that there are two stocks of Walrus in Jones Sound and the map shows an area where distribution does not overlap between the east and west stocks.

The lack of Walrus in the area between northern Hudson Bay and southern Foxe Basin appears to be primarily due to a lack of islands that can be used as haul outs. Walrus prey is largely found in waters of less than 100 m although most Walrus are associated with waters of 20-80 m depth.

Terrestrial haul outs will likely become much more important as ice melts from some areas. However, these terrestrial haul out sites can be easily disturbed and, as Walrus do not seem to like to change their habits, they could be driven away from these areas if they are disturbed by human activity. If there is a lack of ice to use as a haul out, Walrus may have to expend more energy to get to feeding areas and then return to the terrestrial haul out site. Typically, if there is pack ice around then Walrus can rest immediately after foraging. With the loss of pack ice there is a possibility that overgrazing might occur near terrestrial haul out sites, especially if Walrus utilize only a few of these. There is, however, some evidence from Greenland that a loss of pack ice might open up some new areas that could be suitable Walrus habitat. To date, Walrus in Canadian waters continue to return to the same, few sites and there is no evidence of their utilizing any new areas.

Bowhead Whale

Bowhead Whale (*Balaena mysticetus*) are members of the right whale family and have a circumpolar distribution. It was originally thought that there were five stocks of Bowhead Whale, but it is now considered that there are only four as the Davis Strait/Baffin Bay and Hudson Bay animals have been combined into one stock (called the East Canada-West Greenland stock). Bowhead Whale are baleen whales and feed primarily on copepods. They are ice adapted species found along flow edges. Canadian populations of Bowhead Whale are currently listed as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

The population is currently growing and likely has been since European commercial whaling ended. In the early 1500s Basque whalers took large numbers of Bowhead Whale much further south than their current range. The original range of the species may have extended to as far south as Newfoundland. The split between Bowhead Whale and Right Whale (*Eubalaena glacialis*) harvests was initially thought to have been approximately 50%, but recent genetic work suggests the harvest of Bowhead Whale may have been as high as 90% of a harvest of 25,000 to 40,000 whales. The area may still be suitable habitat for them although climate change may be limiting its use. There was one reliable report of a Bowhead Whale along the northern Labrador coast in 2009 at Saglak Fiord (58^{o} 28' N).

As there are some reports of Bowhead Whale moving into more easterly areas of the western Arctic, with a reduced ice extent there may eventually be a merging of populations in the central Arctic as has occurred in the past. Bowhead Whale were harvested and used to occur near the Ottawa and Belcher Islands although it has been many years since they have been seen in that area. Bowhead Whale likely breed in their wintering areas off east Baffin, perhaps near Disko Island on the coast of Greenland.

During 2002-2004, surveys were flown along the north Baffin coast, the Gulf of Boothia, Foxe Basin and northwest Hudson Bay. Due to the location of the surveys and population estimates being made over the course of two years, there is only a partial stock estimate of 6,000 animals for the area of Foxe Basin and the Gulf of Boothia. This number is not concrete, but it is currently the only available estimate and numbers have definitely increased as is agreed to by Inuit Traditional Knowledge.

There have been extensive efforts to satellite tag Bowhead Whale in Greenland near Disko Island with many of the whales entering Canadian waters and circumnavigating Baffin Island. Previous DFO tagging took place near Igloolik and Cumberland Sound with recent tagging in Admiralty Inlet. Tagging being done by the Alaskans has demonstrated movement into Canadian waters like the Banks Flaw Lead and areas to the north.

The Bowhead Whale map is based on scientific survey data, Traditional Knowledge and reports from communities with very little extrapolation of range distribution (Fig. 8). Whales have been harvested in Hudson Strait in August by Nunavik hunters suggesting there might be some summer residency within the area. However, it might also be early winter migrants coming into the area. The area identified as a Bowhead Whale feeding area in the western Arctic is based on survey data within that area. There are similar feeding areas around Isabella Bay and Repulse Bay. Isabella Bay has recently been declared a National Wildlife Area.

The Bowhead Whale population, in general, exhibits significant age and sex structuring, such as is seen by the large number of cows and calves found in the Foxe Basin area near Igloolik in the summer. From April to June about 85% of the whales near Greenland are adult females. It is unknown where the younger whales are during this time. Many of the females moving into Foxe Basin in early spring are likely giving birth. Cow-calf pairs usually show up in Igloolik around the third week of June.

Killer Whale predation on Bowhead Whale is currently not a concern, but may be in the future. In the past 50-60 years Killer Whale have begun to colonize Hudson Bay and Foxe Basin. Whaler log books documented Killer Whale along the Baffin coast, but it is only recently that Killer Whale have begun to enter these other areas. It may be that Bowhead Whale cow-calf pairs are using the area around Igloolik because of the ice cover that helps to protect them from Killer Whale. Changes to ice may affect the distribution of Bowhead Whale as it permits Killer Whale to move into new areas.

Bowhead Whale are present in the Bathurst polynya in the western Arctic in the spring, as early as May. Many were seen along the flow edge near the Norton River in 1997. In the eastern Arctic they sometimes over winter along the flow edge near Repulse Bay. Traditional Knowledge suggests that Bowhead Whale may also occasionally overwinter in Committee Bay.

Killer Whale

Killer Whale travel widely and migrate into Hudson Bay, Foxe Basin and the central High Arctic each ice free season, which makes constructing a distribution map challenging. This map has categorized areas into a gradient of Killer Whale occurrence: regular/extended (common), regular/transient (uncommon), occasional/possible (rare) and absent (Fig. 9) based on past sightings and the current scientific knowledge (one satellite tag and prey distribution) and Inuit Traditional Knowledge (movement patterns and ecological knowledge). These categories are meant to summarize a pattern of seasonal movement into and out of hunting areas, patrolling while hunting within those areas and possible areas that Killer Whale could investigate. The area marked as absent is due to a combination of permanent or continuous high concentration of ice coupled with low prey density. Because past sightings are a major data source, many areas where Killer Whale are reported occur near communities. Reliance on sighting data may underestimate the true extent of areas where Killer Whale are hunting during the ice free season.

The information used to generate this map was derived from historical sighting records, Traditional Knowledge, and research conducted by DFO. There is a large difference between this new and the 1994 map, primarily because the knowledge of this species has increased. There are likely also more Killer Whale currently using Hudson Bay than in the past because the lower ice conditions within the bay and Hudson Strait allow Killer Whale to enter the area more frequently.

It is difficult to ascertain if Killer Whale numbers are actually increasing or if sightings are increasing and simply being reported more often. It is likely that numbers are increasing in response to increased access to summer (ice free) hunting areas and potential recovery from whaling era depredations. Historical accounts indicate that Killer Whale were sometimes destroyed when they tried to feed on whales taken during the European commercial harvest. Currently there is no estimate of abundance for Eastern Arctic Killer Whale.

Many communities in Nunavut are concerned that an increase in Killer Whale will have a negative impact on shared prey stocks [*e.g.*, Bowhead Whale, Narwhal (*Monodon monoceros*), Beluga Whale (*Delphinapterus leucas*), and seals]. In order to learn more about the distribution, ecology, and possible impacts on other species, DFO and the University of Manitoba have initiated programs to collect sighting records and Traditional Knowledge, as well as research projects to learn more about Killer Whale ecology in the Arctic.

Beluga Whale

Based on 28 years of aerial surveys, 20 years of satellite tracking studies and a great amount of Inuit Traditional Knowledge, it is possible to state that Beluga Whale are found almost everywhere in the Canadian Arctic except for the central Arctic (Fig. 10). Even in that region, however, two Beluga Whale were observed in Bathurst Inlet in the1990s. The areas marked as "Absent" on the map do not mean that Beluga Whale are absolutely never present in these areas, but rather that the extreme high Arctic and the central Arctic areas are areas of very infrequent use. Beluga Whale are very mobile animals so, except for the annual use of some estuaries and key summer feeding or over wintering habitats, it is difficult to show what areas might be most important when these frequently change. Areas between summer and winter use areas should be inferred as migratory routes.

Western Arctic Beluga Whale aggregate in the Mackenzie River estuary in the Beaufort Sea for a few weeks in late June and early July. Later in the summer, males move into the higher Arctic Archipelago while females, juveniles and calves tend to remain closer to the mainland, often performing a clockwise "loop" in Amundsen Gulf. After spending a few weeks near Wrangel Island in the fall, these animals migrate through the Bering Strait to winter in the Bering Sea southwest of St. Lawrence Island. This population seems stable at about 40,000 animals.

Canadian high Arctic Beluga Whale, also known as the Baffin Bay population, winter in Baffin Bay and Davis Strait. In early summer, they aggregate in estuaries around Somerset Island: particularly Cunningham Inlet, and Creswell, Batty and Elwin bays. They spend only a few weeks in those bays before moving to Peel Sound where they spend 3-4 weeks. In the autumn, most of them move to the northwest portion of Baffin Bay where they overwinter in the North Water polynya. About 15% of the population moves further into central-west Greenland waters where it winters in Davis Strait. Historically there were some Beluga Whale summering north of Baffin Bay, but they disappeared in the 19th century and have not been seen since. The wintering aggregation of the Baffin Bay stock off Greenland exhibited a declining trend for three decades, but it has since levelled off and there seems to be signs of recovery.

The small Cumberland Sound population summers at the head of Cumberland Sound, aggregating particularly in Clearwater Fiord. These whales winter in the northeast corner of Cumberland Sound in a recurring polynya where they can avoid ice entrapment. Later in the winter, they move to the west coast of the sound and in June make their way north to the flow edge at the head of the sound. When the fast ice breaks up, they move into Clearwater Fiord again. This population, now slowly recovering, may soon be listed under the Species at Risk Act (SARA).

The greatest number of Beluga Whale in Canadian waters is found in Hudson Bay. The Nelson River estuary holds the Arctic's largest aggregation and approximately 25,000 animals frequent this area in the summer. While most high Arctic animals spend only a few weeks in estuaries, this population spends three months in the area and may remain for up to four months. The Seal, Churchill and Nelson rivers harbour large aggregations of Beluga Whale totalling around 56,000 animals and are collectively known as the Western Hudson Bay (WHB) population. WHB animals migrate to Hudson Strait, where they spend the winter. Smaller summer aggregations are also found in the Winisk and Severn rivers, but their stock origin is unknown. James Bay, which acts as a large estuary due to a number of rivers emptying into it, also has a few thousand Beluga Whale in summer and there are indications that they remain there year-round.

The Eastern Hudson Bay (EHB) population summers mainly around the Nastapoka River of Quebec. Historically there was an additional aggregation near the Little Whale River, but few Beluga Whale are found there nowadays. Eastern Hudson Bay Beluga Whale migrate to the Labrador Sea for the winter. This population may also soon be listed under the SARA.

There are Beluga Whale, other than those from the EHB population, around the Belcher Islands in winter, spring and summer, but their stock of origin is unknown. There is a recurring polynya between the Belchers and the coast of Quebec as well as numerous small leads that are used by some over-wintering whales. There are also approximately 1,000 whales found near Southampton Island in the summer that are thought to be related to the WHB population.

Historically, there was a Beluga Whale stock in Ungava Bay, but these animals may have been eradicated by early 20th century commercial whaling. It is unclear if the few whales that are now seen in the summer in southern Ungava Bay are remnants of this stock or belong to another stock. Only 12 whales were sighted in this area during extensive surveys in the late 1990s.

There are several dozen to a hundred whales commonly found in Frobisher Bay in the summer and it is thought that these whales may be stragglers from the WHB stock. These whales overwinter in Hudson Strait and Davis Strait, near Frobisher Bay. Genetic studies suggest that there is very little exchange between neighbouring Beluga Whale populations around southeast Baffin and those in Hudson Bay.

Overall, Beluga Whale are doing relatively well in Canadian waters and, in total, there are probably in excess of 150,000 Beluga Whale in the Canadian Arctic, making it the largest aggregate population in the world. Around 56,000 of these whales are found along the Manitoba coast and this population appears to be stable. The eastern Hudson Bay population is listed under the SARA because the population trend was declining at the time of the assessment. The decline may have stopped with the introduction of a quota and an area closure, but it is still hunted in the spring and fall.

Increased survey and tracking effort over the years has expanded the known range of Beluga Whale distribution and our understanding of their movements. Subarctic whales tend to be relatively sedentary in summer compared to their northern counterparts. In fact, some of the subarctic populations have summer and winter ranges that overlap (*e.g.*, St. Lawrence River, James Bay, Cumberland Sound, Cook Inlet). Arctic populations are migratory (*e.g.*, Baffin Bay, Eastern Beaufort Sea), presumably to avoid ice entrapment in winter fast ice or consolidated pack ice. Hudson Bay populations are also migratory, also presumably due to the heavy ice conditions that can exist there in winter, although some groups are occasionally seen in leads and polynyas during winter.

It is probable that Arctic Beluga Whale associate with summer pack ice, where available, in part to avoid predation from Killer Whale. Shallow estuaries may also be important to Beluga Whale in summer because Killer Whale are reluctant to enter these waters for fear of getting stranded. This may be why there are so many females and young higher up the estuaries. During a 2004 survey, there were around 7,000 Beluga Whale counted in the Seal River estuary; more than twice as many as have been seen in this location in the past. The next day a pod of seven Killer Whale was seen about 60 km to the east, near Cape Churchill, suggesting that Killer Whale may have been the cause for that extraordinary aggregation in the Seal River estuary.

The plan is to resurvey all populations at least every ten years to help maintain information on population trends and habitat use. There were no systematic surveys prior to the 1970s, which has created difficulties in estimating population size. As an example, there were no surveys of Beluga Whale in James Bay prior to hydro development so it is unknown exactly how habitat use in response to freshwater input or population size may have changed. There were some surveys of the Little Whale and Nastapoka river estuaries areas prior to hydro development, but nothing in James Bay. Some reconnaissance surveys were done in the Nelson and Churchill estuaries in the 1970s.

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Beluga Whale overwinter in productive areas like Baffin Bay, and Hudson and Davis Strait where they can feed on squid, shrimp and Greenland Halibut (*Reinhardtius hippoglossoides*). Capelin (*Mallotus villosus*) may be increasingly available as prey to Cumberland Sound Beluga Whale. Shrimp are also available to them in Hudson Strait and Hudson Bay. While Capelin may be increasing their range, the distribution of Beluga Whale does not seem to have changed in response. Beluga Whale are likely one of the most adaptable whale species due to the variety of prey species they eat across their range. Minke Whale (*Balaenoptera acutorostrata*) are becoming more common in the Arctic, such as in Hudson Strait and in Cumberland Sound. Minke Whale are probably not Beluga Whale competitors, in part due to their relatively low numbers.

Narwhal

Narwhal have a higher latitude distribution than Beluga Whale. They prefer deep waters and therefore are uncommon in most of Hudson Bay and the western Arctic and are found in these areas only as strays (Fig. 11). There are a few observations of Narwhal near the top of Greenland from cruise ships. A recent survey in the Kane Basin may reveal how common Narwhal are in this area. In the high Arctic (Parry Islands) there is a substantial harvest and sightings of animals that cannot be assigned to any particular stock. This suggests that there may be other distinct high Arctic stocks and one stock in particular with a westerly range. Surveys of the high Arctic Archipelago could provide evidence and numbers for these hypothesized stocks. Because Narwhal can tolerate up to 99% ice cover, they could exist in the high Arctic Archipelago with little difficulty.

The 1994 workshop report map was based only on summer aerial surveys while newer information comes from tracking data and winter surveys. There are two main populations of Narwhal with the largest one being found in the North Baffin region in summer and probably numbers around 80,000 animals. The largest aggregations are in Eclipse Sound, Prince Regent Inlet and the Gulf of Boothia, with many of the latter also occupying Peel Sound later in the summer. A second population is found in northern Hudson Bay and is centred near Repulse Bay and Frozen Strait. It numbers approximately 5,000 animals and has been assessed as a species of Special Concern by COSEWIC and may be declining slightly. The North Baffin animals over winter in Baffin Bay and Davis Strait while the Hudson Bay population winters in the eastern portion of Hudson Strait and in southwest Davis Strait. Narwhal are generally very sedentary in summer. In September and October North Baffin Narwhal begin to move about the archipelago and later on move towards their overwintering areas where they tend to remain for the winter.

In Nunavut, Narwhal were tagged in Tremblay Sound (Eclipse Sound area), Admiralty Inlet and in Creswell Bay (Somerset Island). These tagged whales moved into southern Baffin Bay and Davis Strait for the winter. Aerial surveys and Traditional Knowledge also reveal a substantial number of Narwhal in Cumberland Sound in winter. Little is known about the size of the Narwhal populations in the high Arctic or where these animals may overwinter.

There are not enough Narwhal in Cumberland Sound in the summer to consider it an important summering area. Sixteen years ago there was no information to suggest that Narwhal were overwintering in Foxe Basin although it does not appear to be a major overwintering area for the northern Hudson Bay population. In the past, there were only infrequent accounts of Narwhal going through Fury and Hecla Strait, so Narwhal overwintering in Foxe Basin may be a recent occurrence. Narwhal that used to summer in Prince Regent Inlet, with diminishing summer ice, are now moving further down into the Gulf or Boothia, so some may be going though Fury and Hecla Strait into Foxe Basin on a more regular basis.

Based on lack of observations, Narwhal distribution does not extend into McClintock Channel (east side of Victoria Island) due to heavy, multi-year pack ice. It is also unlikely that this type of ice cover makes for good production of Arctic Cod (*Arctogadus glacialis*) which would be the main prey species for Narwhal in summer. Due to multi-year ice in Larsen Sound, even though it does have leads though it, Narwhal only occasionally make it as far south as Taloyoak. This may be changing with diminishing multi-year cover.

Repulse Bay and Frozen Strait are important summer habitat for the northern Hudson Bay population. Prince Regent Sound, Eclipse Sound, Gulf of Boothia and Admiralty Inlet are very important areas along with the many bays along the east Baffin coast for the Baffin population. Later in summer, some Narwhal go through Bellot Strait into Peel Sound and may later move towards Taloyoak. The largest summer aggregations of Narwhal can be found in channels around Somerset Island and in Eclipse Sound.

There is some evidence for stock structuring based primarily on tracking data while genetic and contaminant research has not provided clear evidence. Stock structure is therefore still under investigation. Only the northern Hudson Bay Narwhal population is clearly distinct by all forms of evidence.

Narwhal have been tagged in only a few areas like Creswell Bay, Kakiak Point in Admiralty Inlet and Tremblay Sound in the Eclipse Sound area. This amounts to approximately 60 animals tagged out of 80,000 which is insufficient to provide a true understanding of migration behaviour of all Canadian Narwhal. Declaring key areas based solely on that sample would be unwise. There may be other areas of importance that have not been covered by the results to date.

The wintering area in Davis Strait is not exactly the same every year so it is difficult to declare a specific zone as important for wintering. There are probably a number of habitat factors at play that determine where Narwhal overwinter. When Narwhal migrate, it appears quite directed and they do not linger in any one area suggesting that there are likely no significant staging areas between the summer and winter areas. However, it is unknown exactly how quickly they migrate to summering areas in the spring. Two tagged animals returned to an area close to where they were tagged the previous summer suggesting some level of philopatry for specific summering areas.

Narwhal tend to feed on Greenland Halibut during the winter in an area of Davis Strait that has been closed to commercial fishing to protect the habitat of both hard coral and Narwhal. However, it is difficult to draw hard boundaries around the ranges of transient animals that may be responding to a number of factors that may change on an annual basis. In the spring and late summer Narwhal feed on Arctic Cod that congregate along the floe edge or in coastal waters. Arctic Cod may be declining somewhat in Hudson Bay, so it may be impacting Narwhal in the area. Narwhal also eat squid, although it does not appear to comprise a large portion of their diet. Because of the importance of Greenland Halibut, it is likely that Narwhal will follow their movement or decline in numbers if changes due to climate change or fishing pressure affect fish stocks. Stomachs of Narwhal harvested in the summer are typically empty.

Long dives by Narwhal, often deeper than 1 km for up to 25 minutes, make them susceptible to predation by Killer Whale when they surface because they require a recuperation period. If ice cover thins due to climate change, it may allow Killer Whale to enter Narwhal overwintering and summer areas earlier and increase predation.

Narwhal may follow ship tracks in ice, but it may depend on how heavy the broken ice is that remains behind the ship. Narwhal may take advantage of these artificial leads in late spring or early summer.

Fishes

Arctic Char (*Salvelinus alpinus*) are found in many areas along the mainland coast of the Northwest Territories and Nunavut and also throughout most of the southern islands of the Arctic Archipelago (Fig. 12). Arctic Char are the dominant salmonid species throughout much of the Arctic. It is probably no coincidence that most Arctic communities are associated with one or more rivers having large populations of char that traditionally could be used as a fairly constant and reliable food source. Arctic Char are not restricted only to the areas shown, but the populations shown are primarily the largest and of greatest importance in a commercial or subsistence sense. Anadromous char begin annual migrations to the near shore ocean areas to feed before becoming sexually mature and return to over wintering lakes in the early fall. Distribution of Arctic Char seems to be limited more by the availability of overwintering habitat than food availability. The more northerly in the Arctic the populations exist, the greater the extent of facultative anadromy. This means that if the ice goes out the fish will go to sea and if it doesn't, they will remain in freshwater. A number of Arctic Char stocks support commercial fisheries with one of the largest and longest being that of Cambridge Bay. The Pangnirtung Arctic Char fishery, targeting a number of stocks, is also growing.

A close relative of the Arctic Char is the Dolly Varden (*S. malma*) found as a northern form in rivers of the Yukon North Slope, the Peel River and areas of the lower Mackenzie River. Like Arctic Char, these fish stay close to shore when they do enter the marine environment in the summer months and may move as far as Alaska. Alaskan fish may similarly move into Canadian waters. Both Dolly Varden and Arctic Char are adapted to a wide range of conditions, but they are generally poor competitors with other fishes and are found primarily north of 60^{o}. Both species exist in both anadromous and land-locked forms.

Coregonids, including Broad and Lake whitefish (*Coregonus nasus* and *C. clupeaformis*), Inconnu (*Stenodus leucichthys*), and Arctic and Least cisco (*Coregonus autumnalis* and *C. sardinella*), are the other main group of anadromous Arctic fishes. Unquestionably, the largest concentration of these types of fishes occurs in the western Arctic near the Mackenzie River estuary. Most of these species are semi-anadromous in that they prefer brackish waters. The whitefish species are well documented as using the lakes of the Tuktoyaktuk Peninsula as nursery areas after the young have been swept downstream from spawning areas in the Mackenzie River. In contrast, in most years young Arctic Cisco are carried by westerly currents along the Yukon North Slope into Alaskan waters where they remain in areas like the Colville River for up to seven years before migrating back to the Mackenzie River as adults to begin the cycle anew. The area of Liverpool and Wood bays just east of the Husky Lakes is also important to a number of anadromous fishes, as is the area of eastern Coronation Gulf near the mouth of rivers like the Coppermine.

Studies have recently taken place along the Yukon North Slope of the Beaufort Sea to compare older data with more recent information, especially as it may relate to oil and gas activity. Thus a study near Phillips Bay has been initiated to replicate one carried out in 1986 to, in part, determine presence of species and understand migratory patterns. While the results are not yet all compiled, there is some indication of a decline in species like Arctic Cisco with an increase in others species such as Pacific salmon (*Oncorhynchus* spp.) and Starry Flounder (*Platichthys stellatus*). However, normal fluctuations in year class abundance and distribution due to prevailing winds may explain some of these early findings.

Pacific Herring (*Clupea pallasi*) are found primarily in areas like Liverpool and Wood bays and along the south shore of Dolphin and Union Strait at the border of the Northwest Territories and Nunavut. This stock is fished and has been identified as important by residents of Paulatuk.

Important marine fish include the Arctic Cod; a fish that is ubiquitous in distribution and a pivotal component of the Arctic food chain consumed by other fish, birds, and a number of marine mammals. While limited deep-water fishing has been carried on in the western Arctic, species such as Greenland Halibut have been captured in the area near Banks Island as have Northern Wolfish (*Anarhichas denticulatus*), a species typically found in the eastern Arctic.

Greenland Cod (*Gadus ogac*) are generally abundant in the Beaufort Sea, Amundsen Gulf, through Coronation Gulf/Queen Maud Gulf into Hudson Bay, Hudson Strait and the near shore areas of Baffin Bay and Davis Strait. Greenland Shark (*Somniosus microcephalus*) are common to most Arctic waters and often appear in the Greenland Halibut fishery near Pangnirtung.

Ultimately, except for the areas commercially fished in eastern Arctic waters such as Davis Strait, more is probably known of the near shore Beaufort Sea than any other area. Knowledge of the fisheries has often been driven by commercial fishing in the east and the desire for industrial activities in the west leading to required pre-development survey work.

Difficulties in understanding the fisheries resource in the Arctic are due to issues such as the seasonal appearance of species within some areas, the vast geographic area and the widespread presence of sea ice throughout much of the year. If sampling does not cover a range of seasons, the presence of some species might be missed or the use or importance of an area to a species could be over or under estimated. Costs associated with all Arctic sampling mean that it is often difficult to sample an area in consecutive years or even on a regular basis. Annual variation in weather, winds and currents may cause species to appear in abundance within an area in which they are normally absent or more common. Thus, sampling may take place when annual fluctuations for a species are in times of high or low abundance.

Revisions to the map since 1994 largely reflect increased knowledge resulting in some clarifications (Fig. 12). As examples, the 1994 map did not differentiate between Arctic Char and Dolly Varden and this map also clarifies the use of the Mackenzie Delta and Tuktoyaktuk Peninsula by anadromous coregonids. There have been some minor corrections to the distribution of Arctic Char to reflect limited anadromy in extreme northern populations and improved distributional data for the species shown in 1994. Species that are common to many areas, such as Capelin, and are not well studied have been removed from the new map. Areas of shellfish and crab identified in 1994 have also been removed largely because the areas identified on those maps were probably not the most important areas for the species and certainly not the only areas where these species are found. Arctic Char were removed from a large area of the east Baffin coast because it did not reflect detailed knowledge of distribution. This detailed information is still largely unknown except for a few locations near communities.

There are a few landlocked populations of Atlantic Cod (*Gadus morhua*) in some areas of the south and east Baffin coast. These are unique in that these populations are known from meromictic, salt water lakes. Studied populations are present in Ogac Lake near Frobisher Bay and Qasigialiminiq and Tariujarusiq Lakes in Cumberland Sound. Inuit residents also report populations in a number of other lakes. The status of these populations is currently under review by COSEWIC. These lakes were isolated from the ocean by isostatic rebound thousands of years ago and they are becoming less linked to the ocean as the land around them continues to rise. These populations are unique and genetically isolated.

Greenland Halibut

Exploratory fisheries for Greenland Halibut, marketed as Turbot in Canada, began in Baffin Bay in 1993 and expanded in 1999 and again in 2006. The fishery was converted from an exploratory to a commercial license in 2008. The Cumberland Sound winter fishery began in 1986. The Davis Strait commercial fishery has a longer history that may have included some catches from Ungava Bay. In 1999, DFO initiated multi-species surveys using bottom otter trawl gear in the offshore area. The Greenland Halibut map (Fig. 13) is based on information from these multi-species surveys, and exploratory and commercial fisheries.

The multi-species surveys originally covered depths from 400 m to 1500 m, but recently the area from 100 m to 400 m was added for the southern portion of Baffin Bay and Hudson Strait. It is possible that Greenland Halibut distribution extends beyond 1500 m and in areas that have not yet been surveyed or explored for fishery purposes. No Greenland Halibut have been found on the Canadian shelf within Baffin Bay. However, Greenland Halibut have been found in deep troughs (>500 m) adjacent to some fiord areas (*e.g.*, Buchan Gulf, Scott Inlet, Home Bay and Broughton Island) where warmer Atlantic water is able to move into the near shore areas. No Greenland Halibut were found at depths of 300 to 400 m on the portion of the Greenland shelf that extends into Canadian waters in eastern Baffin Bay. While there may be some juvenile Greenland Halibut in the area, based on shrimp survey data, the overall numbers are low.

There may be Greenland Halibut in water depths of 100 m to 400 m on the shelf area of Davis Strait (southeast Baffin coast), but data from surveys in this area have not been examined for Greenland Halibut records. Recent surveys in Hudson Strait show Greenland Halibut distribution is limited to the central portion of the strait in waters >300 m and that Greenland Halibut are absent or uncommon in southern Ungava Bay.

There is no information on Greenland Halibut distribution in the middle of Baffin Bay in the area between 1500 and 3000 m as it has yet to be surveyed. While not shown on the map, the distribution of Greenland Halibut includes areas of Baffin Bay and Davis Strait that lie within Greenland's waters.

The Canadian fisheries for Greenland Halibut in Baffin Bay and Davis Strait are concentrated in offshore waters around the 1000 m depth contour and extend north to about 73^{o} N. Inshore fisheries have not developed along the Baffin coast like they have in Greenland (*e.g.*, the inshore fishery located in Disko Bay and several other fiords north of there). The Greenland and Baffin coasts are very different in terms of oceanographic qualities, so there are no expectations for similar aggregations of fish in Canadian waters. Spawning is thought to be concentrated in Davis Strait and the eggs and larvae can drift for several months along currents that run north along the West Greenland coast and west towards the Labrador coast. Greenland has the benefit of a greater amount of warmer water along their western coast and there are also several large banks on the Greenland shelf (*e.g.*, Store Hellefisk Bank, Disko Bank) that are important nursery areas where Greenland Halibut larvae settle. These banks are probably feeding the adjacent fiords in Greenland. In contrast, the Canadian banks along the east coast of Baffin Island are much smaller and are fed primarily by less saline and colder waters from the north. Habitat limitations may explain the near shore gaps in distribution of Greenland Halibut in Canadian waters found during surveys in Baffin Bay and may limit the potential for fisheries development along the Baffin coast.

A shallow sill between Canada and Greenland acts as a barrier to warm water that circulates in the Labrador Sea and could limit fish species distribution to the north. As you move north of the sill, fewer number of species are encountered. Survey results have shown approximately 40 species captured north of the sill with upwards of 70 captured south of it.

The distribution of other bottom species can be determined using data from the multi-species surveys. The species distributions seem to correspond to temperature and depth both north and south of the Greenland-Canada sill. Arctic Cod are caught in the survey, but only occasionally since they are more pelagic and are likely caught during deployment or retrieval of the bottom otter trawl gear. Several species that have been captured by the surveys have been or are currently being reviewed by COSEWIC [*e.g.*, Deepwater Redfish (*Sebastes mentella*), Roundhead (*Odontomacrurus murrayi*) and Roughhead (*Macrourus berglax*) grenadier, American Plaice (*Hippoglossoides platessoides*)].

The offshore Greenland Halibut fishery takes 94-98% halibut with little by-catch. Less than 1% of the by-catch in this fishery is Greenland Shark. Greenland Shark was a targeted fishery in the 1930s in Baffin Bay and off the west coast of Greenland. Greenland Shark is found in good numbers in Cumberland Sound, Pond Inlet and likely throughout the Baffin coast. The offshore Greenland Halibut fishery also takes some Arctic Skate (*Amblyraja hyperborea*), grenadiers and redfish, but all in low numbers.

In the western Arctic in 1993, eleven Greenland Halibut were captured on a long line near Sachs Harbour, Banks Island in 430 m of water. These captures suggest that Greenland Halibut may be irregularly distributed throughout the Arctic although perhaps not in sufficient abundance to support commercial fisheries. Therefore, the area marked as “unknown” on the map indicates an overall lack of survey work in most of the Arctic. There are some areas, such as much of Hudson Bay, where Greenland Halibut are not expected to be present due to habitat conditions.

Shrimp, Coral and Sponges

The areas on the maps are the areas of main concentrations for these organisms (Fig. 14). The information is derived from commercial observer data and a multi-species survey program.

There are two species of shrimp commercially harvested in the area; *Pandalus montagui*, the Striped Shrimp, and *P. borealis*, the Pink or Northern Shrimp. While they have different distributions, the map is a compilation of the distribution of both species. The main distribution of *P. montagui* is in Hudson Strait between 63° W and 70° W and down the Labrador coast. Primarily only *P. borealis* is present east of 63°W. Between 63°W and 66°W the two species are about equal in abundance while west of 66°W *P. montagui* makes up about 77% of the total *Pandalus* population.

Commercial shrimp fisheries have taken place in the eastern Arctic since the late 1970s with 100% observer coverage so there is good information about where fishing has taken place. Multi-species research surveys cover all shrimp fishing areas plus western Hudson Strait to 78°W. The northern extent of the surveys is at 72.2^{o} N. The survey in western Hudson Strait carried out in 2009 found only low biomass of either *Pandalus* species.

The northern extent of the *P. borealis* distribution appears in SFA 0. The main reason the shrimp are limited north of this area is lack of suitable habitat. *P. borealis* shrimp require water temperatures to be positive, ideally between 1 and 4^{o} C, in depths between 300-600 m. The area in which this occurs is very limited in SFA 0 therefore limiting population size. On the other hand, *P. montagui* can tolerate water temperatures as low as -1^{o} C allowing it wider distribution than *P. borealis* in the Arctic. As a result, SFA 0 has a total estimated biomass of approximately 900 tonnes of *P. borealis*, SFA 2 has about 50,000 tonnes of *P. borealis* and 6,500 tonnes of *P. montagui* and SFA 3 has approximately 70,000 tonnes of *P. montagui* and about 17,000 tonnes of *P. borealis*. Greenland estimates of shrimp biomass from their surveys are approximately 180,000 tonnes so their production is much greater than Canadian waters. Part of this is due to the warm water currents which flow up the west side of Greenland and a much greater shelf area in the correct depth range for shrimp.

The commercial fishery in the southern area east of Baffin Island takes about 3,000 tonnes each year while a small area east of Resolution Island is responsible for approximately 6,000 tonnes of harvest each year. Little fishing is currently taking place in SFA 3.

Strong tidal currents in the Resolution Island area may cause shifts in the shrimp populations in response to changes in water temperature. Changes in climate may result in changes to shrimp distribution and abundance, but overall, any changes to shrimp abundance would be relative to possible increases in productivity within the area. Currently the shrimp are probably primarily controlled by surface water temperature. Synchronization of water temperatures and spawning time may lead either to successful or unsuccessful years.

Pandalus shrimp are important forage species for seals, whales, Greenland Halibut, cod and other species. A study of Beluga Whale diet near Whale Cove in Hudson Bay showed that the stomach content was dominated numerically by *P. montagui*. *P. montagui* has been found in a number of areas, but generally in low abundance. There have been no shrimp surveys west of 78^{o} or north of 72.5°W. The lack of proper surveys sampling for shrimp populations outside the current study area makes it is difficult to say what population levels might be in other areas, but given known oceanographic conditions and requirements of the species, the abundance of *Pandalus* species would likely be low. There are perhaps up to 15 other shrimp species distributed throughout the Arctic, although none appear to be present in large concentrations in any locations surveyed.

Only two areas are well known for concentrations of hard corals in the Canadian Arctic and both are identified on the map. Soft corals are not species of concern as they grow quickly and are common through much of the Arctic. Hard coral locations have been identified both through scientific surveys and commercial fishery observer reports. Just east of the sill drop off south of Resolution Island is a known area of hard corals. Industry has voluntarily closed fishing within most of the area. The northern concentration of corals began as a Narwhal closed area near 67^{o} N and 57^{o} W, but surveys encountered hard corals there also. The fishery closure in that area therefore now protects both Narwhal and hard corals. The shrimp fishery has little effect on the corals here as the corals tend to exist in deeper waters than those fished by industry.

The area east of Resolution Island is also an area with large concentrations of sponges. Sponges are structure forming and an important component of the ecosystem, in some case providing habitat to juvenile fish and invertebrates.

Seabirds and Migratory Birds

The map of important seabird and migratory bird areas (Fig. 15) is a combination of all existing protected areas which includes National Wildlife Areas and Migratory Bird Sanctuaries which by definition have more than 1% of a national population of some species of bird. Many of these sites are seabird colonies or large goose colonies. The information contained in this map was updated with the most recent information possible at a workshop in December 2009. While it is possible to break this map down into areas used by specific species, it has not been done for this workshop.

Of note on the map for seabirds and migratory birds (Fig. 15) is the location of two small sanctuaries which were enlarged on the map so that their locations would be visible. These are the 2.3 km^2 Cape Parry sanctuary and the 28 km^2 Seymour Island sanctuary.

Changes to this map since 1994 are due mainly to opportunistic research rather than identification of new areas of importance. Most areas that are identified as important are primarily breeding colonies although there are a few that are used for moulting and other purposes. Many of the specific sites shown on this map haven't been visited for 20-30 years so some of these data may not be accurate and there could be some large, unknown changes.

One of the largest findings in the recent past is that the Coronation Gulf area is being used by perhaps 90% of Canada's Pacific Common Eider (*Somateria mollissima*) on their way to or from the Beaufort Sea. Because eiders feed on the bottom and the area is quite shallow, and because there is a lot of discussion about a port in Bathurst Inlet or more shipping due to use of the Northwest Passage, the area could be heavily affected by ship use. This in turn, either by use or accident might reduce the habitat quality or suitability of the area for eiders.

Areas that are known to be important for seabirds and migratory birds, but not yet under legal protection, include the Prince Charles Island and Airforce Island area of the eastern Foxe Basin. These areas appear to be important for shorebirds and waterfowl and have a highly diverse concentration of migratory bird species.

The majority of research done on Ivory Gull (*Pagophila eburnea*) and Ross's gulls (*Rhodostethia rosea*), both Species at Risk, has been done near Bathurst Island. Bathurst Island has only recently been confirmed as a nesting area for Ross's Gull, a Threatened Species at Risk. In the Foxe Basin area, Ross's Gull nest in areas important for many shorebirds. It is suspected that more Ross's Gull than we know of are using this area for nesting because their presence has been reported by community harvesters, and they were observed there by Canadian Wildlife Service (CWS) researchers during past surveys. However, no recent work has been done in the area to confirm these nesting areas.

The monitoring data is sparse, but white gulls [*e.g.*, Thayer's (*Larus thayeri*) and Glaucous (*Larus hyperboreus*) gulls], generally appear to be declining in the Arctic. The Bathurst Islands colonies of white gulls are being surveyed regularly, as are the Ivory Gull colonies on the south and east sides of Ellesmere Island. Local Inuit knowledge suggests that Ivory Gull may be beginning to recover a bit, although recent survey data suggests that declines have continued over the past eight years. Kittiwakes (*Rissa tridactyla*) are declining elsewhere in the North Atlantic, but seem to be stable or increasing in the Canadian Arctic. Thick-Billed Murre (*Uria lomvia*) are stable or increasing. Coats Island in northern Hudson Bay is visited fairly regularly to monitor the Thick-Billed Murre colony there. Trends in abundance for Black Guillemot (*Cepphus grylle*) are unknown, while Fulmar (*Fulmarus glacialis*) populations seem to be stable. There are some concerns that Arctic Tern (*Sterna paradisaea*) populations may be declining although it is a bit early to say with certainty. Collectively, marine bird species whose populations in Canada are at risk, or may be in decline (at least regionally) include: Ivory Gull, Ross's Gull, Arctic Tern, King Eider (*Somateria spectabilis*), Common Eider, Glaucous Gull and Thayer's Gull.

There are many possible causes for the decline of bird species and the cause of any single species decline remains unknown. As an example, Ivory Gull have very high levels of mercury in their eggs, but it is unknown if this may be contributing to their decline. The cause of the decline may be due to changes in the food chain and their primary prey or it may be due to their being hunted in Greenland. On the Kivalliq coast, near Whale Cove and Rankin Inlet, Inuit hunters are seeing fewer Arctic Tern and Black Guillemots than they did in the past. It is unclear whether these changes may reflect broad patterns in the population or if they are the result of their own egg harvest practices in the area.

Some birds may fly hundreds of kilometres to feed, so while the nesting sites may not be near productive polynyas, the polynyas may be important for feeding. Along the west shore of Cumberland Sound is an important area for Common Eider and Iceland Gull (*Larus glaucoides*).

Parks Canada has begun working with the CWS on some of the bird colonies such as the one on Bylot Island. Queen Maud Gulf has been looked at as have other areas with large goose colonies. Overall, however, there is not a lot of new work being done on Arctic marine birds although it is needed in a number of areas. There is, however, monitoring of a few key areas and species.

Seabird distribution appears to be very restricted in areas where they may nest on a cliff and yet feed over a radius of a hundred kilometres or more. It depends on how an important area is defined. Because in the 1994 workshop report important areas were based on at least 1% of the national population, the areas where the birds are most dense automatically fall out as small areas. The data presented in this workshop is simply more recent or refined than that of 1994 and should not necessarily replace it. For seabirds using Hudson Strait or Lancaster Sound you may have up to 30 or 40% of the population using that area. If anything ever happened to those areas, you would run the risk of losing those populations as well as a number of other bird and non-bird species.

Some seabird colonies have hundreds of thousands of birds. To support these populations, a very productive area or areas are required. Because a great many species with different nesting and feeding needs are being shown on one map, an additional map (Fig. 16) illustrating the level of information on birds, along with bird sanctuaries and polynyas within different geographic areas, was prepared. This allows for some comparison with the 1994 map with the same type of information.

The whole Davis Strait/Baffin Bay coast appears to be very important as millions of young birds attempt to swim out of the Arctic annually. Murre swim out of this area and some biologists have reported them as having extremely dense aggregations. The entire coast therefore becomes extremely important and one large anthropogenic disaster in the area could easily wipe out a year class of a number of species. There are also millions of Dovekies (*Alle alle*), feeding in the area and yet the species rarely nests in Canada, as most nest in Greenland. This east Baffin coast area is therefore probably underrated for its overall importance to seabirds.

Davis Strait and Baffin Bay are not only important as migration routes of some Canadian breeding birds, but the area is critical wintering habitat for Canadian birds, as well as migrants from Greenland, Iceland, Norway/Svalbard, and even the United Kingdom. This has been demonstrated recently by tracking marine birds using geolocators. Atlantic Puffin (*Fratercula arctica*), Ivory Gull, Fulmars, Kittiwakes and murres can all be found in this area in the winter.

Polar Bear

Polar Bear make extensive use of the sea ice environment to meet their life history needs while the use of terrestrial habitats is, for the most part, restricted to denning and summer use. Because female Polar Bear and their young show fidelity to denning areas, the areas identified in the 1994 map are still being used. Recent studies have identified new denning areas in the western Arctic, primarily in the Mackenzie Delta (Fig. 17). Although Polar Bear in some parts of the Arctic den on sea ice, the level of denning activity and the distribution of dens occur at such low densities that trying to map out these areas would be extremely difficult. In portions of the Canadian Arctic and subarctic, such as the southern Beaufort Sea, Polar Bear are forced ashore when the sea ice melts in the summer and many of them move into the Arctic Archipelago until the following winter. This obligatory use of the terrestrial environment is expected to increase as sea ice conditions continue to decline due to climate change.

In 1994 important sea ice habitat for Polar Bear was identified using expert opinion from over 20 years of field work on Polar Bear in the Arctic. However, recent changes in sea ice dynamics have influenced the distribution and availability of sea ice across the Arctic and it is unknown whether areas identified in 1994 continue to hold high concentrations of bears. In the past 15 years, developments in satellite tracking of Polar Bear and remote sensing of sea ice have allowed researchers to assess Polar Bear habitat use at multiple spatial scales. Results from this research have shown that Polar Bear inhabit ice covered waters across the entire Canadian Arctic and that they prefer biologically productive areas over the continental shelf which possesses high to moderate sea ice concentrations. As in the 1994 Arctic Marine Workshop report, it is important to note that flaw leads and polynyas are often the preferred habitat of Polar Bear when they are available. These areas tend to attract seals and whales and these increases in prey density usually result in increased use of these areas by Polar Bear.

As part of this workshop, an attempt was made to identify polynyas across the Canadian Arctic using SSMI/SSMR (Special Sensor Microwave Imager/Scanning Multichannel Microwave Radiometer) sea ice concentration data from the National Snow and Ice Data Centre in Colorado. Despite the fact that the spatial resolution of this data is very coarse (25 km^2 pixels), it is still possible to identify polynyas across the Canadian Arctic. Using this technique, areas such as Hell Gate, Penny Strait, and the North Water polynya can be reliably identified. This opens up the possibility of discovering new polynyas that may be used by Polar Bear as sea ice conditions continue to change. At the same time, however, it is important to note that not all polynyas contain high densities of marine mammals. As an example, Roes Welcome Sound was thought to be a wintering site for several Hudson Bay marine mammal species, but when it was surveyed it was discovered that only a few seals were using the area in the winter. Thus polynyas have to be more than just open water areas if they are to attract wildlife.

It is important to note that most of the information that has been collected on Polar Bear habitat use has occurred below the 75th parallel. To date, very little information exists on Polar Bear populations and habitat use in the high Arctic Archipelago. It is believed that as this area of the Arctic shifts from a multi-year sea ice system to an annual ice system, it will become an increasingly important area for Polar Bear, especially as sea ice conditions continue to decline at the southern limit of Polar Bear range.

Productivity

Areas not identified on the map as being productive are not necessarily non-productive. Rather the areas identified in Figure 18 are known to be extremely productive and important. Phytoplankton is found everywhere in the Arctic in the summer and the winter, but due to local conditions, some areas are much more productive than others.

There are three main factors to consider when looking for specific areas of importance for productivity: light, nutrients and water column structure. Light is important for controlling the onset of production and even during the dark of winter some limited production [no production (*i.e.*, photosynthetic growth) occurs in the dark but phytoplankton/algae are still present] is occurring. Areas near the mouths of rivers where suspended sediments may interfere with light penetration are not conducive to high primary production. Nutrients are important and need to be brought to the surface where the phytoplankton can access them. Nitrate often seems to be the limiting nutrient in the Arctic. A stable environment without too much mixing and some stratification is also required to promote phytoplankton growth. Based on these three factors, there are five main areas in the Arctic that possess the proper combination of conditions required to be identified as the most productive.

The North Water polynya may be the most productive ecosystem north of the Arctic Circle. It is an extremely productive area because of a longer growing season. The growing season within the North Water polynya is up to six months; nearly twice as long as nearby Lancaster Sound. The polynya reaches an area of up to 80,000 km^2 at its maximum extent. It meets the definition of a polynya because it is an area of recurring open water or only thin ice. The North Water polynya has been sustained by the presence of an ice bridge in northern Smith Sound which stops ice from the very high Arctic flowing into the polynya. However, in the last 3-4 years the ice bridge has not formed so there is an expectation that the polynya will change in terms of its' productivity. The Northeast Water polynya on the northeast coast of Greenland was smaller than the North Water polynya and effectively quit functioning as a polynya in 2001-2005 due to changes in ice conditions. In 2007 the Northeast polynya was the smallest size ever recorded and there are fears that with the loss of the ice bridge in Smith Sound that the North Water polynya may have a similar fate.

A second important area is Lancaster Sound which represents a well mixed environment with currents that bring nutrients to the surface. It does not have an overly long growing season, but it is highly productive due to the nutrient supply. The highest ice algal biomass measured in the Arctic occurs within the Lancaster Sound area. Ice algae contributes approximately 25% of total primary production of the Arctic and it's very important for the grazers in the spring. Productivity is higher in the eastern portion of Lancaster Sound than in the western portion.

Hudson Strait is another location of high productivity because of a good balance between mixing of water and flow rate which can be observed in the high tide ranges. Recent work in Hudson Strait has shown that the productivity in the strait is an order of magnitude higher than inside Hudson Bay. Even Foxe Basin is much less productive than Hudson Strait.

The area west of the Belcher Islands was first identified as an important area in the 1980s, but it has not been sampled recently and so its current state is somewhat unknown. It is debatable where the nutrients are coming from in this area, but they could be coming out of the nearby rivers of Ontario and Quebec. Alternatively, a process called entrainment, by which different water masses move over each other and the friction they create allows nutrients to surface, could be responsible for the increased productivity. There are a number of moving leads and small open water areas in the area around the Belcher Islands throughout the winter that are used by various seabirds and marine mammals.

In the western Arctic, the Cape Bathurst polynya can be broken into two areas with the western portion of the polynya having higher production than the eastern. The Beaufort Sea (offshore) in general is highly stratified and not very productive as the surface waters have low nutrients. An increase in production is reliant on upwellings that bring nutrients from deep Pacific waters up to the surface where they can be used by phytoplankton. Bottom features help contribute to re-occurring upwellings of nutrients which contribute to increased production. Flaw leads, found between pack ice and landfast ice, also contribute to longer growing seasons.

The area between Banks Island and Cape Bathurst has recently had considerable study during the CASES (Canadian Arctic Shelf Exchange Study) studies of 2002-2004 and other studies which has led to a good understanding of the area [*e.g.*, ArcticNet, Circumpolar Flaw Lead system study (CFL)]. Previous study has shown that the growing season within the area may vary by as much as three months (lasting from 4-7 months) and this was discovered prior to major changes to ice cover. In 2007 there was a massive full shelf upwelling in the area in the fall bringing nutrients to the surface that was recorded by the CFL study. Because the growing season was over, the nutrients were not used by phytoplankton. However, the nutrients were available in the spring for primary producers with both ice algae (4X) and phytoplankton (2X) increasing in production relative to what was observed during the CASES study. This event showed that estimates of what we believe may be occurring may be incorrect, and unless sampling is taken place in these locations when the events occur, they may remain unknown.

It seems probable that even with a reduction of sea ice there will likely not be a huge increase in primary production in many areas because of a lack of nutrients or other needed conditions. Climate change may result in more wind driven upwellings, but these only occur along coasts or against ice edges where winds blow waters away from shore and allow nutrients to rise up with deeper waters.

Commercial and Industrial Areas of Interest

Major Projects

This presentation focuses on Environmental Assessments (EA) that are close to completion. EA are supposed to determine if the effects of a project will have a significant effect on the environment. When doing EA, there is a need to know the probable environmental effects from activities and thus, the information on faunal distribution presented at this workshop will be useful in helping to understanding these potential effects.

Figure 19 shows high mineral potential centred in the areas near Bathurst Inlet/Coronation Gulf and western Hudson Bay. The geology of this area has produced prime locations for mineral and diamond mines. The James Bay and southern Hudson Bay areas are currently being considered for additional hydro electric projects. Two major roads have been, or are being, proposed. One would eventually open up the Bathurst Inlet area and service gold and diamond mines in an area of low human population. The other would open the western shore of Hudson Bay where a number of communities exist and a road would increase tourism in the area as well and provide access for servicing mines.

The Mary River Project (Baffinland Iron Mines Corporation) is proposed as a large open pit mine with a possible port in Steensby Inlet for shipping iron ore to European markets. There is the possibility of a shipping component associated with this project that would require year round ice breaking through eastern Hudson Bay and Hudson Strait. The project is not moving forward at this time but is instead at the Nunavut Impact Review Board. Most of the fuel and supporting equipment required to date by the mine has been brought in from the north via Milne Inlet. It is possible, therefore, that the company might eventually decide to ship iron ore out this way instead of going through Steensby Inlet in the south. The final decisions will obviously determine which species and which stocks of animals might be potentially affected by shipping and ice breaking.

The lack of infrastructure in many areas is delaying projects at this time. The creation of a Bathurst Inlet Road could open up the area near Coronation Gulf and allow several projects currently on hold to proceed. As an example, the Hope Bay gold mine, east of Bathurst Inlet, has been approved, but little will happen for a while. The potential Doris North gold mine is also in the area. There has long been talk of the Bathurst Inlet area being used as a major deepwater port with shipping taking place to and from the west although it seems likely that a major port in this area is at least ten years off. Gold related activity between Coronation Gulf and Queen Maud Gulf may be moving forward and there would be some shipping associated with projects in those areas. There may also be some shipping out of Grays Bay situated on Coronation Gulf east of Bathurst Inlet which has an advanced gold project.

The Baker Lake area also has intense and fairly advanced mining projects including the Meadowbank Gold Mine Project which consists of three open pits north of Baker Lake. There is a lot of gold and uranium in the area. Shipping would probably take place by barge out Chesterfield Inlet although there has been some talk about flying product out of the area. Closer to Hudson Bay, the Rankin Inlet gold project is ready to enter the EA phase.

With gold prices currently being high there is a lot of interest in moving forward with projects that have been at a standstill for some time. It is probable that a lot more of the gold projects will move ahead which will increase marine traffic in some areas. The impacts of increased shipping will need to be addressed in the EA process.

Some James Bay hydro projects are awaiting approval. The Lower Mattagami River project, if approved, will change the flow into the estuary in James Bay and likely change the amount of sediment entering the bay. This and other proposals in western James Bay will further change the flow regime in the area with summer flows into the bay reduced and winter flows increased as stored water is released. The results of some of the actions are unknown although it could have an affect on nutrient cycling and therefore all animal distribution. Rivers in Manitoba such as the Lower Nelson are already heavily developed and more development is planned as people generally see hydro as a “green” source of renewable energy.

The Roche Bay iron project near Hall Beach may barge its’ product to Churchill for distribution further south.

Overall there are a great many potential projects in the Arctic. Many never go ahead due to lack of funding, some that begin are never completed and some are discussed for years with little actual movement. It is difficult to say which of the above may actually move forward first and , if so, possibly present threats to the marine environment.

Marine Transportation

The map shows the routes used by most forms of marine transportation in 2008 (Fig. 20). A similar map could be created if data were used from most other years. Much of the non-government vessel traffic represents community resupply which is accomplished with barges. Some community resupply involves large tankers delivering fuel. Government vessel tracks shown on the map are primarily Canadian Coast Guard ships assisting supply vessels or, in the case of the western Arctic, primarily the tracks of ships carrying out scientific research.

One of the primary concerns with shipping in the Arctic is the possibility that ballast waters may contain a non-native species which may be introduced into a new area. As an example, there are approximately 20 ships going to Churchill, Manitoba annually that release 30–35,000 tonnes of water prior to taking on a load of goods. There is a need to ensure that ballast water is managed to ensure non-native species are not introduced. The Canadian Ballast Water Control and Management Regulations outline what needs to be done to ensure non-native species are not introduced to new areas. There are currently two proposed Alternate Ballast Water Exchange Zones (ABWEZ) in the western Arctic which are not listed in regulations. There are two areas in regulations in the east for westbound traffic (east of 80^o for Lancaster Sound and east of 70^o in Hudson Strait; both in waters in excess of 300 m) (Fig. 20) that may be used if a vessel was unable to exchange ballast on the high seas (at least 200 nautical miles offshore where water is at least 2000 m deep). To date it is thought that none of these ABWEZ has been used.

Ballast water is pumped out of a ship at a port when cargo is taken on. Transport Canada has water reporting forms to ensure that this has been done when staff cannot be available to check ballast water. The forms request data on when ballast was exchanged and which method was used. It is also possible to check the salinity of ballast water tanks to ensure people are doing what they say. Transport Canada has limited personnel in the north and must rely on only the reporting forms in many northern areas.

There are two main ballast water exchange methods. The flow through method is used when the ship is in transit and results in the water in the ballast tanks being replaced or flushed. The water volume must be replaced at least three times for this method to be effective. A second method is simple flushing and replacement. However, severe accidents have happened during ballast water exchange when it was not carried out properly or when it was carried out under rough sea conditions and the ship has lost stability. Therefore, ABWEZ have been established so that if exchanging ballast on the high sea is considered unsafe, there are options to do it in areas that may be safer for the ship and crew. Few ships actually keep their ballast on board at all times although cruise ships may take on some ballast and retain it during their entire trip. Ballast water currently does not need to be exchanged if a boat is sailing from a Canadian port to another Canadian port and stays within Canadian waters. This is something that, from a biological point of view, may need to be looked at in the future.

Hull fouling may be another means by which non-native species may access a new area. There are no regulations concerning hull fouling at the moment and there are questions about the utility of anti-fouling paints. As the time nears for the ship to be repainted it is possible that the anti-fouling paint has long lost its effectiveness and organisms are constantly attaching to and detaching from the hull. Currently ships are not examined to see if they are carrying attached organisms.

Some Arctic ports are currently only open for three or four months of the year. With increased mining activity in the Arctic, there will be interest in keeping some of them open longer. There are increased concerns about introducing non-native species to many areas because once the mines are established and product begins to ship out, these ships will come in under ballast and then release it at the port. There is also a great concern from some areas about increased ice breaking in many areas due to later shipping seasons. An increase in shipping may also increase the possibility of ship strikes on marine mammals, especially slow moving Bowhead Whale.

Fishing vessels are largely not even being considered at the moment. The tracks of fishing vessels do not appear on the map (which would be concentrated along the coast of east Baffin) largely because many of them are not going into Canadian ports. Fishing vessels in Canadian waters are tracked with VMS (Vessel Monitoring Systems) which transmits information about position. The Arctic Marine Traffic System (known as NORDREG) will make reporting where ships are going as well as reporting all incidents and spills mandatory as of July 1, 2010. NORDREG will affect all ships over 300 tonnes as well as smaller vessels that may carry hazardous materials or pollutants.

Oil and Gas

The oil and gas potential map (Fig. 21) has been adapted from United States Geological Survey maps produced on a circumpolar scale. This map shows specific areas likely to hold promising finds. An area of relatively high potential is in the Sverdrup Basin of the Arctic Archipelago. There are several high Arctic oil and gas discoveries (based on drilling results) in the Sverdrup Basin area and drilled locations are shown on the map. The potential for future development in this area is low, however, considering distance to market, competing closer sources of oil and gas, and the current lack of infrastructure.

The Beaufort Sea/Mackenzie Delta has a relatively high potential for oil and gas development. The Beaufort Sea is relatively close to markets and the potential Mackenzie Valley Pipeline continues to be discussed. Therefore, this area will develop more intensely and sooner than other areas in the Arctic. The Beaufort Sea proper can be further differentiated into shallow water and deep water zones. Shallow water areas are in some ways similar to areas on the Mackenzie Delta where access is relatively commonplace in contrast to deep water areas. Many known discoveries exist in the shallow waters of the Beaufort Sea whereas the deep water zone has no known discoveries, though ongoing exploration work may soon change that.

The area offshore of eastern Baffin Island has some areas of relatively high oil and gas potential. Unlike other areas, practically no drilling has taken place there, with the exception of one well drilled in this area in the 1970s. As well, there has been relatively little seismic work in this area compared to others (Fig. 22). However, there appears to be increasing interest by industry in this area. In neighbouring Greenland's offshore areas, an exploratory drilling program is planned for 2010.

Wells need to be drilled within a certain time period in order to maintain the licence to its full term. If areas are drilled and nothing is found, generally the licence is allowed to expire. It should be noted that Indian and Northern Affairs Canada (INAC) gives rights for access to land (including areas offshore), but does not actually grant approval for geophysical (seismic) operations or drilling. Companies must go to the National Energy Board to seek approval for seismic work and drilling.

There are currently no nominations for the high Arctic call area, nor have there been any in the last ten years. Some interim planning is underway on a proposal to start holding calls in the area offshore of eastern Baffin Island in the near future.

INAC is currently continuing to improve and expand its Petroleum and Environmental Management Tool (PEMT) to help inform stakeholders about sensitivities in the Arctic marine environment. The PEMT has three versions (Fig. 23); one for each of the Oil and Gas areas in the Arctic [Beaufort Sea/Mackenzie Delta, High Arctic, and Eastern Arctic (Offshore Eastern Baffin Island)]. Sensitivity maps on several environmental and socio-economic components have been modeled based on available life history data. Information from this workshop will be useful and may add important details to sensitivity layers in the PEMT.

DISCUSSION

While the Parks Canada (1995) report referred to geographic areas as “hot spots” with “high diversity and/or high biomass”, this diversity referred only to those vertebrate species that were the focus of presentations at the 1994 workshop. There are many more species in the Canadian Arctic than those discussed at this or the 1994 workshop and only a few of them are well known in terms of their distribution. Therefore, to prevent confusion with the 1994 workshop and other terms, we have chosen to call areas in which the well studied species (both vertebrate and invertebrate) discussed at this workshop exhibit a “common” (*i.e.*, frequently found in an area during some period of the year) distribution which overlaps another’s, as areas of High Biological Importance (HBI). We believe that this term is a better descriptor than “areas of high diversity” partly because these areas of overlapping use are not always utilized at the same time by all species (thus diversity may be seasonally low, high or moderate). In addition, the term “hot spot” may have negative connotations for some and in the literature is a term often used to denote extreme taxonomic richness, endemism or areas under significant threats (*e.g.*, Myers, 1989; 1990). The methods used to determine areas of HBI are described below. Areas of Special Interest (ASI), first identified at the 1994 workshop, are also discussed below.

Areas of High Biological Importance (HBI)

When possible, we first grouped species using taxonomic similarities and created layers or groups of species similar to those of the seabird and migratory birds and fish maps. Because Ringed Seal were identified as “common” throughout the Arctic, the seal layer included only areas where a seal species, except Ringed Seal, was identified as being common. For the toothed whale layer, we utilized areas in which any toothed whale was considered common. We included the winter range of Beluga Whale when making this layer as a “common in winter” area had not been identified. This meant that Beluga Whale formed the toothed whale layer in the western Arctic whereas Beluga Whale, Narwhal and Killer Whale formed the eastern Arctic toothed whale layer. We concluded that the use of an area, often only spatially and not temporally or for the same reason, by three related species, did not make the area three times as important as an area used by one. By creating these layers we hoped to eliminate the need for treating geographic areas differently or otherwise somehow “weighting” data.

After creating the layers of toothed whales and seals, there remained several species or species groups found only in the eastern Arctic. These are Walrus, Greenland Halibut and the shrimp, corals and sponges group. We included Walrus and the shrimp, coral and sponge group in our analysis as their distribution in the Arctic is fairly well known, but we excluded Greenland Halibut because the complete distribution of the species is unknown (Fig. 13).

Our final layers for the analysis therefore included; key habitat for seabirds, Polar Bear denning areas, toothed whales (common areas plus winter range for Beluga Whale), Bowhead Whale (common areas only), fishes (excluding landlocked Atlantic Cod), shrimp, coral and sponges, Walrus and a seal layer (common areas only excluding Ringed Seal). We also included the five areas of high productivity under the assumption that these areas were surrogates for high lower trophic level importance (Table 1). General polynya locations in the Arctic (Fig. 16) were not used in the analysis because it was unclear from the discussions as to which polynyas were actually productive and used by wildlife and which simply provided open water habitat.

Table 1: Distributional attributes used to create biological layers to determine areas of High Biological Importance.

LAYER	SOURCES	ATTRIBUTES USED
Toothed whales	Killer Whale	Common
	Beluga Whale	Common year round Common in summer Winter range (surrogate for common)
	Narwhal	Common in winter Common in summer
Bowhead Whale	Bowhead Whale	Common in summer Common in winter
Seabirds	Key Habitat sites	All
Fishes	Arctic Char	All
	Dolly Varden	All
	Anadromous coregonids	All
	Pacific Herring	All
Polar Bear	Polar Bear	Denning areas
Productivity	Productivity	Highly productive areas
Seals	Bearded Seal	Common
	Harbour Seal	Common
	Harp Seal	Common in summer Whelping patch
	Hooded Seal	Common in summer Whelping patch
Shrimp, corals and sponges	Corals and sponges	All
	Pandalus spp. shrimp	All
Walrus	Walrus	Range (including common in winter areas)

At the 1994 Arctic Marine Workshop participants identified important areas in the east and west using a Delphic type approach while looking at a single area of the Arctic at a time, presumably without consciously thinking about the greater number of species in the eastern Arctic. We, however, analyzed all areas at the same time by performing a GIS ArcInfo 9.3 analysis which showed where the greatest number of overlaps among species or species groups occurred based on the data given to us by presenters. While in 1994 there was likely inclusion of some areas by participants due to their knowledge of a particular importance of certain areas to some species, any location bias in our method came only from the presenter declaring the area of use by the species as “common” which was based on knowledge gained through survey work, tagging studies and/or Traditional Knowledge. Our method of creating species distribution layers prior to analysis was designed to minimize personal bias associated with having participants collectively discuss and identify the location of species overlap and did not require weighting of data for any specific area (*e.g.*, adjusting for low species numbers in the western Arctic).

The result of the overlay analysis was a single map that showed areas of overlapping use by species and species groups described by a series of isolines. Isolines enclose areas of equal value and in this case represent the number of species or species groups utilizing a specific area. The initial map was, however, very “rough” due to the coarse nature of the data. Therefore a neighbourhood analysis was performed to “smooth” the data. This analysis re-calculates each cell in the map by taking the average of the surrounding cells. This type of smoothing is often used to average out errors from remote sensing data, but does not change the basic results. In this analysis, each cell was re-sampled based on the average of the surrounding cells and a radius of 12 cells was used to create the final map. The result of the analysis after smoothing is shown in Figure 24. “Hot spots” were identified in 1994 by overlaying the distribution maps of multiple species using an overhead projector. Smoothing of the data was done by hand, possibly introducing some bias as to where the final isolines were placed.

There are a total of ten locations shown in Figure 24 found in six areas which contain the highest maximum number of species or species group overlaps. These areas are; Beluga Bay in the Mackenzie Delta estuary, North Water polynya (2), Lancaster Sound (2), Frozen Strait, Hudson Strait (2), Frobisher Bay and Resolution Island. Six of these locations are within areas identified as being amongst the most productive in the Arctic (*i.e.*, North Water polynya, Lancaster Sound and Hudson Strait). Based on the diversity of species using these areas, it is possible that these areas may represent places of even greater species overlap and importance than is suggested here. Many species of vertebrates and invertebrates not discussed at this workshop may be utilizing these areas.

Although Table 2 shows seven species or species groups within Cumberland Sound, which could identify the area at the highest level of areas of HBI, the size of Cumberland Sound is such that no more than five species ever exhibit an overlap in distribution at any single location. A Delphic approach would have likely identified the entire area as a high level area of HBI. Examination of individual species shows that that Cumberland Sound can actually be divided into eastern and western areas with Arctic Char being unique to the western and Walrus being unique to the eastern portion. A similar situation exists for the east Baffin coast which, while it has six species within the area, no more than five overlap in any single location. In the case of both areas, some of the species using these areas do so at different times of the year.

There are fifteen more or less distinct areas with the second highest number of species or species group overlaps (Fig. 24). In some cases these areas are large enough that they could be used as the basis for research planning or localized MPA networks. It is at this second level that many of the areas identified are sufficiently large enough that the major ecological influences of the area (*e.g.*, upwellings, freshwater input, polynyas) probably control the structure of, or are the reason for, the fauna found within the isolines. At the next level (four overlapping species or species groups) an even greater number of areas are identified (nineteen), but the majority (fourteen) radiate outward from the second level isolines perhaps

Table 2: Species and species groups found within the 19 areas of High Biological Importance.

	SPECIES/SPECIES GROUP									
	Toothed whales	Bowhead Whale	Seals	Walrus	Fishes	Polar Bear	Seabirds	Shrimp, coral and sponges	Productivity	**Total overlapping in area**
AREA										
1. Yukon North Slope	X	X	X		X	X	X			**6**
2. Cape Bathurst/Tuktoyaktuk Peninsula	X	X	X		X	X	X		X	**7**
3. Banks Island East Coast		X	X			X	X			**4**
4. North Water Polynya	X	X	X	X			X		X	**6**
5. Jones Sound			X	X	X	X				**4**
6. Lancaster Sound complex	X	X	X	X		X	X		X	**7**
7. Pelly Bay/Cape Chapman	X	X	X		X	X				**5**
8. Northern Foxe Basin	X	X	X	X	X					**5**
9. Frozen Strait/Repulse Bay	X	X	X	X	X		X			**6**
10. Southampton Island		X	X	X		X	X			**5**
11. Chesterfield Inlet	X	X	X	X	X					**5**
12. Belcher Islands			X	X	X		X		X	**5**
13. Akimiski Island/James Bay	X		X			X	X			**4**
14. East Baffin Coast	X	X	X	X			X	X		**6**
15. Cumberland Sound	X	X	X	X	X	X	X			**7**
16. Frobisher Bay	X	X	X	X	X	X	X			**7**
17. Resolution Island	X	X	X	X			X	X		**6**
18. Hudson Strait	X	X	X	X			X	X	X	**7**
19. Davis Strait	X	X	X					X		**4**

signifying only a greater sphere of influence from the previous areas. It is at this level that entire stocks of some animals could probably be protected. With a few exceptions at this stage, the map of areas of HBI (Fig. 25) looks similar to that of the “hot spots” from the 1994 workshop (Fig. 26). Some of the divisions between areas of HBI shown in Figure 25, specifically those near southeast Baffin Island, are somewhat arbitrary although we attempted to define the areas based on the species present and the geographic or oceanographic features of the area.

At the fourth level of overlap (not shown), many areas, especially in the eastern Arctic, begin to exhibit such a high degree of overlap that the areas enclosed by isolines become so large that these new areas become relatively meaningless and indistinct (*e.g.*, almost all coastal areas are identified and connected). At this fourth level, approximately 40% of Nunavut territory is covered by isolines.

In the western Arctic, beyond a slight expansion seaward of the three areas already identified near the Mackenzie Delta and Banks Island, some near shore areas in Amundsen Gulf are identified at the fourth level. These areas include Cape Parry, an area near the Nunavut/Northwest Territories border, the area offshore and including Prince Albert Sound and Minto Inlet (Victoria Island) and DeSalis Bay (Banks Island). The fact that there are more species in the east than in the west may suggest to some that we should have looked at a lesser number of overlapping species when determining areas of HBI in the western Arctic and gone to this fourth level. We believe that by creating species layers the areas identified in the west were identified without any weighting or special consideration. However, for those who believe this extra step should have been taken, this explains where the next area of HBI would have been located. The areas identified are noted for the presence of Arctic Char and Bowhead Whale.

The method used to determine the areas of HBI resulting in groups of isolines does allow for narrowing in on specific areas (Fig. 24) and shows the primary area of biological importance or interest as opposed to enclosing a single area with one large isoline. The major difference between the areas of HBI identified at this workshop and the results from 1994 is that the 1994 isolines were created by the participants and were thought to encompass areas of high diversity and importance. For this workshop, we let the data itself determine where the areas of HBI were and attempted to remove as many biases as possible from the selection of the areas.

The three levels of areas of HBI enclosed by the isolines permit identifying increasingly larger areas that may lend themselves well to MPA network creation. However, overlaying these areas on the recently developed DFO marine ecoregions map (DFO, 2009) shows that two of the five Arctic ecoregions do not include any areas of HBI (Fig. 27) and only a small area in the southwest portion of the western Arctic ecoregion has an area of HBI. This underscores the need for continued research within these data deficient ecoregions as well as illustrating that while MPAs in many eastern areas could protect multiple species or species groups, those in the west, except for a few areas of HBI, may be primarily suited to the protection of individual species.

The results in Figure 24 are very comparable to a map of areas of HBI produced prior to the workshop (not shown). The reason for this, we believe, is that while most presenters revised their maps following the workshop, the end result was that the areas which are considered the most important and the distribution of most fauna discussed at this workshop have been known for many years. Therefore, although we used the revised data, it really didn’t affect the areas of greatest use (*i.e.*, the species “common” areas) which were those areas that were identified prior to and presented at the workshop. Few areas identified by us as areas of HBI prior to the workshop did not appear in Figure 24. As a result of map revisions, only three new areas were added and all of these were in Hudson Bay. Interestingly, when the pre-workshop map of areas of HBI was shown to participants near the end of the workshop, some stated that certain areas should have fallen out as more or less important. These statements, we believe, showed a bias towards expected or desired results; something that undoubtedly took place when the 1994 “hot spots” were being developed and something that we tried to avoid at this workshop.

Noteworthy is that while the areas of HBI are generally very similar to the 1994 “hot spots” map, in most cases, the areas are considerably smaller than the “hot spots”. Several new areas were identified as areas of HBI although with a few exceptions (*i.e.*, Hudson Strait) these areas are also typically small in size. Due to our mapping method, the areas of HBI fall out as very specific, and therefore, relatively small. We believe that having a concise area to focus on for possible protection is a better starting point than looking at larger areas.

Some of the greatest changes evident between the 1994 results and those of this workshop include the downsizing of all of Jones Sound from a “hot spot” to a very small area of HBI. Similarly, the Southampton Island “hot spot” has been greatly reduced in size while several smaller, surrounding areas appear as distinctive areas of HBI including Frozen Strait/Repulse Bay and Chesterfield Inlet (with a lesser area along the coast to the south). The western Arctic Cape Bathurst polynya area of 1994 has also been greatly reduced in size. The east Baffin coast is now recognized as an important, if still a poorly studied, area of HBI while Hudson Strait is now identified as an area of HBI rather than an ASI as in 1994.

Areas of HBI were named from west to east and north to south. Table 2 names these areas and identifies all species and species group overlaps within these areas. A brief description as to why these areas are important is given below. We have changed the names of a few areas first identified as “hot spots” in 1994 only when the initial descriptor now seemed inadequate.

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1. Yukon North Slope (Mackenzie Delta estuary to the Alaskan border)
- Area extends up to 60 km offshore in places.
- Areas of upwelling near Herschel Island used by Bowhead Whale for feeding.
- Important area for anadromous fish feeding and migration including passive transport of larval fish to Alaskan waters (*i.e.*, Arctic Cisco).
- The only marine area used by the northern form of Dolly Varden in Canada.
- Polar Bear denning habitat along this area.
- Area is used by Ringed and Bearded seal.
- Mackenzie River is the largest source of freshwater input in the Canadian Arctic.

2. Cape Bathurst Polynya/Tuktoyaktuk Peninsula
- Mackenzie Delta estuary extending to north and east of Cape Bathurst.
- Area extends up to approximately 50 km offshore.
- Cape Bathurst polynya is the largest, most consistent recurring polynya in the western Arctic (location variable).
- Important Bowhead Whale feeding areas exist offshore.
- Near shore and polynya creates important staging areas for numerous seabird species.
- Near shore areas and bays used by Pacific Herring and anadromous coregonids.
- Beluga Whale, Ringed and Bearded seal abundant in this area.
- Polar Bear denning occurs throughout this area.
- Perhaps the most productive and important area in the western Arctic.

3. Banks Island East Coast (Kellett River to Bernard River)
- Important for seabirds and Polar Bear denning.
- Area used by Bowhead Whale, Beluga Whale and seal species for feeding.
- Adjacent to flaw lead used by seabirds and Bowhead Whale in the spring.

4. North Water Polynya
- The largest and probably the most productive recurring polynya and one of the most productive areas north of 60^{o}.

- Used as an overwintering area by several species of seals as well as Beluga and Bowhead whale.
- Supplies critical habitat for some seabird species.

5. Jones Sound (Bear Bay area)
- Polar Bear denning area.
- Area holds one of two stocks of Walrus in Jones Sound
- Arctic Char common in area.
- Harp and Bearded seal common throughout area.
- Arctic Char present along south side of sound.

6. Lancaster Sound complex (including Barrow Strait, Admiralty Inlet and Eclipse Sound)
- Lancaster Sound including portions of north-western Prince Regent Sound, Admiralty Inlet and Eclipse Sound including Navy Board and Pond inlets.
- All areas identified as seasonally possessing high numbers of most marine mammals.
- At some point in the year the area holds almost all of the Canadian Narwhal population.
- Important to a number of seabird species with associated cliff area providing nesting habitat.
- Polar Bear denning habitat.
- Portion of area identified as one of the most productive areas in the Arctic.

7. Pelly Bay/Cape Chapman
- Common area used by Killer Whale, Bowhead Whale and Arctic Char.
- Includes a known Polar Bear denning area.
- Bearded, Harp and Ringed seal common.

8. Northern Foxe Basin (Cape Wilson, northeast to Baird Peninsula to Fury and Hecla Strait)
- Largest concentration of Walrus in Canada.
- Polynyas in area provide important habitat for multiple species including seabirds.
- Identified as perhaps the only Bowhead Whale nursery area in the Canadian Arctic.

9. Frozen Strait/Repulse Bay
- Area is used by almost every marine mammal species present in the Arctic.
- Distinct population of Narwhal found in this area.

10. Southampton Island (Cape Bylot to Ell Bay including north and western Coats Island)
- Important habitat for Walrus, including overwintering area, and numerous seabird species.
- Important Polar Bear denning habitat.
- Bowhead Whale utilize area around the island.

11. Chesterfield Inlet (including Hudson Bay coast – Whale Cove to Arviat)
- Important area for Killer Whale and Beluga Whale.
- Most seal species common in this area.
- Arctic Char and important seabird habitat common along most of this coastline.

12. Belcher Islands
- Overall highly productivity due to numerous leads and small polynyas.
- Important for Walrus, Beluga Whale, numerous seabird species, Arctic Char and seals.
- Identified as an ASI in 1994.

13. Akimiski Island/James Bay
- Important area for Polar Bear denning and seabirds.

- Important area for Beluga Whale which may be a distinct stock.
- Possible disruption to the area by changes in freshwater input due to hydro development.
- Entire bay probably acts like a single, large estuary.
- Identified as an ASI in 1994.

14. East Baffin Coast (Cape Jameson to Leopold Island)
- Extensive fiords provide habitat to seals, seabirds, Bowhead Whale, Narwhal and Walrus.
- Area used by seabirds migrating out of Arctic.
- Area used by marine mammals travelling into and out of the high Arctic.
- Due to use by seabirds and whales identified as an area of high sensitivity to disruption.
- Many fiords possibly home to Arctic Char stocks.

15. Cumberland Sound (Leopold Island to Brevoort Island)
- Area supports numerous Arctic Char stocks in western portion of the sound.
- Important polynya for Beluga Whale located near northeast corner of sound. Clearwater Fiord is an important Beluga Whale estuary and the only one on southeast Baffin.
- Polar Bear denning near the eastern portion this area.
- Large, important seabird area.
- Walrus wintering area on eastern edge of sound.

16. Frobisher Bay (excluding end of bay area near Iqaluit)
- Important area for Beluga Whale, seals and seabirds.
- Location of small polynya so potential for increased productivity.
- Polar Bear denning near mouth of bay.
- Arctic Char stocks in this area.
- Area near Iqaluit at head of bay is not included in this area of HBI.

17. Resolution Island (extending to Ungava Bay and northern Labrador)
- Area east of Resolution Island important area for *Pandalus* spp. and adjacent to coral area.
- Seabird nesting areas on island.
- Narwhal, Beluga and Bowhead whale overwinter within/near this area.

18. Hudson Strait (including Akpatok, Salisbury and Nottingham islands)
- Important overwintering area for many marine mammals including Narwhal, Beluga Whale and Walrus.
- Highly productive area due to mixing and flow of water: more productive than Hudson Bay.
- Several important seabird areas along coast.
- Very important area for shrimp production.
- Ice edge through strait likely an important, dynamic habitat for numerous species.

19. Davis Strait
- Important wintering area for Bowhead Whale and Narwhal.
- Area used by Harp and Hooded seals in the summer.
- Productive shrimp area.

It should be noted that not all areas that are identified as important to individual species or species groups are encompassed by areas of HBI. For example, some of the locations used by Walrus as haul out sites are found outside the areas of any HBI although the haul out sites themselves were identified as important to the species and falling within the range/common in winter area. Those creating MPAs, conducting Environmental Assessments or otherwise intent on protecting key or important habitats should therefore consider some of the areas that are not explicitly identified on the HBI map, but are referred to in the text or identified in the individual species maps. This again illustrates that due to differing ecological needs, not all areas important to all species can be identified simply by identifying areas used by the greatest number of species.

Areas of Special Interest (ASI)

While the opportunity to have a focussed discussion on Areas of Special Interest as identified in 1994 (Parks Canada, 1995) never arose during this workshop, there were a few areas that were discussed opportunistically or identified by presenters as important that are worth repeating here. We have not mapped any of these areas because our discussions were largely incomplete and due to our methods, mapping them would involve speculation as to where exactly these areas are situated. It is worth noting that one ASI identified in 1994, Isabella Bay, on the east Baffin coast (Fig. 26) was not only identified as part of a larger area of HBI at this workshop, but is now the location of a National Wildlife Area created to protect Bowhead Whale.

<u>Dolphin and Union Strait Area</u>
The Dolphin and Union population of caribou migrate between the mainland and Victoria Island on an annual basis using portions of Dolphin and Union Strait, Coronation Gulf and, sometimes, Lincoln Strait. It was identified that this entire area could be affected either by poor ice conditions due to climate change or winter ship traffic. It is interesting to note that the importance of this marine area is often identified due to its use by terrestrial mammals. The strait was also identified as important for seabirds and migratory birds, as it was in 1994, in part due to the presence of a small polynya. Due to the relatively narrow channel, this important seabird area could be easily disturbed by ship traffic or pollution from ships.

<u>Davis Strait Whelping Patch</u>
The area in southern Davis Strait used as a whelping patch was identified in 1994 and remains an important area for Hooded and Harp seals. Disruption of this area either due to direct anthropogenic activity or climatic disturbance could result in huge declines of seal numbers. The exact area is known to vary on an annual basis, but remains within the same general area.

<u>Churchill/Nelson Estuaries</u>
Similar to 1994, this area remains a well known and important area used by Beluga Whale in the spring/early summer and as a staging area for Polar Bear prior to offshore movement in the fall. Nearby areas are also used for Polar Bear denning. Due to the port in Churchill, introduction of non-native aquatic species could occur in the area with unknown consequences to the local ecosystem.

<u>Bathurst Inlet</u>
Of some note is the ASI identified in Figure 15 of the 1994 workshop report that was labelled Bathurst Inlet, but was situated at Chantrey Inlet. From the original, brief description of the area as “a special migratory area” and information gathered at this workshop, it appears that the wrong area was marked on the map rather than the area being misnamed. The area near Chantrey Inlet does not appear to be particularly important or used by any group of species while Bathurst Inlet is generally important for several species and is a key habitat area for migratory birds (Fig. 15). People using the 1994 report should note this change and ensure that Bathurst Inlet is identified as the proper ASI as we have done in Figure 26. While not explicitly discussed at this workshop, the seabird and migratory birds map shows that the Bathurst Inlet area remains an important migratory area.

CONCLUSIONS

In many ways the areas identified in 1994 have changed little even though there has been an increase in our knowledge of ecological processes and the distribution of Arctic fauna. Changes as to how the data was collected from researchers prior to producing the final maps meant that the areas of HBI identified are typically concise and contain limited participant bias. The information on fishes or Walrus, as examples, shows that while we have clarified distribution a bit, the known distribution of stocks has not changed substantially in 16 years and therefore can now be considered well known. This does not mean we haven't learned more about these stocks or populations since 1994, only that their distributions were largely well known many years ago. Alternatively, when looking at a species like Killer Whale which now has a program dedicated to collecting Inuit and other observations, we have a much better idea not only of their distribution, but perhaps also of their preferred areas of use. However, we are still very much in the process of learning about them and our level of knowledge on their distribution is not yet comparable to that of Walrus. For other species, much of their distributional data falls somewhere in between although for the most part, the changes presented have been slight and at least some are due to climate changes affecting distribution rather than identification of areas unknown in 1994. We've learned much over the intervening years, but it is doubtful that anyone would argue that we currently understand all there is to know. Additionally, while we have made progress, like in 1994, the species higher in the trophic system generally remain much better understood than those at lower levels. Therefore, the total diversity of Arctic fauna and its' distribution remains largely unknown and may remain so for some time.

So if the results are generally similar to those from 1994, what is the advantage of the method used this time around? The primary advantage is that the amount of participant bias has been reduced to that of the presenter of the data for each species or species group rather than that generated through a Delphic approach. This limits bias to that of expert opinion coming from a single person that knows the species best. The result is that multiple levels of bias are not introduced when identifying areas of HBI and therefore the areas of HBI may be as close to reality as possible. This in turn means it is probable that the most important areas, based on the information available for the species discussed, have been identified. A second benefit is that this type of exercise could be done without the need of a workshop. Information could be requested from experts knowledgeable in a species distribution and maps of areas of HBI could be created without ever having all contributors in the same room. We do not, however, suggest such a method be used as it reduces the potential for useful discussions.

Difficulties in trying to study and understand the biological resources of the Arctic remain much the same as they did 16 years ago. What is known remains a function of where research has taken place and where Inuit observations have occurred, and in that respect, areas closest to communities which can act as a base for air support and travel continue to be better studied and better known, more so than more isolated areas. Seasonal sampling and surveying remains necessary, but not always possible, if we are to completely understand the use of an area by some species. If sampling does not cover all seasons, the presence of some species might be missed or the use of an area to a species could be over or under estimated. It is these seasonal knowledge gaps where Inuit Traditional Knowledge may excel in being able to provide information about distribution and wildlife use of areas during times when scientific research typically does not take place. It will be interesting to see how the information from this workshop compares with community views of what are thought to be important areas for Arctic fauna.

The high costs associated with Arctic research means it is often difficult to sample an area in consecutive years or on a regular basis. However, not being able to do such work regularly may mean that research is taking place only when the species is at a peak of abundance or in a naturally depressed stage. The inclusion of Inuit Traditional Knowledge may help to determine at which part of a natural cycle (if any) research is occurring in, but this knowledge may not always provide all the information required. Variation in weather, winds, currents, predators and prey may cause species to appear in greater or lesser abundance within areas in which they are normally absent or much more common. Thus there is a need for as much monitoring of important stocks and populations as possible, especially when there has been a change in ice cover in the Arctic over the past 16 years and such changes are expected to continue.

Areas of High Biological Importance are generally those associated with strong currents (*e.g.*, Foxe Basin, Hudson Strait), polynyas (*e.g.*, Lancaster Sound, Cape Bathurst Polynya, North Water Polynya) and otherwise highly productivity areas due to particular conditions in the area (*e.g.*, Mackenzie Delta and its' freshwater input). There's little change in these findings since 1994 except that a warming Arctic may be affecting the length of time some of these conditions exist, whether the conditions exist at all or the size of the area that these processes influence.

Including the examination of current and planned activities and developments at this workshop was useful in identifying locations where potential conflicts may occur between development and wildlife and highlights some specific geographic areas of concern. The designation of an ABWEZ in Hudson Strait as well as the ABWEZ near Lancaster Sound suggests that the use of these areas should be reconsidered immediately due to their importance to a number of species and overall high productivity. The possibility of the introduction of a non-native species to the areas, no matter how remote, should be considered a serious threat. Potential oil and gas exploration or development in or near Lancaster Sound and the east Baffin Coast could have a negative impact on areas of HBI in the event of an accident. Due to ocean currents within the area and the importance of the areas to marine mammals and seabirds, the east Baffin coast, including Cumberland Sound, stand out as areas that could be affected by activities or accidents occurring many kilometres away.

Based on the current level of activity, the greatest threats to areas of HBI remain oil and gas activity in the western Arctic and marine transportation in the east. However, increasing interest in oil and gas in the east could also make oil and gas related activities (exploration through development phases) the primary threat to eastern Arctic fauna. Changes in climate may eventually affect some of the areas of HBI, most notably the North Water polynya, with unknown effects on the distribution and long-term health of several species which regularly rely on this area. Monitoring the fauna and ecological conditions within any areas of HBI prior to increased human activity may show if changes in wildlife use occur and could perhaps provide information and guidance that might be useful for managing similar activities in other areas of HBI.

The workshop was useful in providing a snapshot of the most recent distribution of many Arctic species and data that could immediately serve the Oceans Programs Divisions' need to identify biologically important areas in locations not already having been subject to examination through an EBSA exercise. The results also document important areas for individual species and species groups, may help to point out important areas for protection within DFO ecoregions and could help guide the development of conservation objectives within and for these ecoregions. The results from this workshop and the EBSA process (DFO, 2004) are not identical although the workshop results do present a plausible way forward for DFO regions which need to plan for an MPA network, but also lack EBSAs. The methods used here provide an alternative to the Delphic method for the identification of important biological areas and therefore minimizes the addition of individual participant bias which may sometimes unintentionally influence the results.

ACKNOWLEDGEMENTS

A workshop such as this would have been impossible without the willing contributions and enthusiasm of a great many people who possess knowledge of the Arctic environment, its' wildlife and the activities that are, and may soon be, taking place there. Although several people were unable to attend, they nonetheless provided information which was used during the course of the workshop and, in some cases, contributed to the revised species maps (Appendix 3).

The authors would like to specifically thank and acknowledge the people who gave presentations at the workshop that, while not included in this manuscript, contributed to the overall knowledge of all participants at the workshop.

We thank Helen Fast (Oceans Programs Division) who reviewed a draft of this manuscript and provided several useful comments and revisions.

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APPENDICES

APPENDIX 1: Summary agenda for the Arctic Marine Workshop, Winnipeg, Manitoba, 2010.

February 16 - Day 1

Welcome – Barry Briscoe – Regional Director Oceans, Habitat and Species at Risk - DFO
National Marine Conservation Areas (NMCA) of Canada – Francine Mercier, Parks Canada
Where's This All Going? – Sam Stephenson, DFO
Parks Canada NMCAs and National Parks – Cliff Robinson, Parks Canada
Rapid Assessment of Features and Areas for Circum-Arctic Ecosystem Resilience in the 21st Century – Pete Ewins, World Wildlife Fund
Land Use Planning in Nunavut – Adrian Boyd, Nunavut Planning Commission

Species Distribution
Seals – Stephen Petersen, DFO
Killer Whale – Stephen Petersen, DFO
Walrus – Blair Dunn, DFO
Bowhead Whale – Jeff Higdon, DFO
Narwhal – Pierre Richard, DFO
Beluga Whale – Pierre Richard, DFO
Arctic Char/anadromous and other species – Sam Stephenson, DFO
Greenland Halibut (Davis Strait/Baffin Bay) – Margaret Treble, DFO
Shrimp, coral and sponges – Tim Siferd, DFO
Productivity – Andrea Niemi, DFO

February 17 - Day 2

Polar Bear – Evan Richardson, Environment Canada
Seabirds and migratory birds – Siu-Ling Han, Environment Canada

The Marine Arctic Biodiversity Monitoring Plan – Jill Watkins, DFO

Commercial/Industrial activities
Major projects – Bev Ross, DFO
Oil and Gas – Tom Duncan, Indian and Northern Affairs Canada
Shipping and Ballast water – Captain Wasif Kamal, Transport Canada

Traditional Knowledge from DFO Oceans Program Community Tour – Maria Healy, DFO

The new(?) Hot Spots – Sam Stephenson/Leah Hartwig, DFO
Where to now? (closing comments)

APPENDIX 2: List of participants at the Arctic Marine Workshop. Presenter's names are in bold. Where no topic is listed, the presenter provided information that has not been included in this manuscript, but is listed in Appendix 1.

Wayne Barchard Environment Canada Halifax, NS	**Jeff Higdon – Bowhead Whale** Fisheries and Oceans Canada Winnipeg, MB
Adrian Boyd Nunavut Planning Commission Yellowknife, NT	Sabine Jessen Canadian Parks and Wilderness Society Vancouver, BC
Ron Brown Government of Nunavut Iqaluit, NU	**Wasif Kamal – Marine Transportation** Transport Canada Winnipeg, MB
Redmond Clarke Fisheries Joint Management Committee Winnipeg, MB	Eric Kan Fisheries and Oceans Canada Iqaluit, NU
Ken Corcoran Canadian Wildlife Service Ottawa, ON	Jeff Maurice Nunavut Tunngavik Incorporated Iqaluit, NU
Mark Dahl Environment Canada Winnipeg, MB	**Francine Mercier** Parks Canada Gatineau, QC
Nicole Deschenes Environment Canada Winnipeg, MB	Dale Nicholson Canadian Hydrographic Service Burlington, ON
Tom Duncan – Oil and Gas Indian and Northern Affairs Canada Gatineau, QC	**Andrea Niemi – Productivity** Fisheries and Oceans Canada Winnipeg, MB
Blair Dunn – Walrus Fisheries and Oceans Canada Winnipeg, MB	**Stephen Petersen – Seals, Killer Whale** Fisheries and Oceans Canada Winnipeg, MB
Pete Ewins World Wildlife Federation Toronto, ON	Ray Ratynski Fisheries and Oceans Canada Winnipeg, MB
Tania Gordanier Fisheries and Oceans Canada Ottawa, ON	**Pierre Richard – Narwhal, Beluga Whale** Fisheries and Oceans Canada Winnipeg, MB
Jason Hamilton Fisheries and Oceans Canada Winnipeg, MB	**Evan Richardson – Polar Bear** Environment Canada Edmonton, AB
Siu-Ling Han – Seabirds Environment Canada Iqaluit, NU	**Cliff Robinson** Parks Canada Vancouver, BC
Leah Hartwig Fisheries and Oceans Canada Winnipeg, MB	**Bev Ross – Major Projects** Fisheries and Oceans Canada Winnipeg, MB
Maria Healy Fisheries and Oceans Canada Winnipeg, MB	Bruce Stewart Arctic Biological Consultants Winnipeg, MB

Jonathon Savoy Nunavut Planning Commission Cambridge Bay, NU	Mike Townsend Nunavut Planning Commission Cambridge Bay, NU
Tim Siferd – Shrimp and Corals Fisheries and Oceans Canada Winnipeg, MB	**Margaret Treble – Greenland Halibut** Fisheries and Oceans Canada Winnipeg, MB
Sam Stephenson – Fishes Fisheries and Oceans Canada Winnipeg, MB	**Jill Watkins** Fisheries and Oceans Canada Ottawa, ON

APPENDIX 3: List of contributors who were unable to participate in the Arctic Marine Workshop.

Lois Harwood – Bowhead, Beluga, Seals Fisheries and Oceans Canada Yellowknife, NT	Jim Reist - Fishes Fisheries and Oceans Canada Winnipeg, MB
Steve Ferguson – Seals, Killer Whale Fisheries and Oceans Canada Winnipeg, MB	Rob Stewart - Walrus Fisheries and Oceans Canada Winnipeg, MB

Figure 1: Map of locations frequently cited in this manuscript.

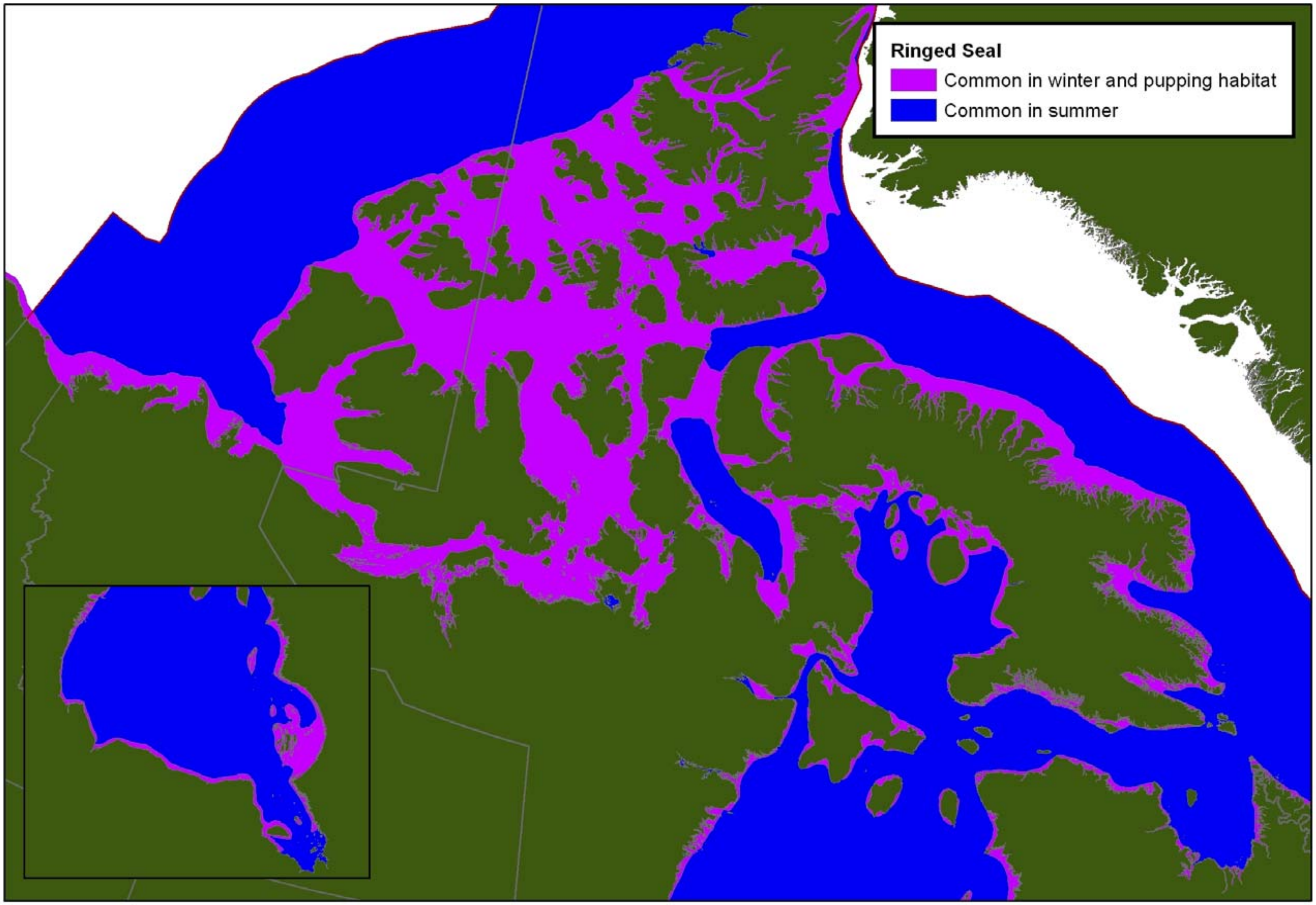

Figure 2: Distribution of Ringed Seal (*Pusa hispida*) in the Canadian Arctic.

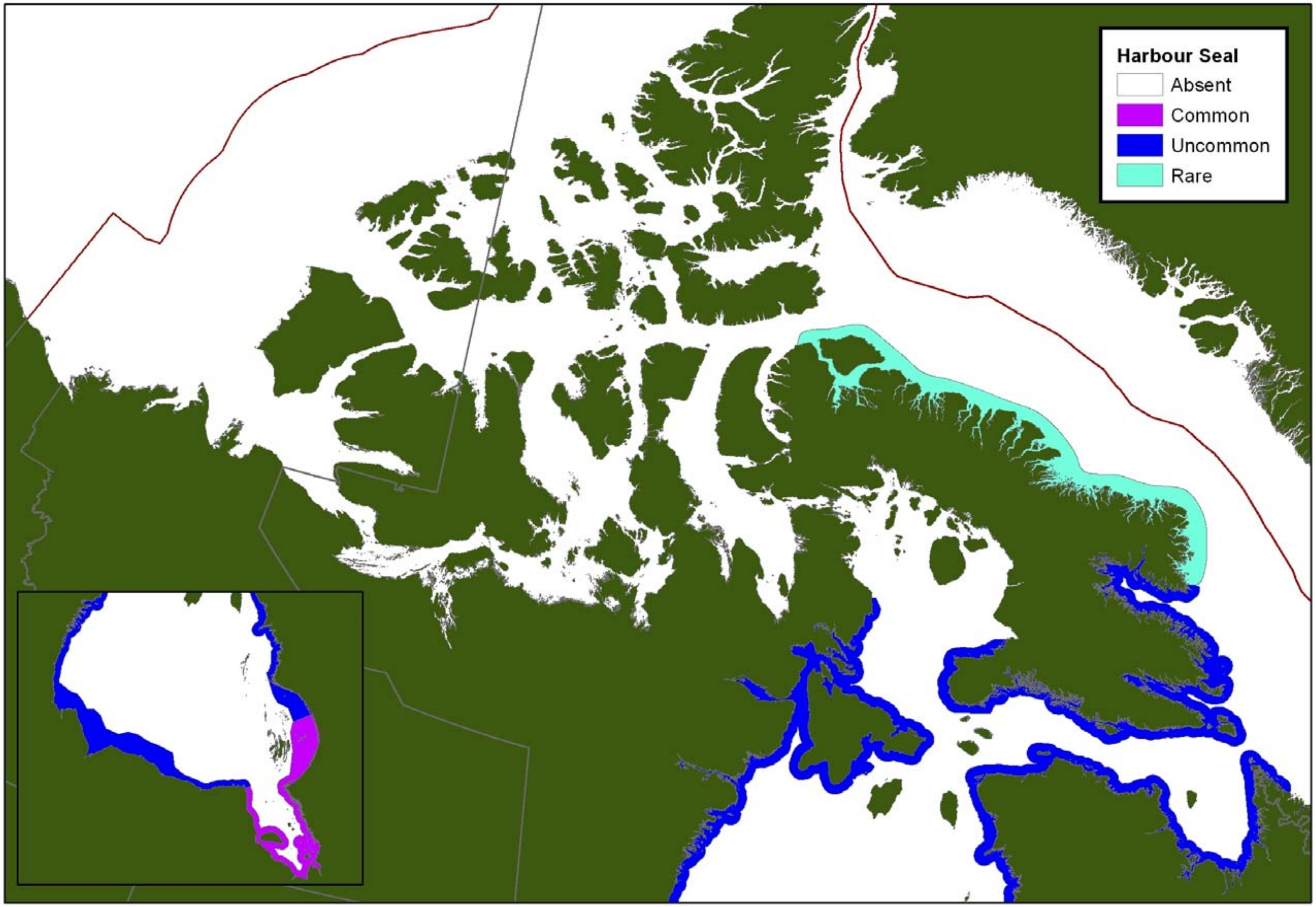

Figure 3: Distribution of Harbour Seal (*Phoca vitulina*) in the Canadian Arctic.

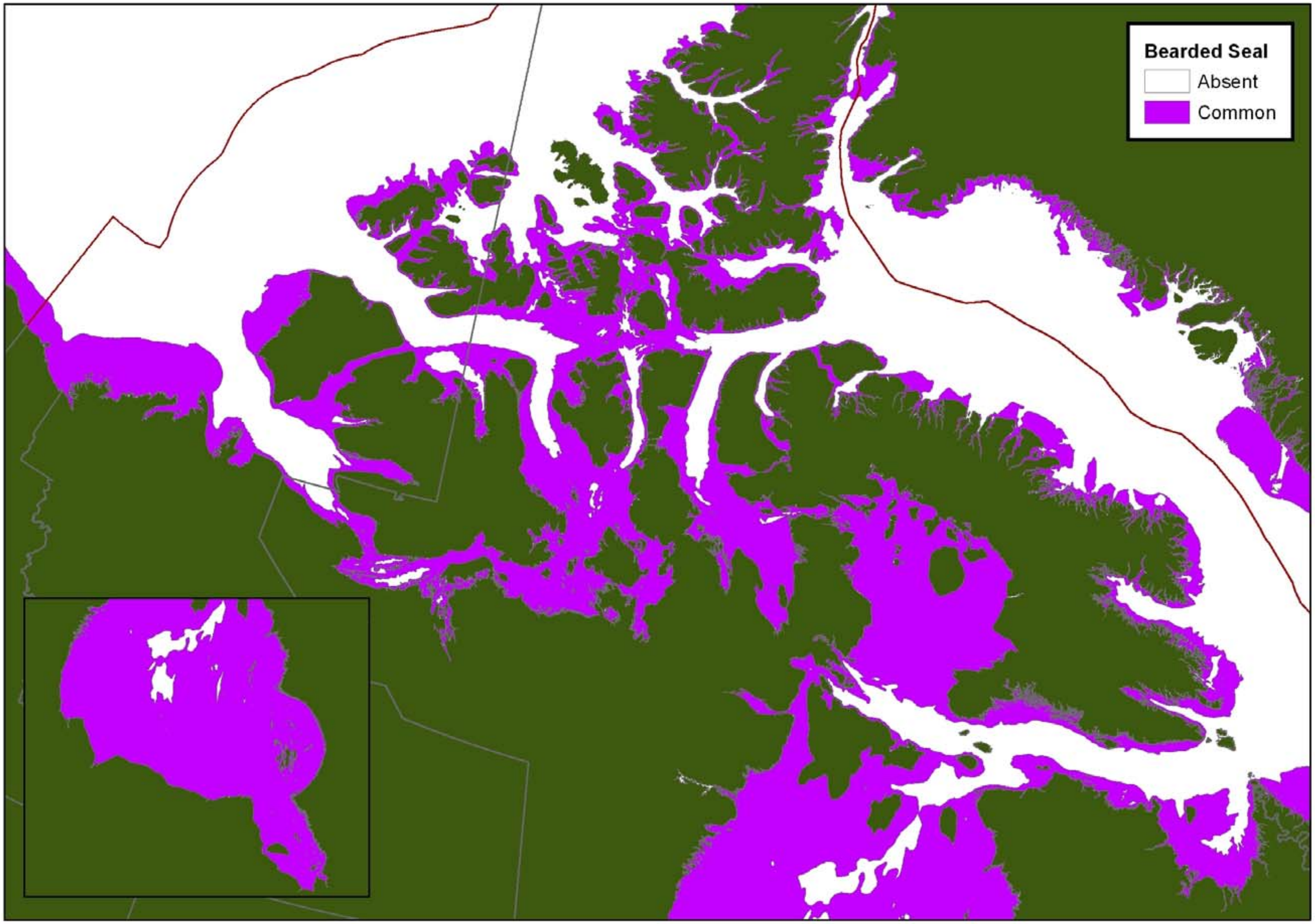

Figure 4: Distribution of Bearded Seal (*Erignathus barbatus*) in the Canadian Arctic.

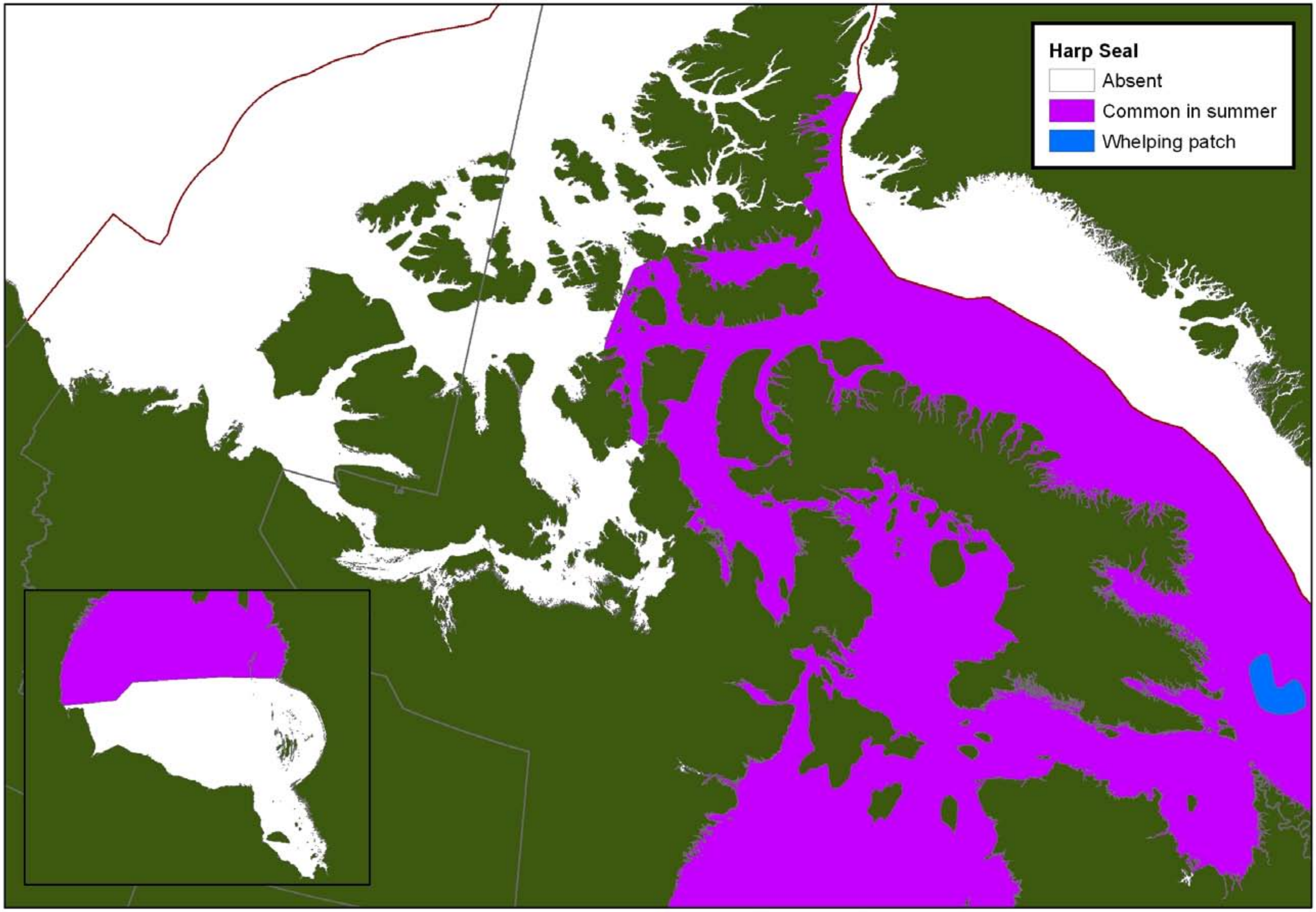

Figure 5: Distribution of Harp Seal (*Pagophilus groenlandica*) in the Canadian Arctic.

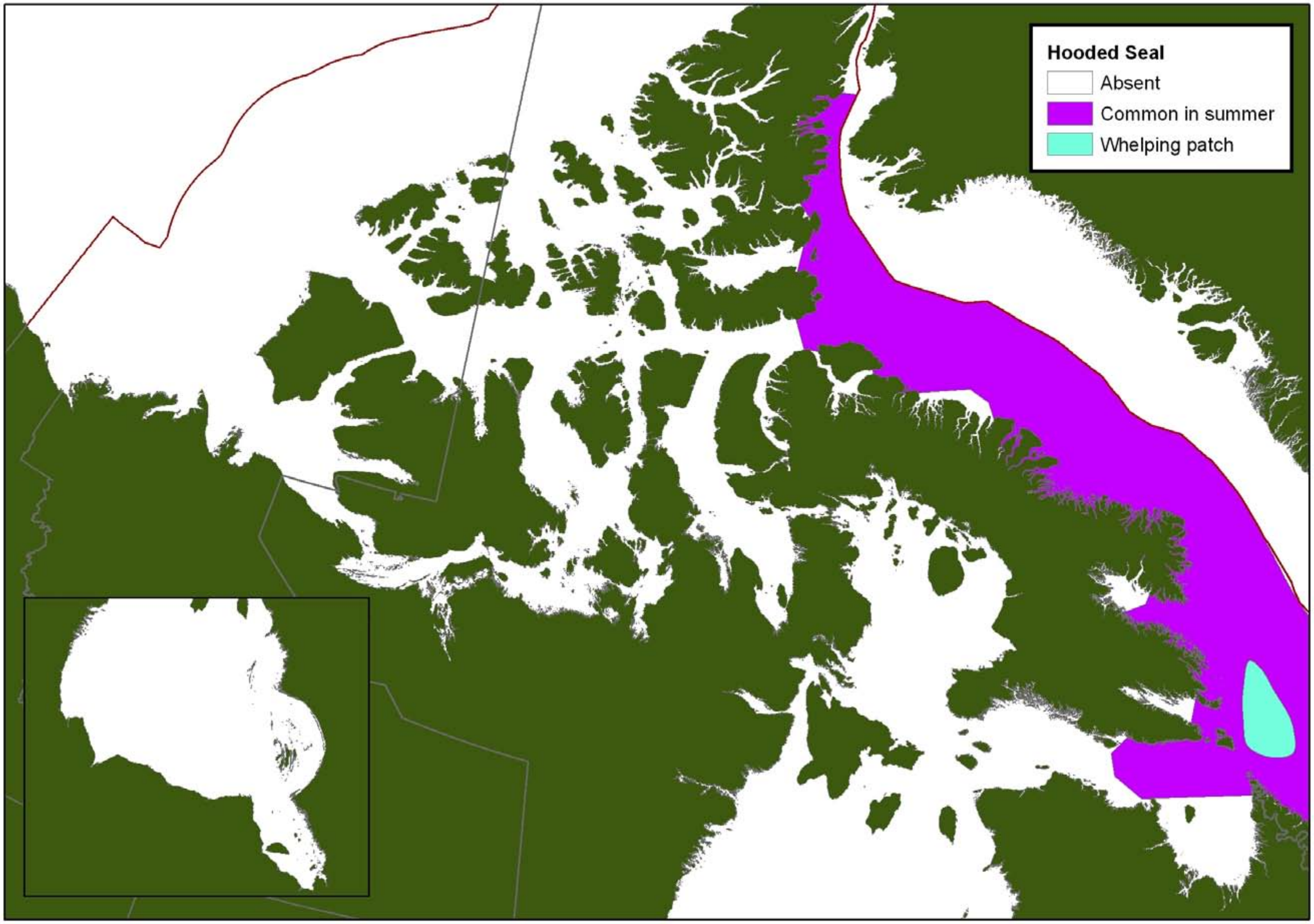

Figure 6: Distribution of Hooded Seal (*Crystophora cristata*) in the Canadian Arctic.

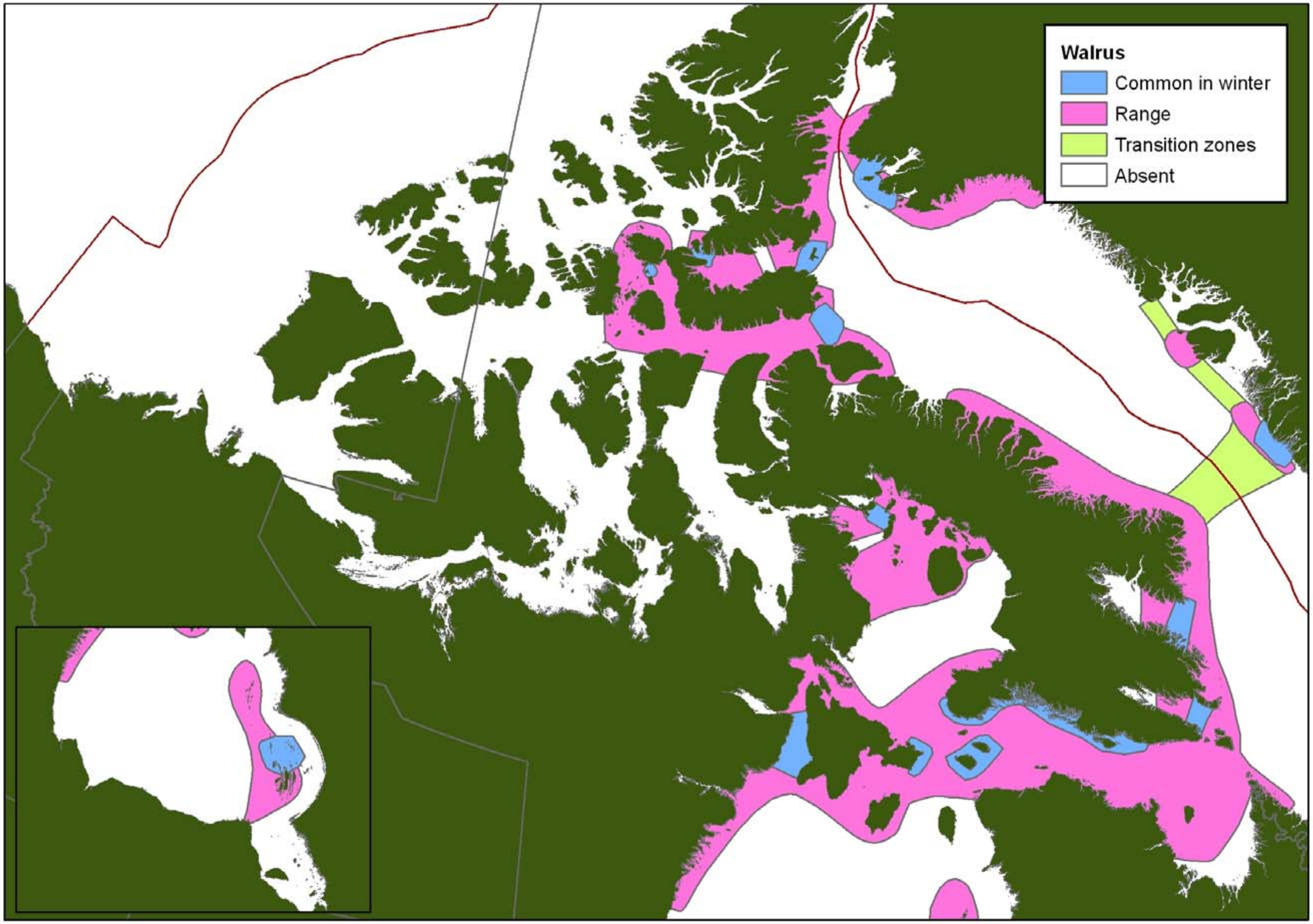

Figure 7: Distribution of Walrus (*Odobenus rosmarus*) in the Canadian Arctic.

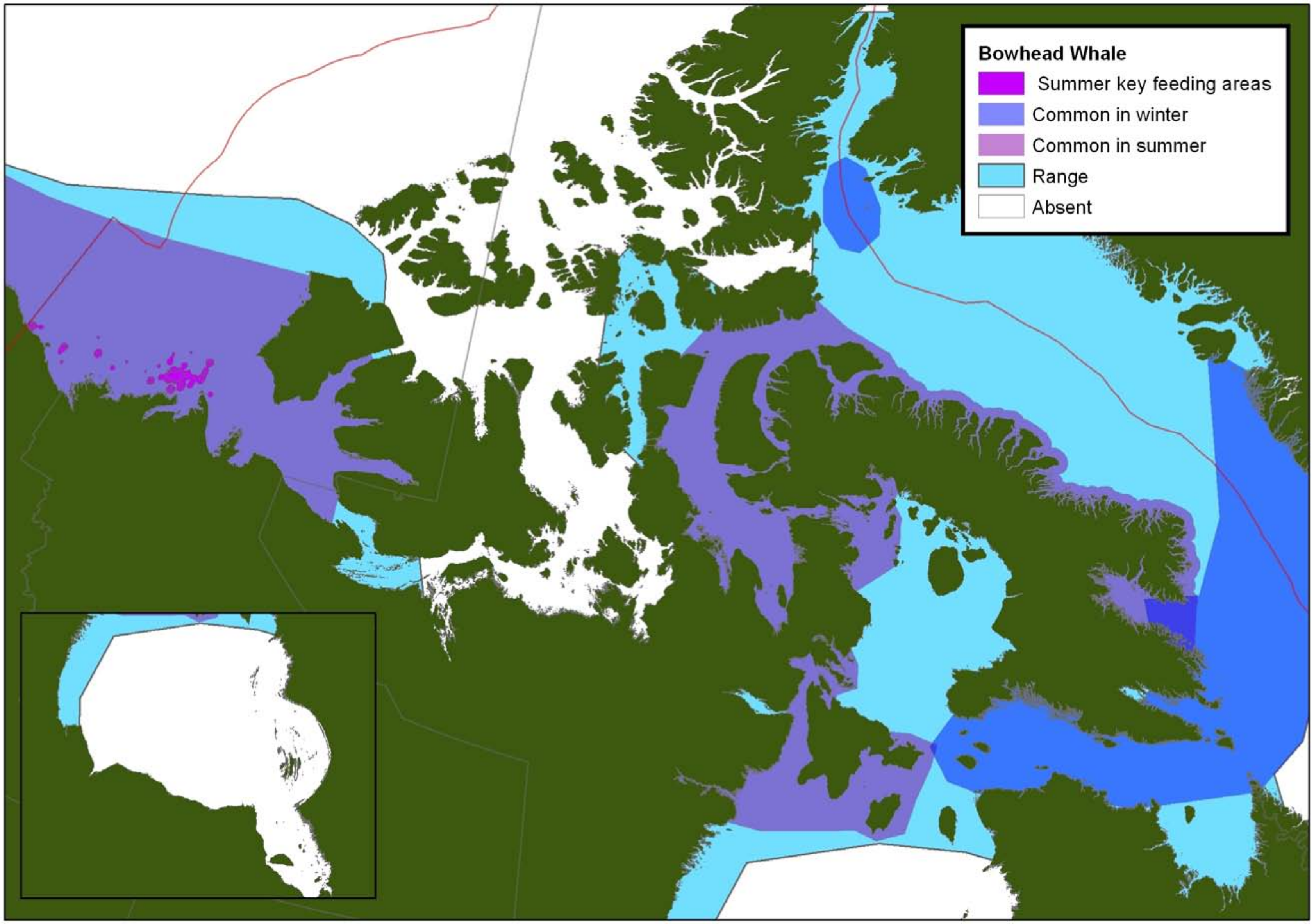

Figure 8: Distribution of Bowhead Whale (*Balaena mysticetus*) in the Canadian Arctic.

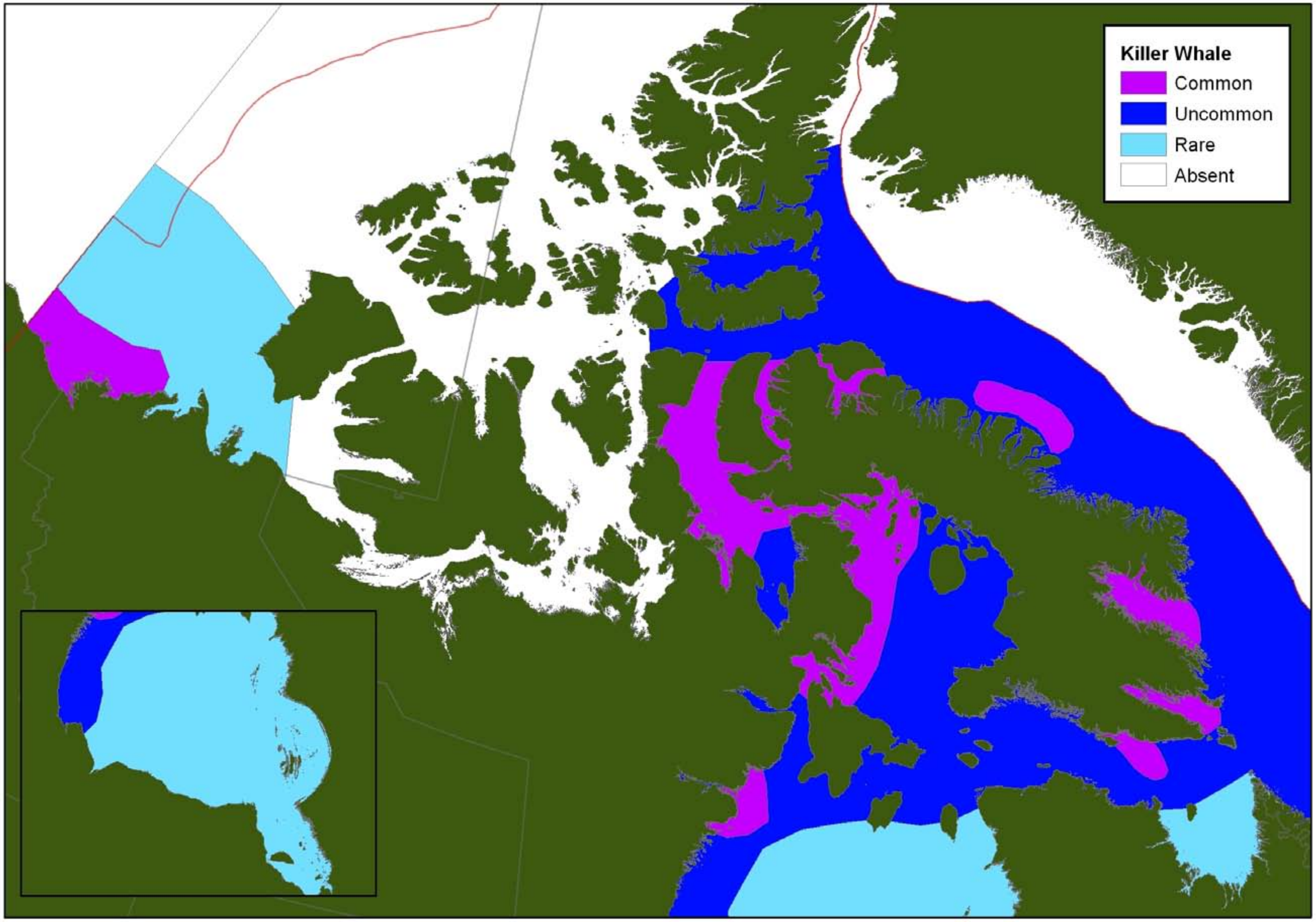

Figure 9: Distribution of Killer Whale (*Orcinus orca*) in the Canadian Arctic.

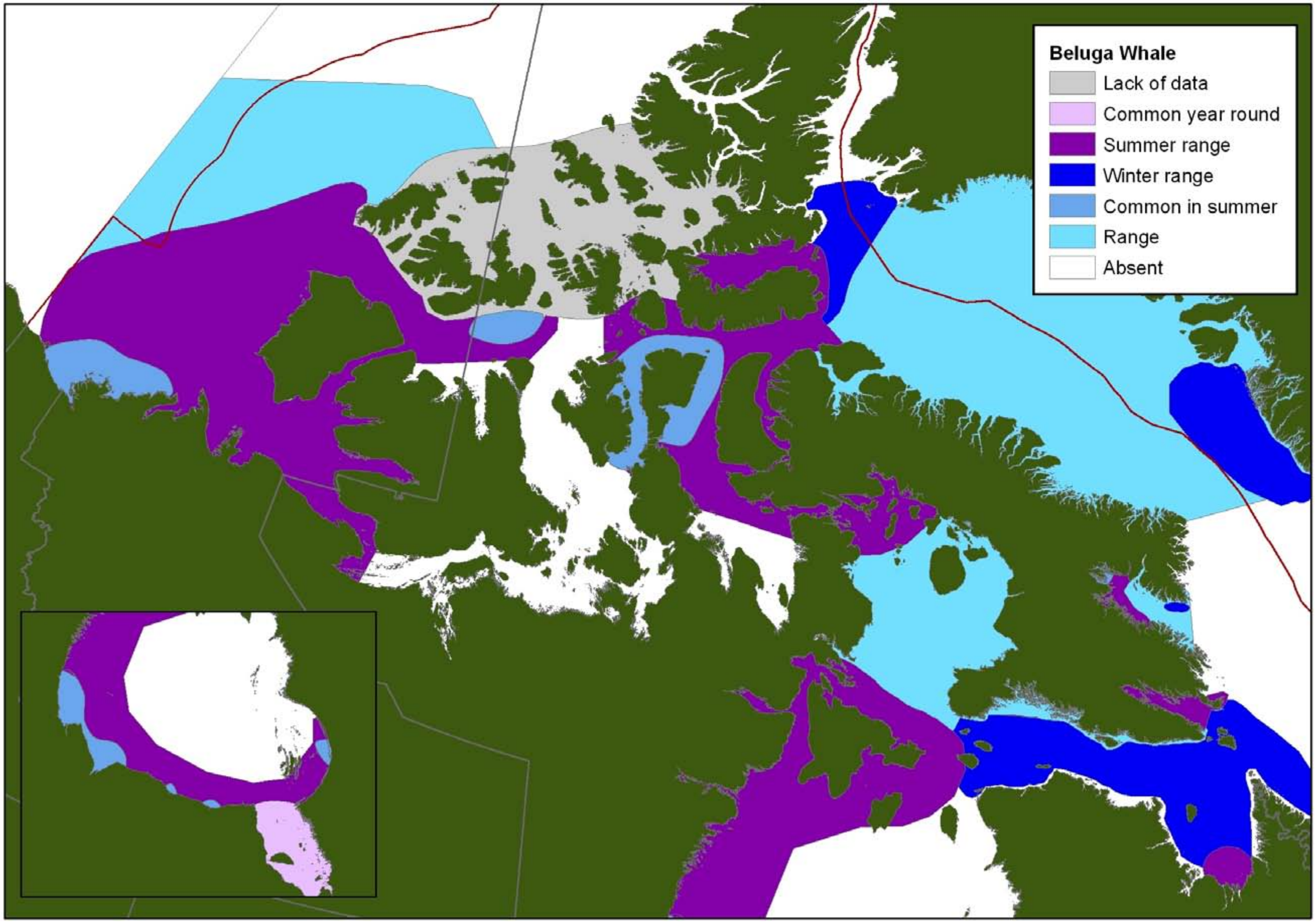

Figure 10: Distribution of Beluga Whale (*Delphinapterus leucas*) in the Canadian Arctic.

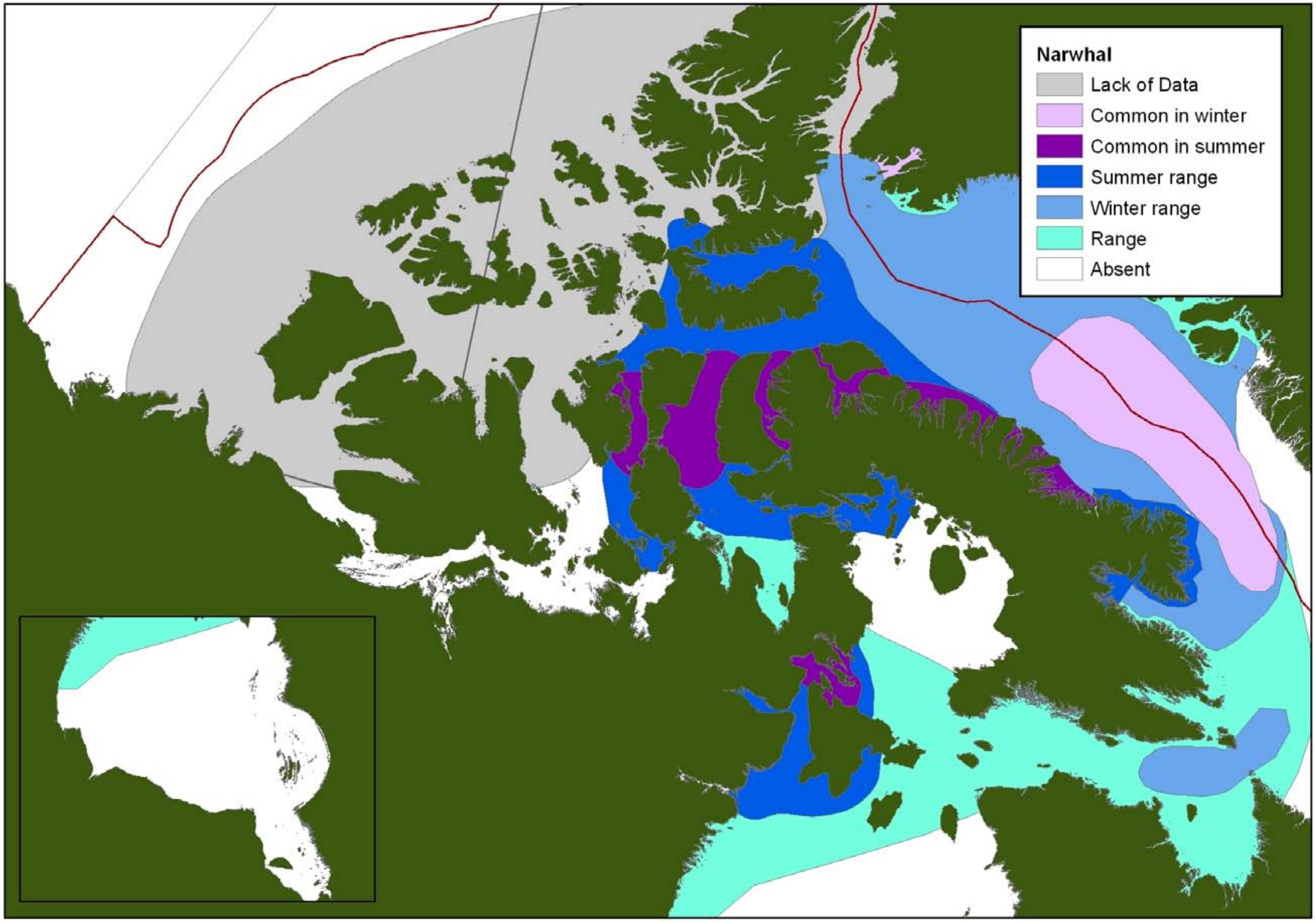

Figure 11: Distribution of Narwhal (*Monodon monoceros*) in the Canadian Arctic.

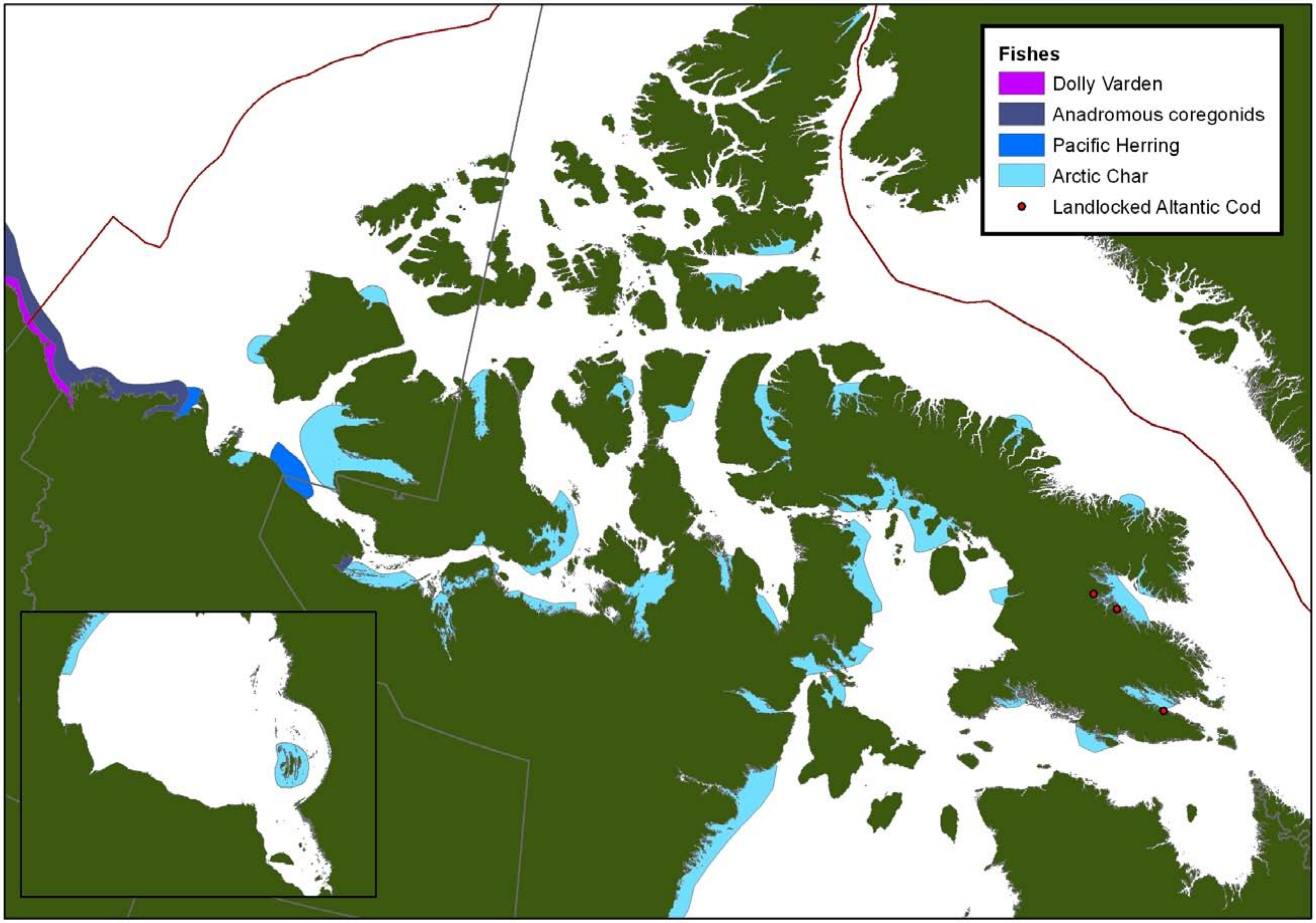

Figure 12: Distribution of selected fishes in the Canadian Arctic.

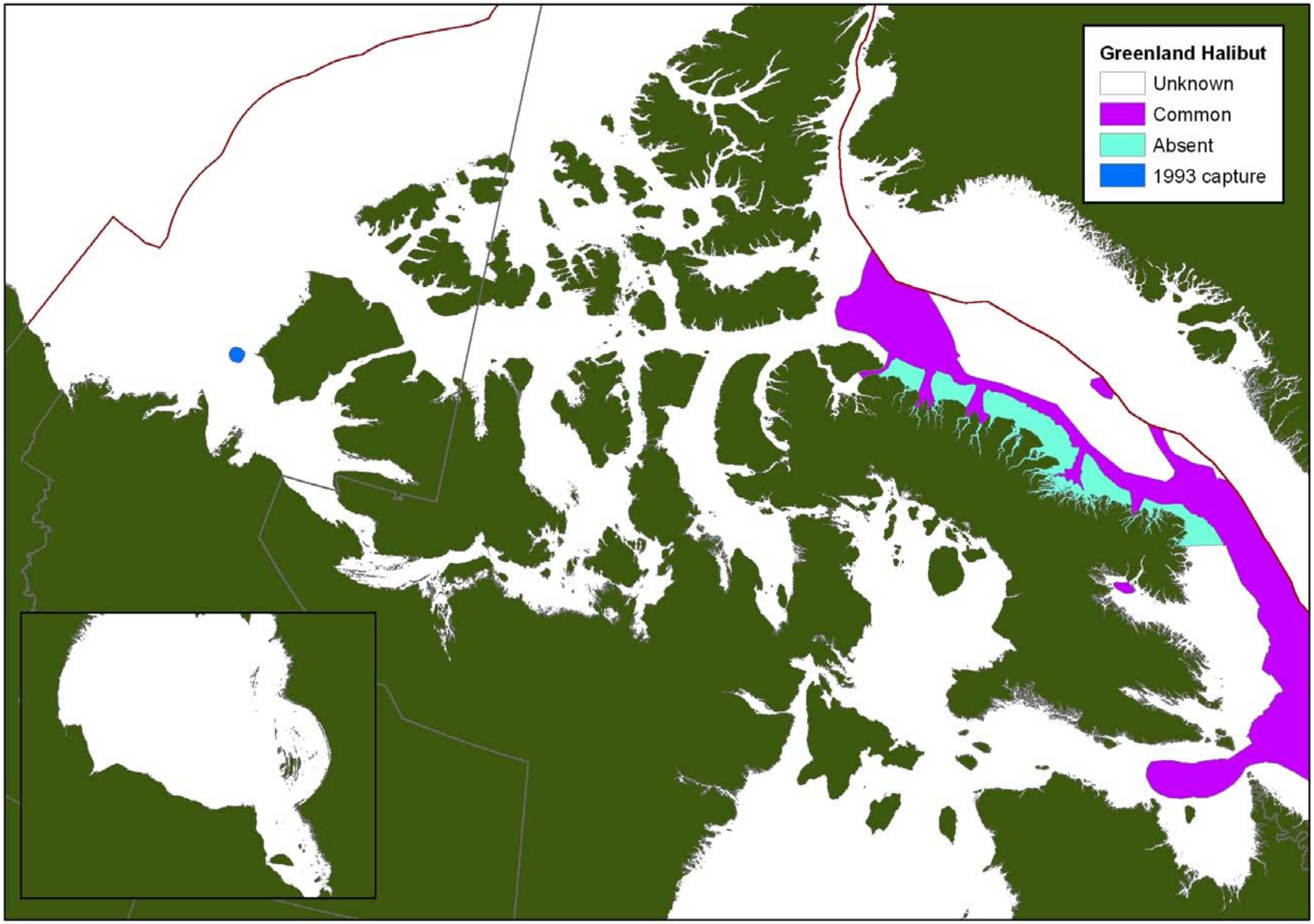

Figure 13: Distribution of Greenland Halibut (*Reinhardtius hippoglossoides)* in the Canadian Arctic.

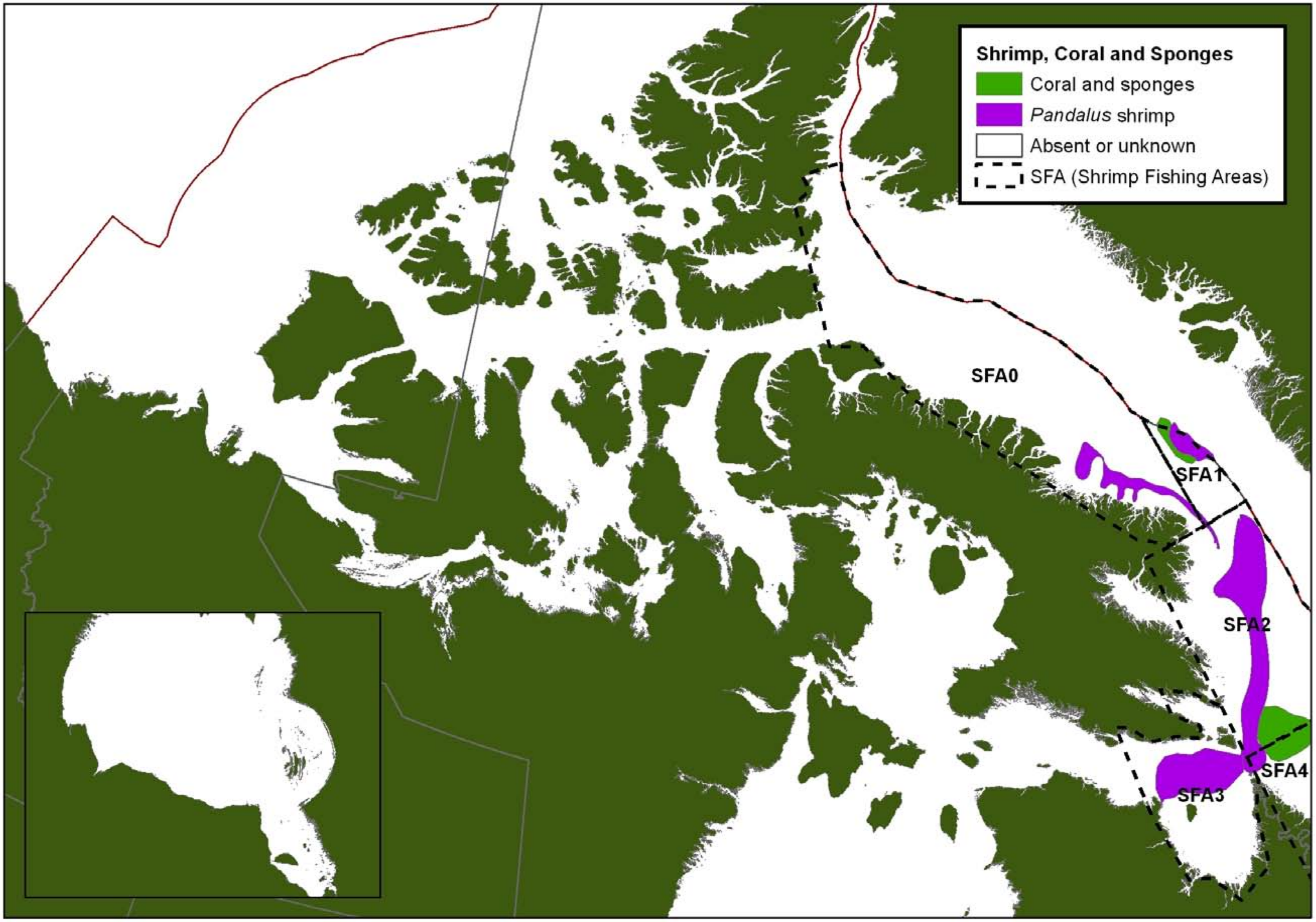

Figure 14: Distribution of shrimp, coral and sponges in the Canadian Arctic.

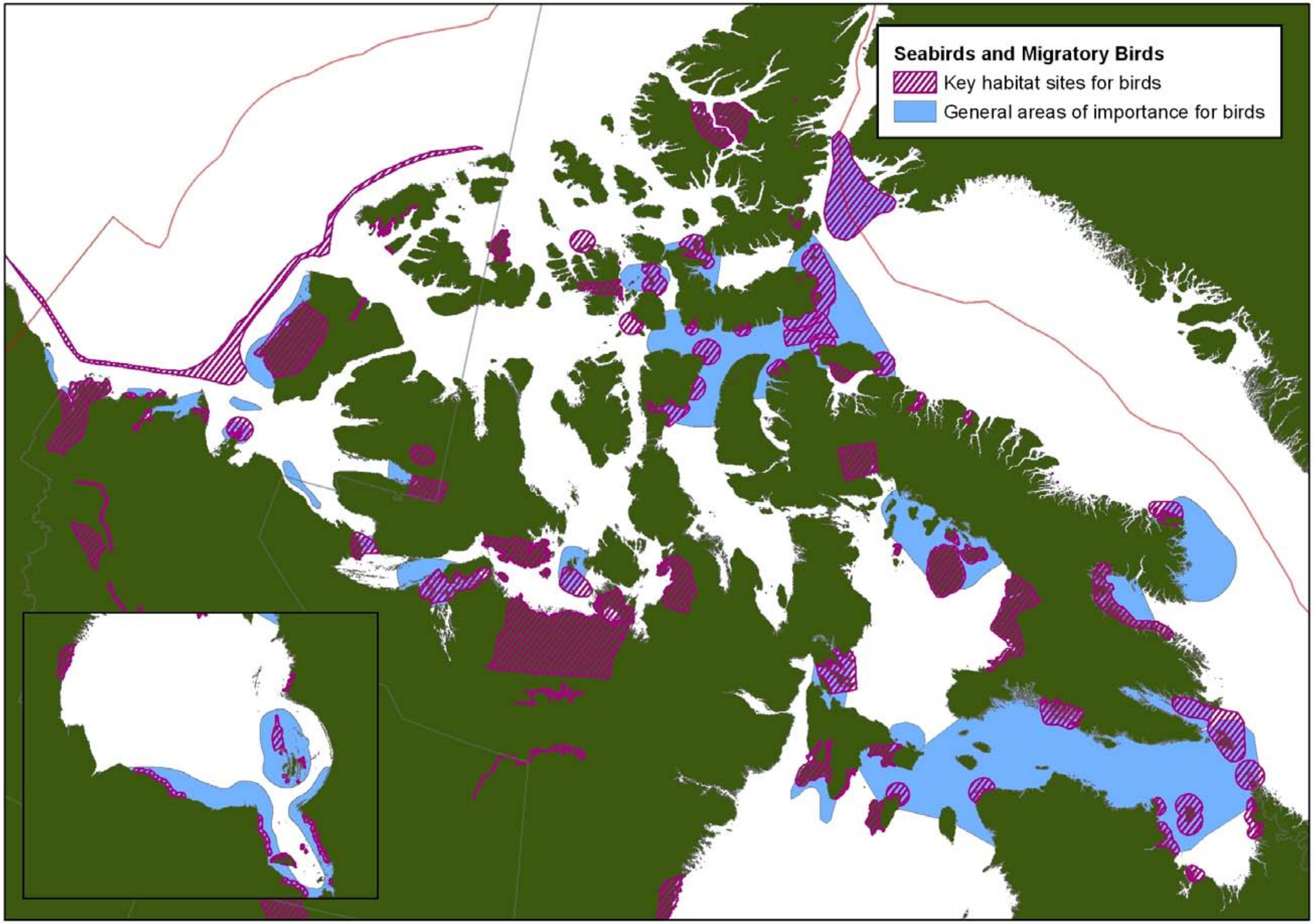

Figure 15: Distribution of seabirds and migratory birds in the Canadian Arctic.

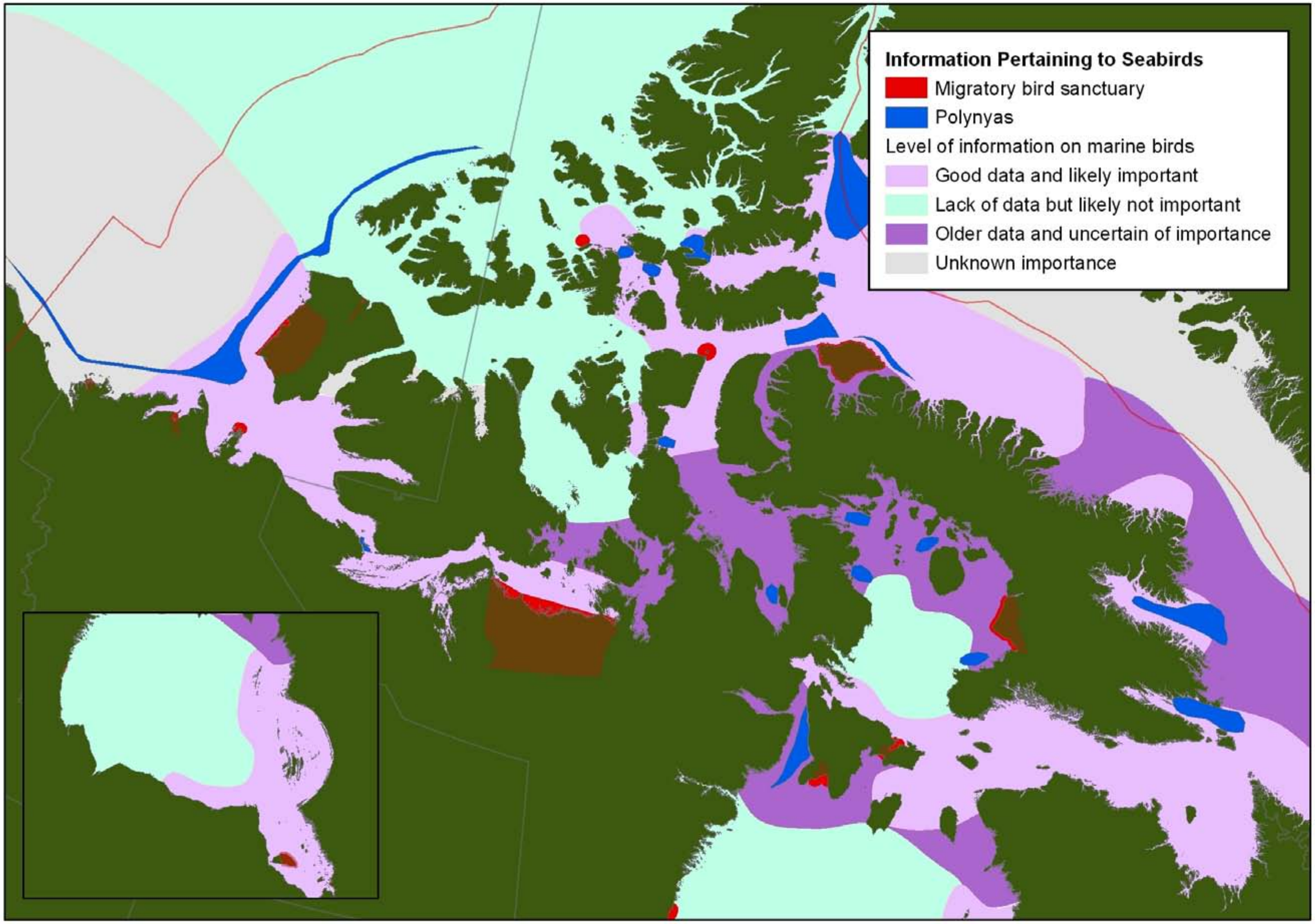

Figure 16: Geographic level of information on seabirds and migratory birds in the Canadian Arctic.

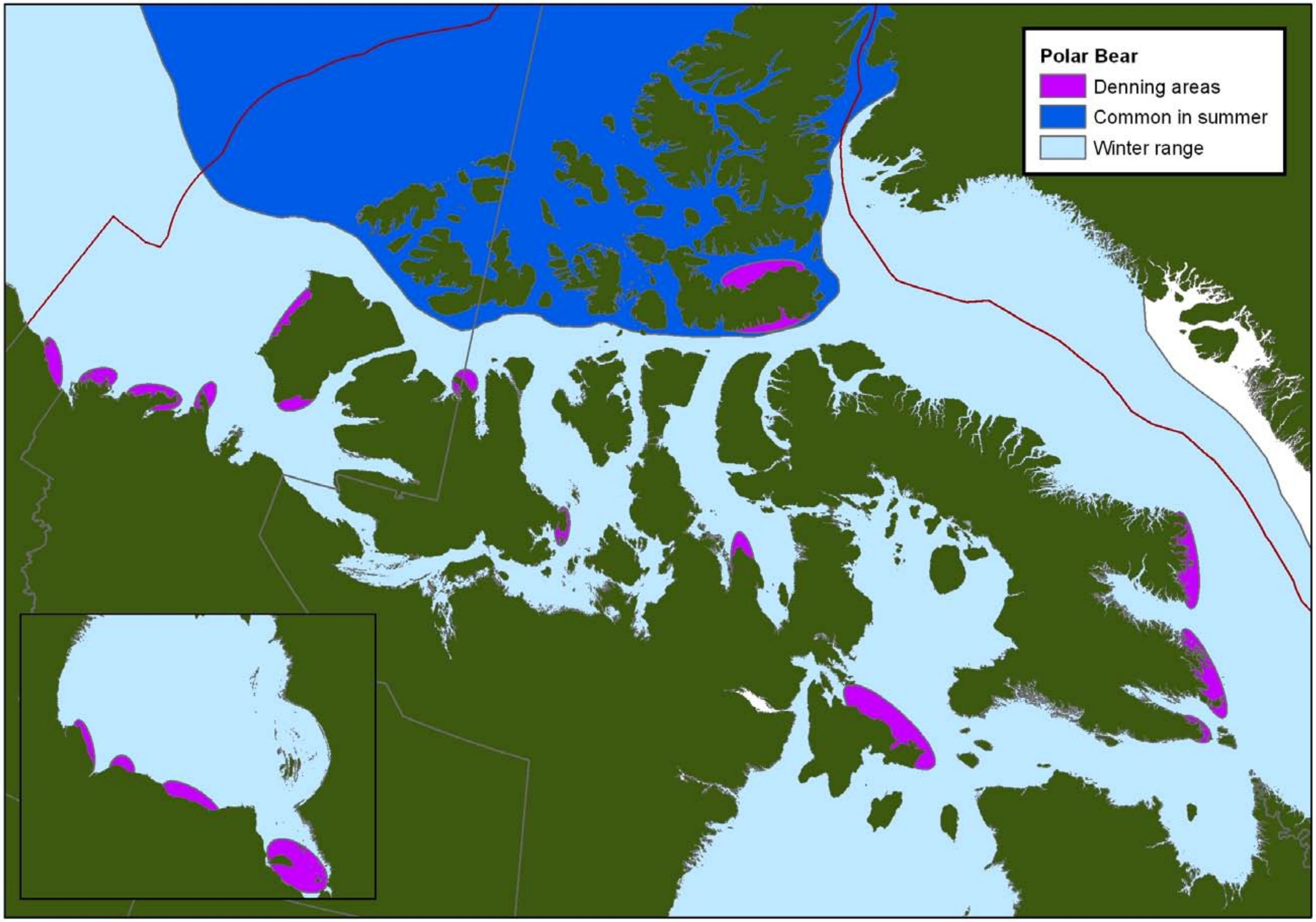

Figure 17: Distribution of Polar Bear (*Ursus maritimus*) in the Canadian Arctic.

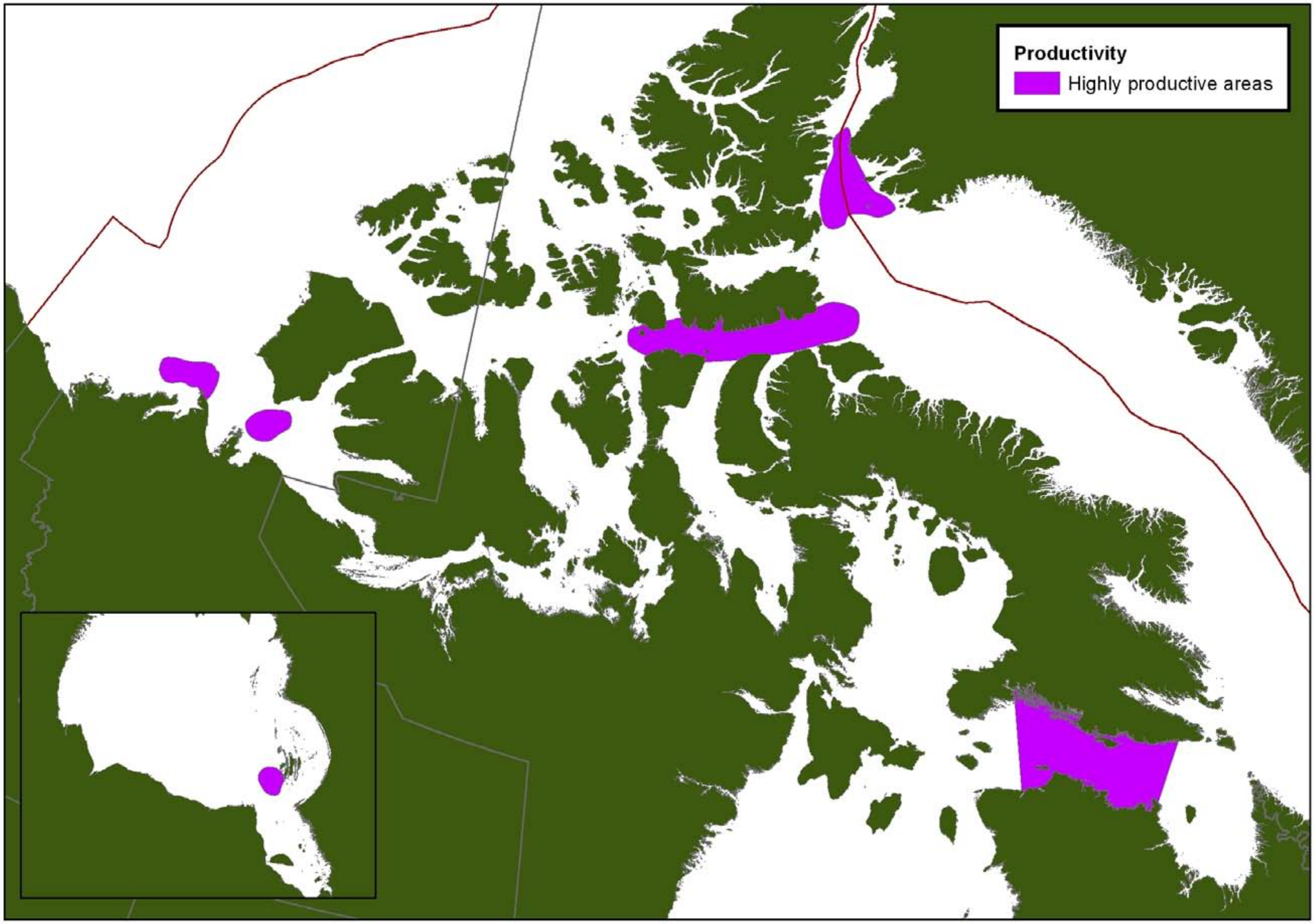

Figure 18: Most productive areas of the Canadian Arctic.

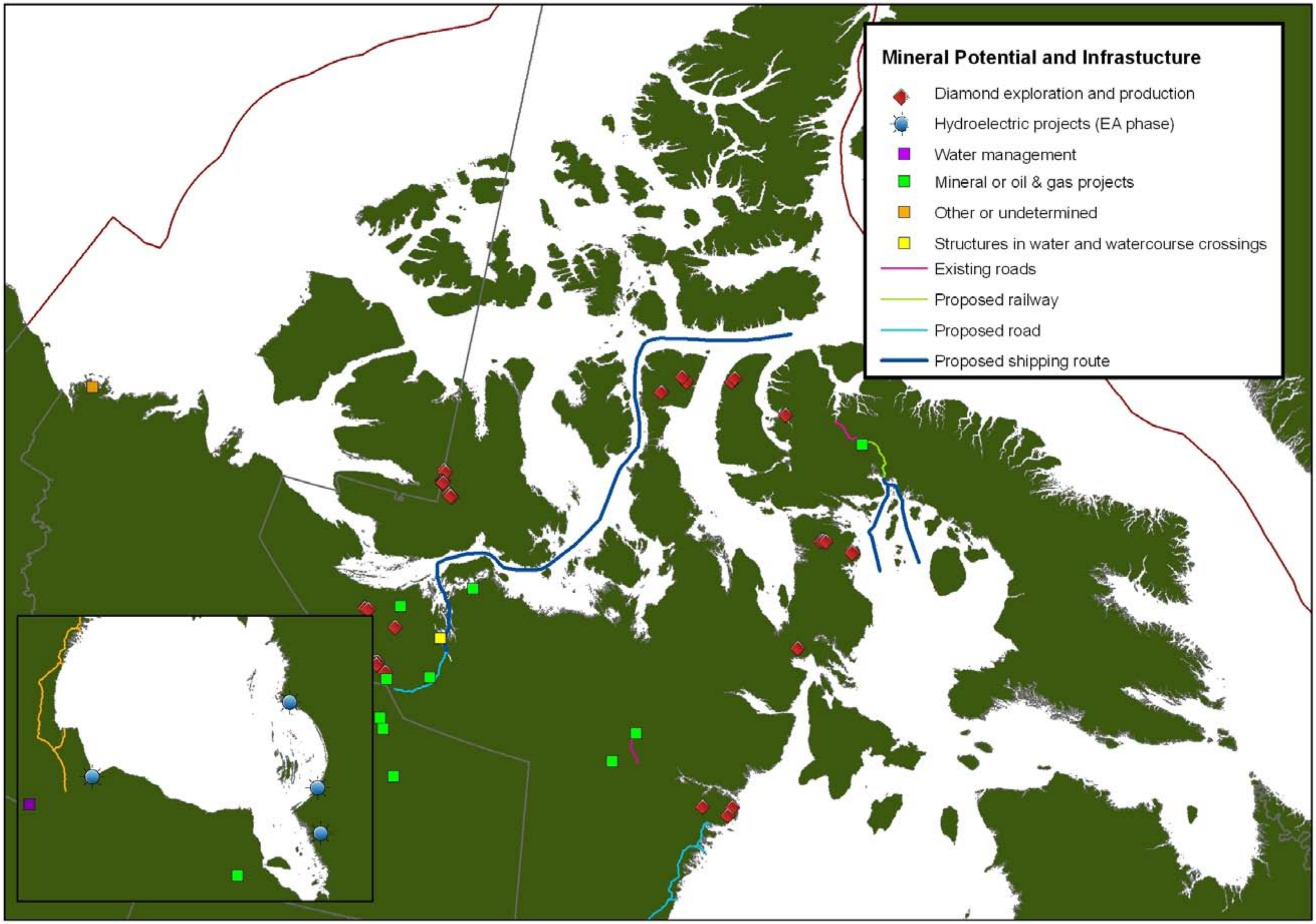

Figure 19: Location of proposed and ongoing major commercial and industrial projects in the Canadian Arctic.

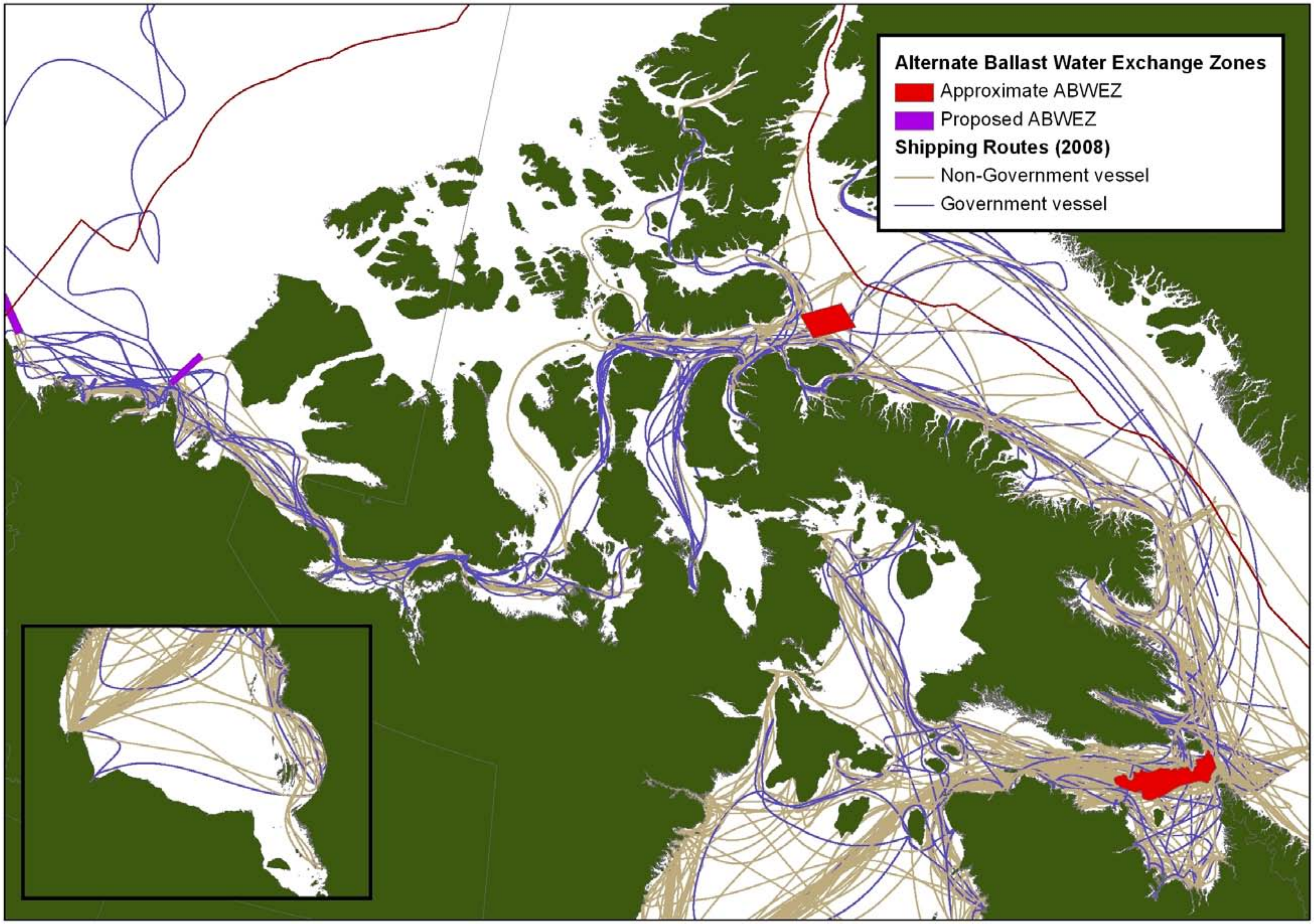

Figure 20: Marine transportation routes, major port locations and ballast water exchange zones in the Canadian Arctic.

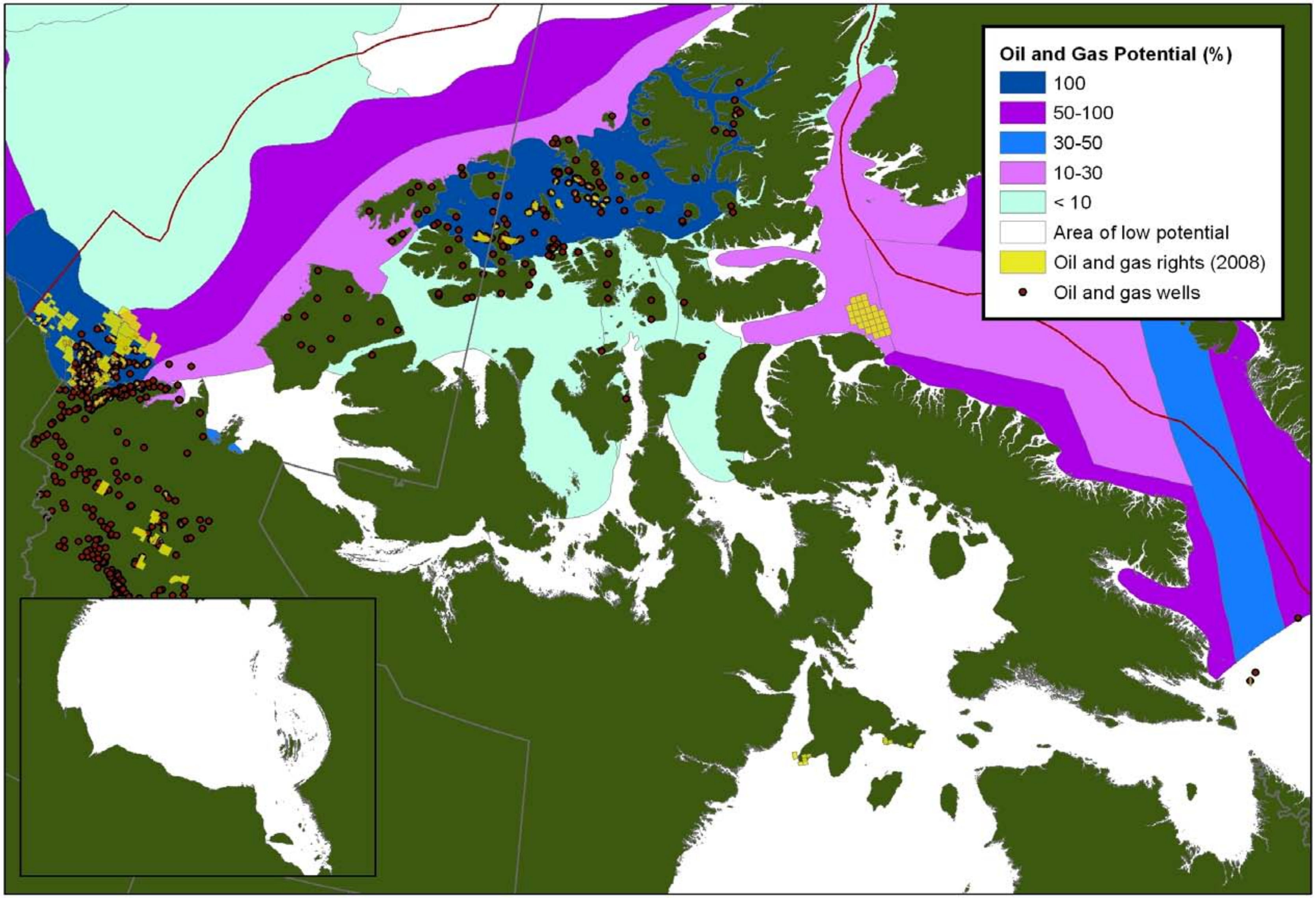

Figure 21: Oil and gas potential in the Canadian Arctic.

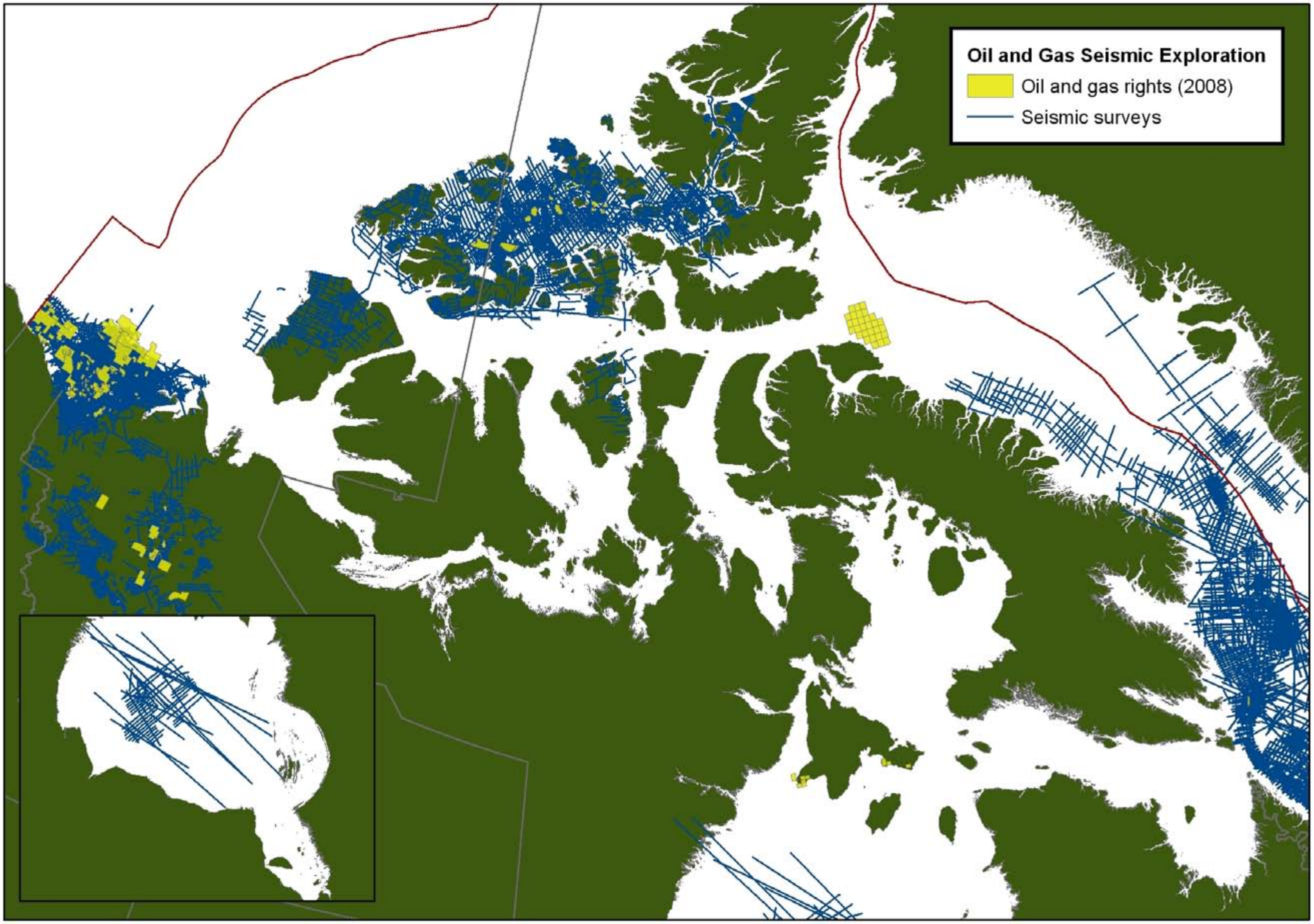

Figure 22: Seismic activity and current oil and gas rights in the Canadian Arctic.

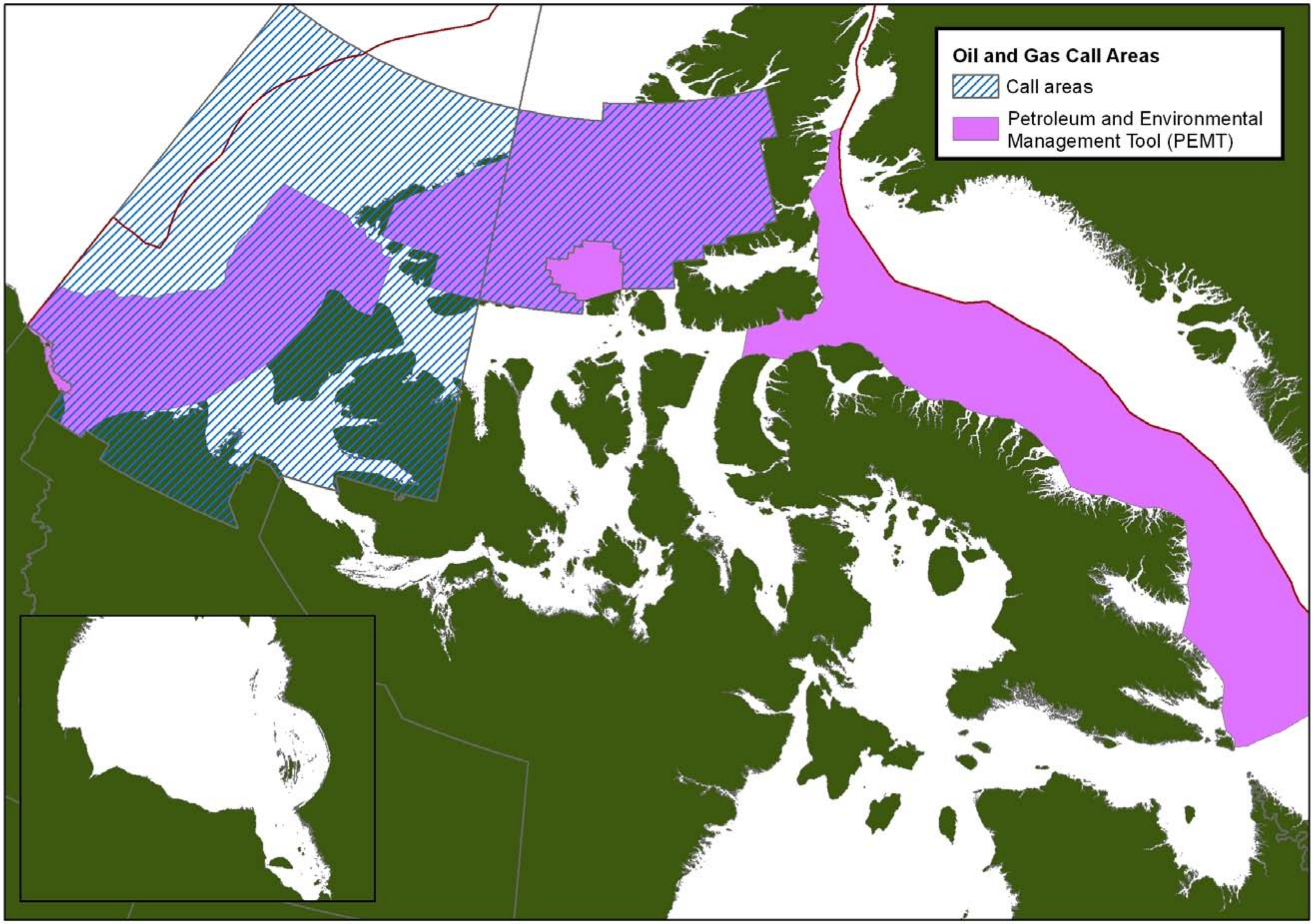

Figure 23: Current oil and gas call areas and areas of the Petroleum and Environmental Management Tool (PEMT).

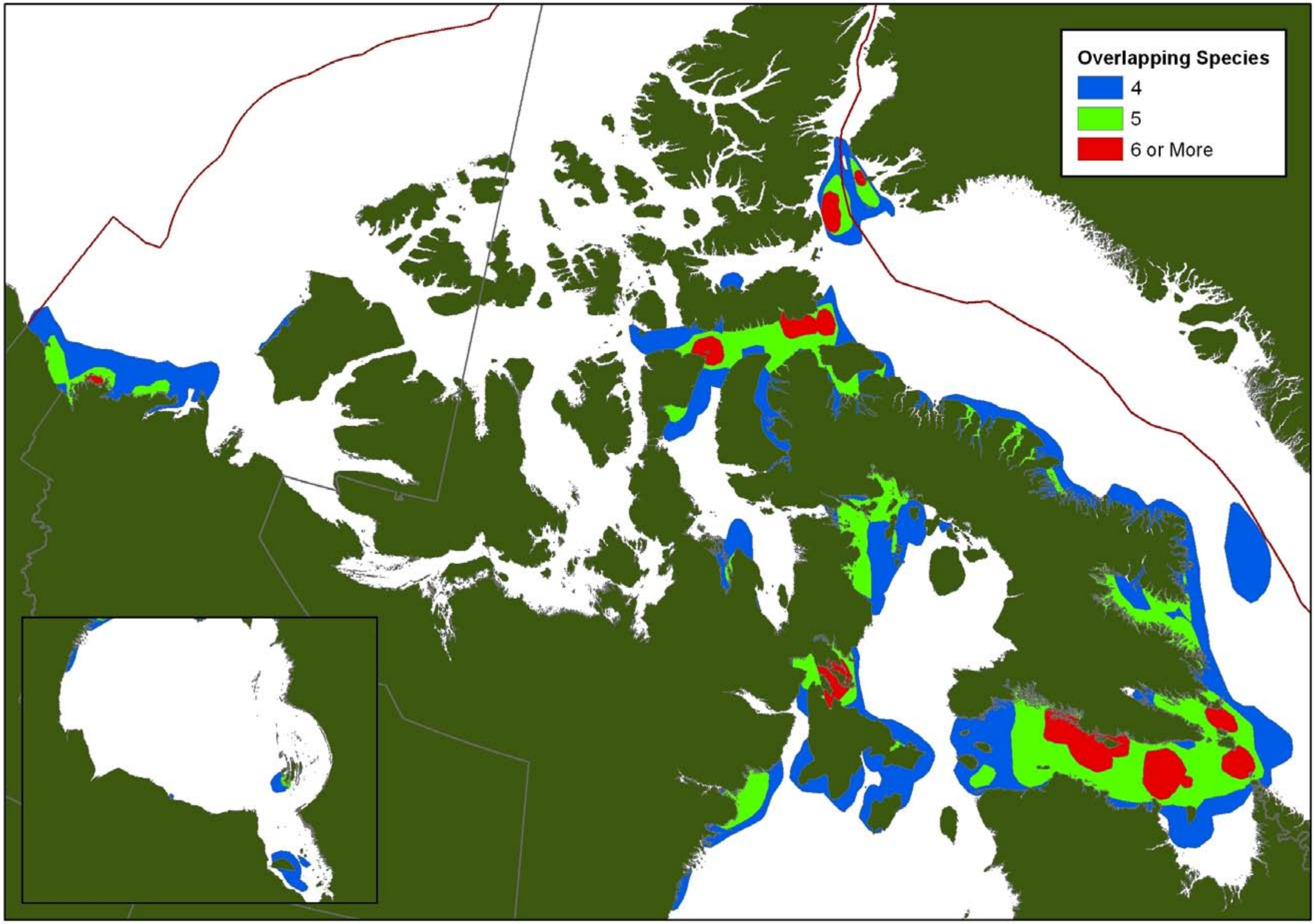

Figure 24: Areas of High Biological Importance (HBI) in the Canadian Arctic showing the number of overlapping species.

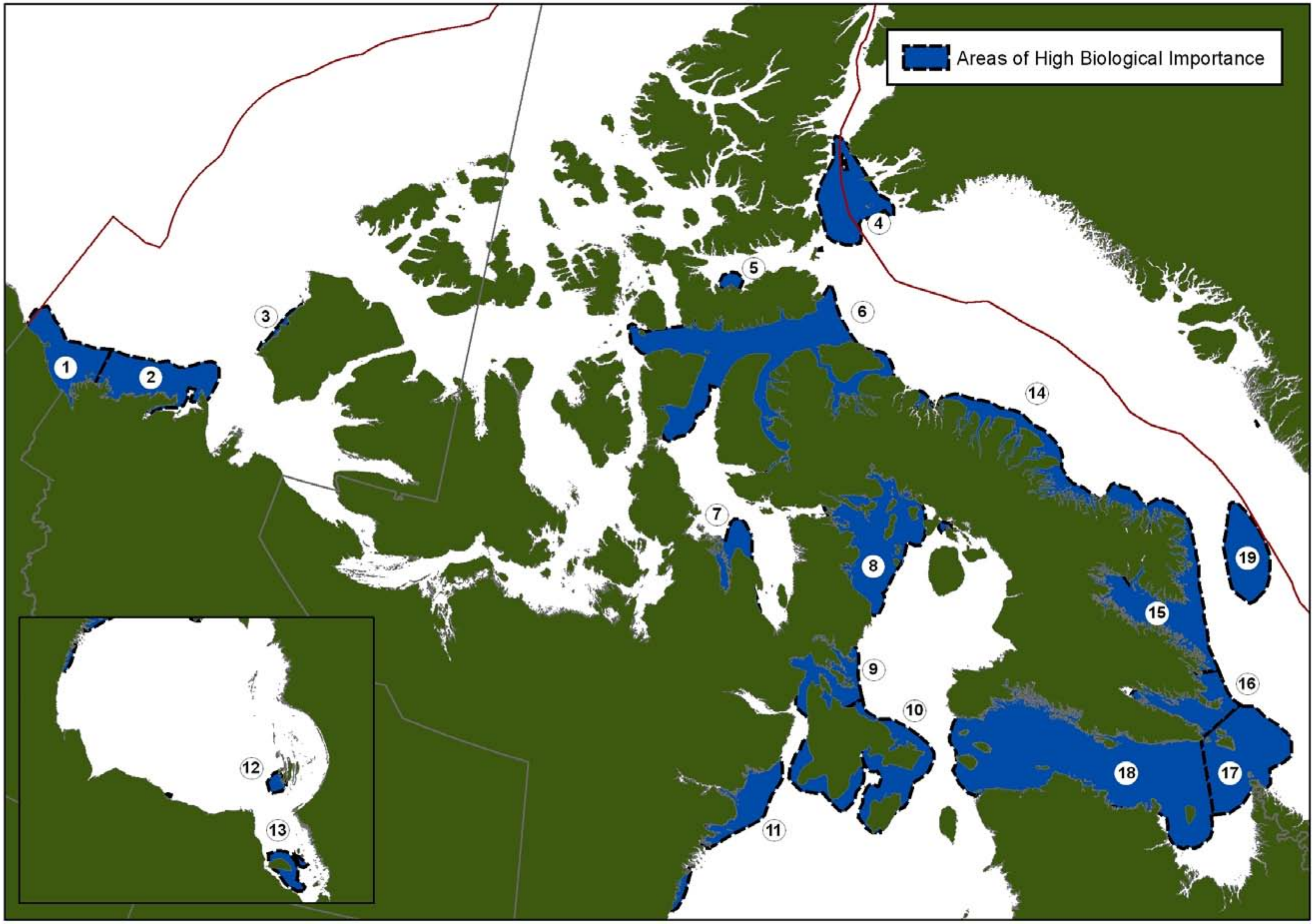

Figure 25: Areas of High Biological Importance (HBI) in the Canadian Arctic with locations numbered as identified in Table 2.

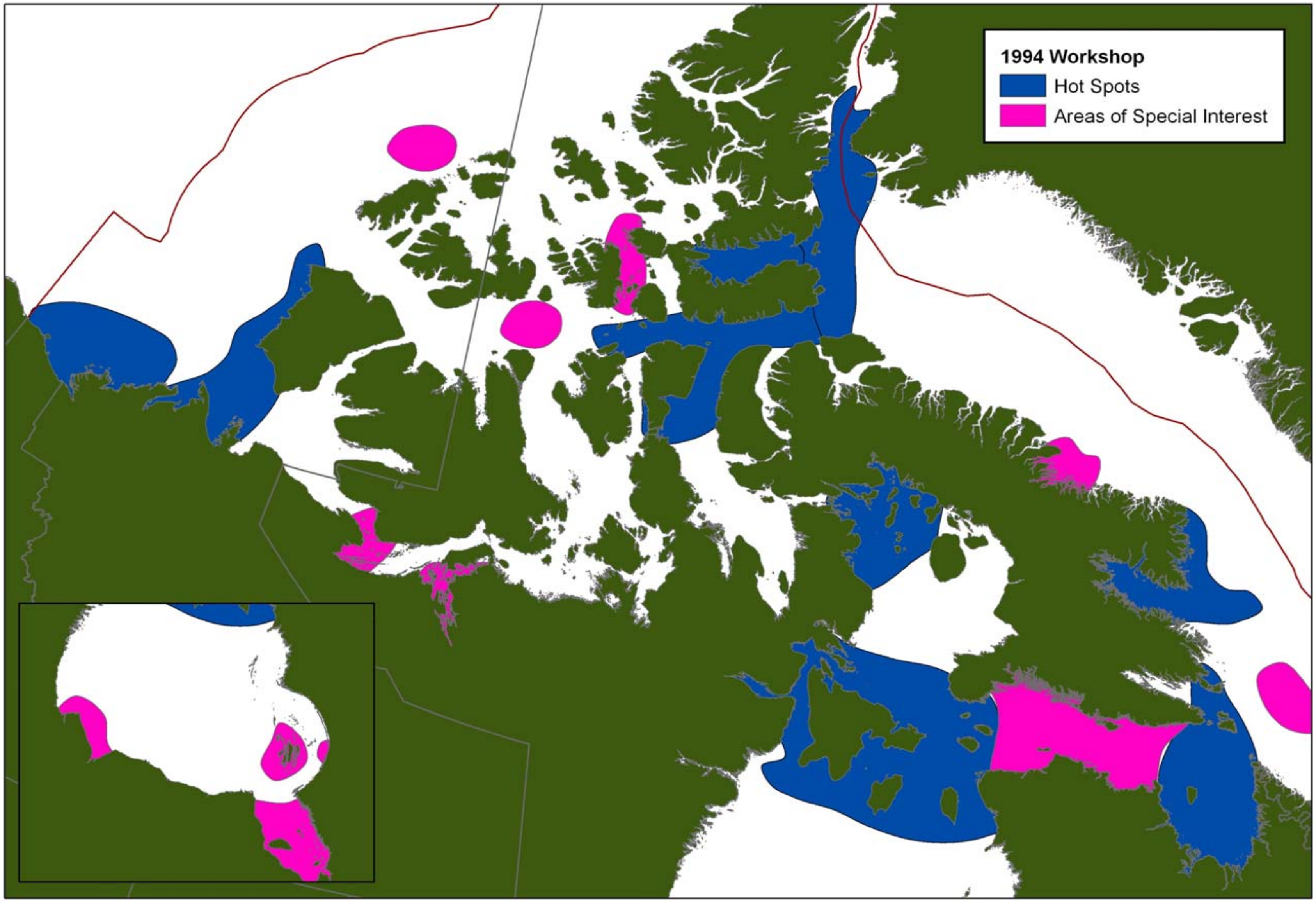

Figure 26: Biological “hot spots” and Areas of Special Interest determined at the 1994 Arctic Marine Workshop (Parks Canada, 1995).

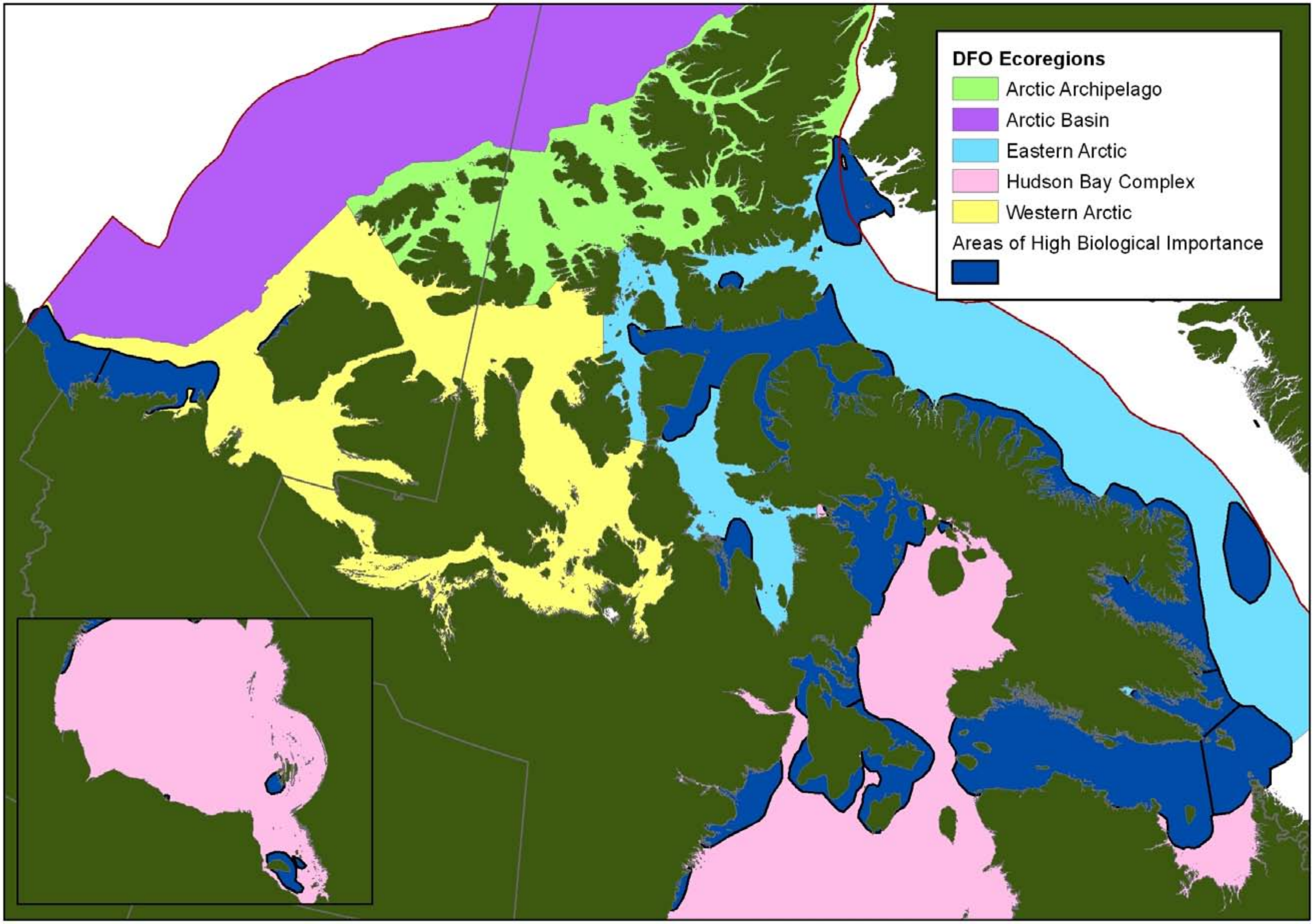

Figure 27: Overlay of areas of High Biological Importance and the DFO marine ecoregions (DFO, 2009).