WWF-Canada - Polynyas in the Canadian Arctic **July 17, 2015**

A response to Baffinland, The Nunavut Planning Commission, and Environmental Dynamics Incorporated from a matter raised at the draft Nunavut Land Use Plan Technical Meeting, June 23rd to 26th, 2015, in Iqaluit, Nunavut.

Context

During the discussion on polynyas at the draft Nunavut Land Use Plan (NLUP) Technical Meeting on Wednesday June 24th, 2015, Mike Setterington, on behalf of Baffinland and Environmental Dynamics Incorporated (EDI) questioned the source information for the polynya locations identified by World Wildlife Fund Canada (WWF-Canada) in our submission to the Nunavut Planning Commission (NPC). Outside of the formal meeting, Mr. Setterington provided WWF-Canada with a map comparing "Polynyas: World Wildlife Fund (Global Arctic Programme, 2014)" against "Polynyas: Environment Canada (Mallory and Fontaine, 2004)" [Figure 1].

This document serves as a response to NPC, Baffinland and EDI, by:

a) commenting on the citation of Mallory and Fontaine (2004) in the map submitted to WWF-Canada;
b) commenting on the omission of shore leads from the Mallory and Fontaine (2004) data and the inclusion of shore leads in the WWF-Canada dataset when attempting to compare polynya locations between the two reports;
c) commenting on the data and methods of the WWF-Canada commissioned report while offering clarification;
d) suggesting ways forward in terms of polynya location identification through concluding remarks.

As a science-based organization, WWF is keen to help NPC ensure that the information underpinning the finalization of the Nunavut Land Use Plan is derived from the best available and most recent data. We appreciate the opportunity to clarify the information from our submission, and submit this response with the hope of clarifying the most recent data concerning the size and location trends of polynyas and shore leads in Nunavut.

A) Citation of Mallory and Fontaine, 2004

In the map provided to WWF-Canada by EDI, Mallory and Fontaine (2004) is cited as the data source for polynya locations [Figure 1]. Through reading Mallory and Fontaine (2004), it is apparent that the polynya data was not a novel dataset generated by this report, but was instead taken directly from Stirling and Cleator (1981) [see Figure 2 and 3]. As such, the correct citation for the polynya data on the EDI generated map should read Stirling and Cleator (1981), rendering this map of polynya locations 34 years old. The Stirling and Cleator (1981) data were obtained largely through an analysis of satellite imagery for the period of January 1975 to December 1979. The 1981 publication notes, "*Because of limitations of the imagery, and our conservative interpretation, only the main characteristics of the larger recurring polynyas were mapped in this study*." Further, in the Mallory and Fontaine (2004) paper, it is noted that, "… *the occurrence and shape of polynyas will vary seasonally and among years and will grow as the ice surrounding them disintegrates into open water (Stirling and Cleator, 1981). Establishing a clear, distinct boundary for the key habitat of a polynya is therefore impractical*."

The data used to create the polynya boundaries outlined in Stirling and Cleator (1981) and Mallory and Fontaine (2004) was based on limited, conservative methods, and are not meant to be interpreted as distinct boundaries for polynyas in the Canadian Arctic.

B) Omission of shore-leads from EDI generated map

The map generated by EDI includes the polynyas identified by Stirling and Cleator (1981) and then reproduced by Mallory and Fontaine (2004), but does not include the shore leads included in both of these maps [see Figures 1, 2 and 3]. Shore leads, also referred to as 'shore polynyas' by the World Meteorological Organization's standard nomenclature, are polynyas between ice and the coastline, and hold the same ecological importance as polynyas completely enclosed by ice. As such, in the WWF commissioned report, Polynyas in the Canadian Arctic (Global Arctic Programme, 2014), polynyas and shore leads are not differentiated, but rather the focus is on the more ecologically relevant qualifier of important winter habitat: the presence or absence of open water in winter. By omitting the shore leads from both Stirling and Cleator (1981) and Mallory and Fontaine (2004), the map generated by EDI is incapable of comparing these sources to the WWF commissioned report, which includes shore leads. Thus, it is not surprising that the major source of discrepancy between these two datasets (the presence of open water in Hudson Strait in the WWF commissioned report), is at least partially explained by the omission of shore leads from the EDI generated map.

C) Background information of the WWF commissioned report

The WWF commissioned report, which is available to any interested party, identifies the probability of the presence of polynya features in the Canadian arctic marine ecosystem through an analysis of MODIS (Moderate Resolution Imaging Spectrodiometer) satellite imagery data from 2002 to 2013. This report, using very recent data, takes into account the annual fluctuation in polynya size and location, and identifies the probability of open water for specific geographical areas at defined temporal scales. For example, Figure 17 from the WWF commissioned report [Figure 4 in this document], depicts the empirical probability of occurrence of open water for the week of April 21-27 over the eleven year time period of 2002 to 2013. This analysis acknowledges the fluctuating nature of polynya size and location (as identified in Mallory and Fontaine (2004), while proposing best estimates for open water occurrence at specific dates in the year. The shapefile WWF provided to NPC was based on locations identified as polynyas if they exhibited a probability of open later greater than 20% during the week beginning May 5th [Figure 5]. This date range was selected as the key epoch based on the MODIS method depending on observing open water with a 1km resolution, and smaller openings/the presence of thin ice had the effect of attenuating the signal in the earlier epochs. This date range is also at least a month prior to the onset of the general melting in the project area. As EDI was not aware of the date restrictions in the map they generated and submitted to WWF-Canada, comparison of the two listed datasets is not possible due to a lack of a standardized date range for comparison.

D) Ways forward for polynya identification

As polynyas (both open water and shore polynyas) vary annually in their size and location, there is no definitive source capable of detailing the location of polynyas in the Canadian Arctic. We propose the best way to identify polynya locations is through a combination of the relatively recent map put forward in Hannah et al. (2009) [Figure 6] (part of the WWF-Canada submission to the Nunavut Planning Commission in February 2014,

and based partially on Barber and Massom (2007) [Figure 7]), and the additional more recent and precise information presented in the WWF commissioned report. Through analyzing the annual variability in polynya size and location using MODIS data from 2002-2013, the WWF commissioned report is a very valuable resource for predicting the presence of open water based on empirical probability. WWF-Canada would also welcome a synthesized map from the 2011 report from LGL Ltd. on behalf of Baffinland Iron Mines Corporation on polynya like-features in Foxe Basin, Foxe Channel, and Hudson Strait.

In conclusion, due to EDI not being fully aware of the methods used to generate the WWF commissioned report, their inquiry into how the data as generated is quite understandable. We believe this document and the accompanying report serve to address this mater. The map generated by EDI [Figure 1] does not fully represent polynya features in the Canadian Arctic by excluding shore leads, and relies on data originally generated in 1981 for the beige polygons. The data produced by the WWF commissioned report [Figure 5] represents the most recent analysis of polynya and shore lead location and persistence, through an analysis of MODIS data from 2002-2013. We would like to thank the NPC, EDI, and Baffinland for the opportunity to clarify our report on this matter, and hope the NPC and other parties find this response document useful.

References cited

Barber, D. G. and Massom, R.A. 2007. The role of sea ice in Arctic and Antarctic polynyas. In: Smith, W.O. and Barber, D. Polynyas: windows to the world, 1st edition. Elsevier Science. Amsterdam, The Netherlands. pp 1-43.

Hannah, C.G., Dupont, F., and Dunphy, M. 2009. Polynyas and tidal currents in the Canadian Arctic Archipelago. Arctic 62(1):83-95.

Mallory, M.L. and Fontaine, A.J. 2004. Key migratory habitat sites for migratory birds in Nunavut and the Northwest Territories. Canadian Wildlife Service Occasional Paper Number 109. 93p.

Stirling, I. and Cleator, H. 1981. Polynyas in the Canadian Arctic. Canadian Wildlife Service Occasional Paper Number 45. 70p.

WWF Global Arctic Programme, 2014. Polynyas in the Canadian Arctic: analysis of MODIS sea ice temperature data between June 2002 and July 2013. Canatec Associates International Ltd. 60p.

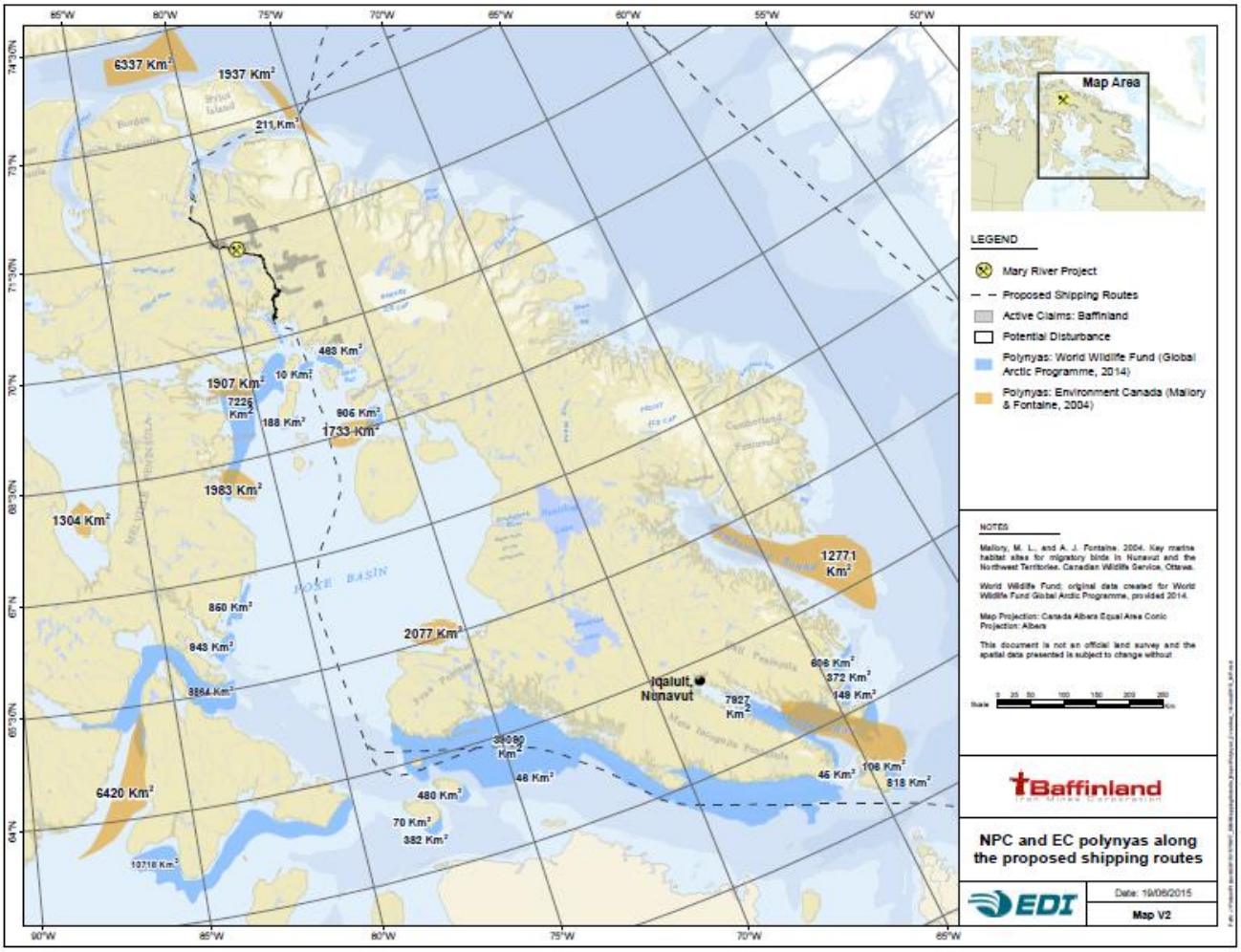


Figure 1 – Map generated by EDI on behalf of Baffinland, and submitted to WWF Canada at the first draft NLUP Technical Meeting in Iqaluit, Nunavut. The WWF commissioned report data is denoted by the darker blue polygons, and the data labelled as Mallory and Fontaine (2004) is denoted by the darker beige polygons.

Figure 2
Recurrent polynyas and shore leads in the Canadian Arctic (from Stirling and Cleator 1981)

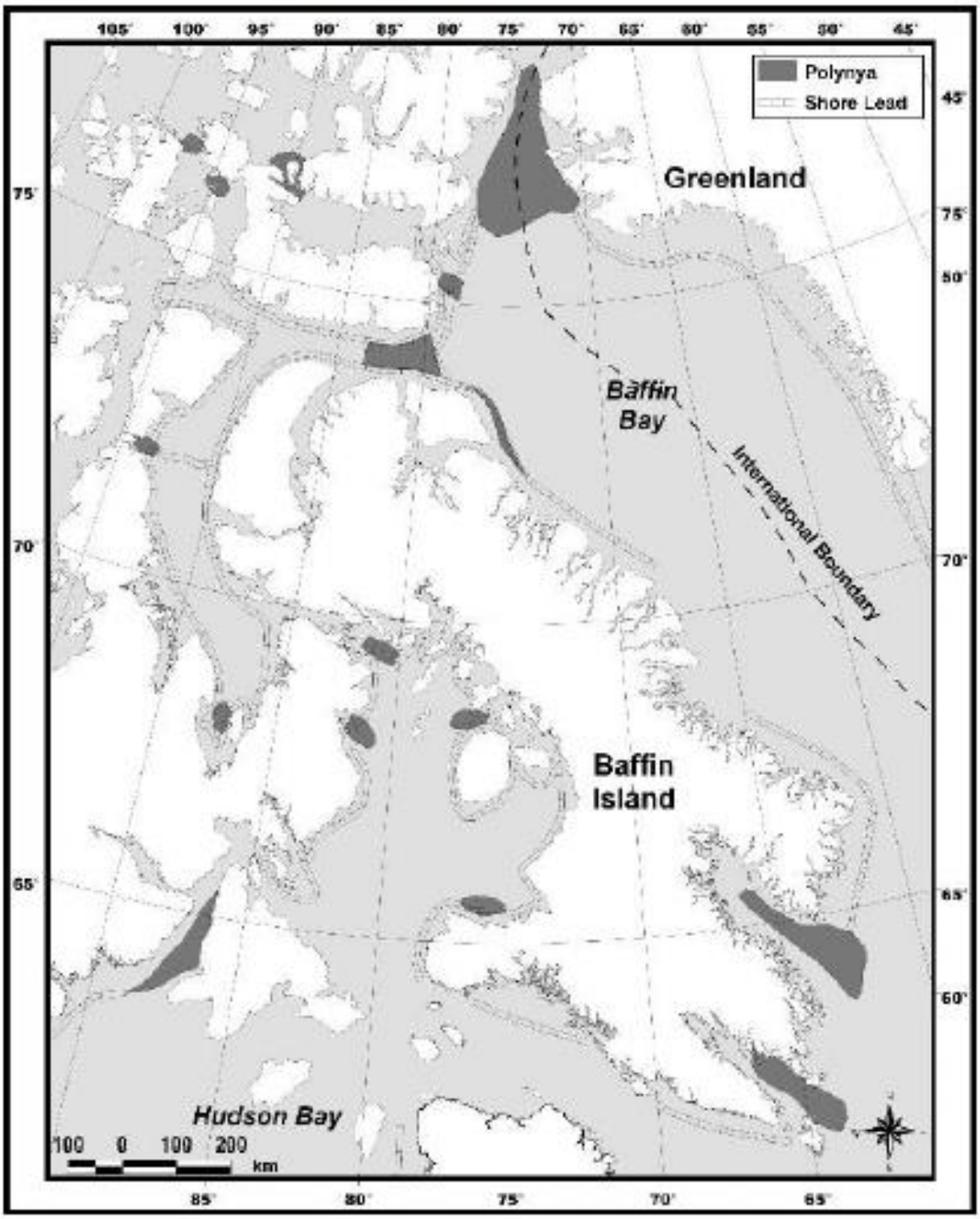


Figure 2 – From Mallory and Fontaine (2004). This figure was presented in Mallory and Fontaine (2004), but is noted in the publication as being taken from Stirling and Cleator (1981) (see figure caption directly above this figure). The shore leads depicted in this figure are not depicted in Figure 1 of this document.

Figure 3 – From Stirling and Cleator (1981). This is the original source of the data presented in Mallory and Fontaine (2004). The shore leads depicted in this figure are not depicted in Figure 1 of this document.

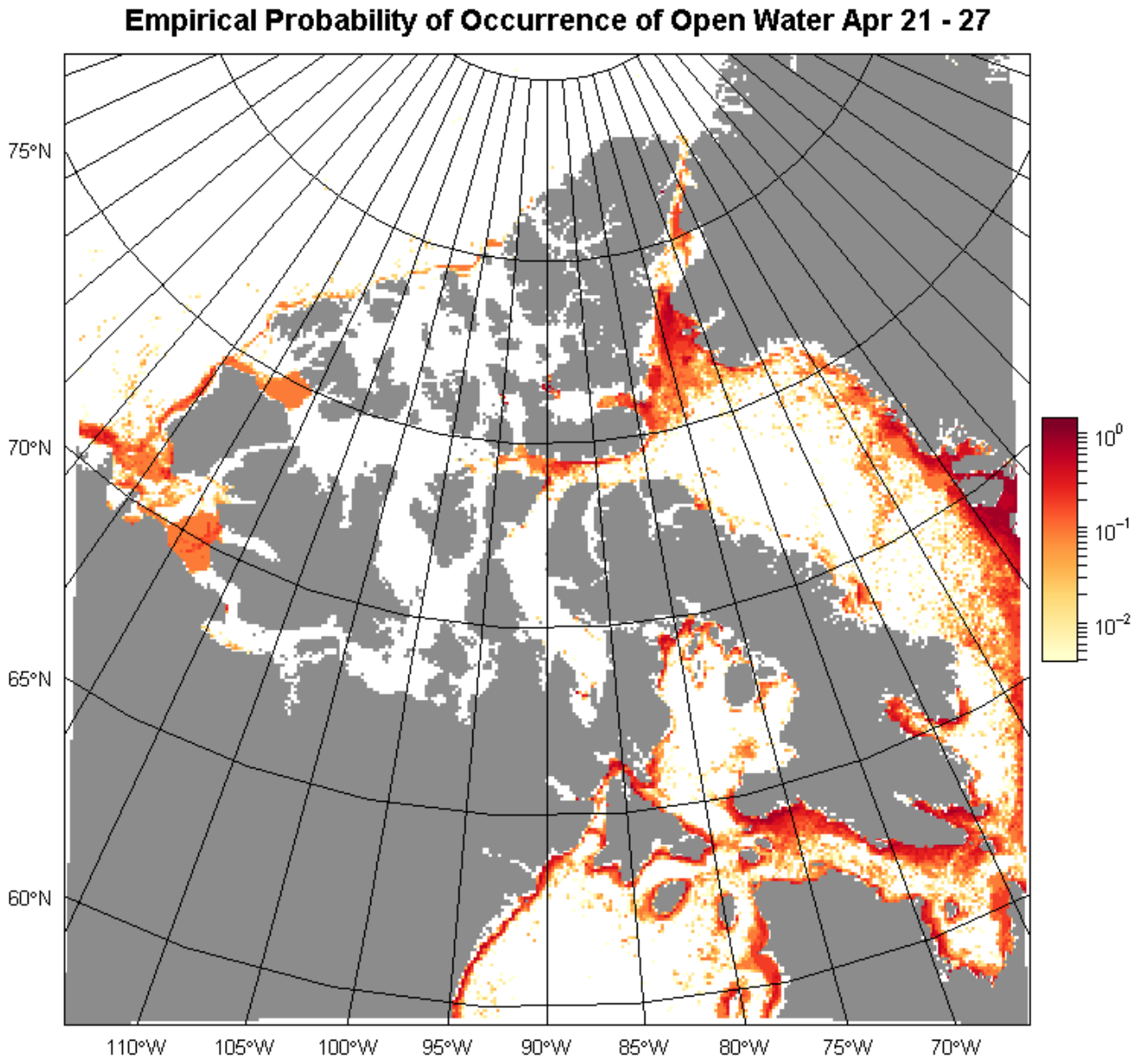
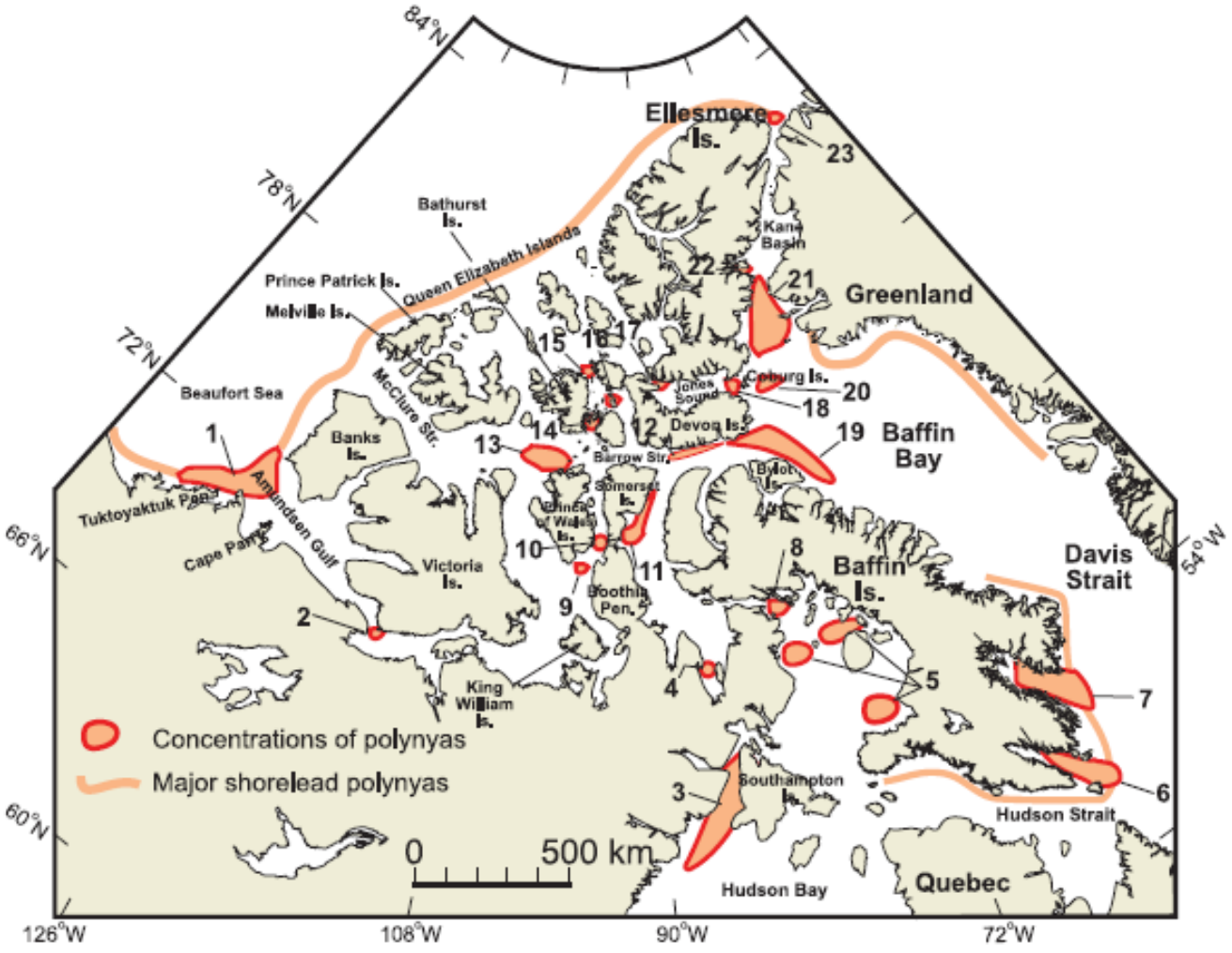


Figure 4 – From the WWF Commissioned report (2014). This figure demonstrates the empirical probability of open water in the Canadian Arctic based on MODIS data from 2002-2013 for the week of April 21-27.

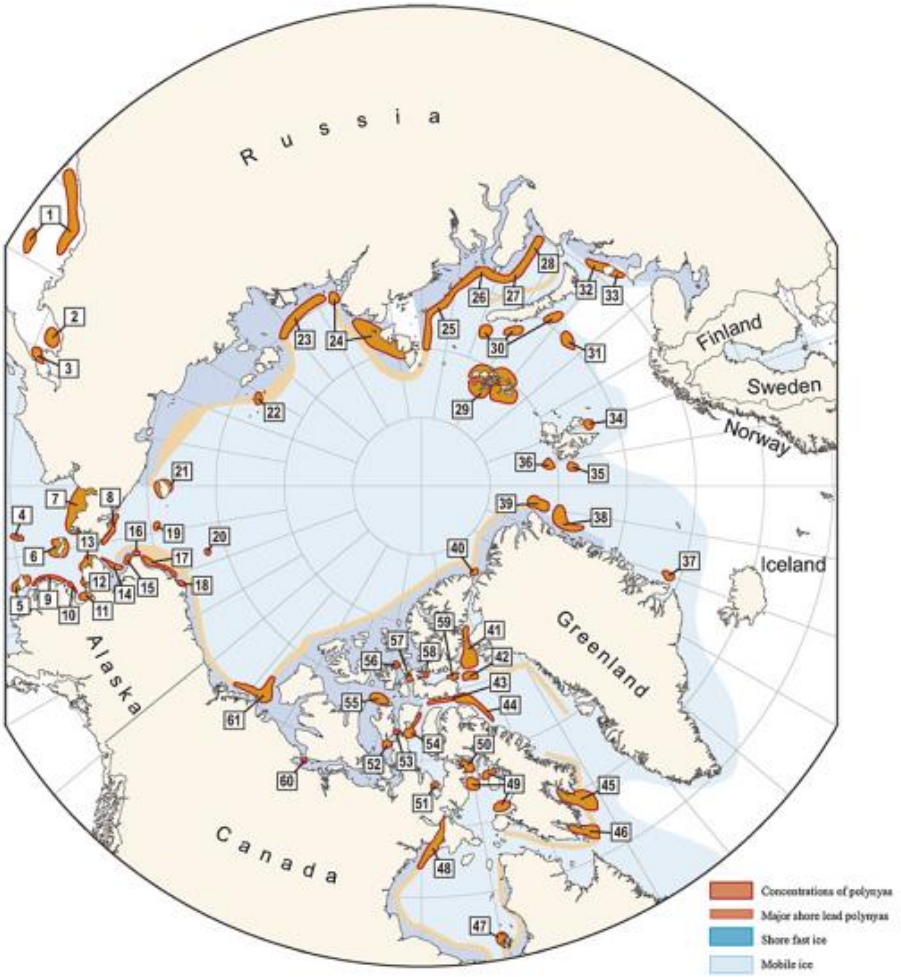
Figure 5 – Data provided to the NPC by WWF. Using MODIS data from 2002-2013, blue areas mapped here represent locations that exhibit a probability of open water greater than 20% during the week of May 5-12. Shapefiles are available upon request.



1 Cape Bathurst
2 Lambert Channel
3 Roes Welcome Sound
4 Committee Bay
5 Foxe Basin
6 Frobisher Bay
7 Cumberland Sound
8 Fury and Hecla Strait
9 Franklin Strait
10 Bellot Strait
11 Prince Regent Inlet
12 Lancaster Sound
13 Viscount Melville Sound
14 Karluk Brooman
15 Queens Channel and Penny Strait
16 Dundas Island
17 Hell Gate – Cardigan Strait
18 Lady Ann Strait
19 Bylot Island
20 Coburg Island
21 North Water (NOW)
22 Flagler Bay
23 Lincoln Sea

FIG. 1. A map of known polynyas in the Canadian Arctic, adapted from Barber and Massom (2007) and Stirling (1981). The Karluk Brooman polynyas were identified by Schledermann (1980) and Brown and Nettleship (1981).

Figure 6 – From Hannah et al., 2009. An updated (2009) and most recent general map of polynya and shore lead locations in the Canadian Arctic. The WWF commissioned report takes into account MODIS data up until 2013.



1 Okhotsk Sea
2 Gizhiga
3 Kamchatka
4 St Mathew Island
5 Nunivak Island
6 St Lawrence Island
7 Sireniki
8 Chukotsk Peninsula
9 Cape Romanzof
10 Yukon Delta
11 Norton Sound
12 Nome
13 Seward Peninsula
14 Kotzebue Sound
15 Cape Thompson - Point home
16 Cape Lisburne
17 Chukchi
18 Peard Bay
19 Herald Shoal
20 Hanna's Shoal
21 Wrangel Island
22 Bennett Island
23 Laptev Sea
24 Severnaya Zemlya
25 Kara Sea
26 Ob'Eniseyskaya
27 Yamalskaya
28 Amderminskaya
29 Franz Josef Land
30 Novaya Zemlya
31 Barents Sea
32 Pechorskaya
33 Cheshskaya
34 Storfjord
35 Hausgarten
36 Whaler's Bay
37 Scoresbysund
38 NEW (Northeast Water)
39 Ob Bank
40 Lincoln Sea
41 NOW (Northwater)
42 Coburg Island
43 Lancaster Sound
44 Bylot Island
45 Cumberland Sound
46 Frobisher Bay
47 Belcher Islands
48 Roes Welcome Sound
49 Foxe Basin
50 Fury & Hecla Strait
51 Committee Bay
52 Franklin Strait
53 Bellot Strait
54 Prince Regent Inlet
55 Viscount Melville Sound
56 Queens Channel & Penny Strait
57 Dundas Island
58 Hell Gate - Cardigan Strait
59 Lady Ann Strait
60 Lambert Channel
61 Cape Bathurst

Figure 1: Distribution map showing the number and names of Northern Hemisphere polynyas detected and identified from (a) an analysis of DMSP SSM/I data using the PSSM method (Markus and Burns, 1995) and (b) a literature review. This listing provides a minimum estimate of the number of recurrent polynyas. Some of these polynyas no longer exist in a fashion analogous to their recent history (e.g., the NEW polynya).

Figure 7 – From Barber and Massom, 2007. A slightly updated (2007) map of polynya and shore lead polynya locations in the Canadian Arctic that was used to inform Hannah et al., 2009 (Figure 6 in this document)