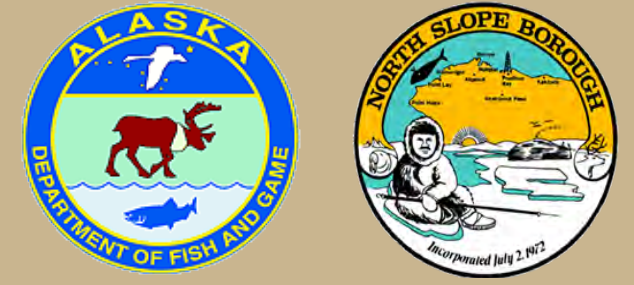


Movements and Habitat Use of Pacific Arctic Seals and Whales via Satellite Telemetry and Ocean Sensing

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Introduction

Studying habitat selection of Arctic marine mammals is difficult due to remote, seasonally ice-covered waters with little daylight during winter months. Satellite-linked transmitters that collect oceanographic data; Conductivity, Temperature, Depth (CTD) tags were deployed on ice seals in Alaska and bowhead whales in Alaska and Canada and have collected ~16,000 profiles in three seas year-round since 2016. These data will allow us to compare oceanographic conditions that marine mammals travel through with conditions where they linger, likely associated with feeding.

Instrumentation



Tags were glued to hair on the seal's back.



Tags remain on the whale's skin attached to an anchor that implants into the blubber.

Since 2016, 10 bowhead whales, 3 ringed, 9 bearded, and 20 spotted seals have been instrumented with CTD tags manufactured by the Sea Mammal Research Unit in St. Andrews, Scotland.

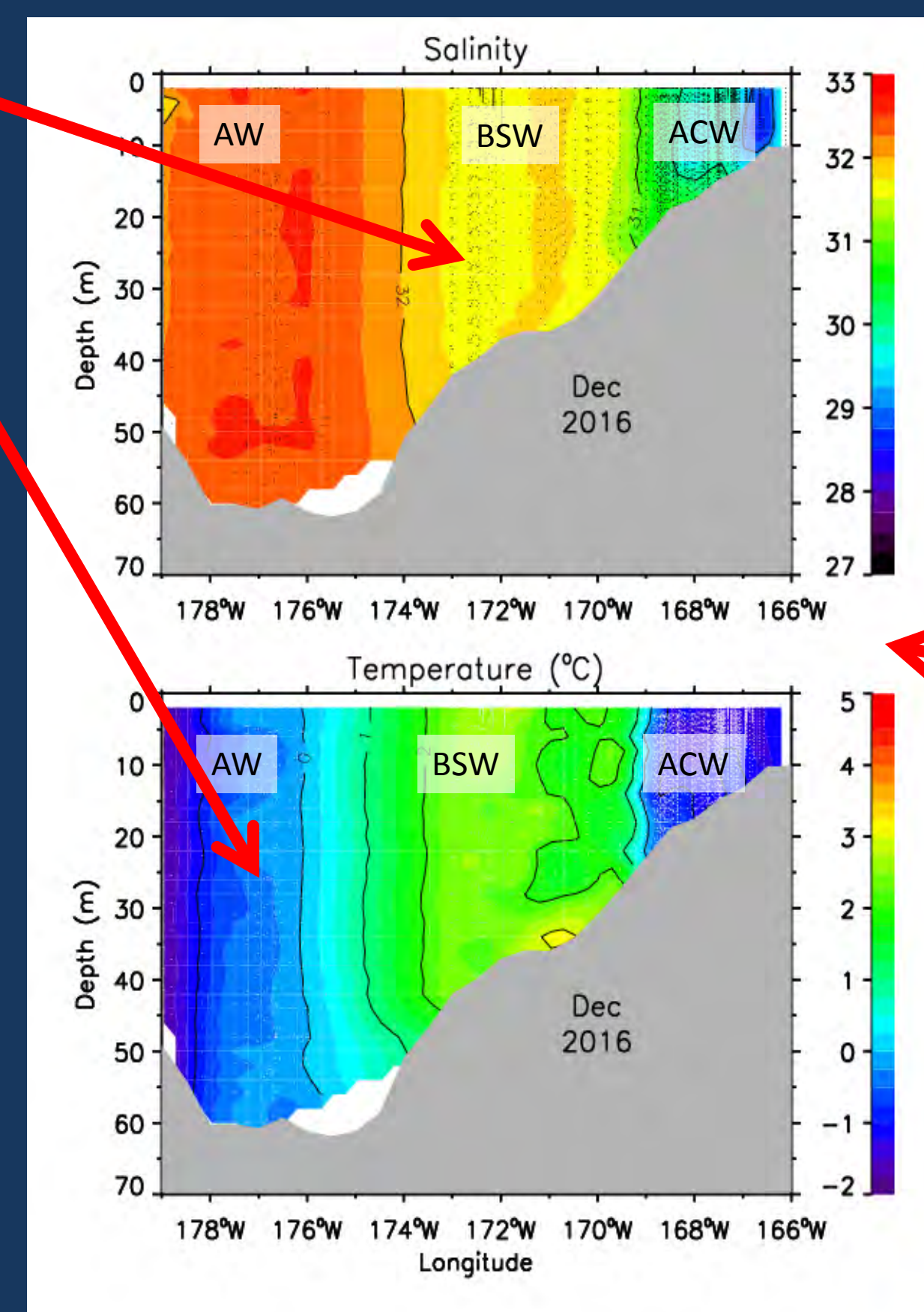
Example - CTD Profiles from Multiple Seals

CTD tags collect salinity (black dots) and temperature data (white dots).

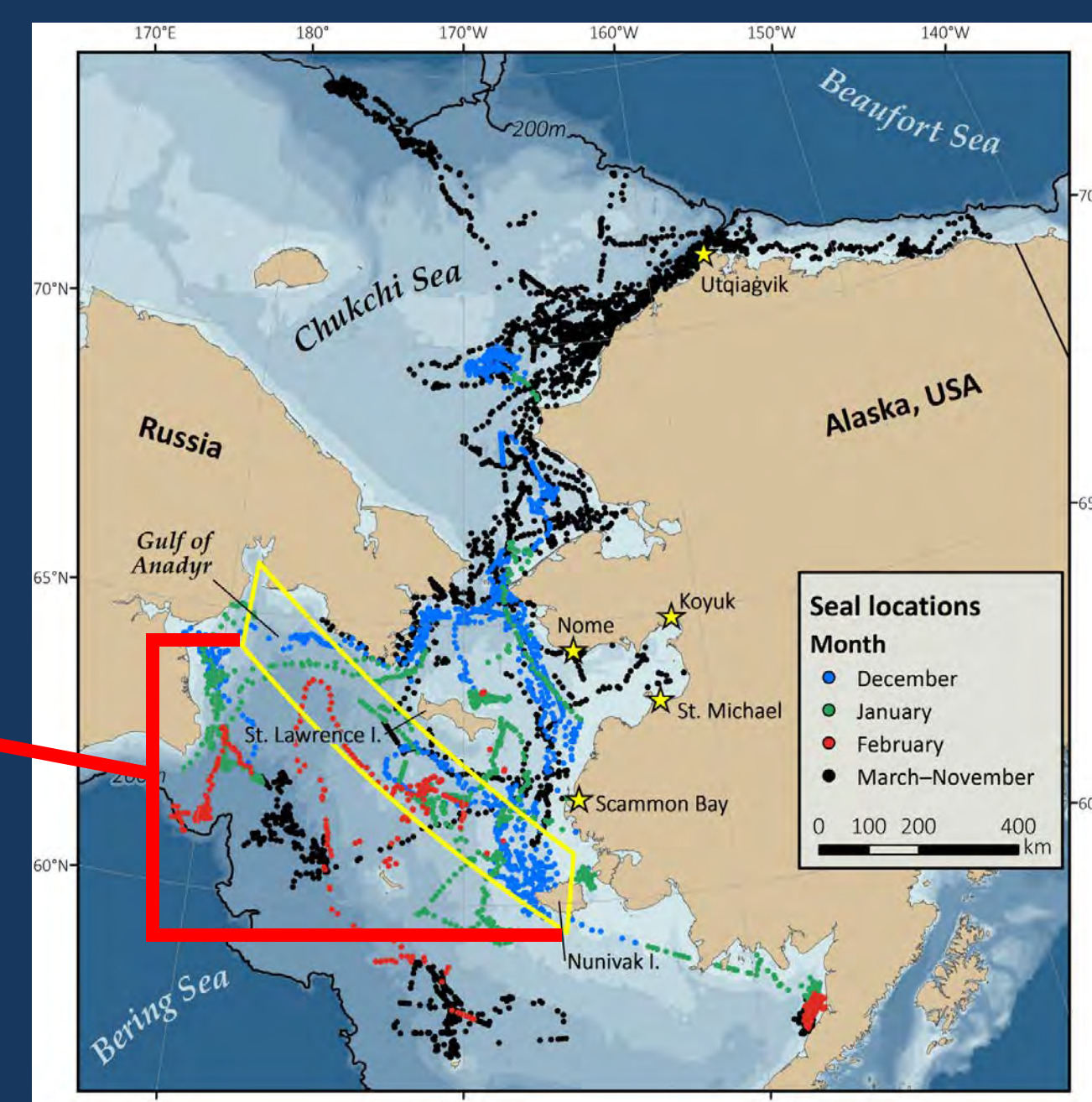
Irregularly spaced CTD data were interpolated to a regular grid using IDL (Harris Geospatial Solutions) subroutines GRID_INPUT, TRIANGULATE and TRIGRID to fill areas with few data.

By combining profiles from different animals within the same region and time period, water masses can be identified. This Bering Sea composite profile shows:

- cold, salty Anadyr Water (AW) near Russia, and
- Fresher and warmer Bering Shelf Water (BSW) and fresher and colder Alaskan Coastal Water (ACW) near Alaska.



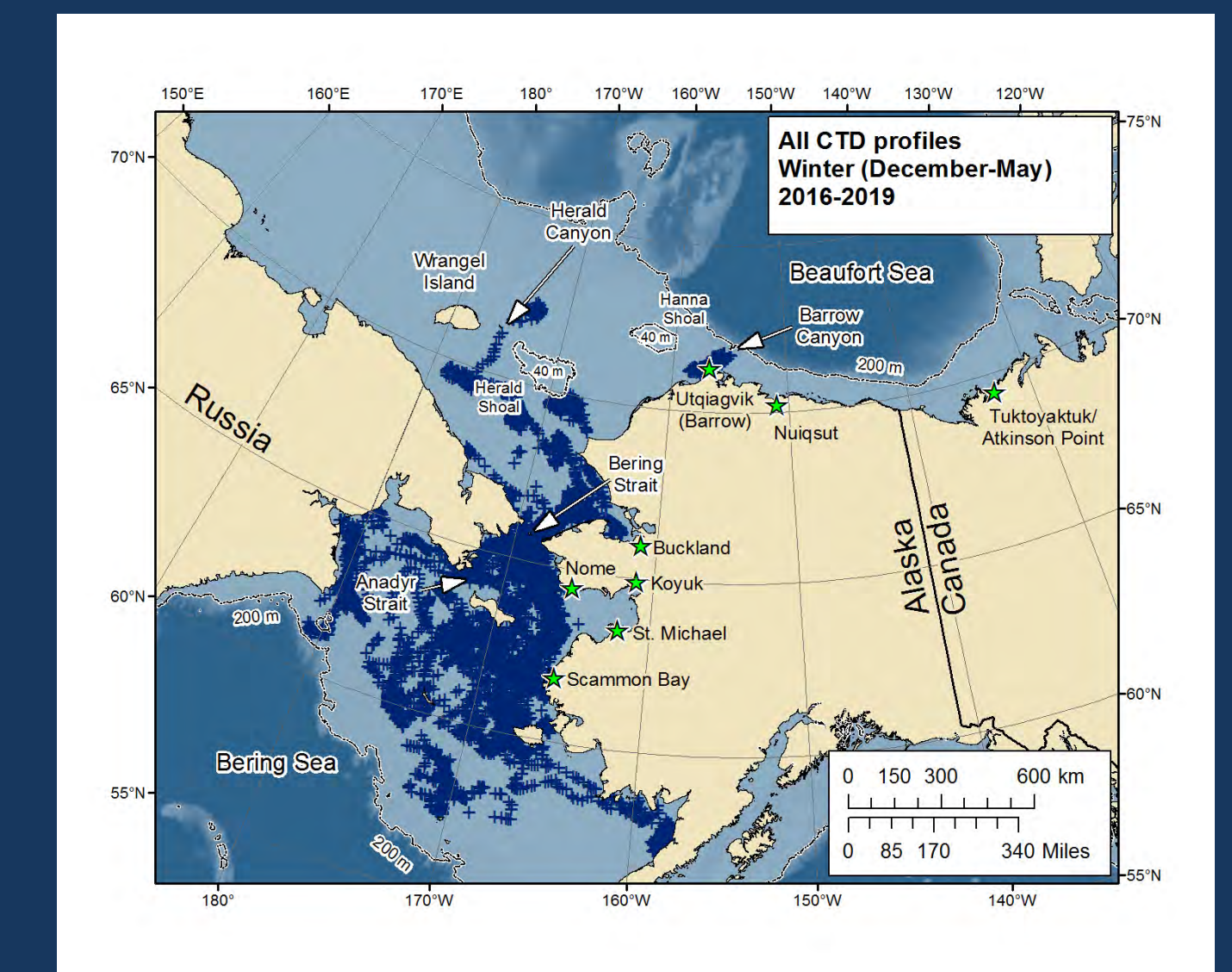
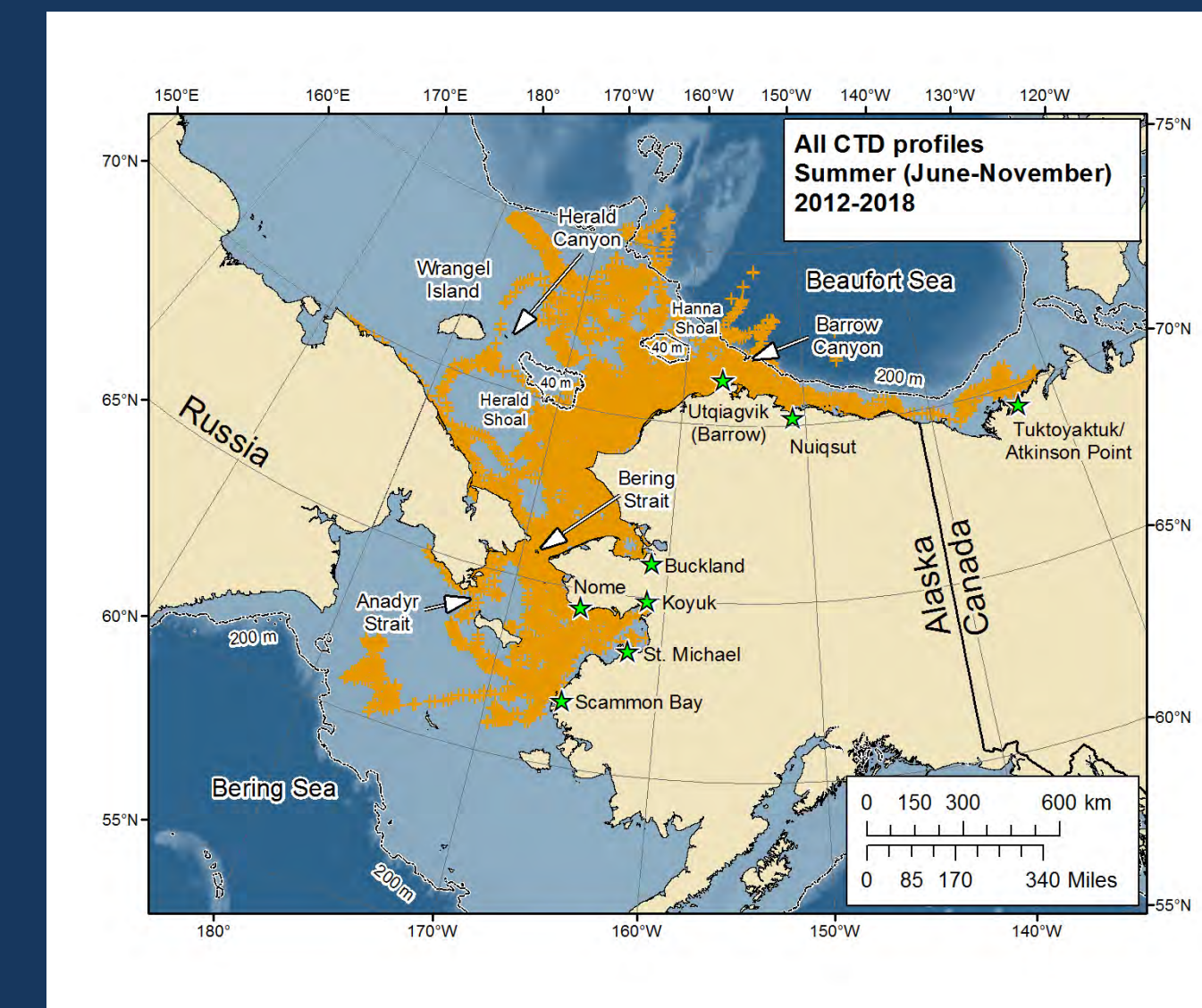
Bering Sea from Gulf of Anadyr (left) to Nunivak Island (right). Region outlined in yellow in map above right.



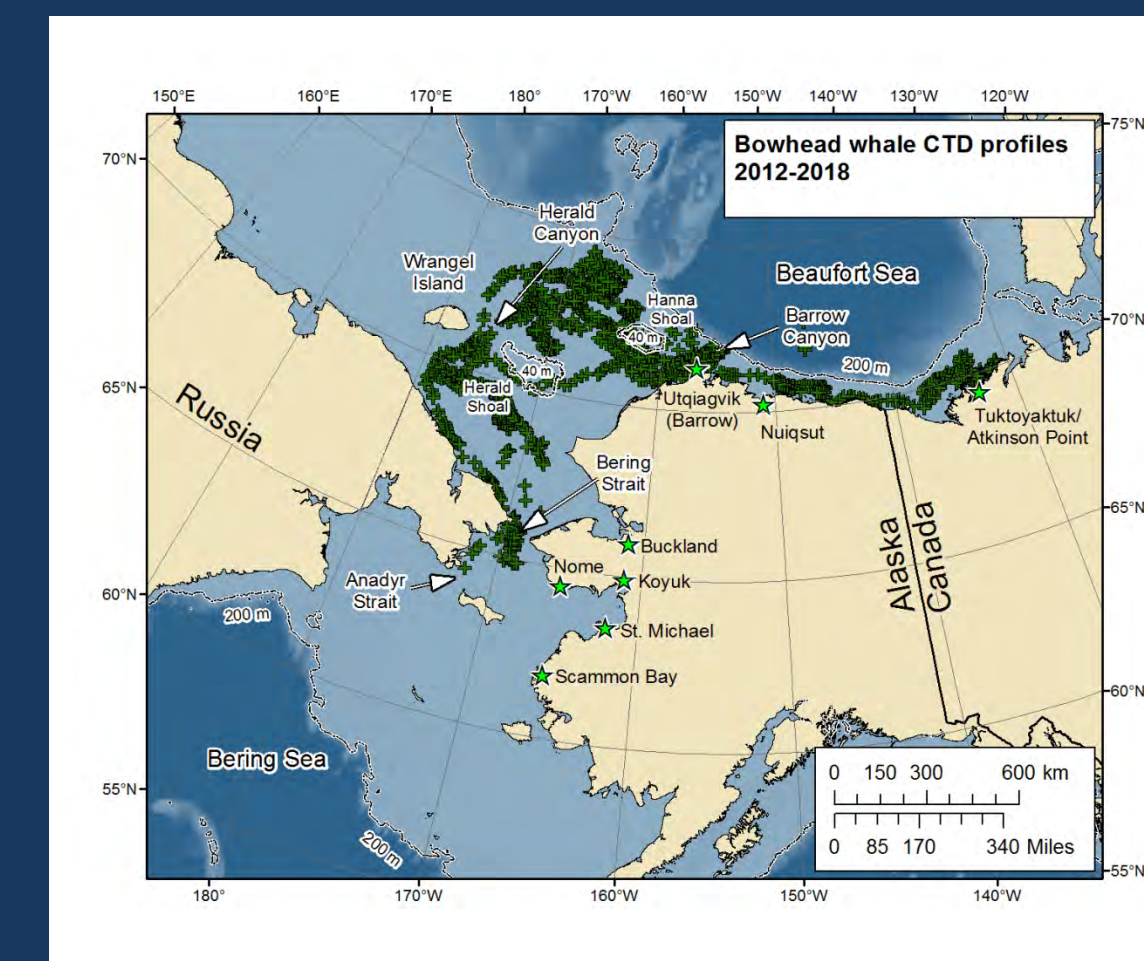
Acknowledgements

This project was primarily funded by the Office of Naval Research, USA, with logistic support for tagging operations shared by Bureau of Ocean Energy Management, USA, and the Department of Fisheries and Oceans Canada (DFO). Seal tagging would not be possible without the support of the Ice Seal Committee, North Slope Borough (NSB), Native Villages of Koyuk, St. Michael, Scammon Bay, Nome, Buckland, Nuiqsut, and their hunter-taggers (Merlin Henry, Alexander Nixsik Jr., Palsson Fitka, Morgan Simon, Wybon Rivers, River Simon, Tom Gray, Raymond Lee III, Richard Tukle, and Vernon Long). Assistance from NSB personnel (Joe Skin and Isaac Leavitt) was critical for seal captures near Utqiagvik, and Dease Inlet. Seal research was conducted under NMFS permits 15324 and 20466. Bowhead tagging would not be possible without the support of the Alaska Eskimo Whaling Commission, the Barrow Whaling Captains Association, the NSB and Utqiagvik whalers (including Billy Adams, Harry Brower, Lewis Brower, Carl Nayakik, Jordan Kippi, and many others), the Tuktoyaktuk Hunters and Trappers Committee, and their shore-based crew (including James and Charles Pokiak, Gary Raddi Jr., and Sr., Sammy Gruben, James Keevik, and many others), and Lois Harwood and Kate Snow from DFO. Bowhead research was conducted under NMFS Permit #18890 and IACUC #2016-23, 0027-2017-27, and 0027-2018-29.

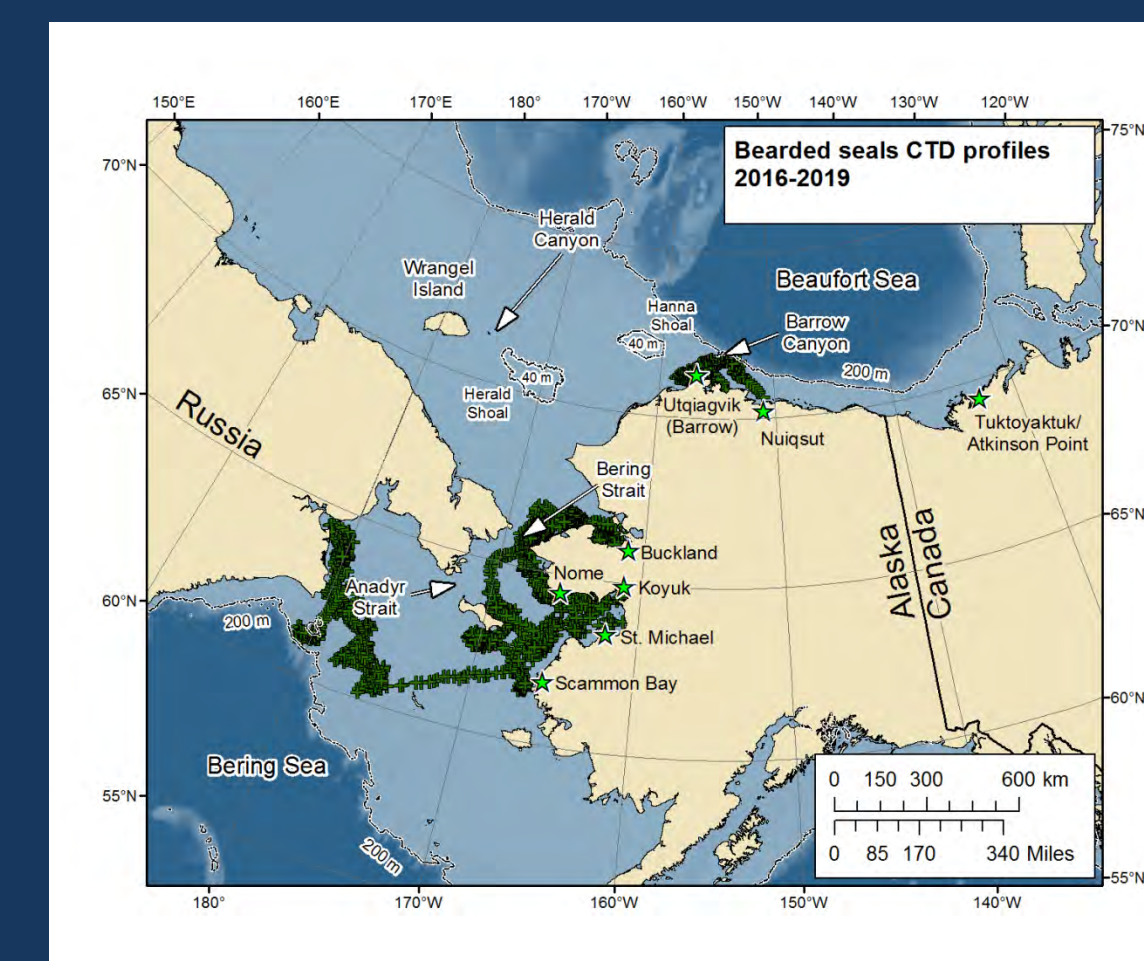
Results



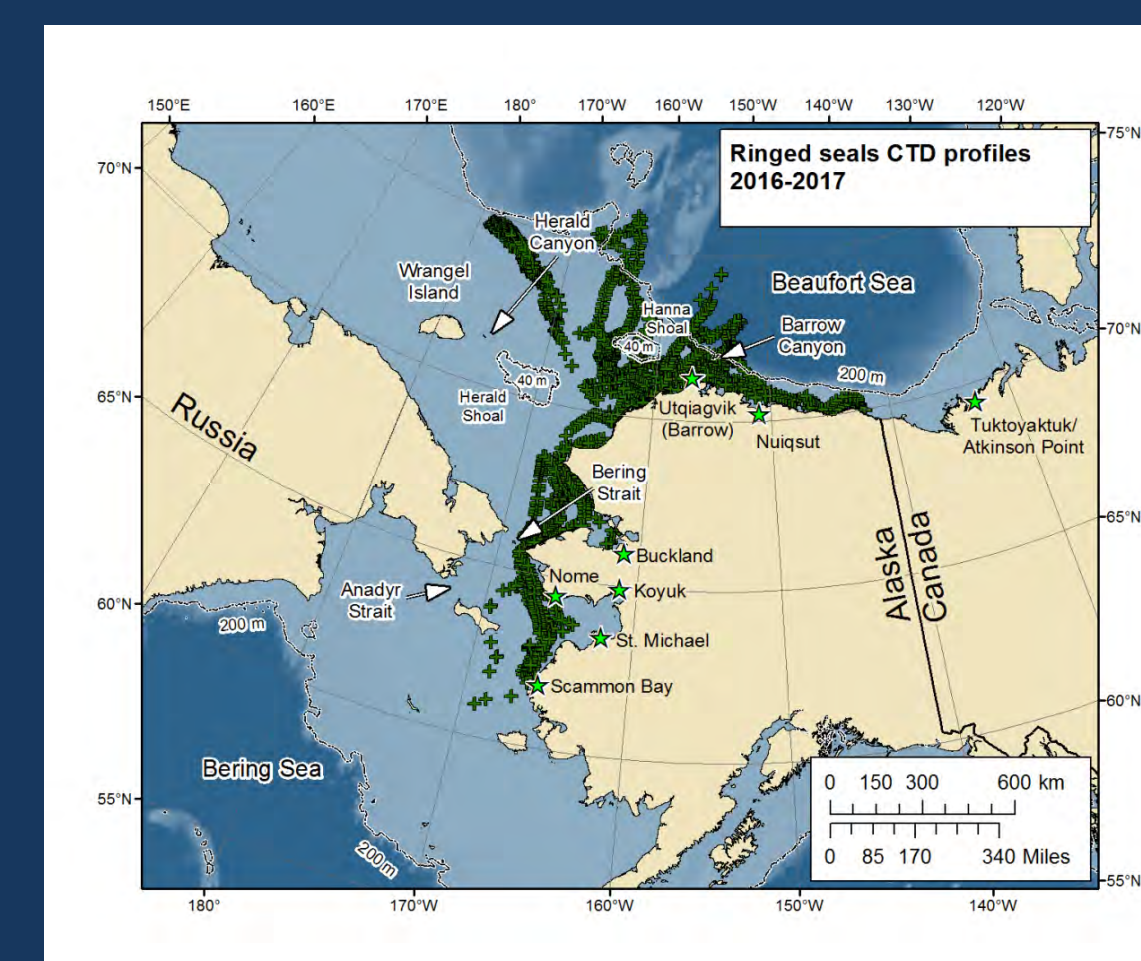
We plotted the locations where CTD tags on seals and whales uplinked oceanographic data. CTD profiles include 9,458 in summer and 6,482 in winter (Table 1). Data from 2012 are from the BOEM bowhead project.



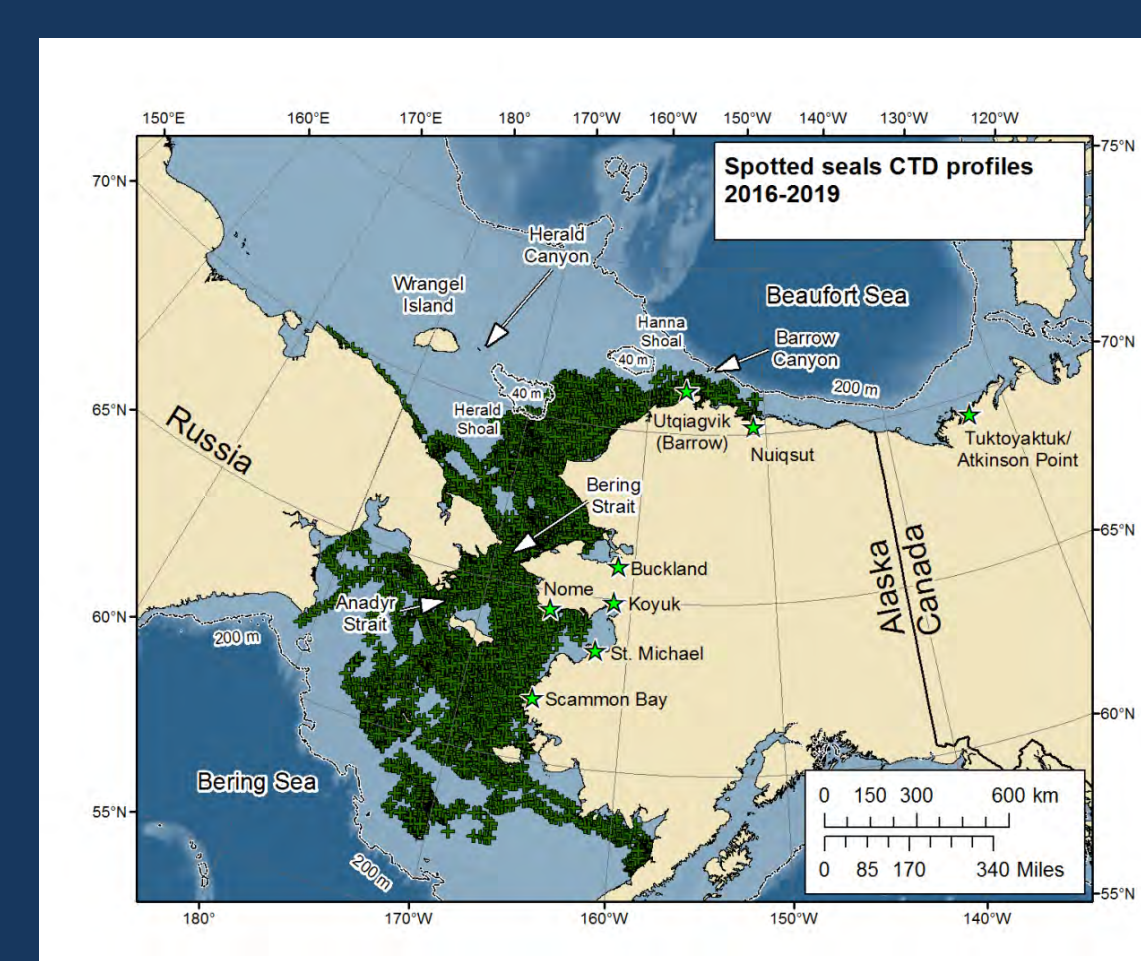
Locations where CTD tags on bowheads collected temperature and salinity profiles.



Locations where CTD tags on bearded seals collected temperature and salinity profiles.



Locations where CTD tags on ringed seals collected temperature and salinity profiles.



Locations where CTD tags on spotted seals collected temperature and salinity profiles.

Table 1. Number of temperature and salinity profiles collected by marine mammal-borne CTD tags by species, season, and location (sea).

Species	Season	Bering Sea	Chukchi Sea	Beaufort Sea	Total
Bowhead whale	Summer	9	809	356	1,174
	Winter	44	256	300	300
	Total	53	1,065	356	1,474
Bearded seal	Summer	632	394	671	1,697
	Winter	1,081	850	214	2,145
	Total	1,713	1,244	885	3,842
Ringed seal	Summer	78	940	331	1,349
	Winter	109	117	226	226
	Total	187	1,057	331	1,575
Spotted seal	Summer	1,235	3,757	246	5,238
	Winter	3,417	394	214	3,811
	Total	4,652	4,151	246	9,049
Totals	Summer	1,954	5,900	1,604	9,458
	Winter	4,651	1,617	214	6,482
	Grand total	6,605	7,517	1,818	15,940

Summer = June-November

Winter = December-May

Conclusions and Next Steps

- CTD tags deployed on ice seals and whales have provided ~16,000 oceanographic profiles in the Bering, Chukchi, and Beaufort seas; ~60% in summer (June-November) and ~40% in winter (December-May).
- The ability to identify water masses and track them through time greatly increases our understanding of marine mammal movements and habitat preference including in areas far from shore, under sea ice, and at depth.
- These data also allow us to compare with and validate powerful oceanographic models.
- Future analyses will include comparing oceanographic conditions that marine mammals pass through with those where they linger and are likely feeding, to identify important habitats.