Data from the BREA-MFP and CBS-MEA research programs describing the Anguniaqvia niqiqyuam Marine Protected Area (ANMPA) ecosystem

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by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Niemi, A., Majewski, A., Eert, J., Ehrman, A., Michel, C., Archambault, P., Atchison, S., Cypihot, V., Dempsey, M., de Montety, L., Dunn, M., Geoffroy, M., Hussherr, R., MacPhee, S., Mehdipour, N., Power, M., Swanson, H., Treau de Coeli, L., Walkusz, W., Williams, W., Woodard, K., Zimmerman, S., Reist, J. 2020. Data from the BREA-MFP and CBS-MEA research programs describing the Anguniaqvia niqiqyuam Marine Protected Area (ANMPA) ecosystem. Can. Data Rep. Fish. Aquat. Sci. 1316: ix + 90 p.

The conservation objectives of the Anguniaqvia niqiqyuam Marine Protected Area (ANMPA) focus on maintaining the integrity of marine habitats offshore of the Cape Parry Migratory Bird Sanctuary that support populations of key species, such as beluga whales, Arctic Char, and ringed and bearded seals. This report provides ecosystem-level scientific knowledge to support the development of monitoring objectives and activities. Physical, chemical and biological data are presented from the Beaufort Regional Environmental Assessment (BREA) Marine Fishes Project (MFP) (2012-2014) and the Canadian Beaufort Sea Marine Ecosystem Assessment (CBS-MEA) (2017-2019). Data were primarily collected from stations within 15 NM of the ANMPA, as well as from oceanographic transects across Franklin and Darnley Bays. Plots of temperature, salinity, nutrients and chlorophyll *a* show variable environmental conditions among years. Spatial and temporal variability is also described for the distribution, abundance and biodiversity of zooplankton, benthic invertebrates (epi- and infauna) and marine fishes, as well as for food web tracers (e.g., stable isotope data) and variables that reflect sediment conditions.

RÉSUMÉ

Niemi, A., Majewski, A., Eert, J., Ehrman, A., Michel, C., Archambault, P., Atchison, S., Cypihot, V., Dempsey, M., de Montety, L., Dunn, M., Geoffroy, M., Hussherr, R., MacPhee, S., Mehdipour, N., Power, M., Swanson, H., Treau de Coeli, L., Walkusz, W., Williams, W., Woodard, K., Zimmerman, S., Reist, J. 2020. Data from the BREA-MFP and CBS-MEA research programs describing the Anguniaqvia niqiqyuam Marine Protected Area (ANMPA) ecosystem. Can. Data Rep. Fish. Aquat. Sci. 1316: ix + 90 p.

Les objectifs de conservation pour la zone de protection marine (ZPM) d'Anguniqavia niqiqyuam mettent l'accent sur le maintien de l'intégrité des habitats marins situés au large du refuge d'oiseaux migrateurs du cap Parry qui soutiennent les populations des espèces clés, comme le béluga, l'omble chevalier, le phoque annelé et le phoque barbu. Le présent rapport fournit des connaissances scientifiques sur l'écosystème afin d'appuyer l'établissement des objectifs et activités de surveillance. Les données physiques, chimiques et biologiques sont tirées de l'évaluation environnementale régionale de Beaufort – Projet des poissons marins (ÉERB-PPM) [2012-2014] et de l'évaluation des écosystèmes marins – mer de Beaufort au Canada (ÉÉM-MBC) [2017-2019]. Les données ont principalement été recueillies à des stations situées dans un rayon de 15 milles marins de la ZPM d'Anguniqavia niqiqyuam et dans des transects océanographiques des baies Franklin et Darnley. Les graphiques de température, de salinité, de nutriments et de chlorophylle a montrent les conditions environnementales variables d'une année à l'autre. La variabilité spatiale et temporelle est aussi décrite pour la répartition, l'abondance et la biodiversité du zooplancton, des invertébrés benthiques (épifaune et endofaune) et des poissons marins, ainsi que pour les traceurs du réseau trophique (p. ex. données sur les isotopes stables) et les variables qui reflètent les conditions des sédiments.

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1.0 Introduction

In 2016, the Anguniaqvia niqiqyuam Marine Protected Area (ANMPA) was established within the Inuvialuit Settlement Region (ISR). The ANMPA wraps around Cape Parry and extends down the western side of Darnley Bay (Figure 1). The ANMPA conservation objectives focus on maintaining the integrity of marine habitats offshore of the Cape Parry Migratory Bird Sanctuary. These habitats support populations of key species such as beluga whales, Arctic Char, and ringed and bearded seals (DFO 2011, DFO 2014). The Cape Parry Migratory Bird Sanctuary contains the only thick billed murre colony in the western Canadian Arctic (Johnson and Ward 1985).

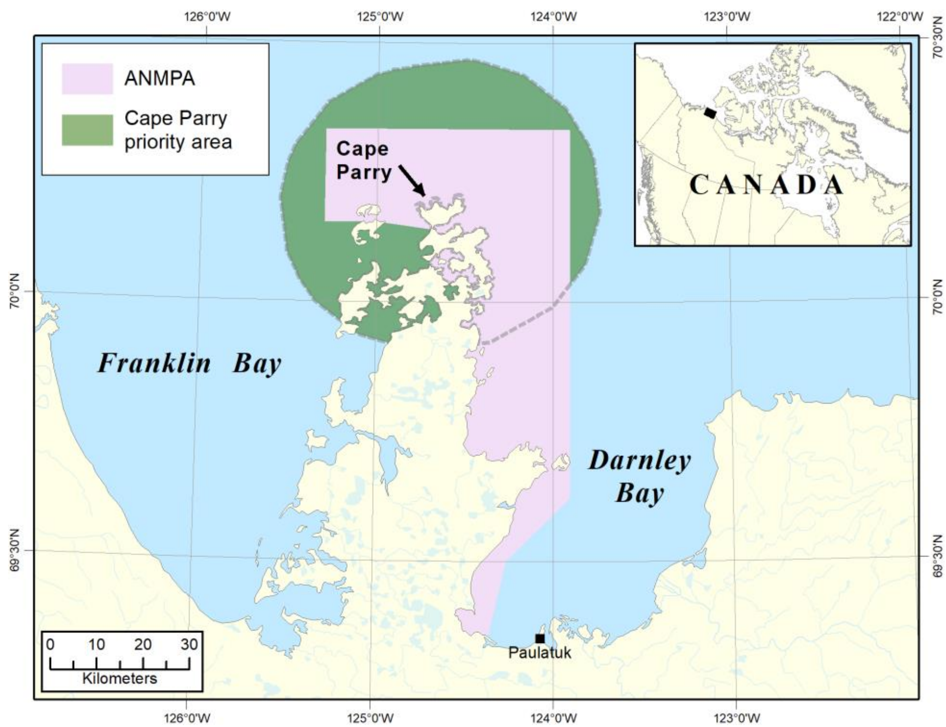

Figure 1. Anguniaqvia niqiqyuam Marine Protected Area (ANMPA) and the Cape Parry offshore marine feeding habitat priority area.

To protect key characteristics and functions of the ANMPA marine system, comprehensive ecosystem-level knowledge is required to develop effective and efficient adaptive management strategies. To develop and implement a successful monitoring plan, scientific and Inuit knowledge are both required for areas within and outside the ANMPA. To that end, this report provides scientific information in support of the ANMPA monitoring plan that is currently being developed by the ANMPA Working Group.

The data herein provide baseline information for species occurrences and distributions, food web linkages, and environmental conditions within a 15 nautical mile area around the ANMPA. Inter-annual data are also presented to provide some measure of temporal variability. Data collected from the Beaufort Regional Environmental Assessment (BREA) Marine Fishes project (MFP) (2012-2014) and the Canadian Beaufort Sea Marine Ecosystem Assessment (CBS-MEA) (2017-2019), provide ecosystem-level knowledge to assess the integrity of the system that supports feeding by beluga whales, Arctic Char, ringed and bearded seals and thick billed murres.

1.1 Field Programs

From 2012 to 2014, the BREA-MFP project, led by Fisheries and Oceans Canada (DFO), addressed priority knowledge gaps related to offshore marine fishes, their habitats, and supporting environmental conditions. The project was delivered in collaboration with co-management partners from the six communities of the ISR. Support for the scientific approach was ratified by the Inuvialuit Game Council (IGC) (Majewski et al. 2016).

In 2012, the BREA-MFP project provided the first systematic, coupled fish (i.e., bottom trawling) and ecosystem study on the shelf and slope areas of the Mackenzie Shelf/Beaufort Sea. Sampling extended to a depth of 1000 m. In 2013 and 2014, station work was completed within Amundsen Gulf in addition to the Beaufort Sea, including at stations off of Cape Parry (prior to the establishment of the ANMPA) and in Franklin, Darnley and Wise bays (Figure 2).

The Canadian Beaufort Sea-Marine Ecosystem Assessment (CBS-MEA, 2017 to present), with the ongoing support of the IGC and ISR communities, continues to build on existing baseline data and ecological knowledge derived from the BREA-MFP. The CBS-MEA focuses on integrating oceanography, food web linkages, physical-biological couplings and spatial and inter-annual variability, while also expanding data on species diversity, abundances, and habitat associations to marine areas previously unstudied in this context. In 2017 and 2018, station work was completed in areas adjacent to the newly created ANMPA, and in 2019, sampling was again completed within the ANMPA, following a work plan approved by the Western Arctic Marine Protected Area Steering Committee (Figure 2).

Science and program integration is required for the delivery of comprehensive research that supports both offshore and coastal priorities in the ISR. Knowledge gained during the BREA-MFP and CBS-MEA programs support research and monitoring approaches for ocean management in the ISR, and provide ecosystem-level context for studies of system integrity that must integrate the effects of natural ecosystem variability with effects induced by climate change and other anthropogenic stressors (e.g., shipping).

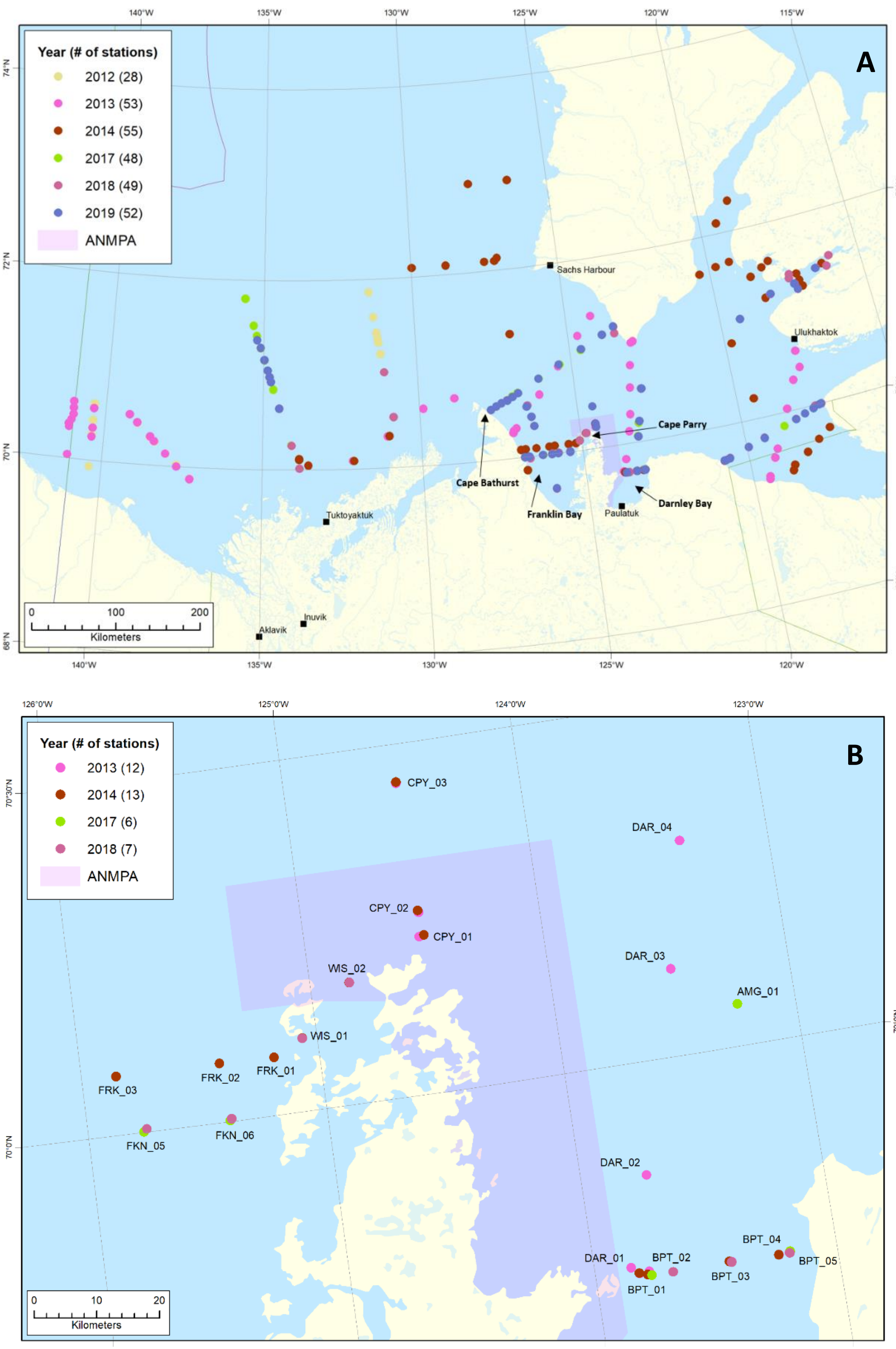

Figure 2. Station locations during the BREA-MFP (2012-2014) and CBS-MEA (2017-2019) programs (A). In B, stations within 15 NM of the ANMPA are labeled with transect ID and station number.

1.2 Oceanographic and biological setting

Within the study area (Figure 2) water properties generally reflect water masses of several origins:

- In the upper 50-100 m, surface waters are mixed by the winds and currents, and are strongly affected by the freeze-thaw cycles of the sea ice;
- Pacific waters in the upper 300 m of the ocean enter through the Bering Strait and are, on a broad scale, comprised of warmer summer waters overlying colder winter waters;
- Atlantic-origin waters occur underneath the Pacific waters. The Atlantic waters are warmer and have higher salinities than the Pacific winter waters and, because of salinity-driven stratification, the Atlantic waters form a deep layer where fishes appear to congregate.

Although the ANMPA surrounds Cape Parry, the strongest physical dynamic processes that affect its waters occur at the junction of the broad Beaufort Shelf and the steep western shore of Franklin Bay at Cape Bathurst. Results from surface drifters show that coastal currents are created when winds blow consistently either east or west. The shape of the sea floor at Cape Bathurst generates strong upward or downward (i.e., vertical) water movements that are not found around Cape Parry itself. These vertical water movements affect biological productivity, as they move nutrients into surface waters where primary producers can use them in the photic zone to produce the energy at the base of the food web. Wind-generated coastal currents transfer nutrient-laden waters between Cape Bathurst and the ANMPA.

Zooplankton convert low-energy carbohydrates from primary producers into energy-dense lipids that are then available to higher trophic levels, and are therefore important for food web functions and biogeochemical cycles in marine waters. Ocean temperature and salinity, as well as currents and dynamic physical processes, are important for understanding the composition and distribution of zooplankton. The timing and magnitude of ice algae and/or phytoplankton blooms are also critical factors that affect growth and reproduction of zooplankton.

Composition of the benthic community and food web structure within the study area are also influenced by regional-scale environmental gradients defined by bottom oceanography, and meso-scale environmental gradients defined by sediment characteristics and food supply to the benthos (e.g., Grebmeier et al. 1989; Link et al. 2013; Roy et al. 2014; Majewski et al. 2017). Benthic chlorophyll (chl) *a* concentrations, the ratio of chl *a* : phaeopigments (an indicator of pigment degradation), and sediment organic matter content can be indicators of the quantity and quality of food available to secondary benthic consumers at the seafloor (Roy et al. 2014). Grain size distributions describe the physical habitat occupied by benthic organisms, and can provide insight regarding habitat preferences by different taxa and/or functional groups.

The marine fish community in the Beaufort Sea is highly structured by depth and ocean conditions (Majewski et al. 2017). Fish assemblages are associated with vertical watermass structure; distinct assemblages are associated with the marine coastal and offshore waters of the Pacific watermass, the Pacific-Atlantic thermohalocline, and the underlying Atlantic watermass. Unique and potentially sensitive benthic habitats within Darnley Bay and the Cape Parry area (e.g., coarse and rocky substrate, macroalgae), and highly dynamic oceanographic conditions, provide a wide range of potential habitats to support marine fishes. The ecology and cultural importance of coastal marine and freshwater fishes around and within the ANMPA have been summarized by McNicholl et al. (2020).

One of the primary goals of the BREA-MFP and CBS-MEA programs is to increase knowledge of the structural and functional relationships among marine biota in the Beaufort Sea and Amundsen Gulf (e.g., Stasko et al. 2018). A key component of those relationships is food web interactions. Understanding which energy sources support a food web, and the feeding relationships that contribute to energy transfer among biota, is key to understanding how food web pathways may respond to environmental change, and how they may or may not facilitate ecosystem resilience (Libralato et al. 2014, Woodward et al. 2010). The analysis of naturally-occurring stable isotopes of nitrogen and carbon can be useful for delineating food web structure in marine systems. Stable isotope ratios of nitrogen ($\delta^{15}N$) can be used to infer the relative position of a consumer in the food chain (higher values indicate higher trophic position), whereas those of carbon ($\delta^{13}C$) can be used to infer the dietary carbon sources utilized by consumers (e.g., DeNiro and Epstein 1981, Peterson and Fry 1987, Renaud et al. 2015). Together, $\delta^{15}N$ and $\delta^{13}C$ can provide key information about feeding relationships.

1.3 Data

Physical, chemical and biological data collected between 2013 and 2019 are presented for stations within 15 NM (27.8 km) of the ANMPA (Figure 2, Appendix A). Some data are also presented for the complete Franklin Bay (FKN) transect, and thus extend beyond 15 NM from the ANMPA. A radius of 15 NM was selected to: 1) provide data of spatial and temporal relevance to the ANMPA and, 2) encompass the Cape Parry offshore marine feeding habitat priority area (Figure 1, DFO 2011). Stations along transects were usually completed sequentially unless weather, sea ice and/or mechanical issues interfered with science activities, as was evident during the persistent summer sea ice year of 2018 (Appendix A).

2.0 Methods

In all years, sampling was conducted from the F/V *Frosti*, a commercial stern trawler based in Richmond, BC. Within 15 NM of the ANMPA, the sampling stations are located at depths of 20 to 350 m. Given priority research questions related to oceanographic drivers and baseline ecosystem characterization, stations are aligned in transects and are not randomly distributed across depth strata.

Station work consisted of water column sampling with a CTD-rosette followed by zooplankton and ichthyoplankton collections with a multinet plankton sampler (depth stratified samples) and bongo nets (depth integrated samples). Next, benthic infauna and sediments were collected with a box core. Finally, three different trawling gear types, as described below, were deployed to sample epifauna and bottom-dwelling and mid-water fishes (Table 1). Hydroacoustic measurements were completed along sampling transects following the completion of station work.

2.1 Oceanography

The primary CTD system used on board was a Seabird SBE9+ CTD, configured with a 16-position SBE-32 pylon with 8L Niskin bottles fitted with internal, stainless steel springs in an ice-strengthened rosette frame. The data were collected real-time using the SBE 11 deck unit and computer running Seasave V7 acquisition software. The CTD was set up with temperature and conductivity sensors, dissolved oxygen sensors, fluorometer, transmissometer, OBS turbidity meter, PAR sensor, and altimeter. A surface PAR sensor was installed for all casts. All sensors had a 0 – 5v analogue output which is included in the CTD data string. The 2012 and 2013 deployments used a slightly different CTD system, a Seabird SBE25.

Further details for 2012 and 2013 deployments are available in Eert et al. (2015) and Niemi et al. (2015), respectively.

At each station the transmissometer sensor windows and PAR sensor were sprayed with deionised water and wiped with a DI water-soaked lens cloth prior to each deployment. Data acquisition was started while the CTD/Rosette package was on deck to get an in-air pressure measurement. The pumps were turned on by the operator upon immersion in salt water at the surface. The CTD system was soaked for 2 minutes at 5 m. The CTD system was then raised to the surface before being lowered to within 4 – 10 m of the bottom at 1 m s^{-1}. Niskin bottles were closed during the upcast after a 30 second pause in retrieval. Upon recovery, the pumps were turned off once the system left the water, and acquisition was halted once it was stable in-air to get a final pressure measurement.

CTD data were processed and archived at the Institute of Ocean Sciences, Ocean Sciences Division, Fisheries and Oceans, Canada. To access data, see http://www.pac.dfo-mpo.gc.ca/science/oceans/data-donnees/index-eng.html and refer to cruise numbers 2012-044, 2013-006, 2014-045, 2017-020, 2018-098, 2019-086.

Surface drifters were deployed intermittently to capture currents generated by strong wind events. These drifters are built almost entirely of materials that will degrade in the oceanic environment (cellulose sponge, wood, steel, aluminum). Non-degradable materials (plastic, batteries) are found in the small 'SPOT' beacon which allows the buoy to be tracked in real time via satellite.

2.2 Nutrients and Primary producers

At each station, water samples were collected at multiple depths using the CTD-Rosette sampler. These samples were processed and analyzed for a full suite of chemical and biological variables including nutrient concentrations, acidification parameters, primary producer biomass and composition (e.g., chl *a*, organic carbon, abundance of phytoplankton groups), stable isotopes and food web biomarkers (e.g., fatty acids), and biodiversity. Section 3.2 presents an overview of nutrient and chl *a* distributions along transects in the ANMPA region, based on results from the BREA (2013-2014) and CBS-MEA (2017-2018) expeditions.

Duplicate chl *a* subsamples were filtered onto 25-mm Whatman GF/F filters and extracted for 24 h in 90 % acetone at 4 °C in the dark, for fluorometric determination (10AU Turner Designs fluorometer), according to Parsons et al. (1984). Nutrient samples were collected in duplicate 15 ml acid-washed Falcon tubes. The samples were immediately frozen at -50 °C or -80 °C and later stored at -80 °C until analyzed. All nutrient samples were analyzed for nitrate (NO_3), phosphate, (PO_4) and silicate ($Si(OH)_4$) using a Seal Analytical AutoAnalyzer 3 following Grasshoff et al. (1999).

Table 1. Summary of sampling variables measured for the water column and benthos as well as species and food web characterization.

	CTD	Bottle samples	Sediments	Phytoplankton/ Protists	Epifauna	Infauna	Zooplankton	Ichthyoplankton	Fish
Water Column									
Temperature	●								
Conductivity	●								
Pressure	●								
Dissolved Oxygen	●								
Fluorescence	●								
Transmissivity	●								
Turbidity	●								
Photosynthetic Active Radiation (PAR)	●								
Salinity		●							
NO_3, NO_2, PO_4, $Si(OH)_4$		●							
$\delta^{18}O$		●							
DIC, Alkalinity		●							
Chlorophyll *a*		●							
DOC/N, POC/N		●							
Acoustics							●		●
Benthic									
Granulometry			●						
Chlorophyll *a*			●						
Organic matter content			●						
Basic Biology									
Taxonomy				●	●	●	●	●	●
Abundance				●	●	●	●	●	●
Biomass				●	●	●	●	●	●
Distribution				●	●	●	●	●	●
Sex/Maturity							●		●
Food web (i.e., biotracers)				●	●	●	●		●

2.3 Zooplankton taxonomy

At each full station during the BREA-MFP project, zooplankton taxonomy samples were collected using a Hydro-Bios MultiNet, Type Midi (0.25 m^2 aperture, 150 µm mesh) deployed to within 10 m of the bottom. The net was hauled vertically (at a rate of 0.5 m s^{-1}) and programmed to collect stratified samples from up to five depth strata. Targeted strata were generally 0 – 25 m, 25 – 50 m, 50 – 100 m, 100 – 200 m and >200 m. Samples from each depth stratum were preserved in a 4 % buffered formaldehyde solution in seawater, after removal of any ichthyoplankton. Also, oblique tows with a Bongo net (500 µm mesh) were performed to provide sufficient biomass for ancillary analyses. Select zooplankton species, from depth integrated bongo tows, were picked by hand and frozen (-50 C) for food web analyses (Section 2.6).

Taxonomy samples processed in the lab were split using a Folsom splitter (2012, Fisheries and Oceans Canada, Freshwater Institute) or beaker method (2013, 2014; van Guelpen et al. 1982, Huntsman Marine Institute). Taxonomic identification was to species, or the lowest possible taxonomic level. Specimens >15 mm in length (>30 mm for Chaetognatha) were removed prior to splitting and identified from the whole sample. The sample was then split and a minimum of 300 individuals, excluding nauplii, were counted and identified. Copepod species were staged; nauplii were not identified to species. The sample was also scanned for rare species not found in the counted split.

The taxonomy data are stored in the Ocean Ecology Zooplankton Database housed at the Institute of Ocean Sciences. To estimate biomass, the database assigns an average weight (mg) and size (mm) for copepod stage or life stage of each species derived either from direct lab measurements or from length–weight regressions (extrapolation from organisms of similar size and shape are used). Dry weight coefficients are taken from published values (Omori 1969, Fulton 1973, Uye 1982, Davis 1984, Larson 1986, Vidal and Smith 1986, McLaren et al. 1989, Nakamura et al. 2017) or are measured from fresh samples.

2.4 Marine Fishes

Three nets were used to collect the fish reported herein: a modified Atlantic Western IIA (W2A) bottom trawl, a hi-lift 3 m benthic beam trawl (BBT), and a Cosmos-Swan 260 m mid-water trawl (MWT). Where bottom habitats allowed, both benthic trawl were fished at each station (Figure 2) to sample the full size spectrum of fishes. The mid-water trawl was fished in conjunction with hydroacoustic data collection (see section 2.4.6) to echovalidate acoustic targets.

2.4.1 Atlantic Western IIA benthic trawl (W2A)

The W2A net had a 22.86 m head rope, 21.23 m footrope and a 1.27 cm (0.5 in) mesh cod-end. The trawl net was paired with Thyborøn Type II, 2.72 m (107 in) bottom-tending doors. A Marport trawl mensuration system recorded bottom contact, net height, depth, and door spread. Speed-over-ground (SOG) was recorded from the ship’s Global Positioning System (GPS). Each of the above-mentioned trawl deployment parameters were recorded a minimum of three, and up to six, times during each deployment. Target tow duration was 20 minutes. Shorter duration tows occurred in areas with rough bottom or inconsistent bathymetry. Whenever possible, tows were conducted along a bathymetric contour to maintain consistent depth. Targeted average speed was 1.5 m s^{-1} SOG, with an acceptable average range of 1.4 – 1.6 m s^{-1} SOG.

Upon retrieval of the net onto the trawl-way, the cod-end and intermediate sections were rinsed with seawater and the contents were flushed into one or more fish tubs. The net and footrope were visually inspected, and any catch items were removed and added to the catch, prior to stowing the trawl.

2.4.2 Hi-lift 3 m benthic beam trawl (BBT)

The BBT had 4.27 m head- and foot-ropes, and was equipped with a 0.63 cm square mesh cod-end liner (Majewski et al. 2009). Net depth was recorded with a Marport sensor. Speed-over-ground was recorded from the ship's GPS. Each parameter was recorded a minimum of three times during each deployment. Target tow duration was 10 min, with two tows conducted at each station. Whenever possible, tows were conducted along a bathymetric contour to maintain consistent depth. Target average speed was 1.03 m s^{-1} SOG, with an acceptable average range of 0.93 – 1.13 m s^{-1} SOG. Relative to the W2A trawl, the smaller-scale and finer-meshed BBT was deployed to capture smaller-bodied, slower swimming fishes.

Upon retrieval of the trawl over the port side cat-walk, the net was rinsed with seawater and cod-end contents were flushed into one or more fish tubs. The net and footrope were visually inspected and fish and invertebrates were removed and added to the catch prior to stowing the trawl.

2.4.3 Cosmos-Swan 260m mid-water otter trawl (MWT)

The MWT net had a 41.4 m head-rope and a 1.27 cm (0.5 in) mesh cod-end. The trawl net was paired with Thyborøn Type II, 2.72 m (107 in) bottom-tending doors. A Marport trawl mensuration system recorded net height, depth, and door spread. Speed-over-ground was recorded from the ship's GPS. These trawl parameters were recorded a minimum of three, and up to six times during each deployment. Target tow durations ranged between 10-20 min, and average towing speeds ranged from 1.29 – 2.29 m s^{-1}. MWT was deployed to sample mid-water targets identified on a Simrad echosounding system. Target depths ranged between 40 and 60 m.

Upon retrieval of the net onto the trawl-way, the cod-end and intermediate sections were rinsed with seawater and the contents were flushed into one or more fish tubs. The net and footrope were visually inspected and fish and invertebrates were removed and added to the catch prior to stowing the trawl.

2.4.4 Onboard and laboratory fish processing

Fish catches were sorted to the lowest taxonomic level possible onboard the vessel. The first 200 fish of each species in a catch were measured for length, and each fish was given a unique identifier before flash-freezing at -50 °C. In instances where there were more than 200 fish of a given species in a catch (typically *Boreogadus saida*), the next 200 fish were measured and bagged in groups of 20 (1+ age class) or 50 (YOY age class). These bags were assigned a single unique identification number. Any remaining fish were counted, without measurements, and bagged in groups of 20 or 50 fish, with one unique identification number per bag. All bulk samples were frozen onboard at -50 °C.

Three to five voucher specimens of each species were fixed on-board the ship in 10 % buffered formaldehyde, and later transferred to 70 % ethanol for long-term archiving. Post-cruise, fish were thawed at the Freshwater Institute in Winnipeg, MB, where each specimen was identified to the lowest taxonomic level possible using published keys (Mecklenburg et al. 2002, Scott and Scott 1988), unpublished notes, and original literature. Identifications of voucher specimens were verified by taxonomic experts at the Canadian Museum of Nature (B. Coad) and the University of Copenhagen (P. Møller). Scientific and common names for all species in this study follow the American Fisheries Society (Page et al. 2013) standard. Species that could only be identified to genus or sub-family levels were typically juveniles for which accurate taxonomic keys were not available. In other instances, soft-bodied specimens such as Liparidae were damaged during capture in the trawl net and/or during the freeze-thaw cycle such that species identifications were not possible based on external physical characteristics.

2.4.5 Fish Data processing

Abundance-based catch per unit effort (CPUE) was calculated from Atlantic Western IIA otter trawl (W2A) tows that met the following criteria:

- Average towing speed fell within acceptable limits.
- Consistent bottom contact was maintained for the duration of the tow.
- The trawl did not hang-up on bottom at any point during the tow.
- Neither trawl door collapsed during the tow.
- Door spread data were available throughout the tow.
- The trawl did not collect excessive sediments, and any sediments retained could be easily flushed by towing off the stern prior to retrieving the cod end onto the ship.

Fish CPUE was reported at the genus level, except for one instance where Stichaeidae species were categorized to subfamily due to difficulty in identifying to species (i.e., *Anisarchus medius*, *Leptoclinus maculatus*, and *Lumpenus fabricii*). These instances are indicated by an asterisk.

The following equations were used to calculate CPUE:

$$Distance\ (m) = Tow\ duration\ (s) \times average\ ship\ speed\ (^{m}/_{s})$$

$$Area\ swept\ (km^2) = \frac{Distance\ (m) \times Average\ Door\ spread(m)}{1000000}$$

$$CPUE\ = \frac{Number\ of\ fish}{Area\ swept\ (\ km^2)}$$

Presence of fish species was summarized by pooling data from both types of bottom trawls, and also mid-water trawl tows. Fish species were listed as present at a station if a single individual was collected from any tow, during any year. Fish were reported to the lowest taxonomic level available.

2.4.6 Hydroacoustics analysis

Hydroacoustics data were collected with a SIMRAD EK60 ship-mounted system with 38, 120, and 200 kHz transducers (Table 2). Data from the 38 kHz transducer are presented herein.

Table 2. Specifications of the three SIMRAD EK60 transducers and operation parameters.

Frequency (kHz)	Transducer model	Power (W)	Pulse duration (μs)	Transmission rate
38	ES38B	2000	1024	1 ping s^{-1}
120	ES120-7C	250	1024	1 ping s^{-1}
200	ES200-7C	100	1024	1 ping s^{-1}

Calculated area backscattering strength (S_a in dB re 1 m^2 m^{-2}) was integrated over the epipelagic layer (0 – 100 m) with a vertical resolution of 0.25 m. Data presented herein include all transects within and close to the ANMPA (69.4 °N to 70.45 °N and -125.86 °W to -123.19 °W) in 2013 and 2014. Hydroacoustic data were also collected in 2017-2019, but was not processed in time for this report.

2.5 Benthic invertebrates and sediment

2.5.1 Epifaunal invertebrate sampling

Similar to fish, epifaunal invertebrates were quantitatively sampled using the High-lift 3 m Benthic Beam Trawl described in Section 2.4.2. Biota captured during trawling were sorted onboard to the lowest possible taxonomic resolution, counted, and weighed. When trawl catches were too large to be feasibly processed onboard, the catch was homogenized on deck and a representative fraction (usually half or one quarter) was retained for processing. The entire sample was then scanned for rare or underrepresentated species. The associated sample fractions were used to estimate abundance and biomass for the entire catch. All specimens for which there was taxonomic doubt, or which were too small for onboard processing,were preserved in 4 % buffered formaldehyde for subsequent identification, weighing, and counting in the laboratory.

2.5.2 Infaunal invertebrate and sediment sampling

Marine sediments were collected with a 0.5 m^2 box corer (Precision Enterprises, Dartmouth, NS). Immediately after draining residual water from the surface, the sediment core was divided approximately in half for sampling. From the least disturbed half, A 60 cc truncated syringe was used to collect samples for benthic pigment concentrations (three pseudoreplicates) and organic matter content from the upper 1 cm of sediment, and samples for granulometry from the upper 5 cm of sediment (Bale and Kenny 2005). Sediment for stable isotope analysis was scraped from the upper 1 cm of sediment. The remaining core surface (target 0.25 m^2) was sieved through 0.5 mm stainless steel mesh using seawater to collect infaunal invertebrates, and sample dimensions were recorded. Sample depths varied depending on sediment composition, but always exceeded the depth of the organic layer (7 – 25 cm). Infauna were preserved in 4 % buffered formaldehyde for later identification in the laboratory. The remaining sediment in the core was sieved through 1 mm stainless steel mesh to opportunistically collect organisms for stable isotope analysis. Organic matter and stable isotope samples were immediately frozen onboard at -50 °C, and benthic pigment samples were frozen at -80 °C (-50 °C in 2012). Granulometry samples were stored at 4 °C.

2.5.3 Laboratory benthic processing

Composition, abundance and biomass of taxa for both epifauna and infauna were determined by taxonomists in the benthic ecology laboratory at the Université Laval (Québec, QC). For epifauna, final biomass and abundance at a station were derived by combining data from the sample portions processed onboard and in the laboratory. Taxonomy was standardized to names currently accepted in the World Register of Marine Species (WoRMS 2019).

Sediment chl *a* and phaeopigment concentrations (µg g^{-1}) were analysed fluorometrically following a modified protocol by Riaux-Gobin and Klein (1993) in a Turner Design 20 fluorometer after a 24 h extraction in 90 % acetone at 4 °C in the dark. Sediment organic matter content (% of total dry weight) was determined as loss-after-ignition following combustion for 6 h at 550 °C. Sediment grain size analysis was performed on wet sediment using a LS13 320 laser diffraction type granulometer (Beckman Coulter) with polarization intensity differential scattering. Prior to analysis, sediments were mixed with a 20 g l^{-1} solution of $(NaPO_3)_6$ as a dispersant and shaken for 24 h to break aggregates.

2.5.4 Benthic data processing

Standardized abundance- and biomass-based CPUE were calculated from area sampled and reported as density as individuals per m^2 (n m^{-2}) and grams per m^2 (g m^{-2}), respectively. For epifaunal invertebrates, area sampled was considered the area swept by beam trawls that met the following criteria:

- Average towing speed fell within acceptable limits.
- Consistent bottom contact was maintained for the duration of the tow.
- The trawl did not hang-up on bottom at any point during the tow.

For infaunal invertebrates, area sampled was considered the surface area sampled from the box core. Abundance and biomass data were used to calculate cumulative biomass density (g m^{-2}), richness, Shannon's diversity (H'), and Pielou's evenness (J') for each individual sample collected within 15 NM of ANMPA (i.e., data were not combined within years or stations). Shannon's diversity accounts for both the abundance and evenness of taxa present in the community, with higher values indicating both a higher number of species present and greater evenness in abundances. Pielou's evenness is a measure of how evenly represented the taxa are within a community, with higher values indicating a more evenly represented community and lower values possibly indicating dominance by a small subset of taxa.

Benthic invertebrate taxa were listed as present for a given transect, if a single individual was collected from any tow, during any year. Benthic invertebrate taxa were reported to the lowest taxonomic level available.

2.6 Stable isotopic analyses

A detailed methodology for sample treatment and stable isotopic analyses is reported in Stasko et al. (2017). Briefly, fishes, benthic invertebrates, zooplankton, and sediment collected for stable isotope analysis were immediately frozen onboard at -50 °C, and later stored at -20 °C in the laboratory. Representative subsets of fish and benthic invertebrates were selected for analysis across the available range of body sizes to capture covariation between size and $\delta^{15}N$. A broad suite of taxa were chosen according to ubiquity, relative abundance, taxonomic diversity, and functional diversity. Various slow-turnover tissues were dissected from biota for stable isotope analysis based on information in the literature and dissection constraints for small-bodied invertebrates (e.g., McTigue and Dunton 2014). Whenever possible, muscle tissue was analysed, and exoskeleton or other calcareous structures were removed. In cases where individuals were too small to dissect, individuals were analysed whole and, if necessary, several individuals were pooled into a bulk sample to ensure sufficient sample material was available. All available zooplankton samples were analysed as bulk samples. For sediment and those animals that could not be separated from their exoskeleton, a subsample of tissue was acidified with 10 % HCl following Jacob et al. (2005) to remove inorganic carbon prior to the determination of $\delta^{13}C$. Tissues were dehydrated and ground to a homogenous powder, then analysed for N and C isotopic composition at the University of Waterloo Environmental Isotope Laboratory (Waterloo, ON). Isotopic data were expressed in standard δ notation as parts per thousand (‰) relative to the international standards Vienna Pee Dee Belemnite for carbon and atmospheric N_2 for nitrogen (Craig 1957, Mariotti 1983). Analytical error for $\delta^{15}N$ and $\delta^{13}C$ did not exceed 0.3 and 0.2 ‰ per run, respectively, based on repeated measurements of laboratory standard material cross-calibrated to the international standards. Repeatability based on all duplicate measurements of sample material was 0.3 ‰ for both $\delta^{15}N$ and $\delta^{13}C$.

3.0 Results

3.1 Oceanographic observations of the waters surrounding the ANMPA

Data collected consisted of vertical profiles of water properties: temperature, salinity, dissolved oxygen, fluorescence (chl *a* wavelength), light transmission, and turbidity collected electronically by CTDs and auxiliary instruments. Individual CTD profiles have been integrated into vertical sections running north from Cape Parry and across Franklin and Darnley Bays. The sections in the bays can be used to investigate the difference between the two embayments and the large-scale currents induced by strong multi-day wind events. Sections in the figures show temperature and salinity, which together define the density structure of the waters. Dissolved oxygen data were also collected, and the sensor was calibrated before and after the cruise. The oxygen sensor is subject to uneven drift over time, and Winkler titrations of water samples to calibrate each cast while on board were not performed due to space and personnel limitations. As a result, DO values should be considered as relatively correct within each cast, with comparisons between casts being less reliable. However, there is no indication of hypoxia in these waters, minimum oxygen levels observed were approximately 6.5 ml l^{-1} (hypoxic values would be below 2 or 3 ml l^{-1}).

Section plots of the waters due north of Cape Parry in 2013, 2014 and 2019 are presented in Figures 3-5, respectively. Warm surface waters in 2014 were observed during a season of early ice retreat (and were also observed further toward the centre of Amundsen Gulf), while in 2013 and 2019 the ice was present or nearby until shortly before sampling.

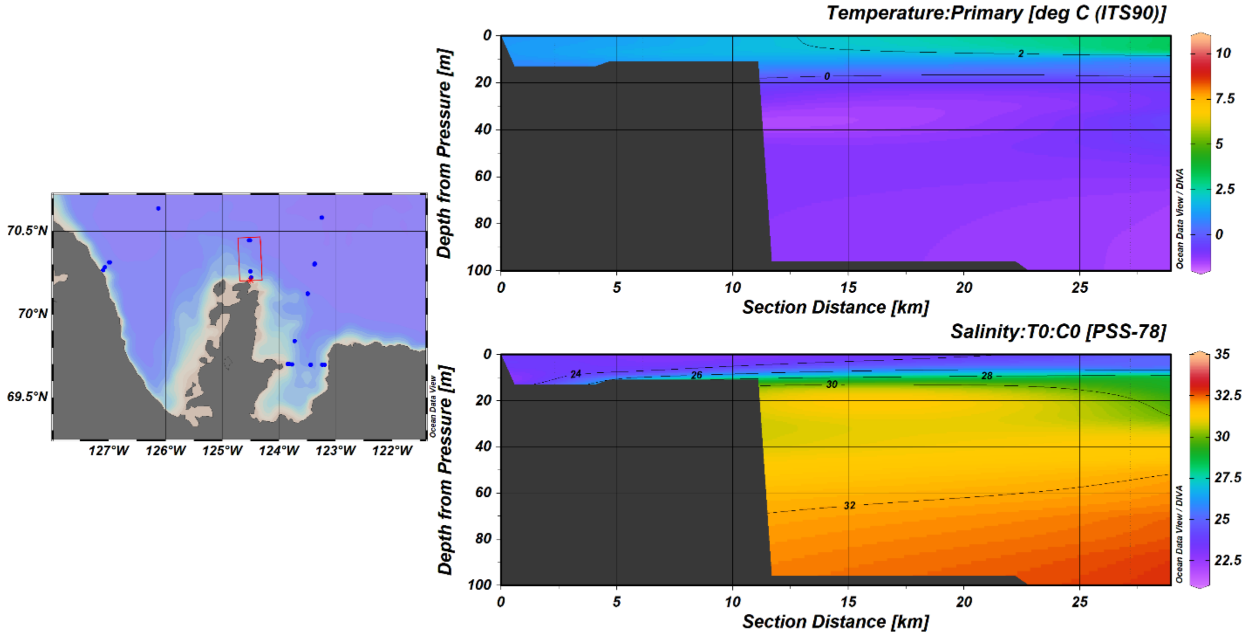

Figure 3. 2013 Cape Parry section plots of temperature and salinity (2-3 August). Red box in map indicates the location of the section stations.

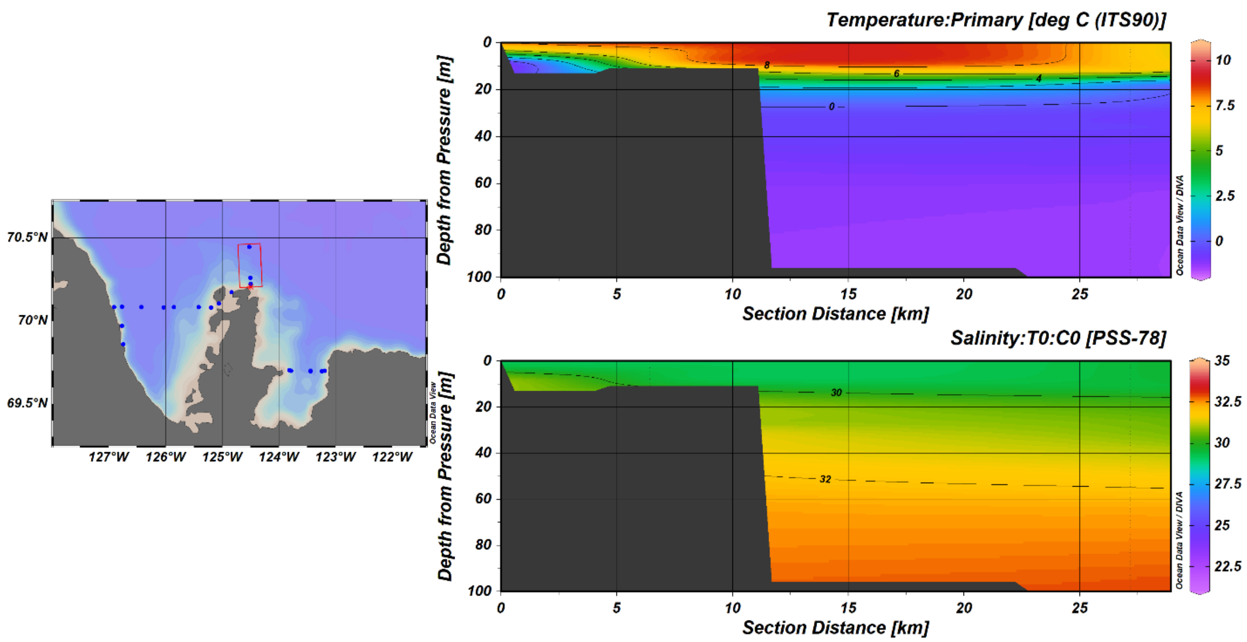

Figure 4. 2014 Cape Parry section plots of temperature and salinity (25-26 August). Red box in map indicates the location of the section stations.

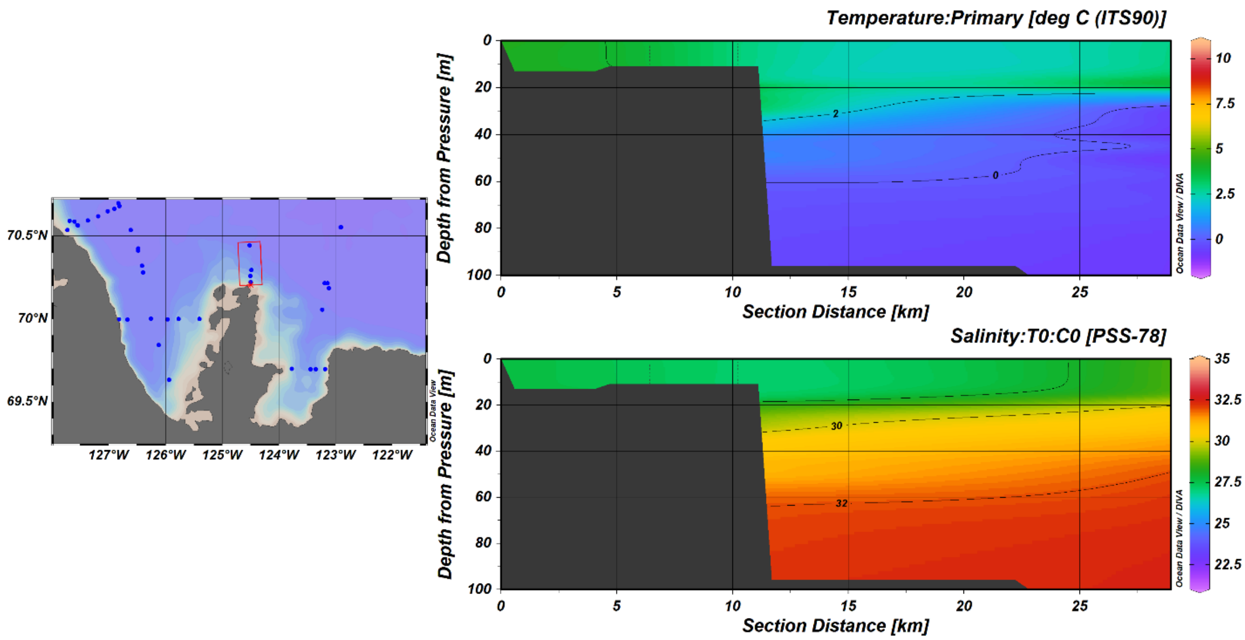

Figure 5. 2019 Cape Parry section plots of temperature and salinity (24-25 August). Red box in map indicates the location of the section stations.

Section plots of Franklin and Darnley bays for 2017 (Figure 6), 2018 (Figure 7) and 2019 (Figure 8) show watermass patterns in the two bays under three wind scenarios. Note that the data collection each year occurred at different dates (Appendix A) in the two bays, as much as a few weeks apart. Sea ice and weather delays are particularly evident in 2018. Within Franklin Bay, the section was sampled over the course of three days. In 2017, sampling occurred during a calm period following a period of moderate easterly winds, in 2018 during a period of strong westerlies, and in 2019 during a period of moderate easterlies.

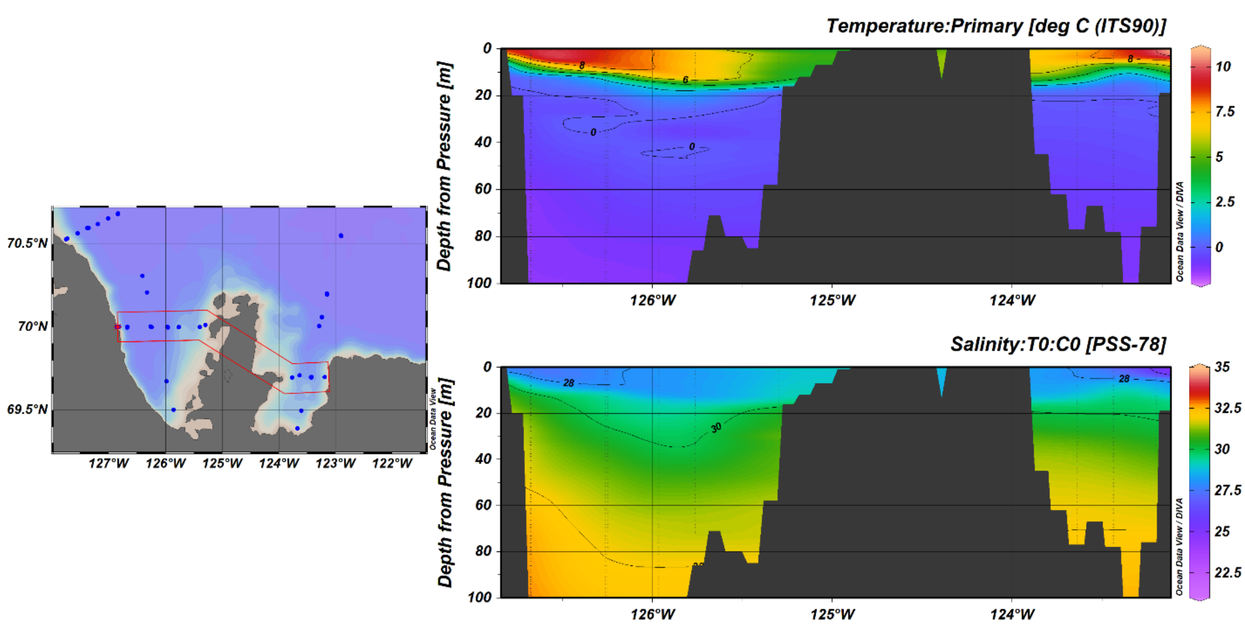

Figure 6. 2017 Franklin (15-17 August)-Darnley Bay (23-25 August) section plots of temperature and salinity. Red box in map indicates the location of the section stations.

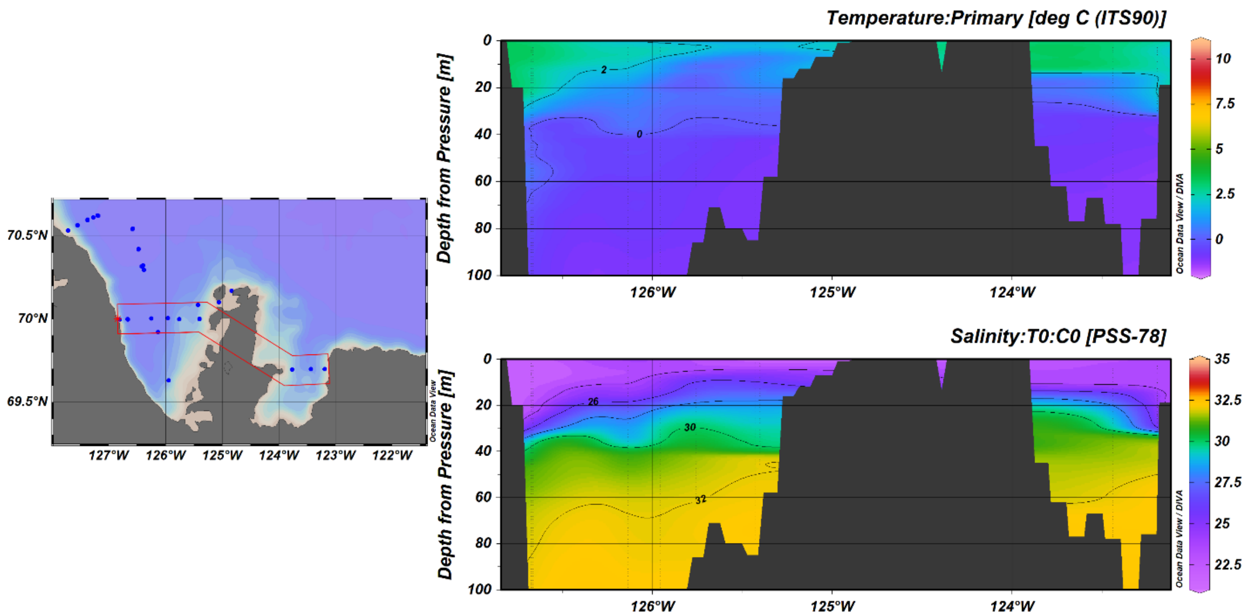

Figure 7. 2018 Franklin (9 August; 30 August-5 September)-Darnley Bay (31 August; 8 September) section plots of temperature and salinity. Red box in map indicates the location of the section stations.

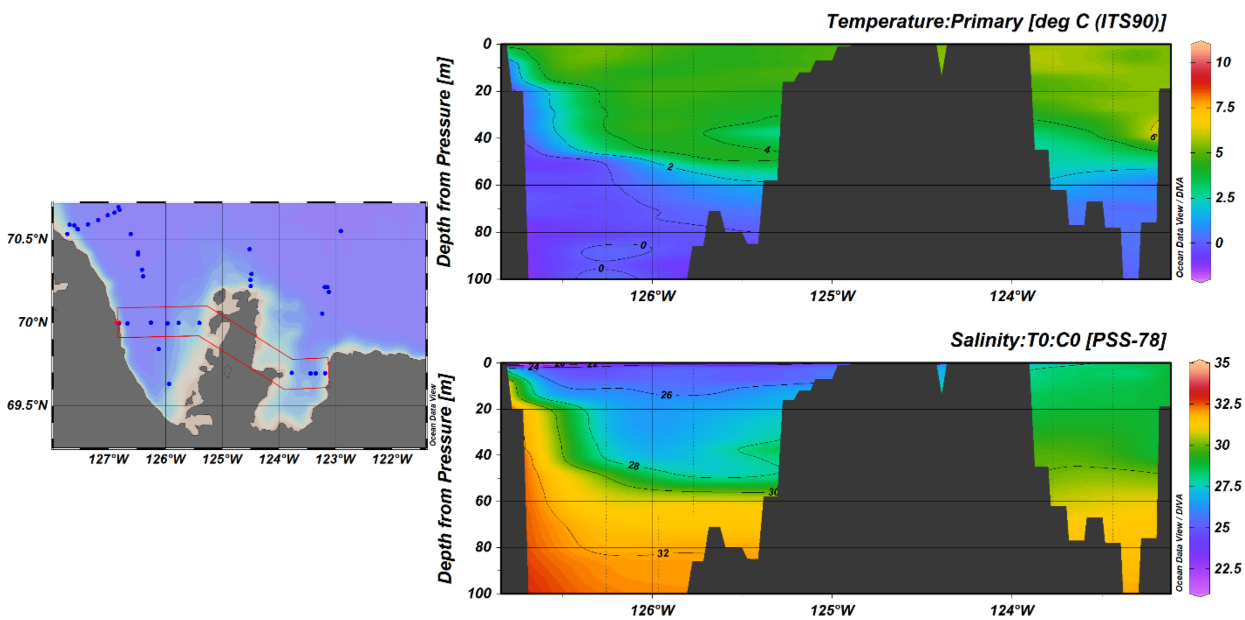

Figure 8. 2019 Franklin (29 August-4 September)-Darnley Bay (22-23 August) section plots of temperature and salinity. Red box in map indicates the location of the section stations.

Surface currents were observed using satellite tracked drifters in 2017 and 2019 (Figures 9 and 10). In 2017, the drifters were deployed during an easterly wind event, while in 2019, the winds were initially strongly from the west and later weakly from the east. Connections between the waters of the Beaufort Shelf and as far east as Dolphin and Union Strait are evident as the drifters travelled from one end to the other in a matter of a few weeks. Drifter deployment and distance travelled is summarized in Appendix B.

In both the temperature and salinity sections and the drifter tracks, the most striking feature is the level of variability on short time scales. Differences from year-to-year are challenging to elucidate when a three-day wind event can completely change the direction of surface drift and underlying currents. These results highlight the need for long-term, continuous measurements (e.g., moored instrumentation) to assess seasonal patterns and to detect changes separate from the observed natural variability.

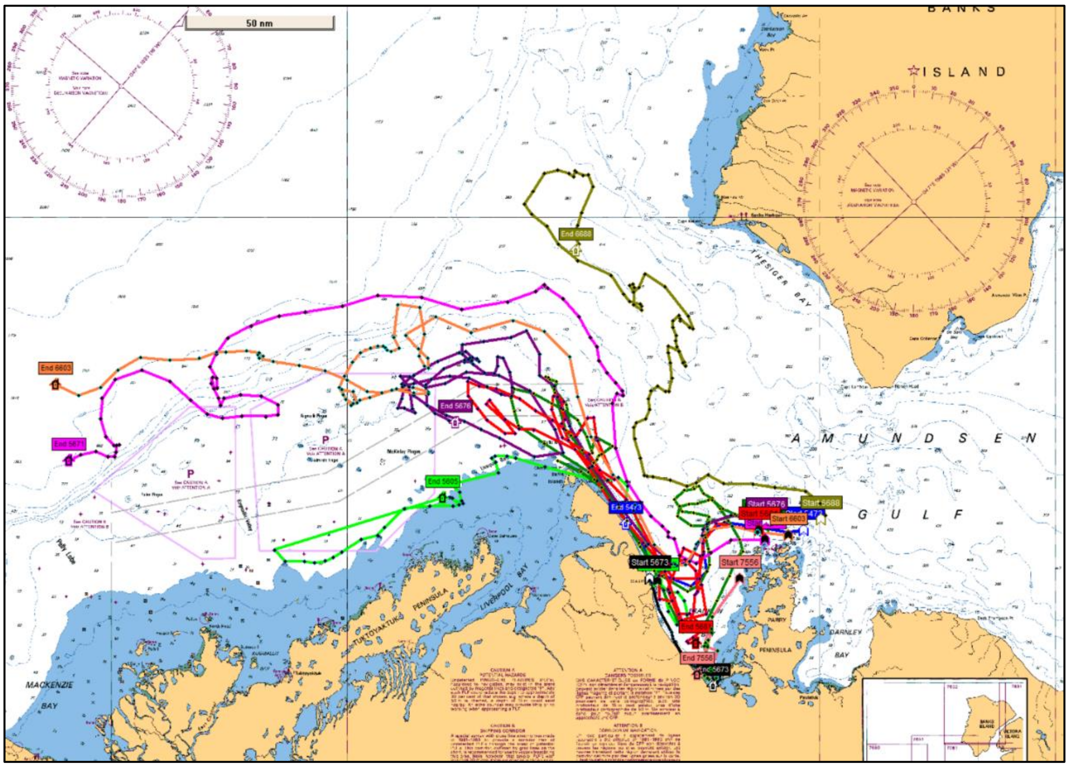

Figure 9. 2017 surface drifter tracks. Colored boxes indicate starting and ending locations of drift-track.

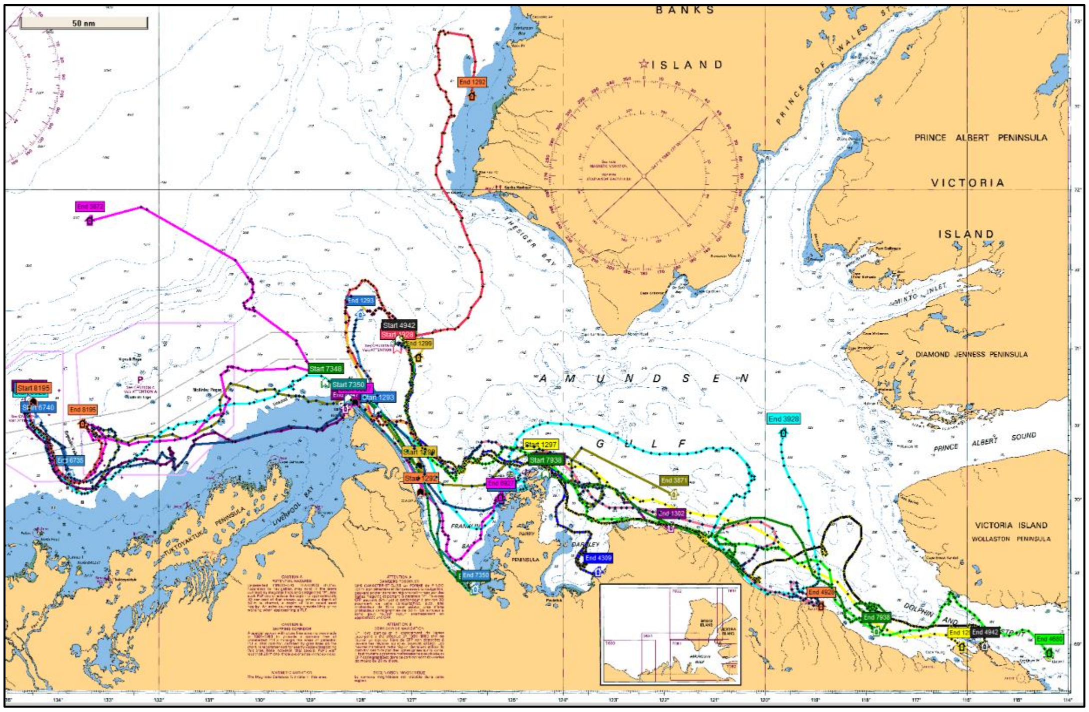

Figure 10. 2019 surface drifter tracks. Colored boxes indicate the starting and ending locations of drift-track.

3.2 Nutrients and Primary producers

A transect across Darnley Bay was visited in 2013, 2014, 2017 and 2018, allowing for an interannual comparison of nutrient distributions at the time of sampling. Figures 11 to 14 show the distribution of nitrate (NO_3) and silicic acid ($Si(OH)_4$), which are building blocks for the production of organic material in the ANMPA and other Arctic marine regions. Nitrate is typically the limiting nutrient for primary production in the Canadian Arctic, therefore its availability influences the productivity potential of the ecosystem. Silicic acid is essential for the growth of diatoms, which are central to food web transfers from primary producers to higher trophic levels. The results from Darnley Bay consistently show widespread nutrient depletion in surface waters at the time of sampling in all years. The extensive surface nutrient depletion extends down to a depth of ca. 50 m in 2013, 2017 and 2018. Results from 2014 show a narrower depleted layer, down to ca. 25 m, and a very strong nutricline leading to maximum nutrient concentrations at depths > 50 m. A preliminary analysis of these results indicates a much higher nutrient inventory, when considering the complete water column, in Darnley Bay in 2014 compared to other years of study.

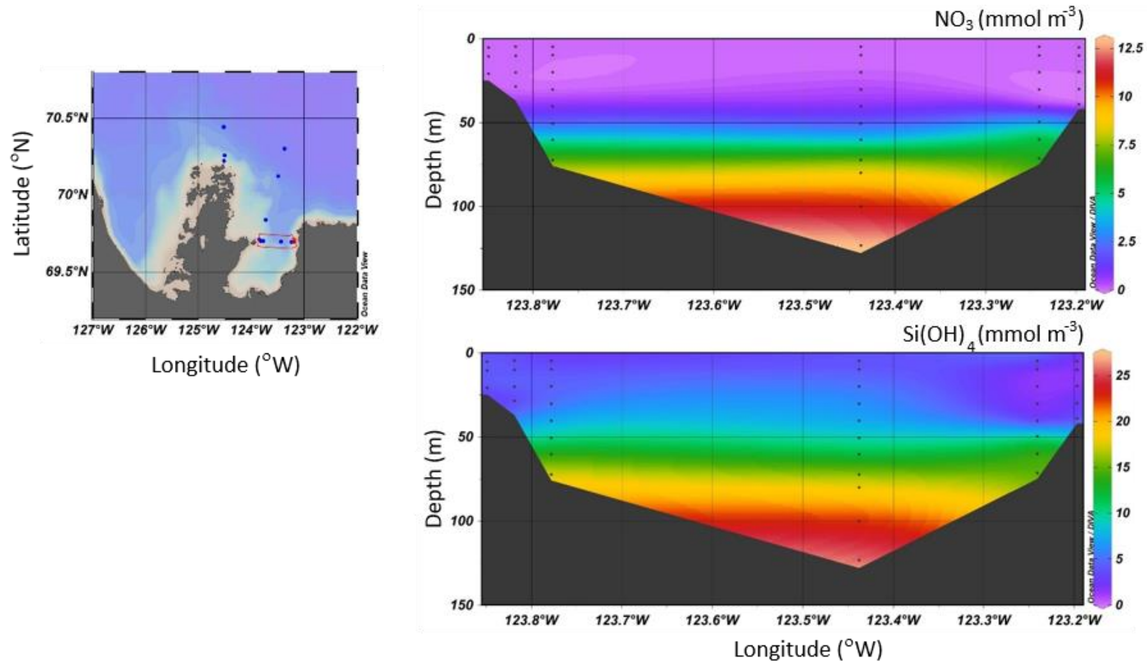

Figure 11. Section plots showing the distribution of nitrate (NO_3) and silicic acid ($Si(OH)_4$) along the BPT transect in Darnley Bay in 2013. Sampling depths at each station are indicated by filled circles. Red box in map shows the section stations. Bathymetry, based on depth measured at each station, is shaded in dark. Figure created by C. Michel using Ocean Data View (Schlitzer, 2018).

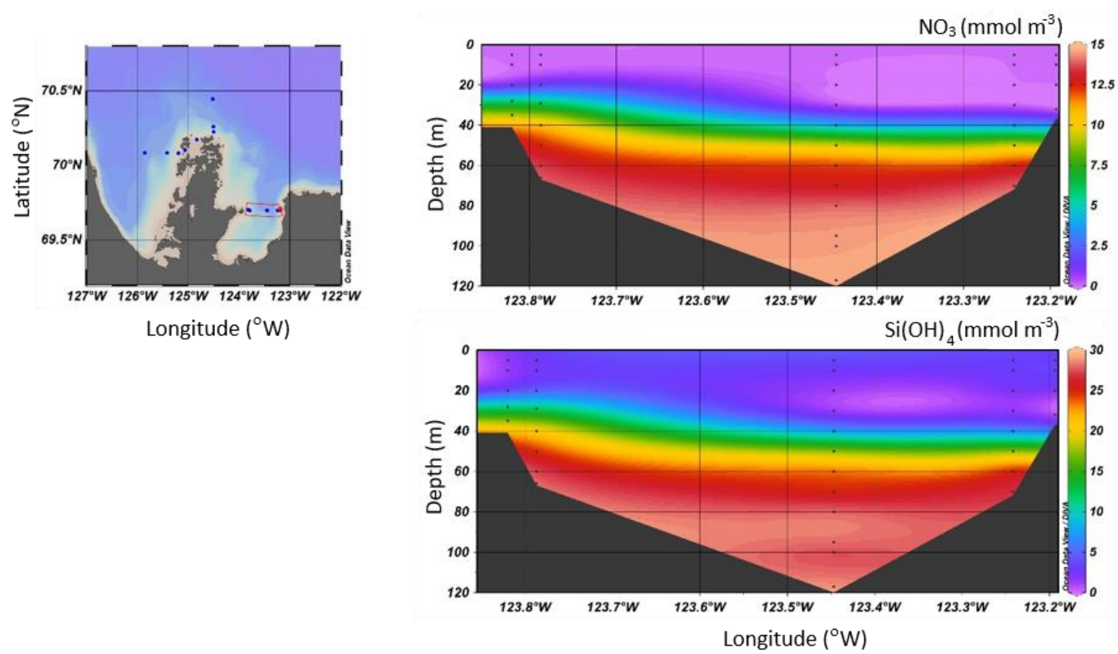

Figure 12. Section plots showing the distribution of nitrate (NO_3) and silicic acid ($Si(OH)_4$) along the BPT transect in Darnley Bay in 2014. Sampling depths at each station are indicated by full circles. Red box in map shows the section stations. Bathymetry, based on depth measured at each station, is shaded in dark. Figure created by C. Michel using Ocean Data View (Schlitzer, 2018).

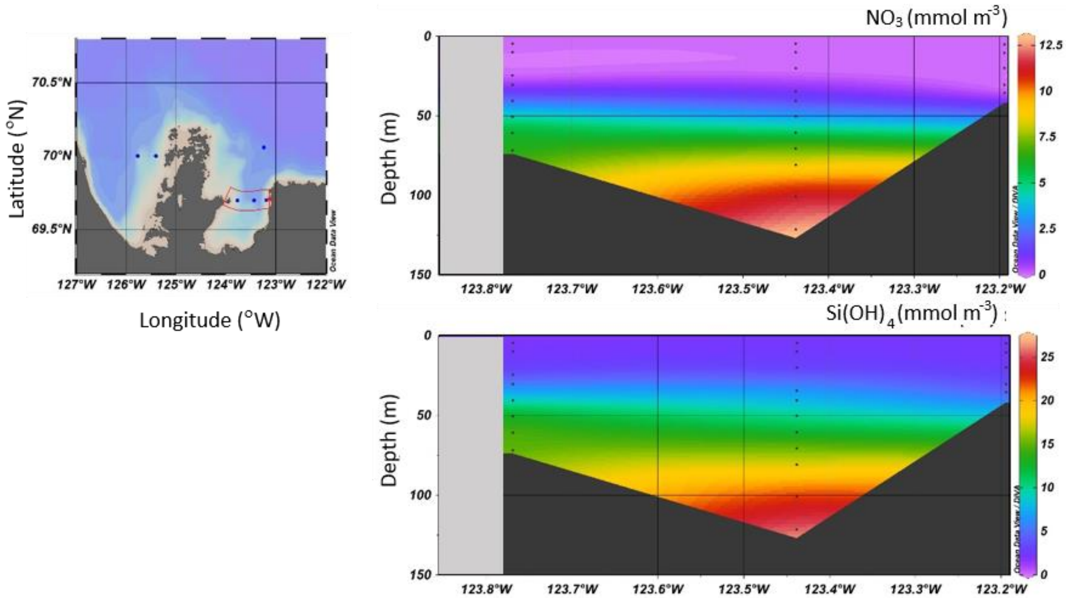

Figure 13. Section plots showing the distribution of nitrate (NO_3) and silicic acid ($Si(OH)_4$) along the BPT transect in Darnley Bay in 2017. Sampling depths at each station are indicated by full circles. Red box in map shows the section stations. Bathymetry, based on depth measured at each station, is shaded in dark. Region not sampled at western extremity of transect line is masked (pale grey shading). Figure created by C. Michel using Ocean Data View (Schlitzer, 2018).

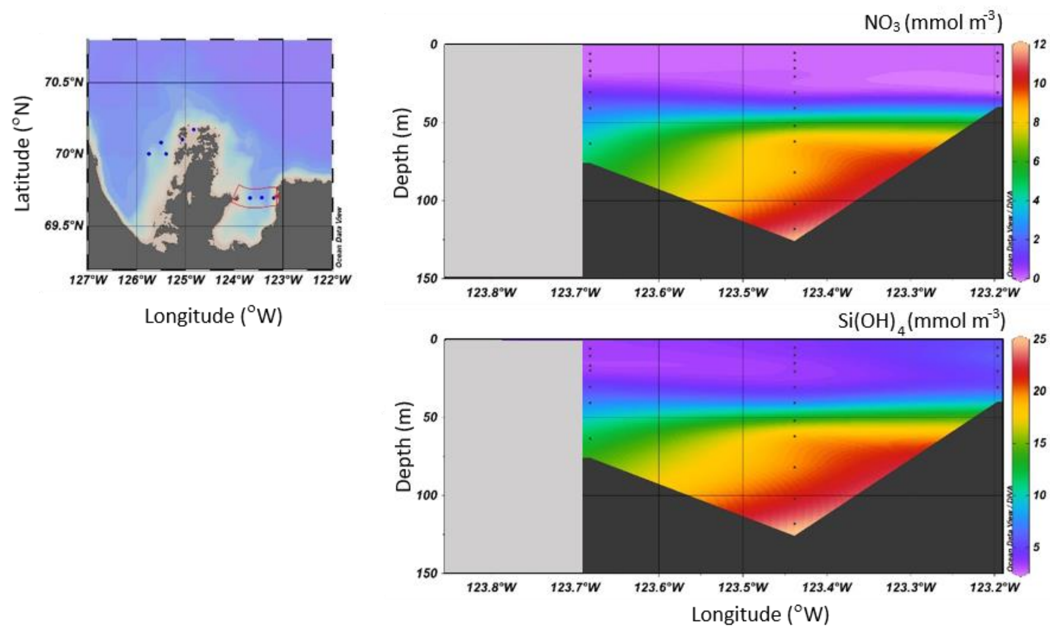

Figure 14. Section plots showing the distribution of nitrate (NO_3) and silicic acid ($Si(OH)_4$) along the BPT transect in Darnley Bay in 2018. Sampling depths at each station are indicated by full circles. Red box in map shows the section stations. Bathymetry, based on depth measured at each station, is shaded in dark. Region not sampled at western extremity of transect line is masked (pale grey shading). Figure created by C. Michel using Ocean Data View (Schlitzer, 2018).

The distribution of chl *a* in Darnley Bay along the same cross-section does not show consistent patterns among sampling years (Figure 15). Overall, chl *a* concentrations were rather low (< 1 mg m^{-3}), with some localized areas of higher chl *a* concentrations (> 1 mg m^{-3}) in all years except 2017 (Figure 15). The lack of consistent interannual patterns in chl *a* distribution and the absence of a clear relationship between chl *a* and nutrient concentrations highlights the importance of measuring biological variables for biomass (e.g., chl *a*) and if possible, production of primary producers to understand ecosystem processes.

The transect extending offshore from Darnley Bay (Figure 16) shows that the surface nutrient depletion in Darnley Bay extends to the wider Beaufort Sea towards the Amundsen Gulf. The localized sub-surface chl *a* maximum in the coastal region could result from a deepening of the surface bloom to access the deeper nutrient pool or from sinking toward the end of the bloom, thereby supporting the benthic food web. Results overall suggest a tight pelagic-benthic coupling in the shallow coastal waters of the bay.

Sections offshore of Cape Parry in 2013 and 2014 (Figures 17 and 18) reflect the complexity of oceanographic processes in the region (see Section 3.1), with chl *a* maxima located either near the coast or further offshore during the study years. With continued extensive nutrient depletion in surface waters, results indicate that the bulk of primary production takes place prior to the study period. The subsurface chl *a* maxima in 2014 is also indicative of such, reflecting a later stage of development of the phytoplankton bloom. It is possible that primary producers could start depleting surface nutrients very early in the season and possibly during the ice-covered period (i.e., under-ice blooms).

Overall, the results indicate coastal areas of potentially higher production and possibly tight linkages to the benthos, suggesting that the ANMPA is a productive area for higher trophic levels. The multiple-year study shows the high interannual variability and complexity of processes supporting primary production and its transfer to higher trophic levels. Results from subsequent years also demonstrate the importance of measuring primary biomass, and if possible production, concomitant with measurements of nutrients and physical parameters, due to the lack of linearity in processes and relationships among key ecological variables.

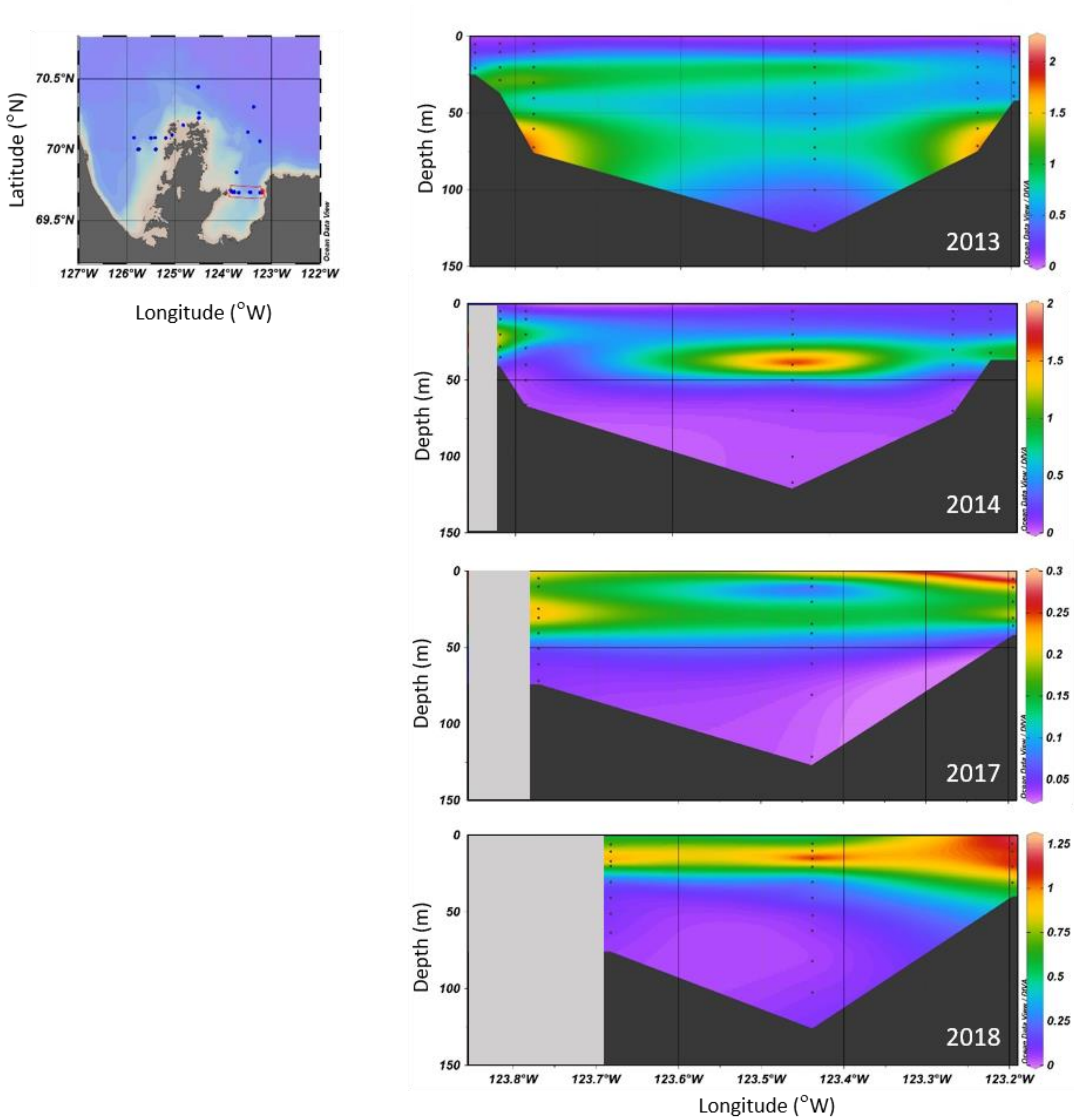

Figure 15. Section plots showing chl *a* distribution along the BPT transect in Darnley Bay from 2013 to 2018. Sampling depths at each station are indicated by full circles. Red box in map shows the section stations. Bathymetry, based on depth measured at each station, is shaded in dark. Region not sampled at western extremity of transect line is masked (pale grey shading). Figure created by C. Michel using Ocean Data View (Schlitzer, 2018).

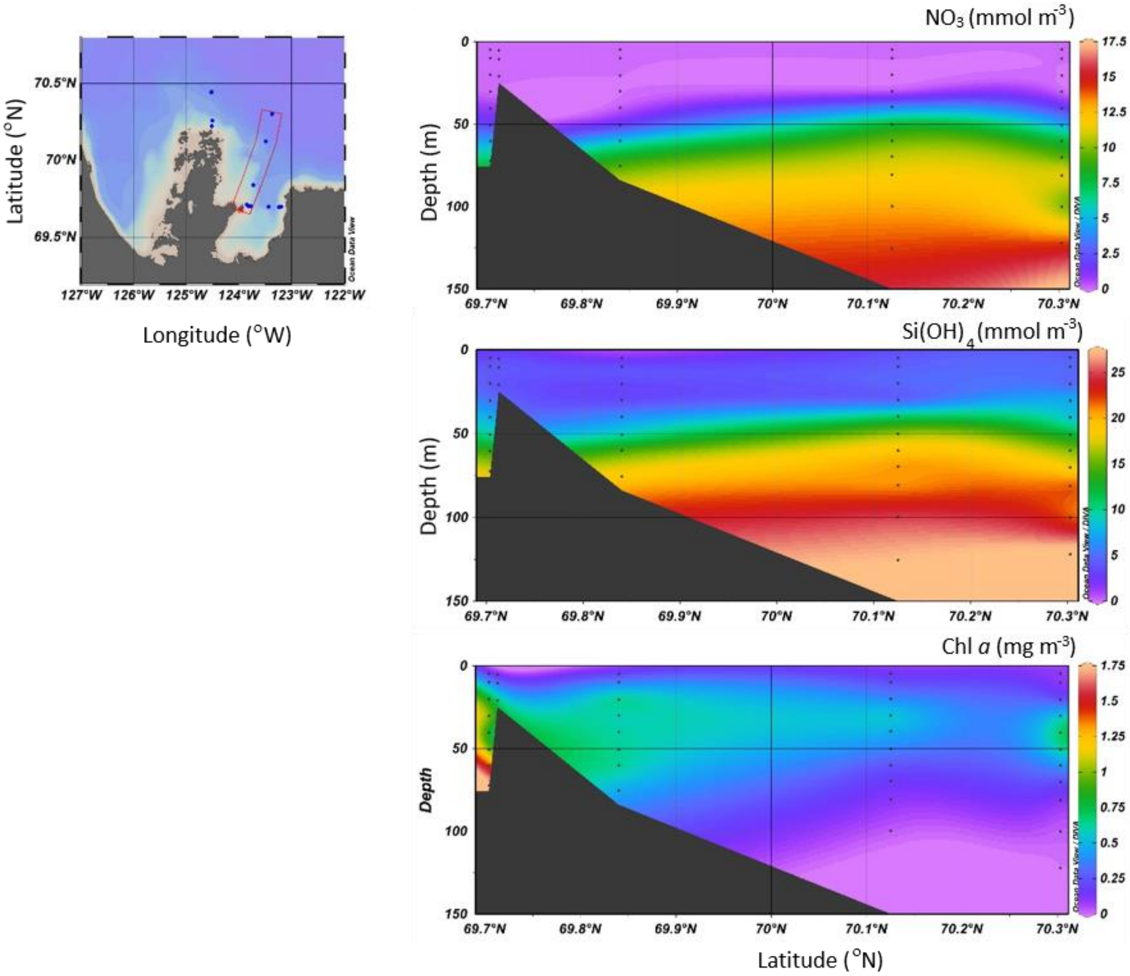

Figure 16. Section plots showing nitrate (NO_3), silicic acid ($Si(OH)_4$) and chl *a* distribution along the DAR transect, extending offshore from Darnley Bay in 2013. Sampling depths at each station are indicated by full circles. Red box in map shows the section stations. Bathymetry, based on depth measured at each station, is shaded in dark. Figure created by C. Michel using Ocean Data View (Schlitzer, 2018).

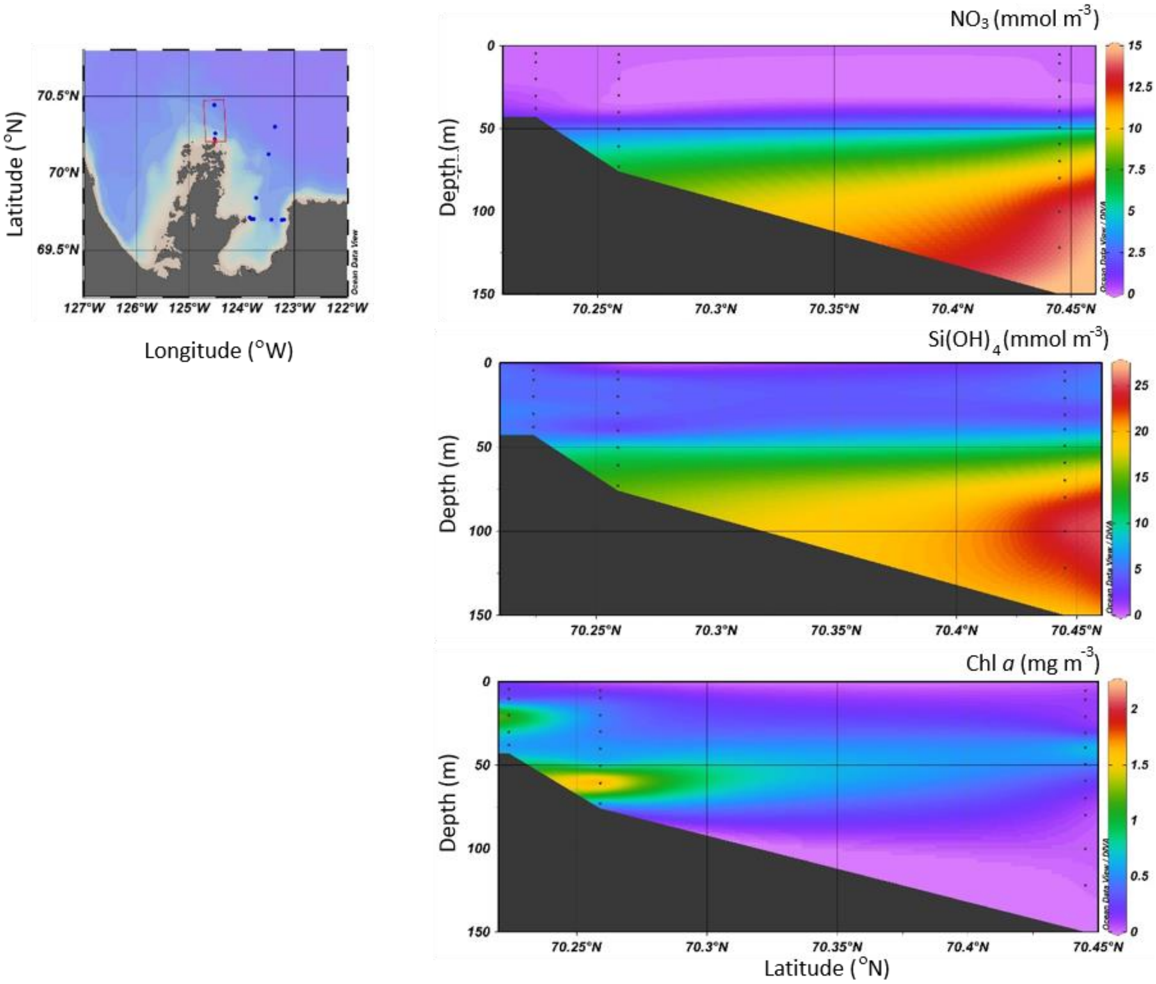

Figure 17. Section plots showing nitrate (NO_3), silicic acid ($Si(OH)_4$) and chl *a* distribution along the CPY transect, offshore of Cape Parry in 2013. Sampling depths at each station are indicated by full circles. Red box in map shows the section stations. Bathymetry, based on depth measured at each station, is shaded in dark. Figure created by C. Michel using Ocean Data View (Schlitzer, 2018).

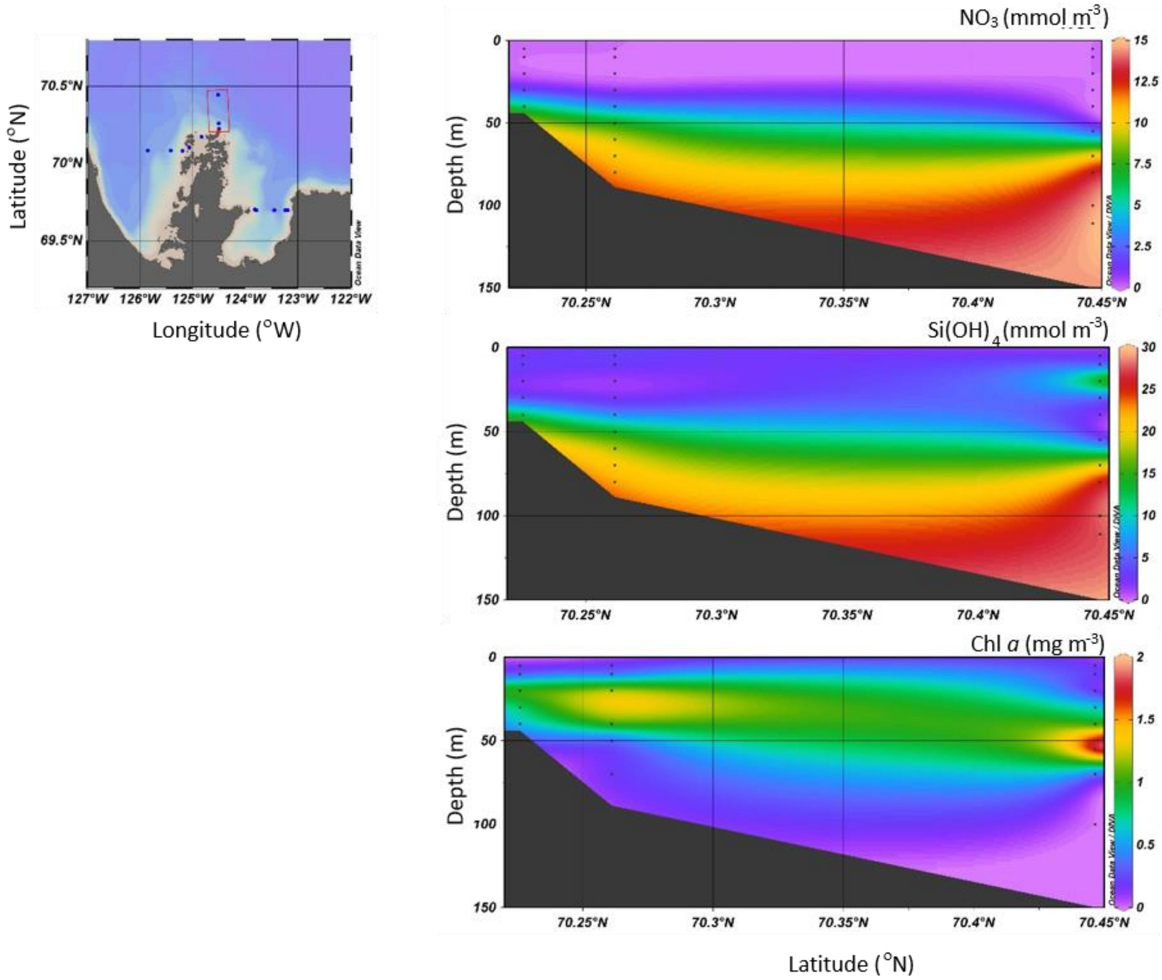

Figure 18. Section plots showing nitrate (NO_3), silicic acid ($Si(OH)_4$) and chl *a* distribution along the CPY transect, offshore of Cape Parry in 2014. Sampling depths at each station are indicated by full circles. Red box in map shows the section stations. Bathymetry, based on depth measured at each station, is shaded in dark. Figure created by C. Michel using Ocean Data View (Schlitzer, 2018).

3.3 Zooplankton diversity, abundance and biomass 2012-2014

From BREA-MFP stations sampled in 2012-2014, within 15 NM of the ANMPA, 65 mesozooplankton taxa were identified, including 42 copepod taxa (Appendix C). At the CPY transect stations (2013 and 2014 combined), copepod species represented >98 %, by number, of all zooplankton collected. Mesozooplankton abundance was dominated by seven different copepod species and copepod nauplii. Gelatinous appendicularian species (*Fritillaria* sp. and *Oikopleura* sp.) were also abundant in and around the ANMPA (Table 3). Zooplankton abundance was variable between years. Interannual variability was especially evident at the CPY transect where, for example, *Calanus glacialis* was 21 times more abundant in 2014 than in 2013.

Table 3. Average abundance of numerically dominant mesozooplankton species from the Bennett Point (BPT), Cape Parry (CPY), Darnley Bay (DAR), Franklin Bay (FRK) and Wise Bay (WIS) transects sampled in 2013 and 2014. Number of stations are in parentheses.

	Average Abundance (ind. m^{-2})						
	BPT		CPY		DAR	FRK	WIS
Species	2013 (5)	2014 (5)	2013 (3)	2014 (3)	2013 (4)	2014 (3)	2014 (2)
Calanus glacialis	1993	15762	822	17682	1310	30633	40460
Calanus hyperboreus	465	281	814	443	850	1890	378
Copepoda nauplii	12014	18989	6321	30823	15093	29278	15281
Fritillaria borealis	28888	13040	1953	18763	18827	12750	20722
Metridia longa	4	29	516	828	689	13	0
Microcalanus spp.	311	390	1438	2361	2540	1870	796
Oikopleura sp.	830	4912	258	3680	527	4193	4427
Oithona similis	27325	56603	13761	75096	25521	56036	57649
Pseudocalanus spp.	5409	3277	2113	13880	5807	15438	29666
Triconia borealis	5118	17777	5205	39971	9994	34636	48667

In 2014, mesozooplankton biomass was higher along the Franklin (FRK) transect than in the ANMPA (CPY transect) (Table 4), with gelatinous and copepod species contributing similarly to total biomass. Along the CPY transect, average mesozooplankton biomass was lowest at the 40 m station in 2013 (72 mg m^{-2}) and increased offshore, with biomass reaching 2688 mg m^{-2} and 5340 mg m^{-2} at the 75 and 200 m stations, respectively (not shown). In 2014, biomass also increased from near to offshore stations (924, 1870, 2882 mg m^{-2} at 40, 70 and 175 m stations, respectively).

Zooplankton community composition observed during BREA-MFP, in and around the ANMPA, was similar to previously (2002) identified shelf assemblages (Darnis et al. 2008) located on the Beaufort Sea Shelf and in Franklin Bay.

Table 4. Top mesozooplankton biomass contributors (average biomass) from the Bennett Point (BPT), Cape Parry (CPY), Darnley Bay (DAR), Franklin Bay (FRK) and Wise Bay (WIS) transects sampled in 2013 and 2014. Number of stations in parentheses.

	Average Biomass (mg m^{-2})						
	BPT		CPY		DAR	FRK	WIS
Species	2013 (5)	2014 (5)	2013 (3)	2014 (3)	2013 (4)	2014 (3)	2014 (2)
Aeginopsis laurentii	170	896	131	0	77	129	36
Aglantha digitale	686	1038	1074	598	1115	3027	245
Calanus glacialis	85	84	158	374	182	1183	872
Calanus hyperboreus	754	380	1664	376	1812	1263	261
Fritillaria borealis	289	130	20	188	188	128	207
Metridia longa	2	17	305	490	376	8	0
Oikopleura sp.	180	49	57	37	117	42	44
Oithona similis	18	31	10	44	22	35	34
Pseudocalanus spp.	8	16	4	21	10	26	55
Triconia borealis	4	35	5	74	15	70	101

3.4 Marine fishes

Herein we provide species occurrence and abundance-based catch-per-unit-effort (CPUE) data for fishes captured within 15 NM of the ANMPA during the BREA-MFP (2013-2014) and the CBS-MEA (2017). Volume backscattering strength (SV) data from linked hydroacoustic surveys (2013 and 2014) within the vicinity of the ANMPA are also presented. Detailed spatial occurrences of fish species are presented by McNicholl et al. (2020).

During 2012, 2013, and 2017, 6831 marine fishes were captured from stations within the 15 NM of the ANMPA. A minimum of 35 species were recorded (see section 2.4.4), representing 20 genera, and 11 taxonomic families (Appendix D). The genus *Boreogadus*, represented by Arctic Cod (*B. saida*), was the most abundant fish across all transects and years, except for at the Cape Parry transect (CPY) in 2014 (Table 5). Arctic Cod is the most abundant marine fish species in the Beaufort Sea (Rand and Logerwell 2010, Majewski et al. 2017), and is also among the most important forage species in Arctic ecosystems (Mueter et al. 2016).

Capelin (*Mallotus villosus*) co-occurred with Arctic Cod at all transects except for at Wise Bay (WIS) and DEX hydroacoustic break points (see Appendix A), albeit in much lower abundances. Capelin was particularly abundant in samples from Bennett Point (BPT) in 2013 (Table 5). Arctic Alligatorfish (*Aspidophoroides olrikii*) were relatively abundant throughout the focal area (Table 5), and were the most abundant fish sampled from the Cape Parry (CPY) area in 2014.

Sculpins (Cottidae family) are common throughout the Beaufort Sea (Mecklenburg et al. 2002, Rand and Logerwell 2010, Coad and Reist 2018, Majewski et al. 2017). Representatives from the genera *Gymnocanthus* and *Icelus* were relatively abundant in proximity to the ANMPA (Table 5). The Arctic

Staghorn Sculpin (*Gymnocanthus tricuspis*) occurred along most transects, with CPUE values highest at BPT and Franklin Bay (FKN) stations in 2017. The *Icelus* genus, represented by the Twohorn Sculpin (*Icelus bicornis*) and Spatulate Sculpin (*Icelus spatula*) also occurred throughout the focal area, and were most abundant in catches at BPT in 2013 (Table 5). Ribbed Sculpin (*Triglops pingelli*) and Bigeye Sculpin (*Triglops nybelini*) were also common, but generally had lower relative abundances than the *Gynocanthus* and *Icelus* species. *Artediellus atlanticus* also occurred at the CPY transect (Appendix D).

Eelpouts (Zoarcidae family) of the genus *Lycodes* occurred throughout the focal area, with the highest CPUE values occurring at the BPT and FKN transects in 2017 (Table 5). Abundances of *Lycodes* were also relatively high at the Darnley Bay (DAR) and WIS stations. *Gymnelus* species also occurred at lower relative abundances at stations along BPT, CPY, and FRK, with the highest relative abundance occurring at CPY in 2014.

Pricklebacks (Stichaeidae family, Lumpeninae sub-family) occurred throughout the focal area in relatively high abundances (Table 5). CPUE values indicated relative high abundances of *Anisarchus* species at WIS in 2014. Species from the genus *Leptoclinus* were relatively abundant at BPT and DAR in 2013. Unidentified Lumpeninae were also relatively abundant at BPT and FKN in 2017.

Species from the families Clupeidae (herrings), Cyclopteridae (lumpsuckers), Liparidae (snailfishes), Myctophiformes (lanternfishes), and Pleuronectidae (righteye flounders) also occurred in the focal area in low relative abundances (Table 5).

Table 5. Abundance-based catch-per-unit-effort (CPUE) for marine fish genera caught within 15 NM of the Anguniaqvia niqiqyuam Marine Protected Area (ANMPA) using a modified Atlantic Western IIA bottom trawl. Locations of transects (BPT, CPY, DRK, FKN, WIS) are shown in Figure 2.

	Catch per Unit Effort (Individuals per km^2)							
	BPT			CPY	DAR	FKN	FRK	WIS
	2013	2014	2017	2014	2013	2017	2014	2014
Aspidophoroides sp.	338	32	121	523	189	151	61	11
Benthosema sp.	0	0	0	0	4	0	0	0
Boreogadus sp.	7587	831	2240	448	2877	312	678	607
Careproctus sp.	0	0	6	0	27	0	0	0
Clupea sp.	17	0	0	0	0	0	0	0
Eumesogrammus sp.	0	0	0	8	0	0	0	0
Eumicrotremus sp.	34	0	15	84	23	0	0	11
Gymnelus sp.	0	0	3	54	8	0	3	0
Gymnocanthus sp.	160	12	333	8	27	40	23	32
Hippoglossoides sp.	0	0	0	0	0	3	0	0
Icelus sp.	432	57	70	88	92	27	15	64
Leptagonus sp.	0	0	6	0	4	0	0	0
Liparis sp.	16.9	5	3	0	38	4	9	64
Lycodes sp.	118	42	48	54	69	31	14	75
Mallotus sp.	2396	7	55	0	219	3	0	0
Reinhardtius sp.	0	0	0	0	8	3	0	0
Triglops sp.	42	0	15	4	12	0	0	0
Lumpeninae*	254	62	160	138	451	77	81	596

*Sub-family was used where genus and species could not be identified.

3.4.1 Hydroacoustics analysis

Hydroacoustic signals reflect off biota, return to the vessel, and indicate the abundance and vertical distribution of marine organisms. Here, the received signal strengths (termed backscattering) indicate the relative abundance of pelagic fishes and large zooplankters present in the surveyed areas between 0 – 100 m depths. Both surveys (2013 and 2014) collected data from Darnley Bay and the northwestern portion of the ANMPA. In 2013 and 2014, area backscattering strength (S_a in dB re 1 m^2 m^{-2}) within the vicinity of the ANMPA ranged over approximately 30 dB, with very similar mean values. The mean was -64 dB in 2013 (standard deviation of – 5 dB and + 2 dB) and -64 dB (standard deviation of – 10 dB and +3 dB) in 2014 (Figure 19). The difference between the upper and lower values of the standard deviation results from the logarithmic scale. These results suggest similar overall abundances of pelagic fishes and large zooplankton between 2013 and 2014. However, during both 2013 and 2014 their abundances were 3 dB greater in the northwestern region of the ANMPA, near Cape Parry (Figure 20). Assuming that the signal was dominated by age-0 arctic cod (*B. saida*) 1.85 cm long (Geoffroy et al. 2016), this would represent a two-fold increase in abundance compared to the rest of the ANMPA (0.537 to 1.072 fish m^{-2}).

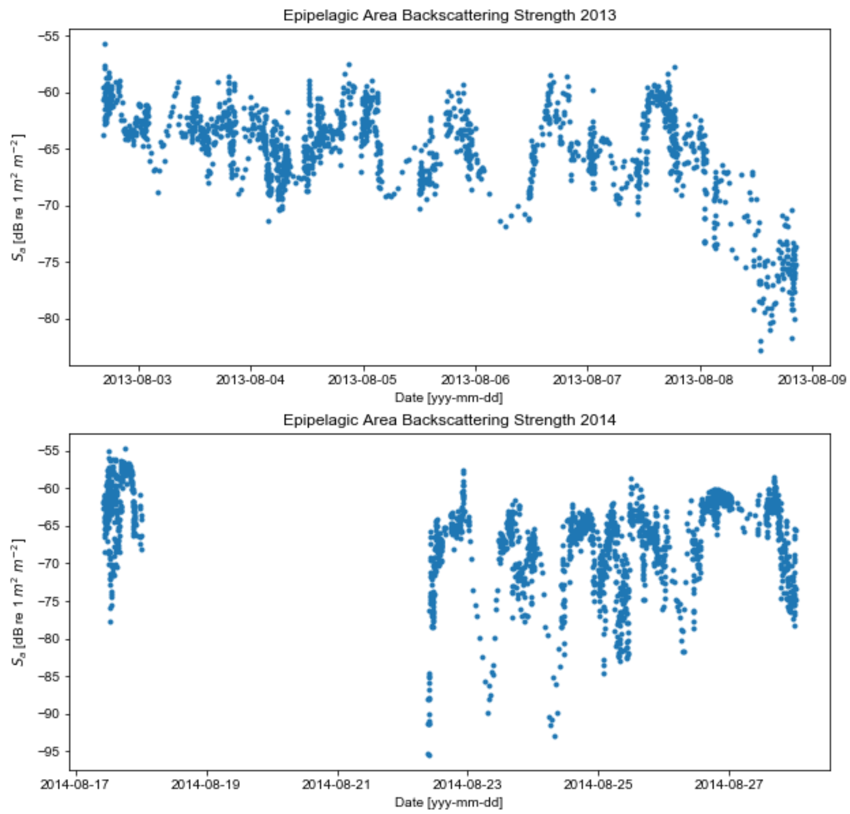

Figure 19. Summary of the area backscattering strength (S_a in dB re 1 m^2 m^{-2}) versus time within the ANMPA during August 2013 and 2014. Each dot represents the area backscattering strength integrated over 0 – 100 m for a distance of 0.25 m.

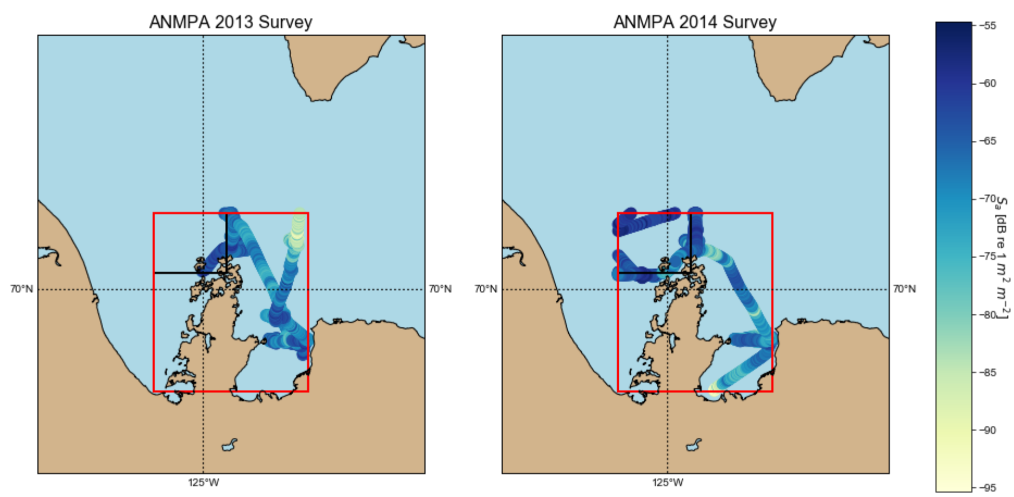

Figure 20. Map of area backscattering strength (S_a in dB re 1 m^2 m^{-2}) integrated over 0 – 100 m within the ANMPA during August 2013 and 2014. The red box indicates the ANMPA zone used for the hydroacoustic analysis, the black box represents the area described as the northwestern region of the ANMPA, near Cape Parry.

3.5. Benthic invertebrates and habitat

3.5.1 Epifaunal biomass density, richness, and diversity

Epifaunal community composition data were available for 21 stations near the ANMPA. Samples were collected during 37 sampling events between 2013 and 2018 (Figs. 21 and 22). For the region surrounding the ANMPA, 400 taxa of benthic epifauna were identified, representing 12 phyla (Appendix E), with a cumulative total biomass density of 24.1 g m^{-2} across all stations and sample years. The ten taxa with the highest biomass densities comprised 76 % of the cumulative total across all stations and years combined. The top nine of these taxa were large-bodied echinoderms, followed by the decapoda *Argis dentata*. The crinoid *Heliometra glacialis* and the brittle star *Ophiacantha bidentata* contributed the most biomass density to the cumulative community total (Table 6), but this was largely driven by unusually high biomass densities observed along the CPY transect in 2014. The brittle stars *Ophiocten sericeum* and *O. bidentata* were observed at relatively high biomass densities more consistently along transects surrounding the ANMPA. Species richness, however, was dominated by Arthropoda, which accounted for 39 % of all taxa sampled in the region, followed by Annelida and Mollusca, each of which accounted for 21 % of taxa (Table 6).

Table 6. Top ten epifauna taxa contributing the most to the cumulative biomass density (g m^{-2}) at stations within 15 NM of the ANMPA from 2013-2018. Biomass density is reported as the cumulative total across all stations, and the cumulative total along each transect by year. CCB: Cumulative Community Biomass; NP = Not Present.

Top biomass contributors	Biomass (g m^{-2})									
	AMG	BPT				CPY		DAR	FKN	
	2017	2013	2014	2017	2018	2013	2014	2013	2017	2018
Heliometra glacialis	0.007	0.029	0.024	NP	NP	0.093	4.906	0.074	0.057	0.016
Ophiocten sericeum	0.014	0.345	0.570	0.060	0.033	0.065	1.084	0.002	0.117	0.168
Ophiacantha bidentata	0.002	NP	0.005	0.000	0.000	0.247	2.028	0.203	0.014	0.016
Urasterias lincki	0.077	0.320	0.410	0.265	0.262	NP	NP	0.030	0.284	0.066
Ophiopleura borealis	0.010	NP	0.018	0.000	0.010	0.017	NP	1.712	NP	NP
Gorgonocephalus sp.	NP	0.115	NP	NP	NP	0.001	0.032	0.138	NP	0.425
Gorgonocephalus arcticus	0.162	NP	0.165	NP	NP	NP	NP	NP	0.379	NP
Ctenodiscus crispatus	0.011	0.233	0.068	NP	0.031	NP	NP	0.273	NP	0.019
Pontaster tenuispinus	0.013	NP	0.013	NP	NP	0.073	0.021	0.455	NP	NP
Argis dentata	0.018	0.020	0.050	0.083	0.128	0.003	0.033	0.027	0.080	0.017

Top biomass contributors	Biomass (g m^{-2})					
	FRK		WIS		Total per taxa	% of total CCB density
	2014	2018	2014	2018		
Heliometra glacialis	0.023	0.115	NP	NP	5.343	22.22
Ophiocten sericeum	0.474	0.000	NP	< 0.001	2.932	12.19
Ophiacantha bidentata	0.090	0.002	NP	NP	2.608	10.84
Urasterias lincki	0.190	0.324	NP	NP	2.229	9.27
Ophiopleura borealis	0.021	NP	NP	NP	1.788	7.44
Gorgonocephalus sp.	0.175	NP	NP	NP	0.885	3.68
Gorgonocephalus arcticus	NP	NP	NP	NP	0.706	2.94
Ctenodiscus crispatus	0.008	0.011	NP	NP	0.653	2.72
Pontaster tenuispinus	0.021	NP	NP	NP	0.596	2.48
Argis dentata	0.008	0.015	0.012	0.015	0.509	2.12

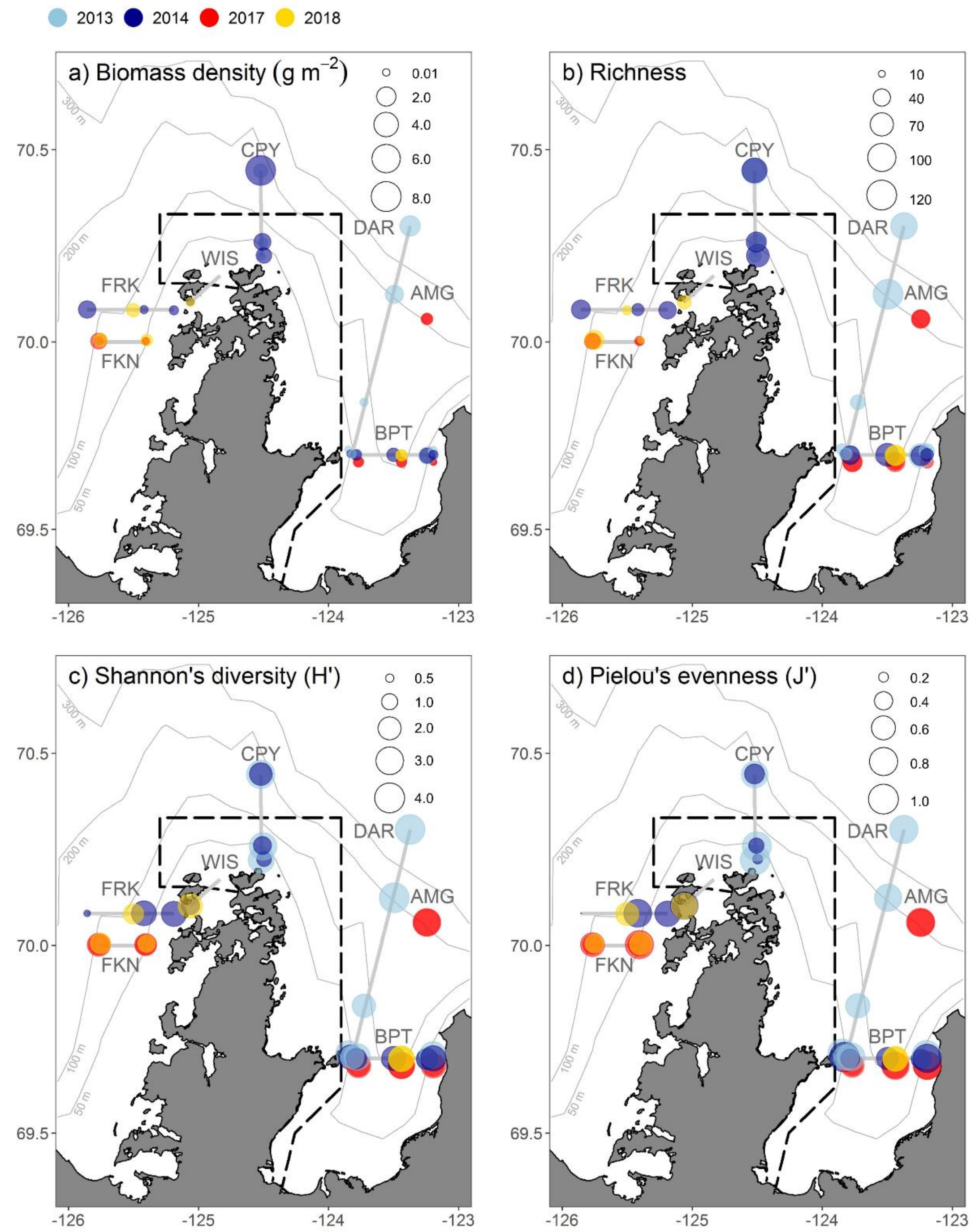

Figure 21. Map of epifauna diversity indices observed at all stations sampled within 15 NM of the ANMPA from 2013-2018, including a) biomass density (g m^{-2}), b) taxa richness, c) Shannon's diversity (H'), and d) Pielou's evenness (J'). Symbol size is scaled to reflect the value observed at each station, with larger symbols indicating higher values. The extent of the ANMPA is indicated by dashed lines.

Richness at individual stations varied from five (WIS_01, 2014) to 114 taxa (DAR_03, 2013), with an average of 40.7 taxa observed per sampling event. Biomass density ranged from < 0.01 (BPT_01, 2017) to 6.85 g m^{-2} (CPY_03, 2014), with an average of 0.59 g m^{-2} observed per sampling event. Epifaunal taxa richness and biomass density were both highest at the deeper stations along the DAR and CPY transects, and lowest at the shallow stations in Franklin and Darnley bays (Figure 21). Inter-annual variation in richness and biomass density was generally low within stations that were sampled in multiple years, with no clear or consistent trend. Shannon's diversity and Pielou's evenness exhibited less variation among stations and years than biomass density and richness, remaining relatively high even at stations with relatively low biomass density and/or species richness (Figure 21). The lowest values of Shannon's diversity and Pielou's evenness were observed at the shallow stations along the FRK, CPY, WIS, and DAR transects.

3.5.2 Infaunal biomass density, richness, and diversity

Infaunal community data were available for 20 stations, collected from 34 sampling events between 2013 and 2018 (Table 7). For the region surrounding the ANMPA, 352 taxa were identified in benthic infauna samples, representing 14 phyla (Appendix F), with a cumulative total biomass density of 2796.3 g m^{-2} across all stations and sample years. The ten taxa with the highest biomass densities comprised 72 % of the cumulative total across all stations and years combined (Table 7). The top three of these taxa were the bivalves *Astarte borealis*, *Musculus niger*, and *Macoma calcarea* (Table 7), which together comprised 49 % of the total cumulative biomass observed. The high biomass density of *A. borealis* was linked to especially high values along the FKN transect in 2017 and 2018, and along the WIS transect in 2014. *M. niger* was only observed along the FRK transect in 2014, but at very high biomass densities. In contrast to the most biomass-dense epifaunal taxa, most of the other ten top biomass-contributing infaunal taxa were not observed consistently across transects or years in the vicinity of the ANMPA (Appendix F, Table 7). High inter-annual variation observed in infaunal community composition may be linked to the small surface area sampled for infauna from the box core (0.12 m^2) compared to the average area sampled for epifauna by the beam trawl (2287 m^2). Infauna taxa richness was dominated by Annelida (39 % of all taxa), Arthropoda (30 %), and Mollusca (22 %).

Richness at individual stations varied from 14 (FRK_02, 2014) to 72 taxa (CPY_02, 2013), with an average of 39.1 taxa observed per sampling event. Biomass density ranged from 2.40 (FRK_02, 2014) to 537 g m^{-2} (FRK_01, 2014), with an average of 75.6 g m^{-2} observed per sampling event. In contrast to epifauna, infaunal biomass densities were highest at shallow stations along the eastern edge of Franklin Bay, and were lowest at deeper stations along the FKN, FRK, CPY, and DAR transects (Figure 22). The lowest values for infauna diversity (H') were also observed at deeper stations along the FKN, CPY, and AMG transects. The relatively high infaunal biomass densities and diversity in shallow compared to offshore areas near the ANMPA may be linked to the localized sub-surface chl *a* maximum that occurred in the coastal region (described in Section 3.2). However, targeted studies would be needed to confirm whether tight coupling with pelagic primary production was responsible for higher benthic infaunal biomass in the coastal regions.

Infauna taxa richness was less variable among stations and years than infauna biomass densities, or than epifauna taxa richness (Figures 21 and 22). Inter-annual variation in infauna richness and biomass density was generally low within stations that were sampled in multiple years, with no clear or consistent trend. Also similar to epifauna, Shannon's diversity and J' exhibited less variation among stations and years than biomass density and richness, remaining relatively high even at stations with relatively low biomass density and/or species richness (Figure 22).

A potentially new Cumacean species was collected in 2014 and 2017 along the BPT transect (S. Gerken, pers. comm). Investigations are underway to confirm the discovery, and, if confirmed, to describe the new species.

Table 7. Top ten infauna taxa contributing the most to the cumulative biomass density (g m^{-2}) at stations within 15 NM of the ANMPA from 2013-2018. Biomass density is reported as the cumulative total across all stations, and the cumulative total along each transect by year.

Top biomass contributors	Biomass (g m^{-2}) AMG	BPT				CPY		DAR	FKN	
	2017	2013	2014	2017	2018	2013	2014	2013	2017	2018
Astarte borealis	NP	NP	NP	3.59	NP	NP	NP	NP	216.00	101.00
Musculus niger	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Macoma calcarea	NP	NP	9.21	NP	NP	NP	37.10	37.70	NP	NP
Nemertea	NP	4.47	10.27	0.52	0.17	0.21	0.83	94.49	0.18	15.48
Ctenodiscus crispatus	NP	NP	NP	NP	NP	NP	NP	121.00	NP	NP
Astarte moerchi	NP	NP	NP	NP	NP	NP	NP	113.00	NP	NP
Periploma aleuticum	NP	NP	NP	38.20	NP	NP	NP	NP	NP	NP
Laonice cirrata	2.67	1.10	4.85	16.81	5.50	2.55	NP	NP	14.63	NP
Balanus balanus	NP	NP	NP	63.20	NP	NP	NP	NP	NP	NP
Yoldia hyperborea	NP	37.30	NP	NP	NP	NP	NP	NP	0.03	12.20

Top biomass contributors	Biomass (g m^{-2}) FRK		WIS		Total per taxa	% of total CCB density
	2014	2018	2014	2018		
Astarte borealis	NP	NP	263.00	NP	583.59	20.87
Musculus niger	519.00	NP	NP	NP	519.00	18.56
Macoma calcarea	NP	NP	45.70	124.00	253.71	9.07
Nemertea	0.19	NP	NP	1.51	128.32	4.59
Ctenodiscus crispatus	NP	NP	NP	NP	121.00	4.33
Astarte moerchi	NP	NP	NP	NP	113.00	4.04
Periploma aleuticum	NP	NP	4.76	50.09	93.05	3.33
Laonice cirrata	2.30	10.00	0.08	13.60	74.09	2.65
Balanus balanus	NP	NP	NP	NP	63.20	2.26
Yoldia hyperborea	NP	NP	7.74	1.02	58.29	2.08

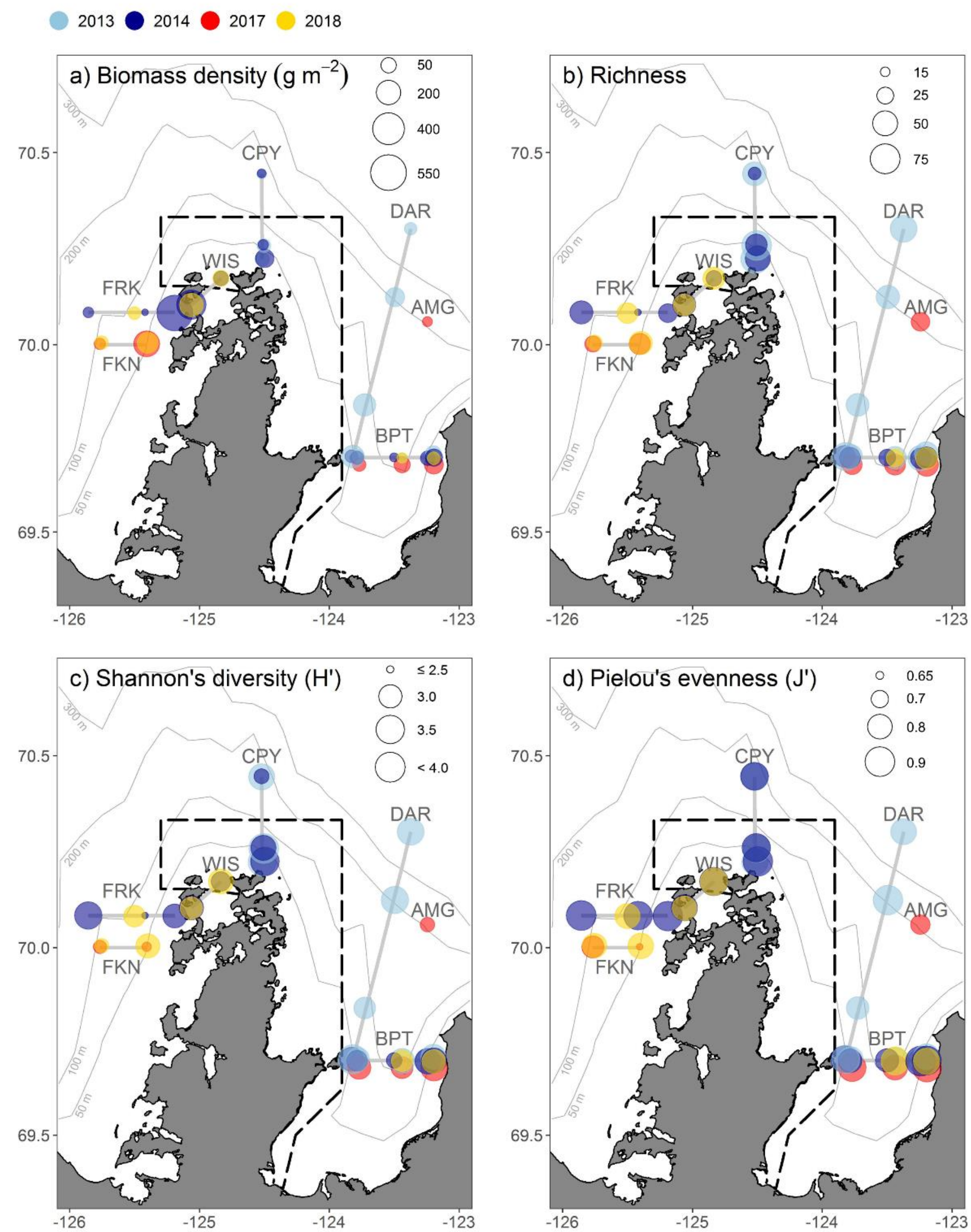

Figure 22. Map of infauna diversity indices observed at all stations sampled within 15 NM of the ANMPA from 2013-2018, including a) biomass density (g m^{-2}), b) taxa richness, c) Shannon's diversity (H'), and d) Pielou's evenness (J'). Symbol size is scaled to reflect the value observed at each station, with larger symbols indicating higher values. The extent of the ANMPA is indicated by dashed lines.

3.5.3 Benthic habitats

Benthic habitat data were available from all stations where infauna and epifauna were collected within 15 NM of ANMPA. There were no clear spatial trends in benthic habitat variables (Tables 8 and 9), and no clear associations between depth and indicators of benthic food supply aside from a potential decrease in benthic chl *a* concentrations with increasing depth (Figure 23), which would be supported by higher sub-surface chl *a* maxima observed in the coastal versus offshore regions (Section 3.2). Benthic pigment concentrations observed at BPT_05 in 2014 were unusually high compared to other observations in the region (chl *a*, phaeopigments, and total pigment concentrations were 43.24, 67.64, and 110.87 mg m^{-2} dry weight).

Table 8. Benthic habitat variables measured from 2013-2018, at each station within 15 NM of the ANMPA including percent organic matter content of dry weight (dw), and granulometry (grain sizes: clay (< 2 µm), silt (2 – 63 µm), sand (63 µm – 2 mm), and gravel (> 2 mm)).

Depth Strata (m)	Station	Year	Sample depth (m)	Organic matter content (% dw)	Granulometry (% composition) Clay	Silt	Sand	Gravel
20								
	bpt_01	2013	20	8.41	16.60	67.20	16.20	0.00
40 - 60								
	bpt_01	2014	40	6.01	16.00	84.00	0	0
	bpt_03	2017	42	1.70	18.10	81.90	0	0
	bpt_05	2013	40	10.08	19.40	80.60	0	0
	bpt_05	2014	40	4.19	21.70	78.30	0	0
	bpt_05	2018	40	7.25	24.70	75.30	0	0
	cpy_01	2013	40	9.45	17.30	82.70	0	0
	cpy_01	2014	40	6.51	23.80	76.20	0	0
	dar_01	2013	40	13.43	20.70	79.30	0	0
	fkn_06	2017	50	3.26	3.45	77.43	19.13	0
	fkn_06	2018	51	7.07	0.90	78.33	20.77	0
	frk_01	2014	40	8.33	19.20	80.80	0	0
	wis_01	2014	50	5.86	0.54	72.13	21.21	6.13
	wis_01	2018	59	7.80	0.21	47.16	27.95	24.67
	wis_02	2014	40	6.26	99.80	0.20	0	0
	wis_02	2018	47	3.27	18.40	81.60	0	0
70 - 80								
	bpt_01	2017	74	3.51	0.87	68.99	19.97	10.18
	bpt_02	2013	75	12.02	1.61	85.27	12.80	0.33
	bpt_02	2014	70	4.91	0.25	52.41	47.34	0
	bpt_04	2013	75	11.49	2.11	79.60	18.29	0
	bpt_04	2014	70	5.70	1.33	69.84	23.39	5.43
	cpy_02	2013	75	8.99	1.05	85.57	13.38	0
	cpy_02	2014	70	5.98	0.17	65.01	20.94	13.89
	dar_02	2013	75	10.36	0.82	72.51	26.44	0.23
	fkn_05	2017	77	3.50	4.37	91.53	4.11	0
	fkn_05	2018	75	6.59	2.88	90.51	6.60	0
	frk_02	2014	75	7.70	1.06	71.10	27.84	0
	frk_06	2018	75	6.33	9.58	77.93	12.50	0
120 - 130								
	bpt_02	2017	127	2.72	9.29	87.02	3.69	0
	bpt_03	2013	125	11.59	7.58	83.83	8.59	0
	bpt_03	2014	120	5.61	4.15	88.63	7.23	0
	bpt_03	2018	130	7.16	0.43	88.66	10.92	0
	frk_03	2014	125	6.75	8.35	81.41	10.25	0
175								
	cpy_03	2014	175	5.57	7.64	80.83	11.53	0
200 - 213								
	amg_01	2017	213	2.33	4.32	84.85	10.83	0
	cpy_03	2013	200	8.95	2.88	83.60	13.52	0
	dar_03	2013	200	9.26	7.08	84.57	8.36	0
350								
	dar_04	2013	350	9.91	7.98	80.76	11.26	0

Table 9. Pigments measured in sediments from 2013-2018 at each station within 15 NM of the ANMPA including chlorophyll *a* (chl *a*), phaeopigments (Phaeo), and total pigments. Stations are grouped by depth categories. ND indicates no data available.

Depth Strata (m)	Station	Year	Sample depth (m)	Chl *a* (mg m^{-2} dw)	Phaeopigments (mg m^{-2} dw)	Total pigments (mg m^{-2} dw)	Chl *a*: Phaeo
20							
	BPT_01	2013	20	ND	ND	ND	ND
40 - 60							
	BPT_01	2014	40	12.35	31.25	43.60	0.42
	BPT_03	2017	42	4.44	38.66	43.10	0.11
	BPT_05	2013	40	14.20	32.96	47.15	0.43
	BPT_05	2014	40	43.24	67.64	110.87	0.57
	BPT_05	2018	40	10.89	37.81	48.70	0.29
	CPY_01	2013	40	8.13	33.79	41.92	0.25
	CPY_01	2014	40	9.10	44.42	53.53	0.21
	DAR_01	2013	40	7.04	34.51	41.55	0.20
	FKN_06	2017	50	ND	ND	ND	ND
	FKN_06	2018	51	ND	ND	ND	ND
	FKR_01	2014	40	4.12	20.87	24.99	0.20
	WIS_01	2014	50	ND	ND	ND	ND
	WIS _01	2018	59	ND	ND	ND	ND
	WIS _02	2014	40	12.84	34.67	47.52	0.38
	WIS _02	2018	47	2.39	22.65	25.03	0.11
70 - 80							
	BPT_01	2017	74	1.04	14.28	15.32	0.07
	BPT _02	2013	75	7.49	33.61	41.09	0.22
	BPT _02	2014	70	ND	ND	ND	ND
	BPT _04	2013	75	6.03	30.97	37.00	0.19
	BPT _04	2014	70	20.83	50.20	71.03	0.41
	CPY_02	2013	75	9.17	41.87	51.04	0.21
	CPY_02	2014	70	4.93	35.56	40.49	0.14
	DAR_02	2013	75	ND	ND	ND	ND
	FKN_05	2017	77	1.80	0.01	1.81	0.10
	FKN_05	2018	75	0.85	0.01	0.86	0.18
	FRK_02	2014	75	ND	ND	ND	ND
	FRK_06	2018	75	1.68	0.01	1.69	0.15
120 - 130							
	BPT_02	2017	127	2.63	16.69	19.32	0.16
	BPT _03	2013	125	2.40	0.01	2.42	0.17
	BPT _03	2014	120	15.51	0.00	15.52	0.11
	BPT _03	2018	130	6.92	13.96	20.87	0.51
	FRK_03	2014	125	5.16	0.01	5.16	0.45
175							
	CPY_03	2014	175	1.12	10.55	11.67	0.11
200 - 213							
	AMG_01	2017	213	2.34	11.46	13.79	0.22
	CPY_03	2013	200	7.47	20.39	27.86	0.36
	DAR_03	2013	200	3.07	12.50	15.57	0.25
350							
	DAR_04	2013	350	5.03	15.32	20.35	0.33

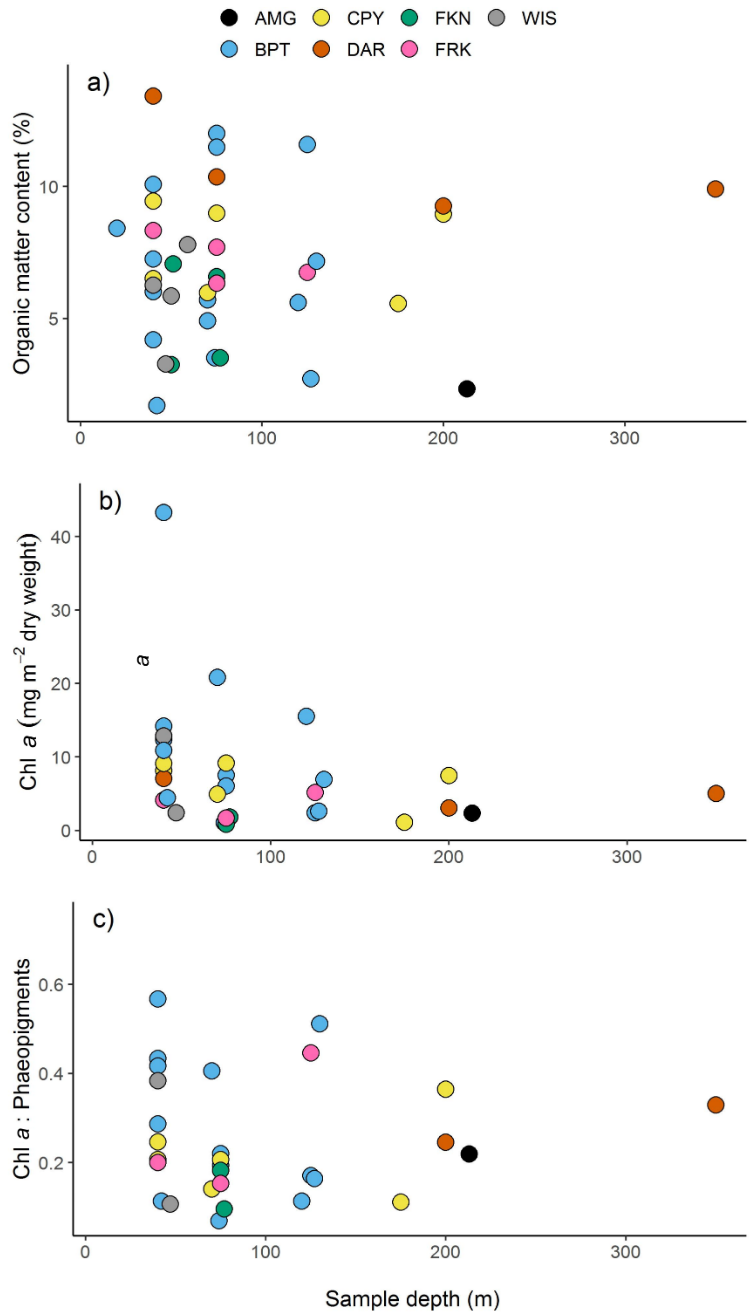

Figure 23. Associations between sampling depth and indicators of benthic food supply observed at all stations sampled within 15 NM of the ANMPA from 2013-2018, including a) organic matter content (%), b) chl *a* concentrations (mg m^{-2} dry weight), and c) the ratio of chl *a* : phaeopigments.

3.6. Stable isotopic analyses for food web studies

Within the vicinity of the ANMPA, $\delta^{15}N$ data were available from 12 stations for sediments and eight zooplankton taxa, representing the pelagic and benthic baselines of the food web, respectively. *Calanus* copepods are mostly herbivorous zooplankton that play a vital role in the Arctic marine food web by concentrating and converting energy captured by phytoplankton into dense lipid stores that are then easily accessible to fish and higher trophic levels. Adult *Calanus* spp. can thus indicate baseline stable isotope values for pelagic food sources due to their position as a pelagic primary consumer and their ubiquity across the Arctic. Similarly, sediment stable isotope values can act as a benthic baseline, providing information about the origin of organic matter sources available at the base of the benthic food web, including terrestrial sources, benthic algae, fast-settling fresh marine sources (e.g., phytoplankton blooms), or degraded marine sources (e.g., Morata et al. 2008). Raw $\delta^{15}N$ and $\delta^{13}C$ data for zooplankton and sediment are reported elsewhere (Stasko et al. 2017), but are briefly described here to provide isotopic baseline context for higher trophic animals analysed from the ANMPA region. Spatial variation in $\delta^{15}N$ and $\delta^{13}C$ was relatively low for *C. hyperboreus* (Figure 24), ranging from 9.48 to 11.08 ‰ and from -27.69 to -26.15 ‰, respectively. The values fall within those previously reported for *Calanus* spp. in the Beaufort Sea and western Canadian Arctic, although the $\delta^{13}C$ values are on the low end of the regional spectrum and suggest a relatively low influence of terrestrial organic matter compared to zooplankton sampled on the Beaufort Shelf to the west (Iken et al. 2005, Pomerleau et al. 2014). Spatial variation in sediment $\delta^{15}N$ and $\delta^{13}C$ (Figure 25) was greater than that of *C. hyperboreus*. Sediment $\delta^{15}N$ ranged from 2.00 to 6.79 ‰, falling within the typical range of marine sediments for the region (Morata et al. 2008, Magen et al. 2010, Roy et al. 2015). Sediment $\delta^{13}C$ mostly ranged from -24.86 to -20.75 ‰, well within the typical range for the region, and indicating that the benthic food supply is dominated by a mixture of fresh and refractory marine organic matter sources rather than terrestrial sources (Magen et al. 2010). However, sediment $\delta^{13}C$ values at BPT_01 and CPY_01 (-9.50 and -9.62 ‰, respectively) were abnormally low for marine sediments compared to those values previously reported in the western Canadian Arctic (Morata et al. 2008, Magen et al. 2010, Roy et al. 2015). These same stations had unusually high C:N ratios of 32.8 and 24.7 (compared to values between 7.9 and 10.7 observed at the other stations in the region), respectively, owing to relatively high % C and relatively low % N. We have no reason to suspect sample contamination, as similarly anomalous sediment $\delta^{13}C$ values were observed at several other shallow stations in the Amundsen Gulf (see Stasko et al. 2017).

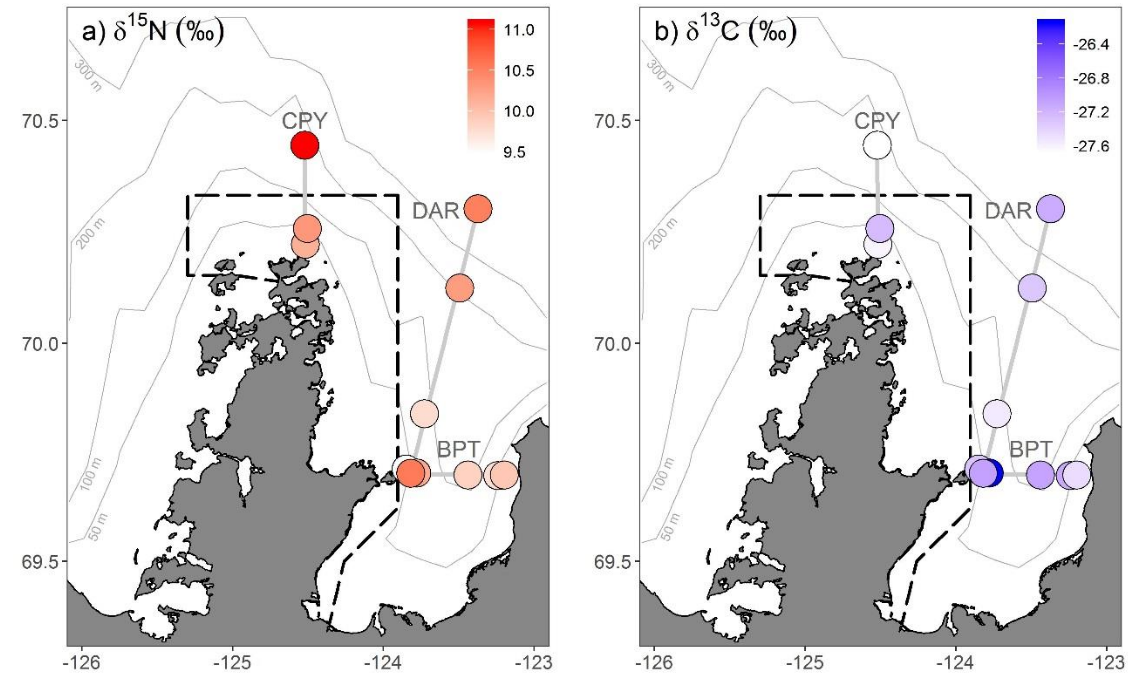

Figure 24. The a) $\delta^{15}N$ and b) $\delta^{13}C$ values measured in the widespread filter-feeding zooplankter *Calanus hyperboreus* at stations within 15 NM of the ANMPA in 2013. Spatial variation in both $\delta^{13}C$ and $\delta^{15}N$ was low.

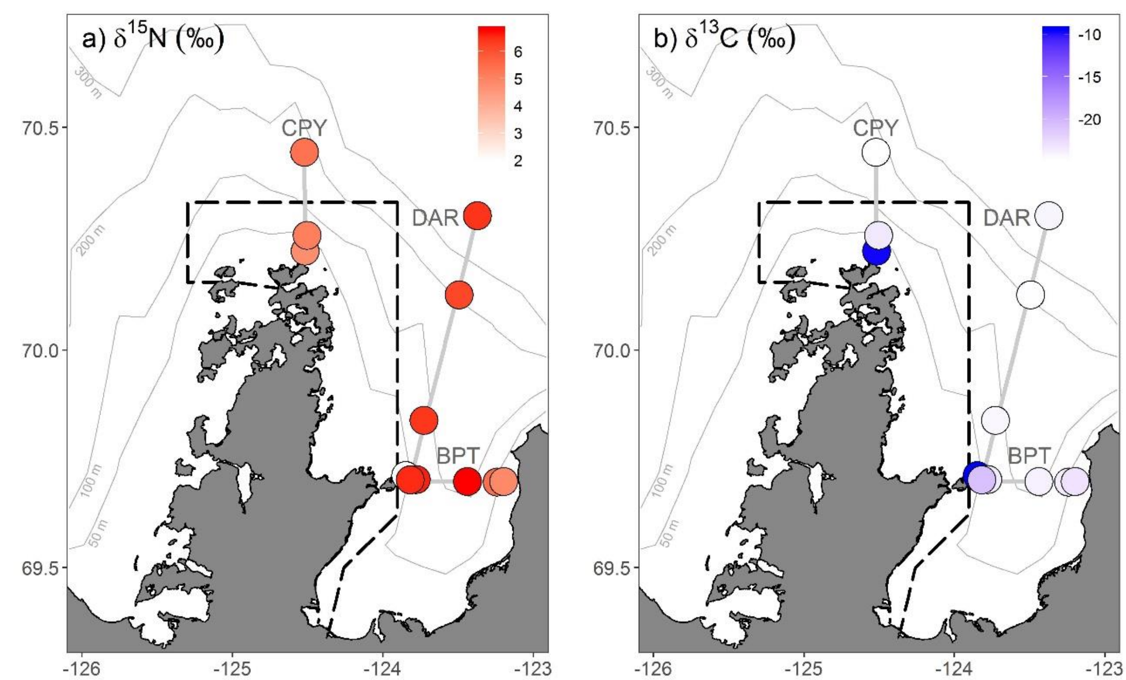

Figure 25. The a) $\delta^{15}N$ and b) $\delta^{13}C$ values measured in surface sediment at stations within 15 NM of the ANMPA in 2013. Spatial variation in both $\delta^{13}C$ and $\delta^{15}N$ was low aside from two anomalously high $\delta^{13}C$ values observed at CPY_01 and BPT_01.

Values of $\delta^{15}N$ and $\delta^{13}C$ were available for 244 samples representing 16 fish, 12 epifaunal, and 10 infaunal taxa from four stations along the DAR transect (Appendix G). Together with the zooplankton, the dataset comprised a wide range of feeding guilds, including: pelagic zooplankton predators, pelagic zooplankton filter feeders, benthic carnivores that live and feed on the sediment surface, highly mobile benthopelagic carnivores that live and feed both at and above the seafloor and some distance above it, benthic subsurface carnivores that live and feed below the sediment, benthic suspension feeders that feed on particles captured or filtered from the water column, and both surface and subsurface deposit feeders that feed on detritus or scavenged materials at the seafloor (Appendix G). Although different subsets of taxa and functional groups were available at each station, some general trophic patterns emerged based on functional groups. Mobile benthic and benthopelagic carnivores, such as Eelpouts (*Lycodes sp*.) and large prawns (*Sclerocrangon ferox*, *Argis dentata*) typically occupied the highest trophic positions, whereas the lowest trophic positions were typically occupied by herbivorous zooplankton (e.g., *Limacina helicina*, *Calanus hyperboreus*, *Beroe cucumis*) and suspension- and surface deposit-feeding infaunal bivalves (*Thyasira sp*., *Nuculana minuta*, *Ennucula tenuis*, *Macoma spp*.; Figure 26, Figure 27). Zooplankton and epifauna typically occupied opposite ends of the pelagic-benthic spectrum of $\delta^{13}C$ values with fish and infauna in between, likely acting as integrators of pelagic and benthic food web pathways (Figure 27).

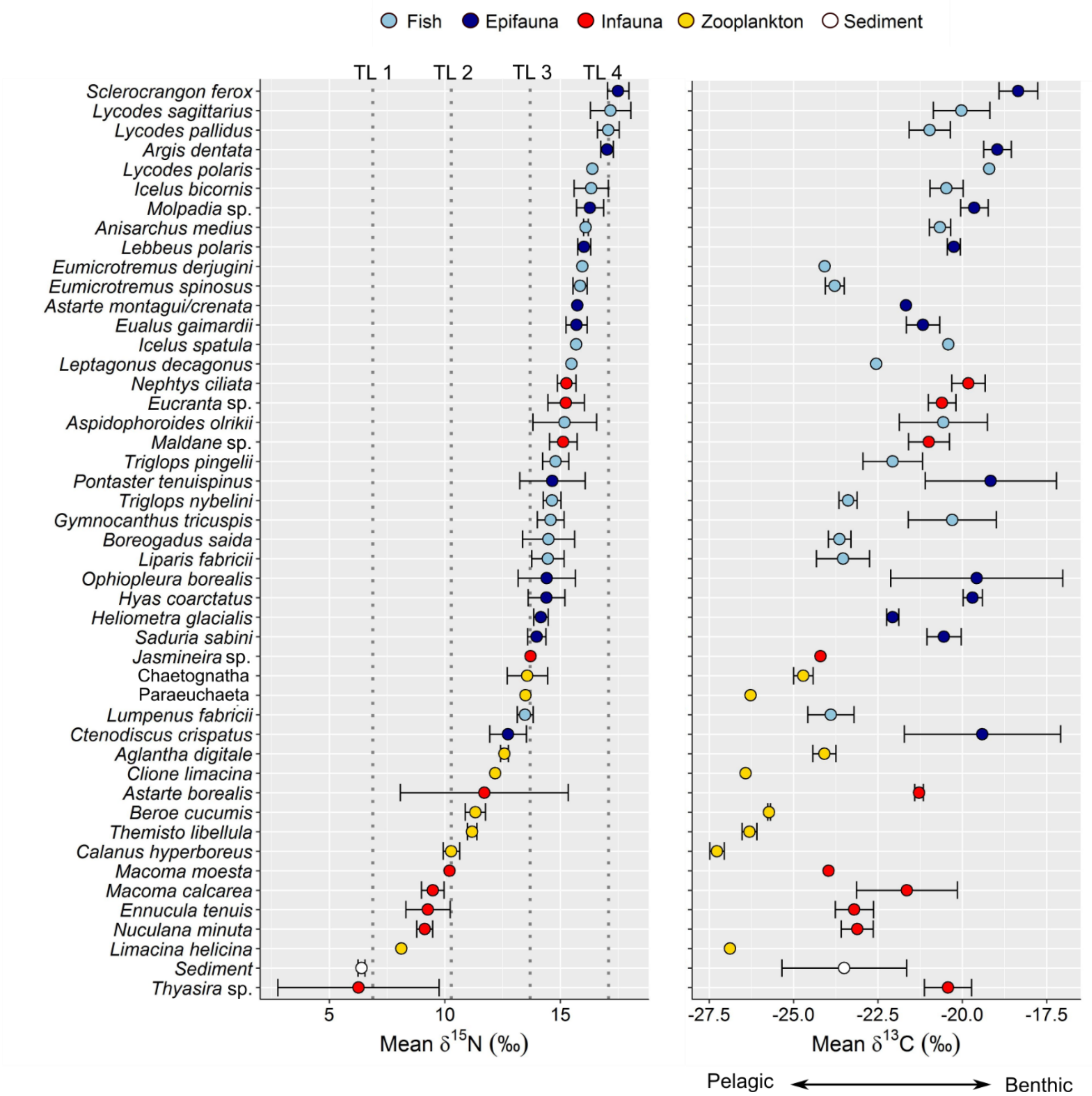

Figure 26. Mean a) $\delta^{15}N$ and b) $\delta^{13}C$ values measured in fish, epifauna, infauna, zooplankton, and sediments sampled in 2013 at stations along the DAR transect that fall within 15 NM of the ANMPA. Error bars represent one standard deviation. Vertical dotted lines delineate $\delta^{15}N$ values that correspond to estimated discrete trophic levels (TL), using *C. hyperboreus* as a representative baseline for TL = 2 and a trophic enrichment factor of 3.4 ‰, following Post (2002). Biota with higher $\delta^{15}N$ at a given station occupy relatively higher trophic positions. More negative $\delta^{13}C$ values suggest that the taxon relies on a relatively greater proportion of pelagic carbon sources, whereas less negative $\delta^{13}C$ suggests greater reliance on benthic carbon sources.

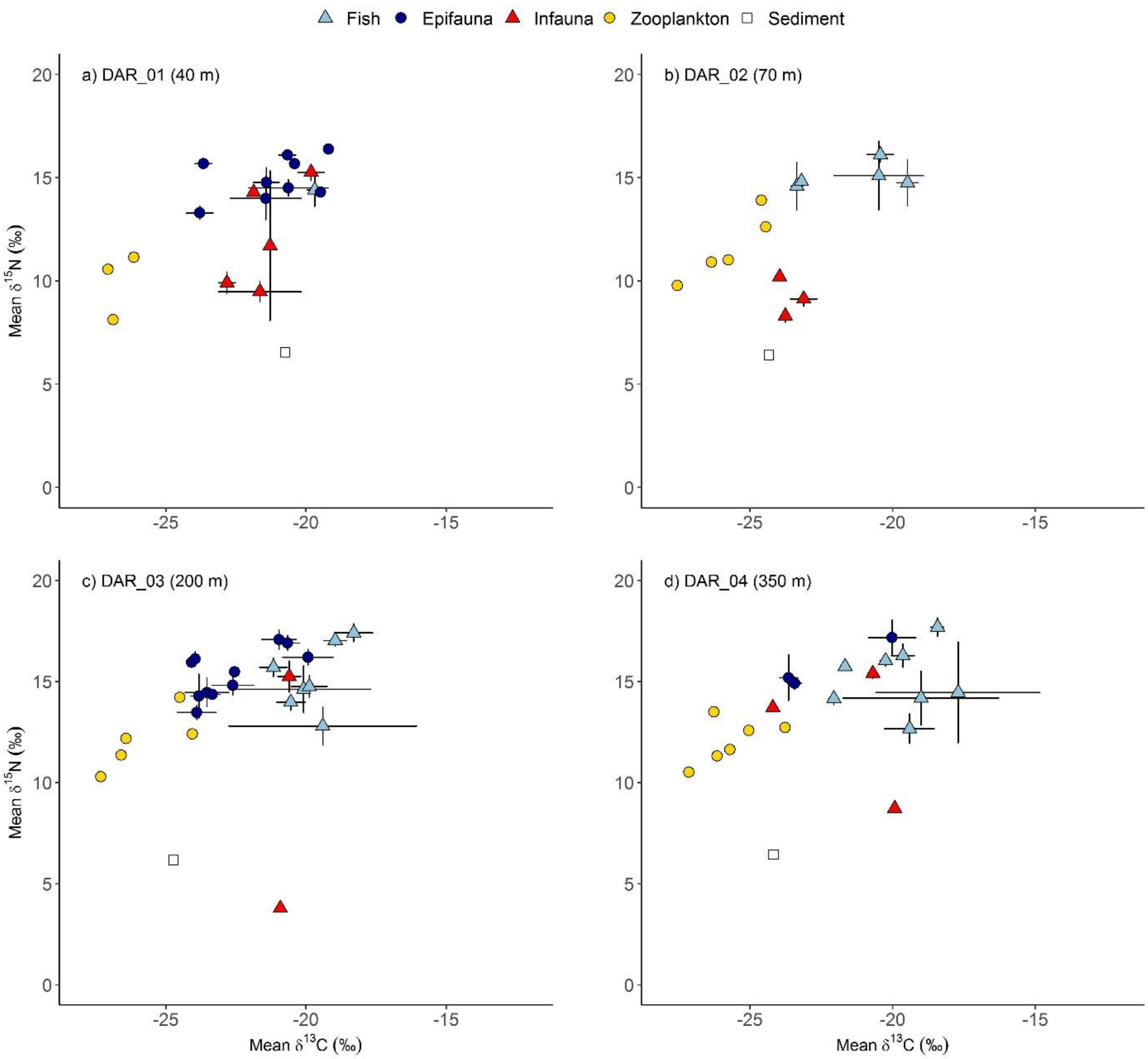

Figure 27. Plots of mean $\delta^{15}N$ vs. mean $\delta^{13}C$ by taxon for fish, epifauna, infauna, zooplankton, and sediments sampled in 2013 at stations along the DAR transect that fall within 15 NM of the ANMPA, including a) DAR_01, b) DAR_02, c) DAR_03, and d) DAR_04. Error bars represent one standard deviation.

4.0 Conclusions

The BREA-MFP and CBS-MEA research programs provide ecosystem-level scientific knowledge required to develop and deliver monitoring plans, assess conservation objectives, and plan future conservation efforts in the western Canadian Arctic. The integration of multiple years of data has informed marine biodiversity, habitat structure and use, foodwebs, as well as oceanographic drivers of variability. The area within and around the ANMPA represents a variable environment, even over short time scales. The physical environment, production at the base of the foodweb, and species interactions are all affected by local conditions (e.g., winds) as well as oceanographic connections with offshore (i.e., Beaufort Shelf) areas. A holistic approach to monitoring the ANMPA requires consideration of spatial and temporal scales described herein. It is evident that sustained monitoring is required to asses the integrity of marine habitats within the highly variable ANMPA ecosystem.

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6.0 Appendices

Appendix A. Metadata for stations sampled within 15 NM of the Anguniaqvia niqiqyuam Marine Protected Area (ANMPA) during the BREA-MFP and CBS-MEA programs, 2013-2018.

Year	Station	Sampling Date	Latitude (N)	Longitude (W)	Bottom Depth (m)
2013	BPT_01	4 Aug	69.7130	-123.8490	20
2013	BPT_02	5 Aug	69.7040	-123.7780	75
2013	BPT_03	6 Aug	69.6990	-123.4380	125
2013	BPT_04	6 Aug	69.6980	-123.2410	75
2013	BPT_05	6 Aug	69.6990	-123.1970	40
2013	CPY_01	2 Aug	70.2240	-124.5170	40
2013	CPY_02	3 Aug	70.2590	-124.5050	75
2013	CPY_03	3 Aug	70.4450	-124.5220	200
2013	DAR_01	4 Aug	69.7030	-123.8190	40
2013	DAR_02	7 Aug	69.8400	-123.7280	75
2013	DAR_03	7 Aug	70.1250	-123.4930	200
2013	DAR_04	8 Aug	70.3030	-123.3720	350
2014	BPT_01	23 Aug	69.7037	-123.8200	40
2014	BPT_02	23 Aug	69.6997	-123.7870	70
2014	BPT_03	23 Aug	69.7000	-123.4470	120
2014	BPT_04	22 Aug	69.6982	-123.2420	70
2014	BPT_05	22 Aug	69.7001	-123.1940	40
2014	CPY_01	25 Aug	70.2259	-124.4970	40
2014	CPY_02	26 Aug	70.2611	-124.5080	70
2014	CPY_03	26 Aug	70.4465	-124.5210	175
2014	FRK_01	17 Aug	70.0828	-125.1900	40
2014	FRK_02	17 Aug	70.0844	-125.4200	75
2014	FRK_03	17 Aug	70.0844	-125.8560	125
2014	WIS_01	25 Aug	70.1046	-125.0620	50
2014	WIS_02	25 Aug	70.1735	-124.8350	40
2017	AMG_01	21 Aug	70.0600	-123.2430	213
2017	BPT_01	23 Aug	69.6982	-123.7693	74
2017	BPT_02	23 Aug	69.6988	-123.4385	127
2017	BPT_03	25 Aug	69.7005	-123.1947	42
2017	FKN_05	15 Aug	70.0018	-125.7640	77
2017	FKN_06	15 Aug	70.0022	-125.3991	55
2017	DEX_HC1	26 Aug	69.3913	-123.6758	39
2017	DEX_HC2	26 Aug	69.4970	-123.6060	84
2017	DEX_HC3	27 Aug	70.0080	-123.2870	189
2018	BPT_03	31 Aug	69.6987	-123.4385	130
2018	BPT_05	8 Sep	69.6979	-123.1966	40
2018	FKN_05	30 Aug	70.0049	-125.7541	75
2018	FKN_06	9 Aug	70.0042	-125.3995	51
2018	FRK_06	9 Aug	70.0827	-125.5005	75
2018	WIS_01	8 Aug	70.1038	-125.0622	59
2018	WIS_02	8 Aug	70.1735	-124.8345	47

Appendix B. Surface drifter deployments in 2017 and 2019 around the ANMPA.

Start date and time	End date and time	SPOT ID	ID on chart	Start location (degrees) Latitude (N)	Start location (degrees) Longitude (W)	End location (degrees) Latitude (N)	End location (degrees) Longitude (W)	Straight line distance travelled (km)
18/08/2017 7:05	29/08/2017 11:42		7556	70.00551	-125.342	69.44139	-126.061	68.5
8/18/2017 07:05	9/27/2017 07:18	3106410	6410	70.00491	-125.344	69.93205	-125.226	9.3
8/18/2017 19:03	10/15/2017 18:41	3105673	5673	69.99891	-126.658	69.37291	-125.781	77.3
8/18/2017 19:26	10/6/2017 09:15	3105605	5605	69.99554	-126.719	71.08356	-138.302	445.5
9/6/2017 05:29	10/16/2017 17:16	3106688	6688	70.34913	-123.948	71.82512	-128.12	222.4
9/6/2017 05:47	9/7/2017 23:41	3105682	5682	70.38515	-123.664	70.40692	-123.805	5.8
9/6/2017 06:08	9/11/2017 16:49	3105473	5473	70.3041	-124.194	70.34702	-127.364	118.7
9/6/2017 07:56	10/13/2017 23:59	3106603	6603	70.25525	-124.49	71.11866	-137.107	473.5
9/7/2017 01:16	10/16/2017 13:10	3105681	5681	70.26035	-124.834	70.6786	-136.701	443.3
9/7/2017 01:29	10/12/2017 06:11	3105671	5671	70.22642	-124.852	70.6786	-136.701	443.4
9/7/2017 01:30	10/16/2017 12:31	3105610	5610	70.29267	-124.817	70.32687	-124.944	6.1
9/7/2017 03:16	10/16/2017 17:27	3105676	5676	70.34153	-124.842	70.88912	-130.162	205.4
8/4/2019 02:03	9/15/2019 14:26	3104680	4680	71.02473	-127.248	68.92492	-114.329	544.1
8/4/2019 03:02	9/28/2019 11:06	3104928	4928	70.99994	-127.263	69.2608	-118.884	370.8

Start date and time	End date and time	SPOT ID	ID on chart	Start location (degrees) Latitude (N)	Start location (degrees) Longitude (W)	End location (degrees) Latitude (N)	End location (degrees) Longitude (W)	Straight line distance travelled (km)
8/4/2019 04:02	9/22/2019 20:18	3104942	4942	71.05896	-127.236	68.97985	-115.637	497.3
8/4/2019 04:03	8/23/2019 06:23	3104309	4309	71.02332	-127.259	69.50314	-123.289	225.2
8/14/2019 19:38	8/15/2019 12:34	3106832	6832	70.67318	-134.518	70.59321	-134.659	10.3
8/14/2019 19:38	9/12/2019 18:57	3153871	3871	70.64866	-134.47	70.03185	-121.793	478.8
8/14/2019 19:39	8/21/2019 16:47	3108195	8195	70.64793	-134.469	70.5074	-133.499	39.1
8/14/2019 20:37	8/26/2019 13:22	3104947	4947	70.67117	-134.534	70.60678	-128.3	229.8
8/14/2019 22:37	8/17/2019 22:08	3156735	6735	70.65052	-134.518	70.15765	-133.722	62.3
8/14/2019 22:40	9/20/2019 20:34	3153872	3872	70.65081	-134.526	71.80619	-133.347	135.1
8/15/2019 01:37	9/21/2019 15:29	3153928	3928	70.62475	-134.541	70.44481	-119.618	552.9
8/15/2019 03:36	8/29/2019 15:00	3156740	6740	70.52113	-134.378	69.99342	-125.202	349.4
8/15/2019 13:53	10/1/2019 08:50	3157348	7348	70.78677	-128.736	69.37402	-125.766	193.1
8/15/2019 15:55	10/1/2019 08:10	3157350	7350	70.67361	-128.236	69.38077	-125.718	172.5
8/15/2019 16:32	8/22/2019 07:30	3156927	6927	70.67052	-128.213	70.01533	-125.218	133.5
8/24/2019 15:08	9/27/2019 01:38	3191297	1297	70.2744	-124.434	68.97736	-116.086	353.7
8/24/2019 20:06	8/29/2019 02:29	3191302	1302	70.17374	-124.342	69.8109	-121.845	103.1

Start date and time	End date and time	SPOT ID	ID on chart	Start location (degrees)		End location (degrees)		Straight line distance travelled (km)
				Latitude (N)	Longitude (W)	Latitude (N)	Longitude (W)	
8/24/2019 20:27	9/15/2019 23:34	3157938	7938	70.17117	-124.333	69.08598	-117.781	280.7
9/4/2019 22:38	9/28/2019 19:28	3191292	1292	70.04971	-126.801	72.55943	-125.795	281.2
9/5/2019 02:38	9/14/2019 23:14	3191299	1299	70.22644	-126.839	70.93925	-126.848	79.2
9/6/2019 02:36	9/9/2019 05:11	3191293	1293	70.58987	-127.651	71.21899	-127.976	70.9

Appendix C. Mesozooplankton taxa sampled within 15 NM of the ANMPA in 2012-2014. Sampling was conducted along BREA-MFP transects at Cape Parry (CPY), in Franklin (FRK), Wise (WIS) and Darnley bays, and at Bennett Point (BPT). Black dots indicate presence. (Ndet., not determined)

Taxa	Presence				
	BPT	CPY	DAR	FRK	WIS
Amphipoda					
Hyperiidae ndet.	●	●		●	●
Onisimus glacialis	●		●		
Onisimus nanseni	●				
Themisto abyssorum			●		
Themisto libellula	●	●	●	●	
Westwoodilla sp.	●				
Hydrozoa: Anthoathecata					
Bougainvillia sp.	●				
Halitholus cirratus			●		
Hydrozoa: Leptothecata					
Obelia sp.	●		●	●	●
Hydrozoa: Narcomedusae					
Aeginopsis laurentii	●	●	●	●	●
Hydrozoa: Trachymedusae					
Aglantha digitale	●	●	●	●	●
Chaetognatha: Aphragmophora					
Parasagitta elegans	●	●	●	●	
Chaetognatha: Phragmophora					
Eukrohnia hamata			●		
Appendicularia: Copelata					
Fritillaria spp.	●	●	●		
Fritillaria borealis	●	●		●	●
Fritillaria gracilis		●			
Oikopleura sp.	●	●	●		
Cladoceran: Onychopoda					
Podon leuckartii	●				

Taxa	Presence				
	BPT	CPY	DAR	FRK	WIS
Polychaete: Phyllodocida					
Eteone sp.			●		
Pteropoda					
Limacina sp.	●	●	●		
Limacina helicina			●		
Copepoda: Calanoida					
Acartia sp.	●	●	●		
Acartia hudsonica	●		●		
Acartia longiremis	●	●	●	●	●
Aetideidae ndet.			●	●	
Aetideopsis armata					
Augaptilus glacialis			●		
Bradyidius similis					
Calanus sp.	●		●		●
Calanus glacialis	●	●	●	●	●
Calanus hyperboreus	●	●	●	●	●
Centropages sp.	●	●	●	●	●
Centropages abdominalis	●		●	●	●
Chiridius obtusifrons		●	●		
Euchaetidae ndet.	●	●	●	●	
Eurytemora sp.	●	●	●	●	●
Eurytemora herdmani	●	●	●	●	●
Gaetanus brevispinus			●		
Gaetanus tenuispinus		●	●		
Haloptilus acutifrons			●		
Heterorhabdus norvegicus		●	●		
Metridia sp.	●	●	●	●	●
Metridia longa	●	●	●	●	
Microcalanus spp.	●	●	●	●	●
Mimocalanus crassus	●	●	●		
Paraeuchaeta glacialis		●	●	●	
Phaennidae ndet.					
Pseudocalanus spp.	●	●	●	●	●
Scaphocalanus sp.			●		
Scaphocalanus brevicornis			●		
Scolecithricella minor	●	●	●	●	
Spinocalanus sp.		●			

Taxa	Presence				
	BPT	CPY	DAR	FRK	WIS
Spinocalanus antarcticus			●		
Xanthocalanus polarsternae			●		
Acartia sp. copepodite	●	●		●	●
Copepoda: Cyclopoida					
Oithona similis	●	●	●	●	●
Triconia borealis	●	●	●	●	●
Copepoda: Harpacticoida					
Microsetella norvegica	●	●	●	●	●
Copepoda: Cyclopoida					
Oithona similis	●	●	●	●	●
Triconia borealis	●	●	●	●	●
Copepod: Mormonilloida					
Neomormonilla sp.				●	
Neomormonilla minor		●	●		
Copepoda: Other					
Euphausiacea ndet. nauplii	●				●
Copepoda ndet. nauplii	●	●	●	●	●

Appendix D. Marine fish taxonomic inventory by transect, within 15 NM of the ANMPA. Catch data from bottom and mid-water trawls are included. Black dots indicate presence. Transect locations are shown in Figure 2.

Taxa	Presence							
	AMG	BPT	CPY	DAR	DEX	FKN	FRK	WIS
Agonidae								
Aspidophoroides olrikii		●	●	●		●	●	
Leptagonus decagonus		●	●	●		●	●	
Clupeidae								
Clupea pallasii		●						
Cottidae								
Artediellus sp.			●					
Gymnocanthus tricuspis	●	●	●	●		●	●	●
Icelus bicornis	●	●	●	●		●	●	●
Icelus spatula		●	●	●		●	●	●
Triglops nybelini	●	●	●	●		●	●	●
Triglops pingellii		●	●	●		●	●	●
Cyclopteridae								
Eumicrotremus derjugini		●	●	●				
Eumicrotremus spinosus	●	●	●	●	●			
Gadidae								
Boreogadus saida	●	●	●	●	●	●	●	●
Gadus macrocephalus			●					
Liparidae								
Liparis sp.	●	●	●	●	●	●	●	●
Liparis fabricii	●	●	●	●	●	●		●
Careproctus reinhardti		●	●	●				
Myctophiformes								
Benthosema glaciale				●				
Osmeriformes								
Mallotus villosus	●	●		●		●		
Pleuronectidae								
Hippoglossoides robustus						●		

Taxa	Presence							
	AMG	BPT	CPY	DAR	DEX	FKN	FRK	WIS
Reinhardtius hippoglossoides				●		●		
Stichaeidae								
Lumpeninae	●	●	●	●		●	●	
Anisarchus medius		●	●	●		●	●	●
Eumesogrammus praecisus			●					
Zoarcidae								
Gymnelus sp.		●	●	●			●	
Lycodes sp.	●	●	●	●		●	●	●

Appendix E. Summary of taxa collected in epifauna samples using a benthic beam trawl at stations within 15 NM of the ANMPA during the BREA-MFP and CBS-MEA, 2013-2018, by transect. Black dots indicate presence. Note that all taxa identified in epifauna samples are listed, although not all demonstrate a strictly epifaunal living habit (i.e., some may be benthopelagic or occasionally pelagic).

Taxa	Presence						
	AMG	**BPT**	**CPY**	**DAR**	**FKN**	**FRK**	**WIS**
ANNELIDA							
Clitellata							
Hirudinea			●	●			
Myzostomida							
Myzostomida				●			
Polychaeta							
Maldane arctica			●	●			
Maldane sp.				●			
Myriochele heeri				●			
Myriochele olgae				●			
Ophelina sp.				●			
Oweniidae		●					
Polychaeta		●					
Polyphysia crassa			●	●			
Pseudoscalibregma sp.	●		●	●	●		
Scoloplos armiger		●					
Spiochaetopterus typicus		●		●			
Cirratulida							
Cirratulida		●					
Eunicida							
Abyssoninoe sp.				●			
Lumbrineris mixochaeta		●		●			
Nothria conchylega	●	●	●	●	●		
Scoletoma fragilis		●		●			
Scoletoma sp.		●					
Scoletoma sp. 1				●			
Phyllodocida							
Aglaophamus malmgreni		●		●			
Bylgides groenlandicus		●	●	●	●	●	
Bylgides sarsi		●				●	
Bylgides sp.		●					

Taxa	Presence						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Bylgides sp. A				●			
Ephesiella sp.		●	●				
Eucranta villosa		●	●	●			
Eunoe barbata			●				
Eunoe sp.					●		
Gattyana cirrhosa		●	●		●	●	
Harmothoe extenuata		●	●				
Harmothoe sp.		●	●				
Harmothoe sp. 1				●			
Harmothoe sp. 2		●	●	●			
Hesionidae		●					
Macellicephala violacea		●					
Nephtys ciliata		●	●	●			
Nephtys incisa				●			
Nereimyra sp.		●					
Nereis zonata			●				
Pholoe longa		●					
Phyllodoce groenlandica		●	●	●		●	
Phyllodoce mucosa			●				
Polynoidae		●	●				
Sphaerodorum gracilis			●				
Syllis sp.			●				
Sabellida							
Branchiomma infarctum			●				
Chone sp.		●	●	●			
Circeis spirillum			●				
Euchone elegans			●				
Euchone papillosa	●	●					
Euchone sp.		●	●	●			
Jasmineira sp.				●			
Sabellidae	●	●			●		
Spionida							
Laonice cirrata		●		●			
Laonice sp.		●		●			
Prionospio sp.				●			
Terebellida							
Amage auricula				●			
Ampharete borealis		●	●	●			

Taxa	Presence						
	AMG	**BPT**	**CPY**	**DAR**	**FKN**	**FRK**	**WIS**
Ampharete finmarchica		●		●			
Ampharete sp.		●	●				
Ampharetidae		●					
Amphicteis gunneri		●	●	●			
Amphicteis ninonae		●	●	●			
Amphicteis sp.				●			
Artacama proboscidea				●			
Bradabyssa villosa		●					
Chaetozone sp.		●					
Cistenides sp.				●			
Eclysippe vanelli			●				
Glyphanostomum pallescens		●	●	●	●		
Lysippe labiata		●					
Neoamphitrite affinis				●			
Neoamphitrite sp.				●			
Pherusa plumosa			●				
Pherusa sp.				●			
Pista elongata		●	●	●	●		
Proclea sp.			●				
Sternaspis scutata		●		●			
Terebellidae		●	●				
Terebellides bigeniculatus		●	●			●	
Terebellides gracilis			●	●			
Terebellides sp.			●				
Terebellides stroemii		●	●	●			
Terebellomorpha		●	●				
Tharyx sp.		●					
ARTHROPODA							
Malacostraca							
Amphipoda							
Acanthonotozoma cristatum			●				
Acanthonotozoma inflatum		●			●		
Acanthonotozoma serratum		●	●		●		
Acanthostepheia malmgreni	●	●	●	●	●	●	
Aceroides (Aceroides) latipes		●	●		●	●	
Amathillopsis spinigera				●			
Ampelisca eschrichtii		●	●	●			
Ampelisca macrocephala			●			●	
Amphipoda							●
Anonyx debruynii	●	●		●			

Taxa	Presence						
	AMG	**BPT**	**CPY**	**DAR**	**FKN**	**FRK**	**WIS**
Anonyx laticoxae		●	●				●
Anonyx lilljeborgi			●	●			●
Anonyx nugax	●	●	●	●	●		
Anonyx ochoticus	●	●	●			●	
Anonyx pacificus		●		●			●
Anonyx robustus		●					
Anonyx sp.		●	●	●	●	●	
Aristias tumidus			●				
Arrhis phyllonyx	●	● ●	●	●	●	●	
Atylus carinatus							●
Byblis gaimardii					●		
Byblis sp.			●	●			
Calliopiidae		●					
Caprella linearis			●				
Epimeria (Epimeria) loricata				●			
Eusirus sp.				●			
Gammaridea		●	●				
Gammarus sp.		●					
Gammarus zaddachi					●		●
Halirages fulvocinctus		●					
Halirages sp.				●			
Haliragoides inermis						●	
Haploops laevis		●					
Haploops sp.		●	●	●			
Haploops tubicola		●					
Hippomedon denticulatus	●	●			●	●	
Hippomedon holbolli	●		●	●	●	●	
Hippomedon propinqvus	●	●	●		●		●
Hippomedon sp. 1			●				
Hyperia galba	●	●			●		●
Hyperia medusarum		●				●	
Hyperia sp.		●					
Ischyrocerus anguipes							●
Lepidepecreum umbo	●	●	●	●			
Megamoera dentata		●					
Melita palmata						●	
Melphidippa goesi		●					
Menigrates obtusifrons	●	●	●	●			
Monoculodes sp.		●					
Neopleustes pulchellus							●
Nototropis smitti			●				

Taxa	Presence						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Oediceros saginatus			●				
Oedicerotidae						●	
Onisimus affinis			●				
Onisimus barentsi group		●	●			●	
Onisimus brevicaudatus group		●	●	●	●		
Onisimus litoralis group		●	●	●			
Onisimus normani group						●	
Onisimus plautus	●	●	●	●			
Onisimus sp.			●				
Opisa eschrichtii			●				
Orchomene amblyops			●				
Orchomene pectinatus				●			
Orchomenella minuta		●					
Orchomenella obtusa			●				
Orchomenella pinguis							●
Paramphithoe hystrix			●	●			
Paroediceros intermedius		●	●		●		
Paroediceros lynceus		●		●			
Paroediceros propinquus	●	●					
Paroediceros sp.		●		●	●		
Pontoporeia femorata		●	●				
Protomedeia grandimana		●					
Rhachotropis aculeata		●	●	●		●	
Rhachotropis helleri						●	
Rhachotropis macropus	●	●			●		
Rhachotropis oculata					●		
Rhachotropis sp.			●	●			
Rhachotropis sp. 2				●			
Rhachotropis sp. 4			●	●			
Rostroculodes kroyeri		●					
Rostroculodes longirostris		●	●		●	●	
Rozinante fragilis		●		●			
Schisturella pulchra			●				
Socarnes bidenticulatus		●					
Stegocephalus inflatus	●	●	●	●		●	
Stegocephalus similis		●					
Stenopleustes sp.				●			
Syrrhoe crenulata	●	●	●		●	●	
Themisto abyssorum	●	●	●			●	●
Themisto libellula	●	●	●	●	●	●	●
Tmetonyx cicada		●	●		●	●	

Taxa	Presence						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Tmetonyx similis		●					
Tmetonyx sp.		●	●	●			
Weyprechtia pinguis		●					
Cumacea							
Diastylidae A		●					
Diastylis goodsiri		●	●	●	●	●	
Diastylis nucella		●			●		
Diastylis oxyrhyncha	●	●	●	●		●	
Diastylis rathkei	●	●	●	●	●		●
Diastylis scorpioides		●	●		●	●	
Diastylis sp.		●					
Diastylis spinulosa	●	●	●	●			
Eudorella emarginata		●					
Leucon (Leucon) nasica		●				●	
Leucon (Leucon) sp.							●
Decapoda							
Argis dentata	●	●	●	●	●	●	●
Brachyura					●		
Bythocaris payeri		●					
Caridea					●		
Decapoda			●		●		
Eualus belcheri	●	●	●		●	●	●
Eualus sp.	●	●	●	●	●	●	●
Hyas coarctatus		●			●	●	
Lebbeus groenlandicus		●	●		●		
Lebbeus polaris	●	●	●	●			●
Pandalus borealis		●			●		
Sabinea septemcarinata	●	●	●	●	●	●	●
Sclerocrangon ferox	●	●	●				
Spirontocaris intermedia		●	●	●			
Spirontocaris liljeborgii		●	●			●	●
Spirontocaris sp.			●				
Euphausiacea							
Euphausiacea						●	
Isopoda							
Bopyroides hippolytes		●					●
Caecognathia elongata		●			●		

Taxa	Presence						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Caecognathia stygia		●		●			
Calathura brachiata	●	●	●	●	●	●	
Dajus mysidis		●		●			
Munnopsis typica	●	●	●	●	●	●	●
Saduria sabini	●	●	●	●			
Synidotea marmorata		●	●				
Mysida							
Mysida	●	●	●	●	●	●	●
Mysis oculata		●	●	●			
Mysis sp.			●				
Stilomysis sp.				●			
Ostracoda							
Myodocopida							
Philomedes sp.		●	●			●	
Pycnogonida							
Pantopoda							
Boreonymphon abyssorum	●			●		●	
Boreonymphon ossiansarsi						●	
Boreonymphon robustum			●				
Colossendeis proboscidea				●			
Cordylochele malleolata						●	
Nymphon grossipes			●				
Nymphon helleri			●				
Nymphon hirtipes	●	●	●			●	
Nymphon longitarse		●	●			●	
Nymphon macronyx	●				●		
Nymphon micronyx		●					
Nymphon sluiteri		●	●	●			
Nymphon sp.			●	●			
Nymphon stroemi			●			●	
Pseudopallene brevicollis		●	●				
CHAETOGNATHA							
Chaetognatha	●	●	●		●	●	●
CHORDATA							
Ascidiacea							
Ascidiacea		●	●	●			

Taxa	Presence						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Phlebobranchia							
Ascidiella			●				
Ciona intestinalis	●	●					
Stolidobranchia							
Boltenia echinata		●					
Molgula griffithsii		●					
CNIDARIA							
Hydrozoa							
Hydrozoa		●		●			
Scyphozoa							
Scyphozoa		●					
Anthozoa							
Actiniaria							
Actinauge sp.					●		
Actiniaria	●	●			●	●	
Actiniaria 1		●		●			
Actiniaria 3				●			
Actiniaria 4		●		●			
Edwardsiidae		●					
Hormathiidae		●					
Metridioidea		●			●		
Alcyonacea							
Gersemia fruticosa	●	●	●		●	●	
Gersemia rubiformis			●				
Nephtheidae		●	●	●			
Staurozoa							
Stauromedusae							
Lucernariidae				●			
ECHINODERMATA							
Asteroidea							
Asteroidea	●	●			●		
Forcipulatida							

Taxa	Presence						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Asteriidae			●	●			
Evasterias sp.			●				
Icasterias panopla	●		●			●	
Pedicellaster typicus					●		
Urasterias lincki	●	●		●	●	●	
Notomyotida							
Pontaster tenuispinus	●	●	●	●		●	
Spinulosida							
Henricia sp.			●				
Paxillosida							
Ctenodiscus crispatus	●	●		●	●	●	
Valvatida							
Crossaster papposus			●				
Lophaster furcifer			●				
Poraniomorpha (Poraniomorpha) tumida			●		●	●	
Velatida							
Hymenaster pellucidus			●				
Pteraster militaris			●				
Crinoidea							
Comatulida							
Bourgueticrinidae			●				
Comatulida				●			
Heliometra glacialis	●	●	●	●	●	●	
Poliometra prolixa			●	●			
Echinoidea							
Camarodonta							
Strongylocentrotus sp.			●			●	
Holothuroidea							
Apodida							
Myriotrochus rinkii	●	●	●	●	●	●	
Dendrochirotida							

Taxa	Presence						
	AMG	**BPT**	**CPY**	**DAR**	**FKN**	**FRK**	**WIS**
Psolus fabricii						●	
Psolus phantapus			●				
Molpadida							
Eupyrgus scaber	●	●	●	●	●	●	
Molpadia sp.				●			
Ophiuroidea							
Ophiuroidea		●					
Amphilepidida							
Amphiura sp.				●			
Ophiopholis aculeata			●				
Euryalida							
Gorgonocephalus arcticus	●	●			●		
Gorgonocephalus lamarckii					●	●	
Gorgonocephalus sp.		●	●	●	●	●	
Ophiacanthida							
Ophiacantha bidentata	●	●	●	●	●	●	
Ophiacantha sp.			●				
Ophioscolecida							
Ophioscolex glacialis				●			
Ophiurida							
Ophiocten sericeum	●	●	●	●	●	●	●
Ophiopleura borealis	●	●	●	●		●	
Ophiopleura sp.				●			
Ophiura robusta		●	●	●	●		
MOLLUSCA							
Bivalvia							
Bivalvia			●				
Cuspidaria glacialis		●	●	●			
Cuspidaria subtorta	●		●	●			
Lyonsia arenosa			●				
Lyonsiella abyssicola			●	●			
Pandora glacialis		●					
Thracia sp.		●	●				

Taxa	Presence						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Adapedonta							
Hiatella arctica			●				
Arcida							
Bathyarca glacialis		●				●	
Bathyarca sp.		●		●			
Cardiida							
Ciliatocardium ciliatum			●				
Ciliatocardium sp.		●					
Macoma calcarea		●	●				
Macoma moesta		●					
Macoma sp.			●				
Carditida							
Astarte borealis		●					
Astarte crenata		●	●	●			
Astarte montagui		●	●	●			
Astarte sp.	●	●	●		●		
Limida							
Limatula sp.				●			
Lucinida							
Thyasira sp. 1		●	●	●			
Thyasiridae				●			
Myida							
Mya pseudoarenaria		●					
Mya truncata			●		●		
Mytilida							
Dacrydium vitreum	●	●	●	●	●		
Musculus discors		●					
Musculus niger						●	
Musculus sp.				●			
Nuculanida							
Nuculana minuta		●	●			●	
Nuculana pernula	●	●	●	●	●	●	

Taxa	Presence						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Nuculana sp.		●					
Portlandia arctica	●	●					
Yoldia hyperborea		●					
Yoldia sp.		●				●	
Yoldiella frigida		●				●	
Yoldiella intermedia	●	●	●	●		●	
Yoldiella lenticula	●	●	●	●	●	●	
Yoldiella solidula		●					
Yoldiidae		●		●			
Nuculida							
Ennucula tenuis		●					●
Pectinida							
Similipecten greenlandicus	●	●	●	●	●	●	
Venerida							
Liocyma fluctuosa			●				
Caudofoveata							
Chaetodermatida				●			
Cephalopoda							
Sepiida							
Rossia sp.		●					
Gastropoda							
Gastropoda			●				
Lepeta caeca						●	
Cephalaspidea							
Cylichna alba		●	●	●	●	●	
Cylichnoides occultus		●			●	●	
Cylichnoides occultus sp. B		●					
Diaphana hiemalis		●			●		
Philine sp.		●	●				
Philine sp. B		●		●			
Praephiline finmarchica	●	●	●			●	
Retusophiline lima		●				●	
Littorinimorpha							

Taxa	Presence						
	AMG	**BPT**	**CPY**	**DAR**	**FKN**	**FRK**	**WIS**
Alvania moerchi					●		
Ariadnaria borealis		●					
Euspira pallida		●					
Frigidoalvania janmayeni			●				
Hydrobiidae						●	
Velutina sp.				●			
Velutina velutina		●					
Neogastropoda							
Admete viridula	●	●	●	●		●	
Buccinum scalariforme				●			
Buccinum sp.			●	●			
Buccinum undatum		●		●			
Colus pubescens				●			
Colus sabini		●	●		●	●	
Curtitoma incisula		●			●		
Curtitoma sp.		●	●				
Curtitoma trevelliana		●					
Mangeliidae				●			
Oenopota declivis		●					
Oenopota elegans			●				
Oenopota obliqua		●					
Oenopota sp. 1		●	●	●			
Propebela arctica				●			
Propebela sp.			●				
Propebela turricula		●					
Nudibranchia							
Nudibranchia			●		●		
Pteropoda							
Clione sp.		●				●	●
Limacina helicina		●	●		●	●	
Trochida							
Margarites costalis		●	●			●	
Margarites olivaceus			●			●	
Margarites sordidus			●				
Margarites sp. B			●				
Scaphopoda							

Taxa	Presence						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Gadilida							
Siphonodentalium lobatum			●	●			
Solenogastres							
Solenogastres		●	●	●	●		
NEMERTEA							
Nemertea	●	●	●	●			
PLATYHELMINTHES							
Platyhelminthes		●	●	●			
PORIFERA							
Polymastia andrica			●				
Polymastia hemisphaerica			●	●			
Porifera					●		
Porifera B				●			
Stylocordylidae		●		●			
Tentorium semisuberites			●	●			
PRIAPULIDA							
Priapulopsis bicaudatus				●			
SIPUNCULA							
Sipunculidea							
Golfingiida							
Phascolionidae		●	●	●	●	●	
Sipunculidae		●		●			

Appendix F. Summary of taxa collected in infauna samples using a box corer at stations within 15 NM of the ANMPA during the BREA-MFP and CBS-MEA, 2013-2018, by transect. Black dots indicate presence. Note that all taxa identified in box core samples are listed, although not all demonstrate a strictly infaunal living habit (i.e., some may be epibenthic, benthopelagic, or occasionally pelagic).

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
ANNELIDA							
Annelida						●	
Clitellata							
Oligochaeta		●	●		●		
Polychaeta							
Aricidea (Strelzovia) cf. *suecica*		●					
Aricidea (Strelzovia) quadrilobata		●			●		
Aricidea nolani		●		●			
Aricidea sp.		●	●	●	●	●	●
Barantolla cf. *americana*		●	●			●	●
Barantolla sp.			●	●			
Capitella sp.					●		
Capitellidae		●	●			●	
Chaetopteridae			●				
Clymenura polaris		●	●				
Cossura pygodactylata		●					
Cossura sp.		●	●		●		●
Euclymeninae				●			
Heteromastus filiformis	●	●	●		●		●
Heteromastus sp.		●	●	●			
Leiochone polaris acirrata		●		●		●	●
Levinsenia gracilis	●	●	●	●	●	●	●
Maldane arctica				●	●	●	
Maldane sarsi	●	●	●	●	●	●	●
Maldane sp.			●	●			
Maldanidae			●	●			
Maldanidae 1				●			
Myriochele				●			
Myriochele heeri						●	●
Myriochele olgae		●	●				
Nicomache (Loxochona) quadrispinata			●				
Ophelina abranchiata	●	●			●		
Ophelina cylindricaudata		●	●	●	●	●	●

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Ophelina sp.		●		●		●	●
Orbiniidae		●		●			
Paraonidae				●		●	
Paraonis sp.				●			
Petaloproctus sp.			●				
Polyphysia crassa		●					
Praxillella gracilis				●			
Praxillella sp. A		●				●	
Praxillura longissima						●	
Pseudoscalibregma sp.		●		●			
Scalibregma inflatum	●	●				●	
Scoloplos armiger group	●	●	●	●	●	●	●
Spiochaetopterus typicus	●	●	●	●	●	●	
Eunicida							
Abyssoninoe sp.			●				
Lumbrineridae		●	●	●			
Lumbrineris mixochaeta	●	●	●	●	●	●	●
Nothria cf. *conchylega*			●	●			
Onuphidae sp.				●			
Parougia caeca		●					
Parougia cf. *nigridentata*						●	
Schistomeringos sp.				●			
Scoletoma fragilis		●	●			●	●
Scoletoma impatiens				●			
Scoletoma sp. 2		●	●				
Scoletoma zatsepini		●					
Phyllodocida							
Aglaophamus malmgreni		●					
Bylgides groenlandicus		●		●			●
Enipo torelli		●	●			●	
Ephesiella sp.			●				
Eteone flava			●				●
Eteone flava/longa		●	●				
Eucranta villosa		●	●	●		●	
Eusyllinae			●	●			
Gattyana cirrosa			●				
Micronephthys minuta		●	●	●	●	●	●
Micronephthys neotena			●				
Micronephthys sp.		●				●	●

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Nephtyidae		●	●	●			
Nephtys ciliata		●			●		
Nephtys sp.		●					
Nereimyra sp.		●					
Pholoe longa		●	●	●	●	●	●
Pholoe sp.		●	●	●		●	●
Phyllodoce groenlandica			●				●
Phyllodoce sp.	●	●	●				
Polynoidae				●			
Polynoidae 1		●	●				
Sphaerodoropsis sp.			●				
Sphaerodorum gracilis							●
Streptospinigera niuqtuut						●	
Streptosyllis sp.				●			
Syllis sp.			●				
Sabellida							
Chone sp.			●	●			
Circeis spirillum		●					
Euchone analis						●	
Euchone incolor							●
Euchone sp.			●	●			
Laonome kroyeri						●	
Oriopsis sp.						●	
Sabellidae		●	●	●		●	●
Sabellidae 1			●				
Spionida							
Apistobranchus tullbergi							●
Dipolydora caulleryi		●	●	●	●		
Laonice cirrata	●	●	●		●	●	●
Laonice sarsi				●			
Laonice sp.				●			
Prionospio sp.		●	●	●	●	●	●
Prionospio steenstrupi	●	●	●	●	●	●	●
Spionidae		●					
Trochochaeta carica						●	
Trochochaeta multisetosa			●				
Terebellida							
Amage auricula				●			

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Ampharete sp.						●	
Ampharetidae		●	●				●
Ampharetinae			●	●			
Amphicteis ninonae				●			
Amphicteis sundevalli		●					
Aphelochaeta sp.	●	●			●	●	●
Artacama proboscidea				●			
Chaetozone sp.		●	●	●	●	●	●
Cirratulidae		●	●	●		●	●
Cistenides hyperborea				●			●
Diplocirrus sp.			●				
Eclysippe vanelli		●	●				
Flabelligera infundibularis							●
Glyphanostomum pallescens		●	●				
Lanassa nordenskioldi		●					
Lysippe labiata		●				●	●
Lysippe sp.		●		●			
Melinna elisabethae		●					
Melinnopsis sp.				●			
Pista maculata			●				
Proclea graffii		●	●				●
Proclea sp.		●	●				
Sternaspidae	●						
Sternaspis fossor		●					
Sternaspis scutata		●		●			
Terebellidae		●				●	
Terebellides bigeniculatus		●	●	●			●
Terebellides gracilis		●				●	
Terebellides sp.		●					
Terebellides stroemii		●	●	●	●	●	●
Terebellinae				●			
ARTHROPODA							
Copepoda							
Cyclopoida							
Cyclopoida		●					
Harpacticoida							
Harpacticoida	●	●	●	●	●	●	
Malacostraca							

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Amphipoda							
Acanthostepheia malmgreni		●					
Aceroides (Aceroides) latipes		●	●		●	●	●
Ampelisca eschrichtii		●					
Ampeliscidae			●	●			
Amphipoda		●					
Anonyx lilljeborgi			●				
Anonyx ochoticus		●	●			●	
Aoridae			●				
Arrhinopsis longicornis		●					
Arrhis phyllonyx		●					
Byblis gaimardii		●	●		●		●
Byblis sp.		●	●			●	●
Caprella linearis						●	
Corophium sp.			●				
Gammaridea		●		●			
Goesia depressa			●				
Guernea (Prinassus) nordenskioldi			●				
Haploops laevis		●	●	●	●		●
Haploops sp.		●	●	●			
Haploops sp. 1			●				
Haploops tubicola		●	●				●
Harpinia pectinata		●	●	●			
Harpinia serrata		●	●				
Hippomedon holbolli						●	
Hippomedon sp.				●			
Lysianassidae		●				●	
Metopa sp.			●				
Microdeutopus sp.		●					
Monoculodes sp.		●					
Oedicerotidae		●	●	●			
Onisimus affinis					●		
Onisimus brevicaudatus group		●					
*Onisimus plautus*group		●		●			
Orchomene serratus		●					
Orchomenella minuta		●					
Paraphoxus oculatus		●	●			●	
Paratryphosites abyssi			●				
Pardaliscidae 1				●			
Paroediceros intermedius		●					
Paroediceros sp.		●					

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Photidae		●					
Photis reinhardi					●		
Photis sp.			●			●	
Phoxocephalidae		●	●				
Pontoporeia femorata	●	●	●	●	●	●	●
Protomedeia grandimana		●					
Tmetonyx sp.			●				
Tryphosa sp.						●	
Cumacea							
Cumacea			●				
Diastylidae		●	●				
Diastylidae B	●	●	●		●	●	●
Diastylis goodsiri		●	●	●		●	●
Diastylis nucella					●		
Diastylis oxyrhyncha	●	●	●				●
Diastylis rathkei		●				●	●
Diastylis scorpioides			●				
Diastylis sp.		●		●			
Diastylis spinulosa		●					
Ektonodiastylis nimia				●			
Ektonodiastylis/Brachydiastylis sp.		●	●	●			
Eudorella emarginata	●	●	●		●	●	●
Eudorella pacifica					●	●	
Eudorella sp.		●	●	●			●
Eudorella truncatula			●				
Eudorellopsis sp.			●				
Leptostylis ampullacea		●					
Leucon (Leucon) acutirostris					●		
Leucon (Leucon) nasica		●	●	●	●	●	●
Leucon sp.		●	●	●			●
Leuconidae				●			
Isopoda							
Caecognathia elongata		●	●		●		
Caecognathia sp.		●			●	●	
Calathura brachiata						●	
Desmosomatidae			●				
Desmosomatinae			●				●
Eugerda sp.					●	●	
Gnathiidae		●	●	●			

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Ilyarachna sp.				●			
Saduria sabini		●			●		
Leptostraca							
Nebalia sp.		●					
Mysida							
Erythrops sp.		●					
Tanaidacea							
Akanthophoreidae		●	●	●			
Akanthophoreus gracilis	●	●	●		●	●	●
Pseudosphyrapus serratus	●	●	●	●			
Pseudosphyrapus sp.				●			
Pseudotanaïdae		●	●	●			
Pseudotanais sp.	●		●				
Tanaidacea		●					
Typhlotanaidae		●	●				
Typhlotanais sp.		●					
Ostracoda							
Myodocopida							
Myodocopida A		●	●	●			
Myodocopida B			●	●			
Philomedes sp.		●	●	●		●	
Scleroconcha sp.	●	●	●	●	●	●	●
Podocopida							
Acanthocythereis sp.		●	●	●			
Actinocythereis dunelmensis		●			●	●	●
Cytherideidae		●	●	●			
Cytheroidea			●				
Hemicythere sp.			●				
Heterocyprideis sp.		●	●	●			
Podocopida		●	●			●	
Rabilimis sp.		●		●			
Robertsonites tuberculatus			●				
Sarsicytheridea sp.			●		●	●	
Trachyleberididae		●			●		
Thecostraca							

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Sessilia							
Balanus balanus		●					
BRACHIOPODA							
Rhynchonellata							
Terebratulida							
Glaciarcula spitzbergensis							●
PRIAPULIDA							
Priapulomorpha							
Priapulidae			●				
Priapulopsis bicaudatus				●			●
Priapulus caudatus		●		●			●
CHORDATA							
Ascidiacea							
Phlebobranchia							
Ascidia sp. 1			●				
Stolidobranchia							
Molgula griffithsii		●					
Styelidae		●		●			
CNIDARIA							
Anthozoa							
Actiniaria							
Athenaria				●			
Thenaria				●			
Alcyonacea							
Gersemia fruticosa		●					
Spirularia							
Cerianthidae				●			
ECHINODERMATA							
Asteroidea							
Paxillosida							
Ctenodiscus crispatus				●			
Holothuroidea							

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Holothuroidea				●			
Apodida							
Myriotrochus rinkii		●		●			
Molpadida							
Eupyrgus scaber		●					
Ophiuroidea							
Ophiuroidea	●	●	●		●	●	●
Amphilepidida							
Amphiura sp.			●	●			●
Amphiura sundevalli			●				
Ophiolepididae				●			
Ophiurida							
Ophiocten sericeum		●	●		●		●
Ophiocten sp.		●	●	●			
Ophiura robusta			●				
Ophiuridae		●	●	●			
HEMICHORDATA							
Enteropneusta							
Enteropneusta		●					
MOLLUSCA							
Bivalvia							
Bivalvia		●	●	●	●	●	●
Cuspidaria sp.				●			
Lyonsia arenosa			●				
Periploma aleuticum		●					●
Thracia septentrionalis					●		
Verticordiidae				●			
Adapedonta							
Hiatella arctica			●	●		●	●
Arcida							
Bathyarca glacialis		●					
Bathyarca sp.			●				

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Cardiida							
Ciliatocardium ciliatum			●		●		●
Macoma calcarea		●	●	●			●
Macoma moesta			●				
Macoma sp.		●			●	●	●
Macoma sp. 1				●			
Tellinidae				●			
Carditida							
Astarte borealis		●			●		●
Astarte cf. *esquimalti*		●	●				
Astarte moerchi				●			
Astarte montagui group		●	●	●			
Astarte sp.		●	●		●		
Astarte sp. 3				●			
Lucinida							
Axinopsida cf. *serricata*	●						
Thyasira cf. *gouldi*							●
Thyasira cf. *sarsii*					●		
Thyasira flexuosa		●					
Thyasira gouldi		●			●		●
Thyasira sp.		●					
Thyasira sp. 1				●			
Thyasira sp. 2		●	●	●			
Thyasiridae	●	●		●	●	●	●
Myida							
Mya sp.		●					
Mytilida							
Dacrydium sp.		●	●	●			
Dacrydium vitreum		●					●
Musculus glacialis		●					
Musculus niger						●	
Musculus sp.						●	
Mytilidae		●	●				
Nuculanida							
Nuculana minuta					●		●

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Nuculana pernula			●		●		●
Nuculana radiata		●			●		●
Nuculana sp.		●					●
Portlandia arctica		●					
Yoldia hyperborea		●			●		●
Yoldia sp.				●			
Yoldiella frigida	●	●	●	●		●	
Yoldiella intermedia	●	●	●	●			
Yoldiella lenticula		●			●	●	●
Yoldiella nana			●				
Yoldiella solidula	●	●		●			
Yoldiella sp.		●			●		●
Yoldiidae			●	●			
Nuculida							
Ennucula tenuis		●	●	●	●	●	●
Pectinida							
Similipecten greenlandicus			●				●
Venerida							
Liocyma fluctuosa			●				
Caudofoveata							
Gastropoda		●	●	●	●	●	
Patellogastropoda			●				
Chaetodermatida							
Chaetodermatida	●	●			●		
Gastropoda							
Caenogastropoda							
Tachyrhynchus erosus					●		●
Cephalaspidea							
Cephalaspidea		●			●		
Cylichna alba		●			●	●	●
Cylichna sp.			●	●			
Cylichnoides occultus					●		●
Diaphanidae					●		
Philine sp.		●		●			

Taxa	Transect						
	AMG	BPT	CPY	DAR	FKN	FRK	WIS
Philinoidea				●			
Retusa obtusa		●			●		●
Retusa sp.		●		●			
Scaphander sp.							●
Littorinimorpha							
Ariadnaria borealis			●				
Frigidoalvania cruenta		●	●		●		●
Frigidoalvania janmayeni	●			●			●
Frigidoalvania sp.		●	●				
Neogastropoda							
Mangeliidae		●					
Oenopota sp.		●					
Pteropoda							
Limacina helicina						●	
Trochida							
Margarites olivaceus				●			
Margarites sp.							●
NEMATODA							
Nematoda		●	●	●		●	●
NEMERTEA							
Nemertea		●	●	●	●	●	●
PLATYHELMINTHES							
Platyhelminthes					●		
PORIFERA							
Porifera		●	●	●			
SIPUNCULA							
Sipunculidea							
Golfingiidae		●	●			●	
Phascolionidae			●	●			
Sipunculidae		●	●				

Appendix G. Mean stable isotopic data for fish and benthic invertebrates analysed from stations within 15 NM of the ANMPA during the BREA-MFP (2013), including the tissue analysed, number of samples analysed per station (n), % N, % C, $\delta^{15}N$ values (‰), $\delta^{13}C$ values (‰), and the ratio of C:N. The $\delta^{13}C$ values reported for samples that contained exoskeleton represent acidified subsamples (see Methods). Raw stable isotopic data for zooplankton and sediments are reported in Stasko et al. (2017). Feeding guild acronyms include subsurface (SS), subsurface deposit feeder (SSDF), suspension feeder (SF), and surface deposit feeder (SDF).

						$\delta^{15}N$ (‰)		$\delta^{13}C$ (‰)		
Taxon	Phylum	Class	Feeding guild	Tissue	n	Mean	SD	Mean	SD	C:N
DAR_01 (40 m)										
Fish										
Boreogadus saida	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	2	13.29	0.34	-23.79	0.49	3.56
Anisarchus medius	Chordata	Actinopteri	Benthic Carnivore	muscle	2	16.10	0.10	-20.66	0.31	3.69
Lycodes polaris	Chordata	Actinopteri	Benthic Carnivore	muscle	1	16.38	NA	-19.20	NA	3.15
Aspidophoroides olrikii	Chordata	Actinopteri	Benthic Carnivore	muscle	4	14.00	1.05	-21.43	1.28	3.43
Gymnocanthus tricuspis	Chordata	Actinopteri	Benthic Carnivore	muscle	5	14.50	0.42	-20.62	1.43	3.23
Icelus bicornis	Chordata	Actinopteri	Benthic Carnivore	muscle	1	14.29	NA	-19.48	NA	3.34
Icelus spatula	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	1	15.68	NA	-20.41	NA	3.22
Triglops pingelii	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	6	14.77	0.72	-21.42	0.48	3.26
Eumicrotremus spinosus	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	3	15.68	0.09	-23.66	0.32	3.55
Epifauna										
Hyas coarctatus	Arthropoda	Malacostraca	Benthic Carnivore	claw muscle	9	14.40	0.80	-19.69	0.29	3.38
Infauna										
Nephtys ciliata	Annelida	Polychaeta	Benthic SS Carnivore	whole body	2	15.27	0.40	-19.82	0.49	4.17
Maldane sp.	Annelida	Polychaeta	Benthic SSDF	whole body	1	14.29	NA	-21.87	NA	4.80

Taxon	Phylum	Class	Feeding guild	Tissue	n	δ15N (‰) Mean	δ15N (‰) SD	δ13C (‰) Mean	δ13C (‰) SD	C:N
Astarte borealis	Mollusca	Bivalvia	Benthic SF	internal viscera	3	11.71	3.63	-21.28	0.13	3.99
Ennucula tenuis	Mollusca	Bivalvia	Benthic SDF	internal viscera	3	9.90	0.52	-22.82	0.32	4.95
Macoma calcarea	Mollusca	Bivalvia	Benthic SDF/SF	internal viscera	5	9.47	0.48	-21.65	1.50	4.94
DAR_02 (75 m)										
Fish										
Boreogadus saida	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	4	14.59	1.14	-23.36	0.20	3.44
Aspidophoroides olrikii	Chordata	Actinopteri	Benthic Carnivore	muscle	4	15.10	1.66	-20.49	1.56	3.49
Gymnocanthus tricuspis	Chordata	Actinopteri	Benthic Carnivore	muscle	2	14.75	1.10	-19.48	0.38	3.17
Icelus bicornis	Chordata	Actinopteri	Benthic Carnivore	muscle	9	16.12	0.36	-20.43	0.45	3.32
Triglops pingelii	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	1	14.82	NA	-23.20	NA	3.33
Infauna										
Nuculana minuta	Mollusca	Bivalvia	Benthic SDF	internal viscera	4	9.13	0.34	-23.12	0.47	4.91
Ennucula tenuis	Mollusca	Bivalvia	Benthic SDF	internal viscera	2	8.31	0.31	-23.77	0.12	5.96
Macoma moesta	Mollusca	Bivalvia	Benthic SDF/SF	whole body	1	10.20	NA	-23.96	NA	4.70
DAR_03 (200 m)										
Fish										
Boreogadus saida	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	4	14.28	1.08	-23.82	0.30	3.40
Lumpenus fabricii	Chordata	Actinopteri	Benthic Carnivore	muscle	4	13.47	0.34	-23.90	0.69	4.14
Lycodes pallidus	Chordata	Actinopteri	Benthic Carnivore	muscle	5	17.07	0.47	-20.97	0.61	3.27

Taxon	Phylum	Class	Feeding guild	Tissue	n	δ15N (‰) Mean	SD	δ13C (‰) Mean	SD	C:N
Aspidophoroides olrikii	Chordata	Actinopteri	Benthic Carnivore	muscle	5	16.20	0.39	-19.93	0.90	3.21
Leptagonus decagonus	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	1	15.48	NA	-22.55	NA	3.46
Icelus bicornis	Chordata	Actinopteri	Benthic Carnivore	muscle	7	16.90	0.37	-20.66	0.41	3.34
Triglops nybelini	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	7	14.36	0.19	-23.35	0.28	3.32
Triglops pingelii	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	5	14.81	0.49	-22.61	0.73	3.31
Eumicrotremus derjugini	Chordata	Actinopteri	Benthic Carnivore	muscle	1	15.95	NA	-24.08	NA	3.52
Eumicrotremus spinosus	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	2	16.12	0.35	-23.96	0.13	3.50
Liparis fabricii	Chordata	Actinopteri	Benthic Carnivore	muscle	4	14.46	0.70	-23.54	0.79	3.29
Epifauna										
Sclerocrangon ferox	Arthropoda	Malacostraca	Benthic Carnivore	tail muscle	10	17.40	0.46	-18.30	0.69	3.30
Eualus gaimardii	Arthropoda	Malacostraca	Benthopelagic Carnivore	tail muscle	10	15.70	0.46	-21.16	0.50	3.47
Argis dentata	Arthropoda	Malacostraca	Benthopelagic Carnivore	tail muscle	10	17.02	0.27	-18.96	0.41	3.29
Saduria sabini	Arthropoda	Malacostraca	Benthic Carnivore	whole body	5	13.97	0.39	-20.54	0.51	3.91
Pontaster tenuispinus	Echinodermata	Asteroidea	Benthic SDF	whole body	10	14.75	0.55	-19.88	0.65	3.85
Ctenodiscus crispatus	Echinodermata	Asteroidea	Benthic SDF	whole body	5	12.79	0.93	-19.40	3.36	4.25
Ophiopleura borealis	Echinodermata	Ophiuroidea	Benthic SDF/SF	whole body	11	14.62	1.16	-20.09	2.38	4.54
Infauna										
Eucranta sp.	Annelida	Polychaeta	Benthic Carnivore	whole body	2	15.25	0.78	-20.60	0.41	3.59
Thyasira sp.	Mollusca	Bivalvia	Benthic SF	internal viscera	1	3.79	NA	-20.92	NA	2.66
DAR_04 (350 m)										

Taxon	Phylum	Class	Feeding guild	Tissue	n	δ15N (‰)		δ13C (‰)		C:N
						Mean	SD	Mean	SD	
Fish										
Boreogadus saida	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	4	15.19	1.15	-23.65	0.32	3.30
Lycodes sagittarius	Chordata	Actinopteri	Benthic Carnivore	muscle	3	17.17	0.88	-20.02	0.84	3.25
Triglops nybelini	Chordata	Actinopteri	Benthopelagic Carnivore	muscle	7	14.91	0.32	-23.43	0.26	3.33
Epifauna										
Sclerocrangon ferox	Arthropoda	Malacostraca	Benthic Carnivore	tail muscle	5	17.69	0.47	-18.43	0.24	3.37
Lebbeus polaris	Arthropoda	Malacostraca	Benthopelagic Carnivore	tail muscle	5	16.03	0.28	-20.25	0.19	3.51
Pontaster tenuispinus	Echinodermata	Asteroidea	Benthic SDF	whole body	5	14.46	2.51	-17.71	2.89	4.53
Ctenodiscus crispatus	Echinodermata	Asteroidea	Benthic SDF	whole body	5	12.67	0.75	-19.41	0.88	3.71
Heliometra glacialis	Echinodermata	Crinoidea	Benthic SF	whole body	5	14.16	0.31	-22.06	0.18	3.07
Molpadia sp.	Echinodermata	Holothuroidea	Benthic SSDF	whole body	5	16.28	0.59	-19.64	0.41	5.61
Ophiopleura borealis	Echinodermata	Ophiuroidea	Benthic SDF/SF	whole body	10	14.18	1.34	-19.00	2.74	2.82
Astarte montagui/crenata	Mollusca	Bivalvia	Benthic SF	internal viscera	1	15.73	NA	-21.67	NA	5.10
Infauna										
Jasmineira sp.	Annelida	Polychaeta	Benthic SDF/SF	whole body	1	13.71	NA	-24.20	NA	5.73
Maldane sp.	Annelida	Polychaeta	Benthic SSDF	whole body	3	15.40	0.25	-20.70	0.19	4.28
Thyasira sp.	Mollusca	Bivalvia	Benthic SF	internal viscera	1	8.72	NA	-19.93	NA	2.95