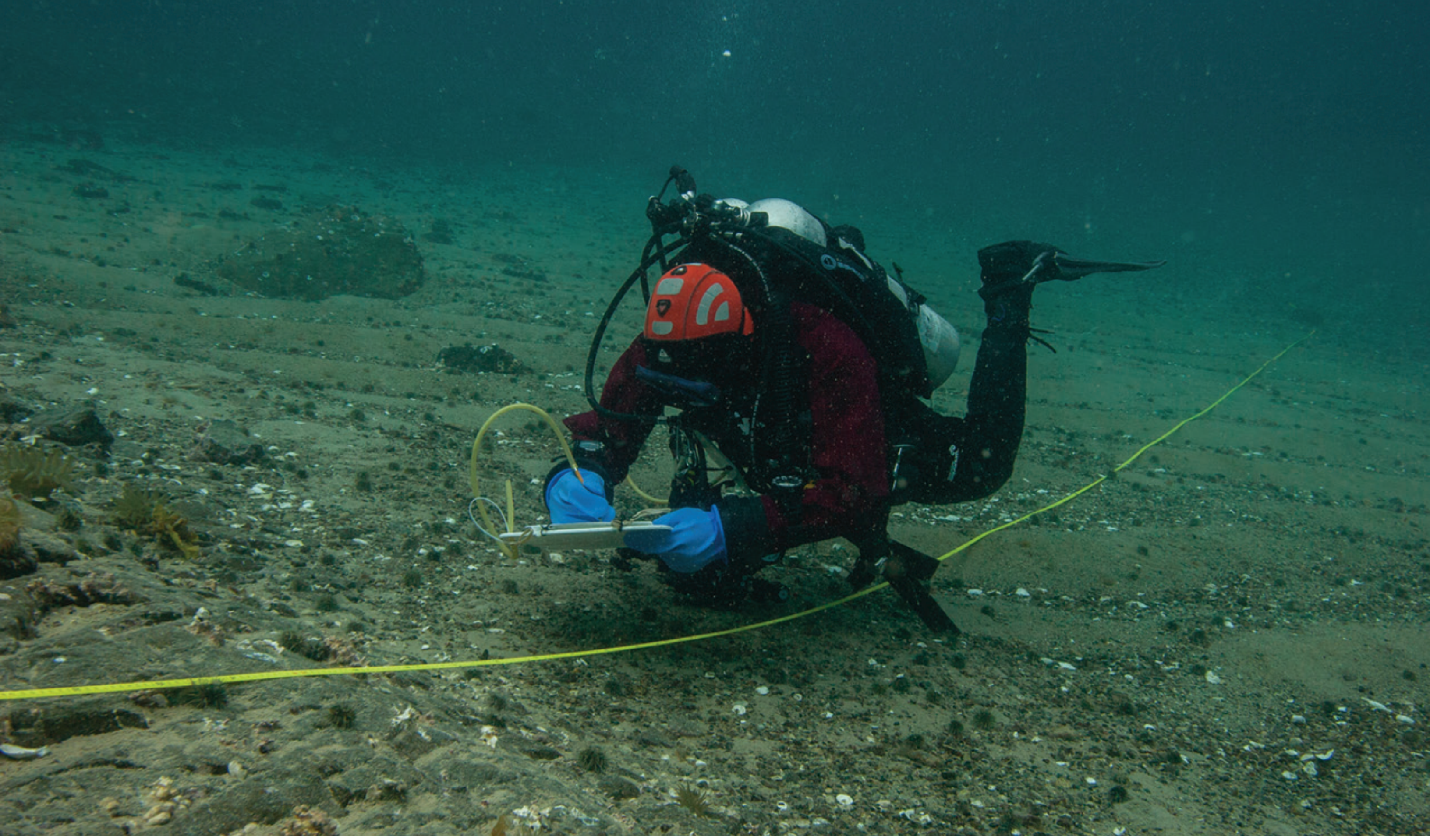





2017 Arctic Marine Ecology Benchmarking Program

FINAL REPORT

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March 2018

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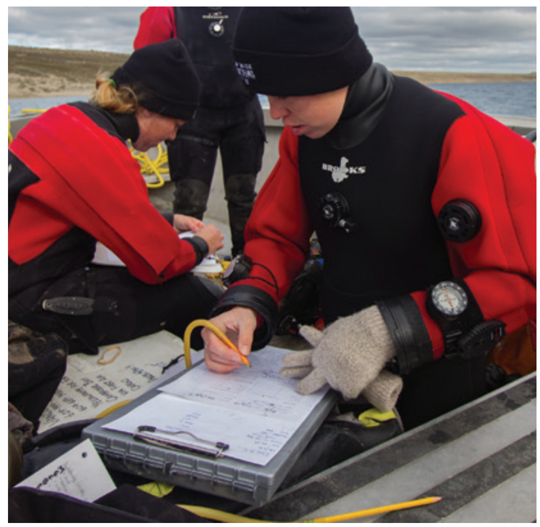
Introduction

Reliable baseline data and ongoing monitoring are essential for developing a full understanding of the changes underway in Canada's Arctic, enabling the development of effective management strategies and conservation plans. There have been, however, very few surveys of nearshore marine flora and fauna in the Canadian Arctic.

The nearshore is a key part of the larger marine ecosystem because it is where most direct human activity, such as boating, hunting, harvesting and community impacts, takes place. This is especially the case with marine algae, invertebrates and fish species. This project attempts to address this significant gap by establishing baseline biodiversity data and initiating long-term monitoring of marine nearshore ecosystems at key sites near Cambridge Bay, Nunavut.

Since 2014 the Ocean Wise Conservation Association working with Polar Knowledge Canada has surveyed 26 nearshore sites in the region around Cambridge Bay to collect data on habitat type and species diversity. The 2017 Arctic Marine Ecology Benchmarking Program (AMEBP) marks the next stage of the research: transitioning from exploration and cataloguing to systematic documentation and ecological benchmarking. In the summer of 2017, Ocean Wise diving scientists established six long-term monitoring sites at which baseline species diversity and abundance data will be collected, with the anticipation of monitoring these sites on an annual basis thereafter.



Objectives

Building on the catalogue of data gathered during the 2015 and 2016 Nearshore Ecological Surveys (NES), the 2017 AMEBP team quantified the biodiversity and abundance of a subset of marine algae, invertebrates and fish species at six selected sites in the Cambridge Bay area. This effort will serve as a pilot study to assess the survey design and make recommendations for future research and monitoring efforts.

Goals of the AMEBP are to:

- Develop a repeatable, long term monitoring program for nearshore marine ecosystems in the Cambridge Bay area.
- Provide benchmark data to which future monitoring results can be directly compared.
- Monitor and describe change to nearshore marine ecosystem biodiversity and species abundance.
- Identify sites of special interest or ecological sensitivity that may require future protection.

- Apply the AMEBP techniques developed in Cambridge Bay across Canada's Arctic as monitoring and benchmarking programs are expanded.
- Engage with the local community to enhance their already strong connection with the marine ecosystem.
- Help establish CHARS as the hub for Arctic scientific marine research and monitoring, and support the implementation, set-up and ongoing operations of the CHARS scientific diving program and dive locker.
- Continue to add data to the NES Catalogue that will serve as reference document for Arctic scientists and policy makers when considering scientific projects.

Because an important goal of the project is to engage with the Inuktitut- and Inuinnaqtun-speaking people of Nunavut, this report will be translated into Inuktitut and Inuinnaqtun. As only a tiny fraction of Nunavut respondents to the 2016 Census indicated French was their mother tongue this report will not be translated into French. French translation can be done at a later date if required.

Polar Knowledge Canada

Polar Knowledge Canada (POLAR) is responsible for advancing Canada's knowledge of the Arctic and strengthening Canadian leadership in polar science and technology. A key mission of POLAR is to manage Canada's new high Arctic research station in Cambridge Bay, Nunavut. There, POLAR expects Canadian and international scientists to conduct world-class cutting edge Arctic research on both terrestrial and marine ecosystems. POLAR serves as Canada's primary point of contact with the circumpolar knowledge community, and liaises with research organizations and institutes throughout the circumpolar world, providing guidance for multilateral scientific projects relevant to Canadian interests.

POLAR's programs consist of a pan-northern science and technology program, a knowledge acquisition management and mobilization function and the Canadian High Arctic Research Station (CHARS, above right) in Cambridge Bay, Nunavut. (www.canada.ca/en/polar-knowledge)

Ocean Wise Conservation Association

The Ocean Wise Conservation Association (www.ocean.org) launched in June 2017 as a new global ocean conservation organization focused on protecting and restoring our world's oceans. Building on the roots of the Vancouver Aquarium Marine Science Centre, which started as a community-based not-for-profit organization, Ocean Wise aims to inspire people in every corner of the planet to participate in creating healthy oceans.

The Vancouver Aquarium, an Ocean wise initiative, has been involved in operations in the Canadian Arctic since 1974, and maintains a collection of living Arctic marine specimens for propagation, research and public display.

POLAR and Ocean Wise jointly provided funding for the 2017 AMEBP.

Logistics, Diving Details and Equipment

The 2017 AMEBP was undertaken by two Ocean Wise scientific dive teams, each spending ten days in Cambridge Bay in July, August and September 2017. Team One, led by Danny Kent and including research divers Mackenzie Neale, Ruby Banwait and Laura Borden were in Cambridge Bay from July 25 to August 4. Team Two, led by Jeremy Heywood and including research divers Donna Gibbs, Jessica Schultz and Crystal Kulcsar, along with Ocean Wise Senior Writer Laura Trethewey, were in Cambridge Bay from August 22 to September 1.

All divers are experienced scientific divers and are qualified to the Canadian Association for Underwater Science Scientific Diver Level II rating, as defined by the Canadian Association for Underwater Science *Standard of Practice for Scientific Diving*. All divers also hold a Transport Canada SVOP Certificate. Both teams contained a mix of divers with previous Arctic diving experience, (including multi-year experience diving around Cambridge Bay) and those new to Arctic diving.

Various team members contributed additional expertise in areas such as data collection and analysis, specimen life support, public engagement, logistics and planning and digital image gathering. Dive team roles are gender non-specific and filled by the diver with the most appropriate skill set.

Dives were no-decompression dives using compressed air. To maintain a conservative dive regimen, no more than two dives per day per diver were planned. Dives met the requirements of the Nunavut Consolidation of General Safety Regulations, Part VI, Section 484: *Commercial Diving Operations*. No ice was present or observed during any AMEBP dives.

Divers (right) used neoprene drysuits, three-finger wet gloves with double cuffs on the drysuit or dry gloves, and hi-vis orange wet hoods, sometimes with additional 1mm neoprene hood liner worn under main hood. They carried a primary 80ft^3 aluminum cylinder and a fully redundant 30ft^3 aluminum cylinder, both with Poseidon XStream regulators. Cylinders were filled using two portable diving air compressors.

Underwater images were collected with:

- Sony NEX-5 in Aquatica housing with Hugyfot video light – used for video and stills.
- Canon 20D in Ikelite housing with Ikelite strobe – used for stills.
- Nikon D800 in Aquatica housing with Sea & Sea strobes – used for stills.
- GoPro HERO 5 Black with ambient lighting – used for video.

A gear checkout and Arctic diving skills refresher dive was conducted as the first dive of each AMEBP team deployment. This allowed for the fine-tuning of diving and imaging equipment and practice of emergency skills prior to the commencement diving operations.

Shore dives were accessed by locally-rented 4-wheel drive vehicle. Boat dives were accessed by the vessel *Ugyuk* (right), a sturdy aluminum, open-deck 8m skiff hired from Cambridge Bay resident John Lyall Jr., who acted as boat operator and guide. The *Ugyuk* maintained a speed of approximately 40 km/hour in good weather conditions. However, vessel speed could be greatly reduced if weather or sea conditions were unfavourable. The boat was loaded and unloaded at the beach adjacent to the Cambridge Bay dock. All dives were conducted as live-boat dives.

Selected live specimens were hand-collected by divers (outside of survey transects area and under appropriate permits) for educational and community engagement activities and for photo documentation. Specimens were held at the Nunavut Arctic College in a portable, chilled seawater holding system constructed by the AMEBP team. See Appendix C for more details.

The AMEBP team's very comfortable accommodations were provided by POLAR at the Canadian High Arctic Research Station facility (right, showing accommodation triplexes in the background) in Cambridge Bay.

Methods

Benchmarking surveys (transect dives)

For this pilot survey, sites near the Hamlet of Cambridge Bay appropriate for monitoring (in terms of safety, depth, accessibility and habitat complexity) were randomly selected from a list of previously explored sites (2015 and 2016 NES). Two sites from each of Cambridge Bay proper, West Arm and the Findlayson Islands areas were selected (Table 1).

Table 1: Pilot survey monitoring sites near Cambridge Bay.

Site Name	Area	Substrate	Latitude	Longitude
West of 5 Island	Cambridge Bay	mud, dropstones	69.0687	-105.1967
Cape Colborne Inside	Cambridge Bay	sand, silt, mud, slope	68.9668	-105.2304
Old Camping Spot	West Arm	silt, boulders, flat	69.1104	-105.0761
West Arm BCB	West Arm	sloping shale, mud	69.1093	-105.1717
Starvation Cove Point	Findlayson Islands	sand, cobble	69.1492	-105.9233
Unnamed Island 1 South End	Findlayson Islands	cobble, boulders	69.0938	-105.8989

Four benchmarking surveys were conducted at each site using scuba (transect dives, right) for a total of 24 transects. Transects were centred on the site coordinates, and followed a bearing on the 10m depth contour parallel to shore as closely as was practical.

To ensure monitoring efforts were robust and repeatable, sampling protocols adapted from the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) were used. (PISCO protocols are widely used in subtidal monitoring and research programs throughout North America, including university programs[2], ecological monitoring by Parks Canada and Ocean Wise initiatives in British Columbia[3].) Divers recorded the start and end time of the each component of the survey to ensure a consistent swimming speed of approximately 7m per minute.

Each transect dive consisted of three components:

1. Fish survey - Selected fish families (see Table 3) were recorded along a belt transect 30m long by 2m wide by 2m high. One diver deployed the transect tape at a constant depth and bearing, while the other counted fish.
2. Invertebrate and algae swath survey - Selected invertebrates and algae (see Table 3) were counted within a 30m x 2m swath centered on the transect. Only invertebrates larger than 2.5cm and algae larger than 30cm were recorded. When more than 50 individuals of a single taxon were encountered, the distance reached along the transect was noted and counting of that taxon was discontinued.
3. Habitat survey - Four habitat parameters (inorganic substrate, organic cover, relief and habitat complexity) were recorded every 2m along the transect according to predetermined categories for each (Table 2). Substrate and cover were taken from the point intersection directly underneath the corresponding metre mark. Relief and complexity were taken from a 1m cross section perpendicular to the transect tape.

2 E.g. Carr et al. 2010, *Knowledge through partnerships: integrating marine protected area monitoring and ocean observing systems*, Front Ecol Environ; doi:10.1890/090096

3 Schultz et al. 2016. *Evidence for a trophic cascade on rocky reefs following sea star mass mortality in British Columbia.* PeerJ: e1980

Table 2: Habitat characteristic categories.

Substrate	
S	Sediment (<5cm particles, mixed sand, shell, mud etc.)
C	Cobble (5 – 20cm)
B	Boulder (> 20cm)
R	Bedrock (continuous rock)
O	Other (anthropogenic, wood etc.)
Cover	
B	Brown algae (other than encrusting brown algae)
G	Green algae
R	Red algae (other than crustose coralline)
EB	Encrusting brown algae
CC	Crustose coralline algae
SI	Sessile invertebrate (e.g. sponge, bryozoan, barnacle etc.)
MI	Mobile invertebrate (e.g. snail, urchin crab etc.)
N	None
Relief	
0	0-10cm
1	10cm – 1m
2	1m – 2m
3	>2m
Complexity	
S	Smooth surfaces, no crevices
L	Low irregularity, few crevices (e.g. continuous cobble)
M	Moderate irregularity, habitat with crevices
H	Highly irregular, many crevices

Roving biodiversity surveys (taxon dives)

To compare the merits of the benchmarking survey approach with methods used for the 2015 and 2016 NES, roving biodiversity surveys (taxon dives) were conducted in parallel with the transect dives whenever time and weather conditions allowed. At least one taxon dive was conducted at each transect site. Divers recorded all organisms observed (to the lowest taxonomic level possible), and estimated the approximate abundance of each. The approach is similar to that used by the Reef Environmental Education Foundation (REEF)[4] citizen science program. Details of the methods are described in the 2016 Nearshore Ecological Survey Report (VAMSC, 2016).

4 www.reef.org

Data analysis - Community composition and habitat characteristics

To approximate species abundance and variation, taxa were summarized using means and standard deviations. Species composition was also summarized by comparing the three sampling areas (Cambridge Bay, West Arm and Findlayson Islands) using an Analysis of Similarity (ANOSIM; Primer 6) of the square root transformed abundance of each taxa for each transect. Habitat characteristics among the three areas were compared using mean proportions and standard deviations.

Data analysis - Power analysis of benchmarking sampling design

Following the methods in Green and McLeod (2016), a linear mixed effects model power analysis to assess the power of the sampling design was conducted to detect changes in green urchin (*Strongylocentrotus droebachiensis*) abundance. Green urchins were used as a case study species to evaluate the benchmarking survey sampling design as a tool for long term ecological monitoring because urchins are abundant and ecologically important[5], and are considered an indicator species in many existing monitoring programs globally[6].

To determine the fixed intercept and random variance to use in the power analysis, a linear mixed effects model on green urchin abundance data was conducted, with survey site as a random effect. Two types of power analyses were conducted using the model output. The first was to determine the number of monitoring years needed under the present sampling design (six sites with four transects each) to detect a 25% change in the urchin population with 80% power. The second was to determine the number of study sites required to detect a 25%, 50% and 2×SD change in the population from one year to the next (i.e. with two years of sampling). Effect sizes of 25%, 50% or 2×SD, and a power threshold of 80%, are considered generally acceptable targets in ecology[7].

Data analysis - Comparison of transect and taxon diver methods

To illustrate the different potential applications of each method, species accumulation curves of the benchmark transects were compared to those of the taxon diver technique. Species accumulation curves were constructed by ordering surveys chronologically and then plotting the cumulative number of species detected with each additional survey for both transect surveys and roving biodiversity surveys.

5 Coyer et al. 1993; Estes & Duggins, 1995
6 e.g. Chen & Hunter, 2003; DFO, 2013
7 Munkittrick et al. 2009

Results[8] and Discussion

Benchmarking surveys - Community composition and habitat characteristics

Overall, there was no difference in the community composition among sites in Cambridge Bay, West Arm and the Findlayson Island (ANOSIM: R = 0.557, p = 0.10). However, the average abundance of invertebrates and algae was higher in the Findlayson Islands than in the other two areas (Fig. 1). The abundance of fish was low (less than 2 individuals per 60 m2) in all areas (Fig. 1; Table 3).

Table 3: The mean abundance of taxa enumerated in 60 m2 transects (n = 24) at six sites in Cambridge Bay, in order of abundance.

Scientific name	Common name	Mean	SD
Hiatella arctica	Arctic saxicave	520.6	725.4
Strongylocentrotus droebachiensis	Green urchin	430.6	583.6
Pachycerianthus borealis	Tube dwelling anemone	223.2	330.7
Various	Non-sessile polychaetes	12.0	18.3
Utricina spp.	Urticina anemones	11.7	17.5
Hormathia spp.	Rugose anemone	8.9	23.1
Psolus fabricii	Scarlet sea cucumber	2.4	4.3
Buccinum spp.	Buccinum snail	1.1	2.3
Dendronotis spp.	Dendronotid nudibranchs	0.8	2.7
Cottoidea	Sculpins	0.8	0.9
Hyas coarctatus	Arctic lyre crab	0.6	1.0
Various	Solitary tunicates	0.6	1.1
Stichaeidae	Pricklebacks	0.5	0.9
Various	Bladed red algae	0.3	0.5
Cucumaria frondosa	Giant black sea cucumber	0.2	0.6
Icasterias panopla	Red spiky sea star	0.2	0.6
Saccharina latissima	Sugar kelp	0.2	0.5
Various	Non-sessile nemerteans	0.2	0.5
Lebbeus polaris	Polar lebbeid shrimp	0.1	0.4
Urasterias lincki	Frilled sea star	0.1	0.3
Various	Dorid nudbranchs	0.0	0.2
Zoarcidae	Eelpouts	0.0	0.2

The most abundant taxa were Arctic saxicave, green urchins and tube-dwelling anemones (Table 3). These three taxa showed considerable variation across transects (Table 3). It should be noted that Arctic saxicave proved to be challenging to identify to the species level from the siphons alone when they were buried in the sediment, and this quantity should be interpreted with caution.

8 All raw data is available upon request.

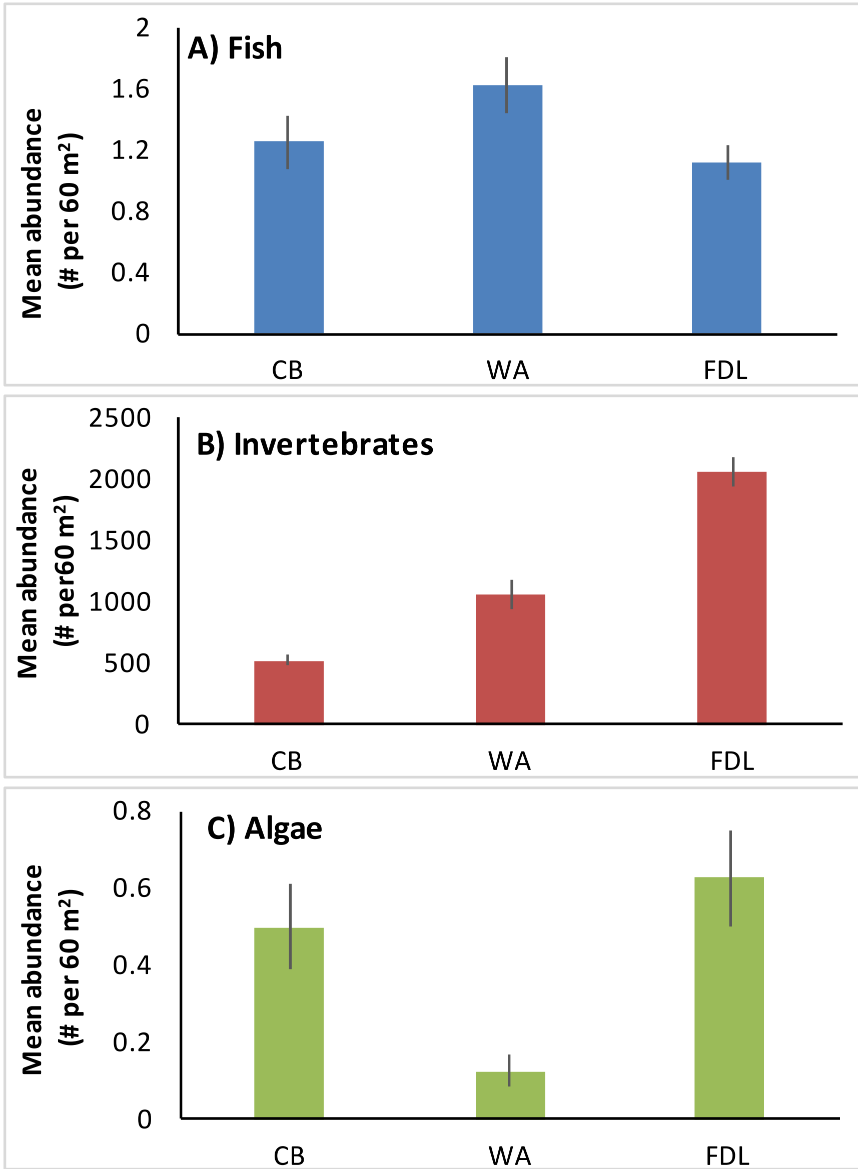


Figure 1: The mean abundance of (A) fish, (B) invertebrates, and (C) algae counted along 60 m2 transects in three areas near Cambridge Bay (CB = Cambridge Bay; WA = West Arm; FDL = Findlayson Islands). n = 8 transects in each area. Error bars represent standard error.

The habitat of most sites was characterized by low relief and low complexity mud or sediment. 83.8% (19.0 SD) of the substrate at the Cambridge Bay and West Arm sites was sediment or mud. However, the Findlayson Island sites had proportionately less sediment compared to the other areas, and a greater proportion of cobbles and boulders (Fig. 2).

At all sites, most intersection points had no organic cover (84.4% ±14.3 SD) and had smooth (score = 0) habitat complexity (70.8% ±30.8 SD). However, the Findlayson Island sites had a lower proportion of zero-complexity points compared to the other areas (38.3% ±25.4 SD), because those sites had a higher proportion of cobble and boulders (Fig. 2). There was minimal habitat relief across all of the transects. With the exception of a single point at one site (Unnamed Island 1 South End), all points along all transects had a relief value of < 1 m.

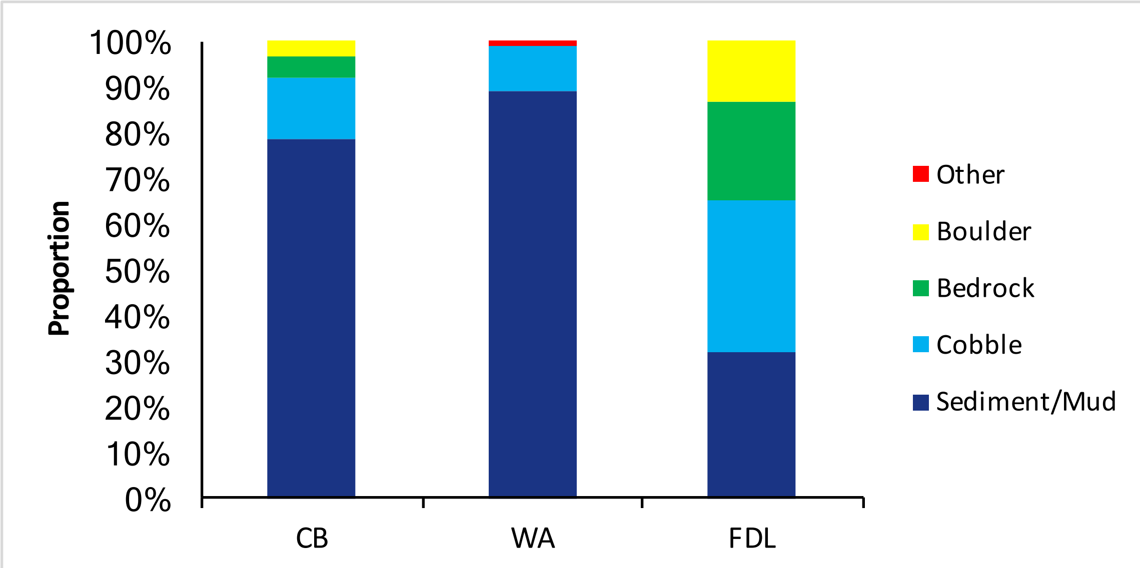


Figure 2: Proportion of substrate type for three areas near Cambridge Bay (CB = Cambridge Bay; WA = West Arm; FDL = Findlayson Islands). n = 8 surveys for each area.

Differences in abundance of fish, invertebrates and algae between the Findlayson Islands and the other areas could be attributed to differences in habitat characteristics. The Findlayson Islands are more exposed to tidal current than the two other areas. As a result, sediments are removed, exposing a higher proportion of hard substrate such as cobble and boulders. In future monitoring, targeting one area could reduce sample variation, but would also narrow the scope of monitoring efforts.

Benchmarking surveys - Power analysis

The sampling design used in this pilot study would be adequate to detect large (e.g. 50% or 2×SD) changes in the abundance of individual species from one year to the next, but a smaller (e.g. 25%) effect size would require several years of sampling and/or more survey sites. With six sites (24 transects total), five years of sampling would be required to achieve greater than 80% power to detect a 25% change in the population of green sea urchins (power at n = five years is 97.8% ± 1.3% [95% CI]).

In order to detect a 25% change from one year to the next (i.e. over two years), the number of sites would need to increase to an unreasonably high number (Fig 3A). However, if a larger effect size is acceptable (e.g. a 50% change in the population), approximately 17 sites would be adequate (Fig 3B). Using the present sampling design (i.e. six sites), a 2×SD change in the urchin population would be detected over two years with 100% ± 0.07% (95% CI) power. For reference, an effect size of 2×SD is equivalent to a 271% change in the population of green urchins in the case of our pilot data (Table 2).

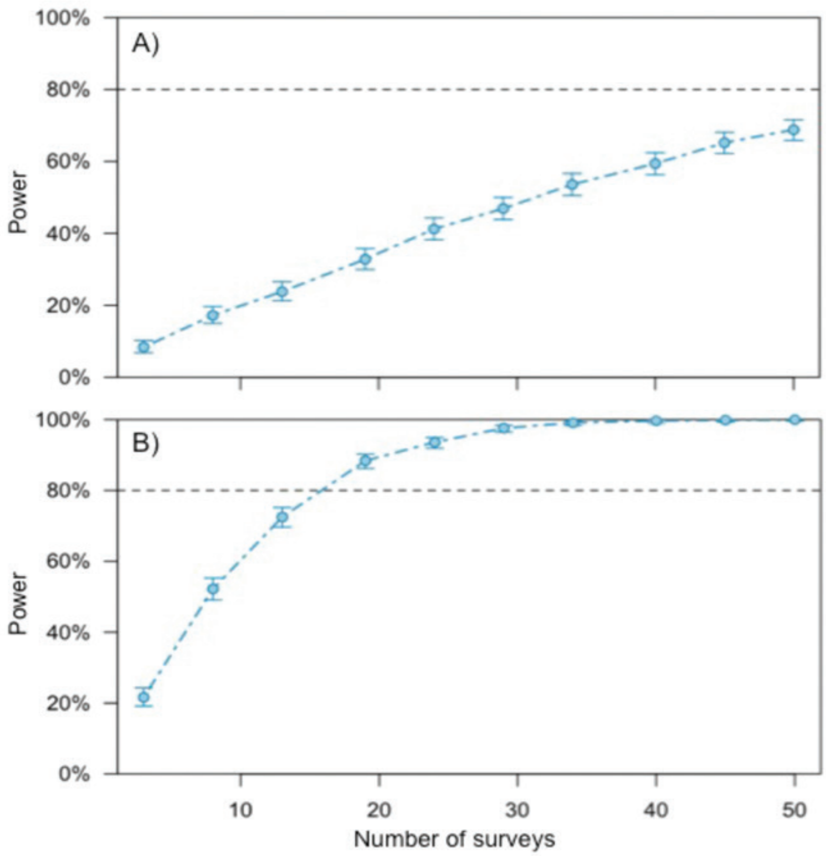


Figure 3: The estimated power to detect (A) a 25% change, and (B) a 50% change in the population of green urchins for a given number of survey sites (with four transects per site) using a linear mixed effects model (R "simr" package; Green and McLeod, 2016). Horizontal dashed lines represent 80% power, which is a common target in ecological studies (Munkittrick et al., 2009).

To ensure an adequate sampling design, it will be important for future monitoring efforts to identify species of interest, and set clearly defined monitoring objectives that include the desired effect size and power.

The most appropriate approach for future monitoring will depend on the long term monitoring objectives and species of interest. For instance, given the very low fish counts, researchers interested in focusing on fish monitoring may consider increasing the number of transects, or perhaps conducting a proportion of fish-only transects to compensate for the low numbers. Power analyses should be re-run for specific species of interest to ensure that the monitoring program meets specific targets for effect size and power.

Roving biodiversity surveys

Eighteen roving biodiversity survey (taxon) dives were undertaken in parallel with transect dives during which 161 species were noted, including 20 not previously recorded during the 2015 or 2016 NES. (Appendix E.)

Figure 4 compares the number of species observed on taxon dives where abundance was estimated in the Cambridge Bay area during the 2015 (6 dives) and 2016 NES (14 dives) and 2017 AMEBP (18 dives).

For some species, 2017 is the first year any abundance was recorded. This suggests a need to continue this type of taxonomic work, as the number of species observed seems to rise with sustained diving effort (e.g. there were 20 species additions to the list in 2017; Figure 5). Continuation of the taxon diving component of the project will allow for longer- term trends to be observed and a more comprehensive list of species to be compiled.

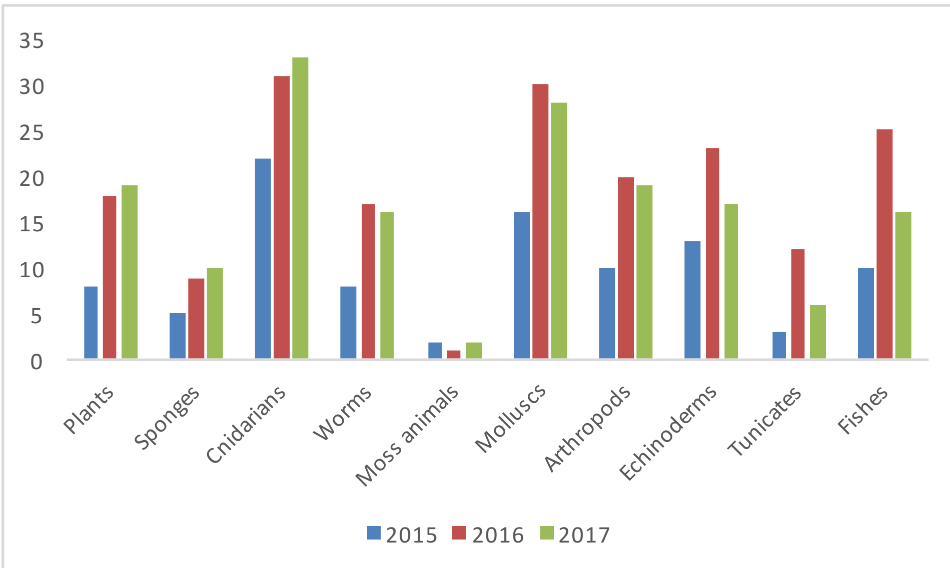


Figure 4: Comparison of number of species observed during the 2015 and 2016 NES, and 2017 AMEBP.

One notable change in 2017 was virtual absence of the folded-stomach jelly *Ptychogastria polaris*. Only longer-term monitoring will indicate whether this is a local blip or a population trend.

As well, the number of observed but unidentified species remains large, especially in the Phyla Porifera (sponges) and Urochoradata (tunicates), and suggests the need for more detailed photo documentation and taxonomic verification combined with tissue collection and DNA analysis.

Comparison of transect and taxon dive methods

Using the taxon dive method, a higher number of species was observed for a given number of surveys than using the transect dive method (Fig. 5). The taxon dive method noted 161 species in 18 dives while the transect dive method noted 22 species in 24 dives. (Fig. 5). The species accumulation curve maintained an upwards trajectory for the roving surveys, suggesting that species richness would continue to climb with additional surveys, while the species accumulation using the transect method is, of course, maximized at the number of target species predetermined in the methods. In contrast, the transect method provides a more rigorous estimate of species abundance (Table 3) than the taxon method, which approximates abundance and is more subjective (VAMSC, 2016).

The most appropriate method for future monitoring will depend on the objectives of the monitoring program. Taxon surveys may be more appropriate if the primary monitoring objectives include capturing a greater breadth of biodiversity, or detecting rare, endangered or invasive species since a greater number of taxa can be detected for a given sampling effort using this method. However, if more repeatable and quantifiable data are required, the transect method may be more appropriate.

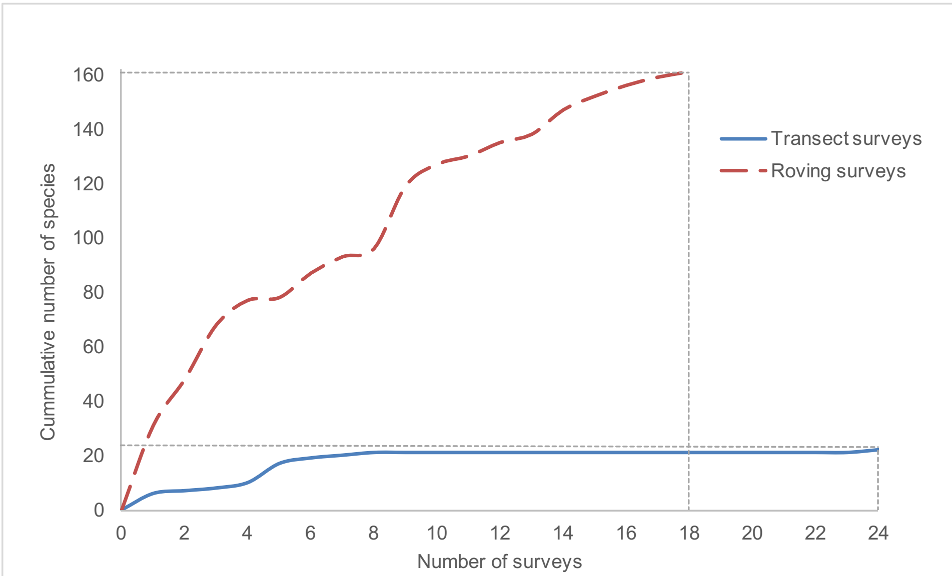


Figure 5: The cumulative number of taxa observed with each additional transect (solid blue line) or roving diver survey (dashed red line). Surveys are in chronological order. 22 taxa were observed after 24 transect dives, and 161 taxa were observed after 18 taxon dives.

A note about taxon dives and rescued data

Ocean Wise maintains a dynamic catalogue of taxonomic observations gleaned from the dive logs of divers during historic dives at Pond Inlet (1994, Doug Pemberton, one dive) and Resolute Bay (Danny Kent 1989-2011, 66 dives), and from the dive logs and data collected as part of the Vancouver Aquarium's Cambridge Bay-area cataloguing efforts from 2014 to 2107 (82 dives to date). A table of these collated observations is included as Appendix G.

The Kent and Pemberton records can be classified as rescued data (data retrieved from unpublished sources, e.g., field notebooks, records on outdated storage media, or photographic records, which are often at risk of loss[9]). Inclusion of these historic observations made by scuba divers, although sometimes limited, demonstrates the value of mining existing records; providing useful data in regions where no other data might exist.

9 Data Management Principles and Guidelines for Polar Research and Monitoring in Canada, May 2017; POLAR, 2017

Physical Water Quality Parameters

As an additional opportunistic project during the 2017 AMEBP, Team One used a YSI ProDSS multi-parameter water quality meter ("sonde") to collect eight water quality profiles, five at AMEBP sites and three at 2016 NES sites. Information collected included temperature (±0.2°C), salinity (±0.1ppt or ±1% of reading, whichever is greater), pH (±0.2units), dissolved oxygen (±0.1mg/L) and turbidity (±0.3FNU or ±2% of reading, whichever is greater). For each deployment, readings were collected approximately every 3m, to the deepest depth possible.

The coldest temperature recorded using the sonde was -0.7°C at the West Arm Tank Farm site (Fig. 6). Surface temperatures varied from day-to-day and were not necessarily related to geographic areas. For example, surface temperature at West of 5 Island was 4.3°C on July 29th, but two days later on July 31st the same site's surface temperature was 1.8°C. The only location where sub-zero water temperatures were recorded was in the West Arm; however, depths greater than 20m were only reached in the West Arm making direct comparisons difficult since sub-zero temperatures were only reached at depths greater than 20m.

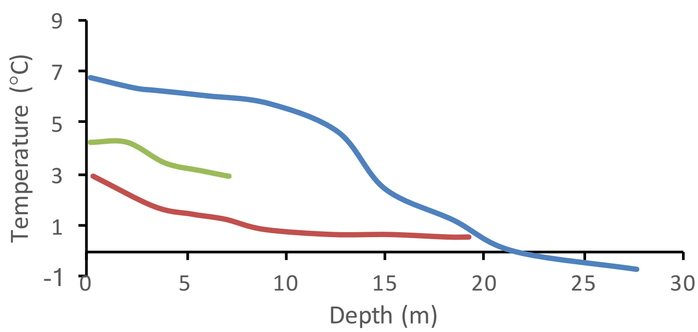


Figure 6: Temperature along a depth profile to thirty meters at three AMEBP sites in 2017. Red = Rectangle Rock, Findlayson Islands; Green = West of 5 Island, Cambridge Bay; Blue = Tank Farm, West Arm.

In general, distinct thermoclines were less apparent in 2017 at the three represented areas than in 2016[10]. Neither salinity (Fig. 7) nor pH (Fig. 8) varied with depth, with the exception of West Arm where salinity increased with depth and pH declined at depths greater than 20m.

10 2016 Neashore Ecological Survey. Vancouver Aquarium and POLAR Knowledge Canada

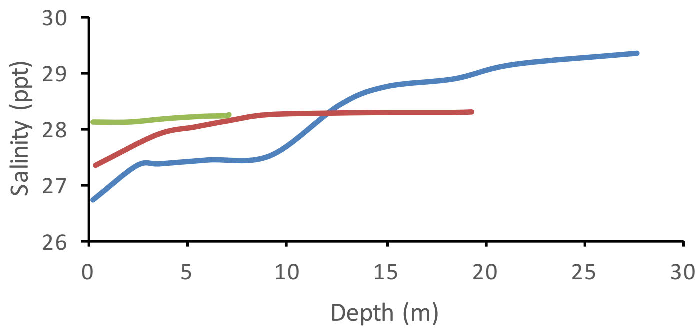


Figure 7: Salinity along a depth profile to thirty meters at three AMEBP sites in 2017. Red = Rectangle Rock, Findlayson islands; Green = West of 5 Island, Cambridge Bay; Blue = Tank Farm, West Arm.

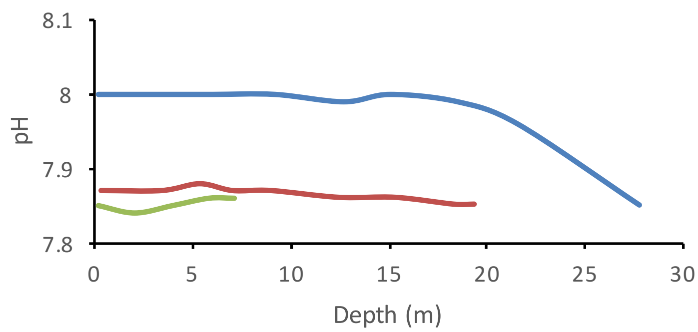


Figure 8: pH along a depth profile to thirty meters at three AMEBP sites in 2017. Red = Rectangle Rock, Findlayson islands; Green = West of 5 Island, Cambridge Bay; Blue = Tank Farm, West Arm.

Three sites surveyed around the Findlayson Islands in August 2016 were also surveyed in late July 2017. For each repeat site temperature (Fig. 9), salinity (Fig.10) and pH (Fig. 11) were compared. Surface temperatures at all sites were 6-7°C colder in 2017, with a more noticeable stratification around 8m depth, beyond which temperature was consistent. In contrast, two of the three sites had small, gradual declines in temperature with depth. pH was also lower in 2017 by approximately 0.2 units. In neither year did pH vary with depth. Salinity was 2-3ppt higher in 2017 and showed the same stratification pattern as temperature. The relationship between these three variables is similar to what exists on shallow seabeds in Howe Sound, British Columbia during summer[11]; colder water temperatures during summer correlate with more saline, and more acidic, water.

11 Jeffrey B. Marliave and Laura A. Borden. Vancouver Aquarium data on Shallow Seabed Physical Oceanography. Chandler, P.C., King, S.A., and Perry, R.I. (Eds.). 2016. State of the physical, biological and selected fishery resources of Pacific Canadian marine ecosystems in 2015. Can. Tech. Rep. Fish. Aquat. Sci. 3179: viii + 230 p.

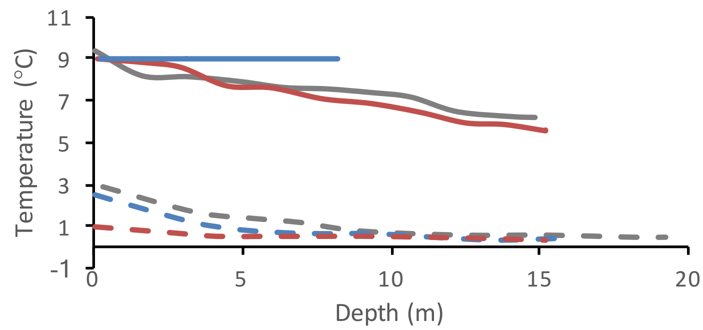


Figure 9: Temperature at three sites in the Findlayson Islands area in 2016 (solid lines) and 2017 (dashed lines), from the surface down to twenty meters depth, or deepest depth possible. Red = Unnamed Island 1; Blue = Starvation Cove Point; Grey = Rectangle Rock.

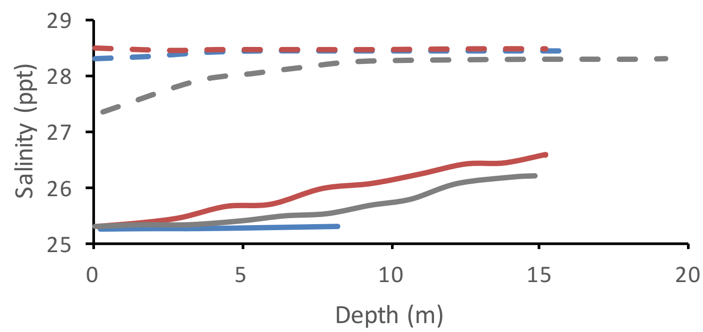


Figure 10: Salinity at three sites in the Findlayson Islands area in 2016 (solid lines) and 2017 (dashed lines), from the surface down to twenty meters depth, or deepest depth possible. Red = Unnamed Island 1; Blue = Starvation Cove Point; Grey = Rectangle Rock.

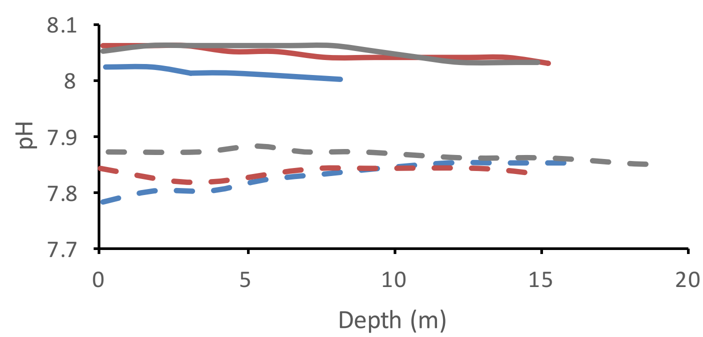


Figure 11: pH at three sites in the Findlayson Islands area in 2016 (solid lines) and 2017 (dashed lines), from the surface down to twenty meters depth, or deepest depth possible. Red = Unnamed Island 1; Blue = Starvation Cove Point; Grey = Rectangle Rock.

As well, water temperature profiles were collected by a Team One diver-carried ReefNet Sensus Ultra Pro data logger (temperature accuracy +/- 0.8oC, depth accuracy +/-0.3m). This is the same temperature logger unit used for the 2015 and 2016 NES.

The coldest temperature recorded with this logger was -0.39oC on dives at Unnamed Island 1 South End site on July 28. These were the only dives to have temperatures below freezing. In all but the last (taxon) dive at South Tip Unahitak Island (2016 NES site), the thermoclines - that in previous years appeared at ~10m and ~25m depth - were rarely crossed. The following figures (Fig. 12-14) show temperature-depth profiles for West Arm BCB (West Arm), West of 5 Island (Cambridge Bay) and Unnamed Island 1 South End (Findlayson Islands) dive sites. More temperature-depth profiles are included in Appendix D.

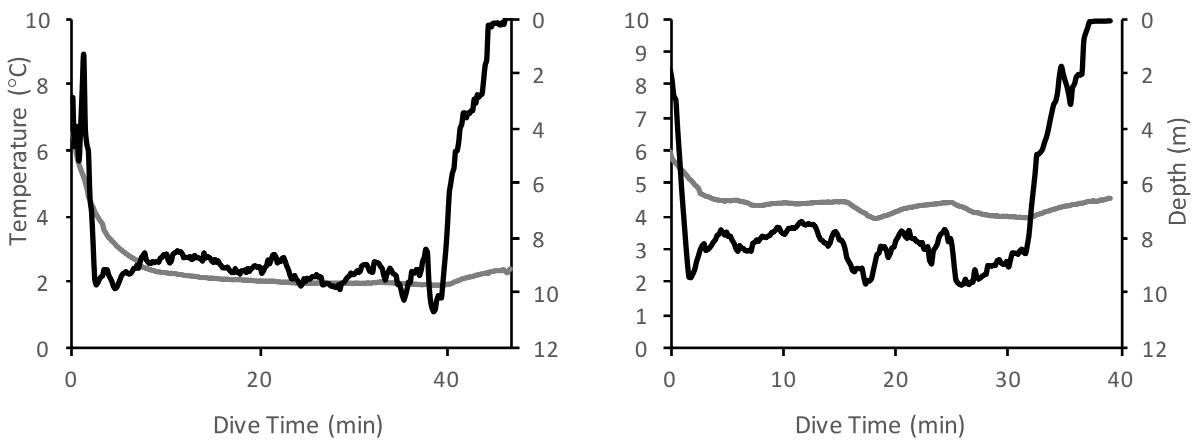


Figure 12: Dive depth (black line) and water temperature (grey line) over the course of two dives at West Arm BCB on July 27, 2017 (left) and July 31, 2017 (right).

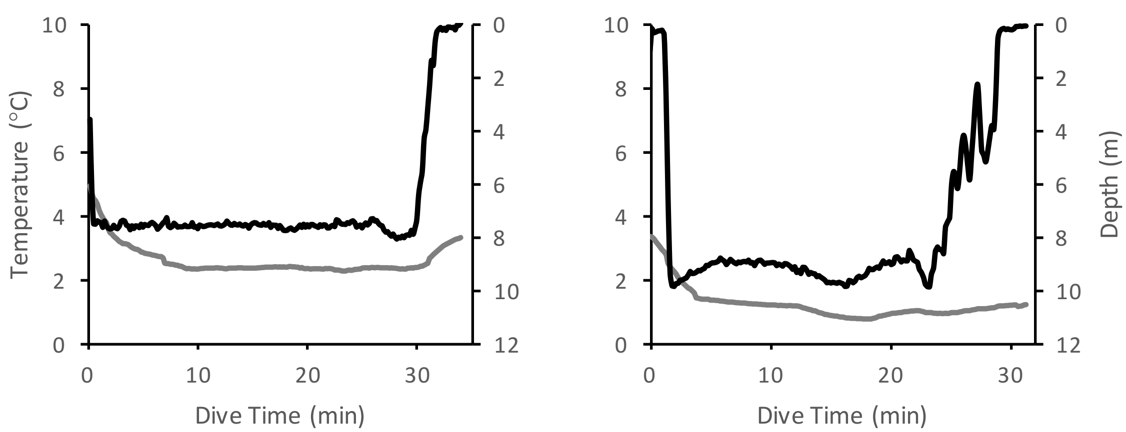


Figure 13: Dive depth (black line) and water temperature (grey line) over the course of two dives at West of 5 Island July 29, 2017 (left) and July 31, 2017 (right).

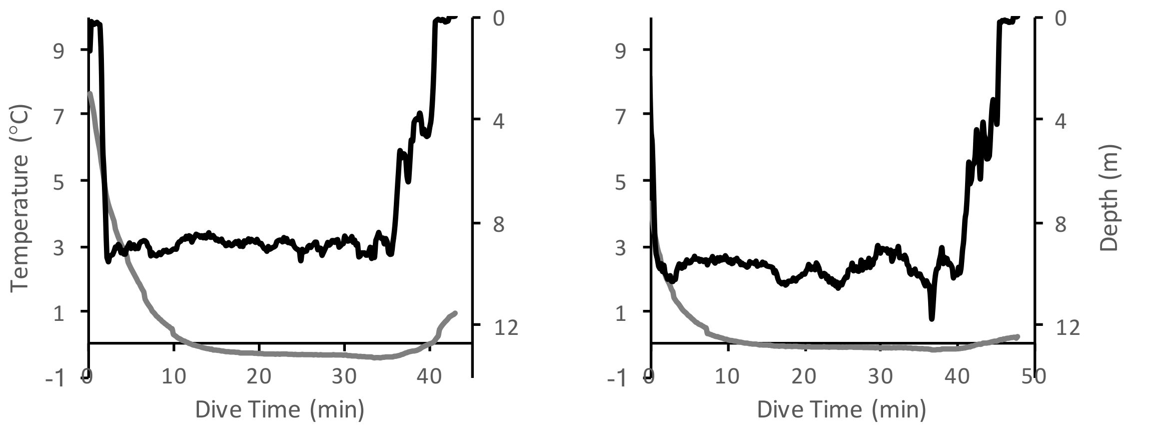


Figure 14: Dive depth (black line) and water temperature (grey line) over the course of two dives at Unnamed Island 1 South End on July 28, 2017

Community Engagement

Over the past several years, Cambridge Bay residents have been very receptive to NES public events, so AMEBP team members continued this community outreach by hosting a public open house at the Elders Palace on July 30 and hosting touch and learn session for Kullik Ilihakvik elementary school students and teachers on August 24. As well, Ocean Wise writer Laura Trethewey spoke to Cambridge Bay residents about their relationship with the environment and how it has changed over time.

One of the missions of Ocean Wise is to connect people to the ocean world. Hosting community events in Cambridge Bay is one of the ways Ocean Wise fulfils this mission. Ocean Wise strongly believes that this increased awareness of the local underwater environment will lead to enhanced respect for its complexity and fragility, and only serve to strengthen community support of ongoing monitoring efforts.

Elders Palace

On July 30, the Ocean Wise team conducted a popular, hands-on community event held at the Elders Palace. Five stations were set up for the event:

Live specimens - specimens collected by Ocean Wise divers included numerous invertebrate species such as clams, crabs, snails, jellyfish, comb jellies, along with a number of fish species. Two team members answered questions and supervised visitor interactions with the animals.

- Dive gear - A team member helped guests try-on dive gear to give them a sense of what diving in the Arctic Ocean is like.
- Photos and videos – a looping series of images and videos collected as part of research conducted in Cambridge Bay over the last several years that showed guests the environment under the waters surrounding Cambridge Bay.
- Publications – copies of NES reports and specimen identification booklet were available for examination. A team member answered questions.
- And of course, at the fifth station were refreshments and snacks.

POLAR staff carried out publication of this event in the community by circulating posters around the Hamlet.

Approximately 50 people, including numerous children, attended this event, many of whom stayed for the entire three-hour duration. The live specimen display, where visitors could touch the animals, was the favourite station. Many of the children enjoyed putting on dive gear and learning how it works. This event also gave team biologists an opportunity to speak with the community and learn about animals that the residents have encountered during fishing and hunting trips.

Feedback from the visitors was entirely positive. (And one guest suggested that more visitors might attend if door prizes were awarded!) Enhancements for future years could include more advertising further in advance of the event and publication on social media channels.

Schools

On August 24, the Ocean Wise team led an interactive program for all Kullik Ilihakvik elementary school students and teachers. Held at the Nunavut Arctic College Lab, all Kullik Ilihakvik classes (approximately 100 students) took turns visiting the live specimens collected by Ocean Wise divers held in the cooled seawater holding system temporarily set-up at the lab.

Each class visited for 20 minutes or so, during which time team members interacted with the students and teachers; discussing details about different specimens including sponges, corals, jellies, anemones, sea stars, crabs and fish. In many cases students were given the opportunity to touch the live specimens – a first for many of the children.

For future visits, pre-visit activity sheets and/or teacher guides could be provided to students and teachers in advance to give some background on the types of animals they will see during their hands-on visit. As well, allocation of more time per class would give Ocean Wise team members more interaction time to allow for more in-depth exploration of topics.

Similarly, post-visit follow-up information, including photos and video collected during dives, could be sent to teachers to summarize the results of the Ocean Wise projects that season.

Efforts were made to arrange for a session at Kiilinik high school as well. Unfortunately the Ocean Wise visit corresponded with the Kiilinik students' On the Land field trip, so no engagement events were possible.

The Ocean Wise team was impressed with the enthusiasm and curiosity of the visiting students. A number shared their experiences with certain animals they have seen around Cambridge Bay. They asked many questions and had to be cajoled to leave when it was time to switch classes.

Continuation and expansion of school programs must be a cornerstone of any future Ocean Wise activities in Canada's North.

Community Interviews

As noted above, Ocean Wise has held community events in Cambridge Bay, Nunavut, inviting the public to learn about in-the-field research and to contribute their thoughts. For the 2017 AMEBP another approach was added: interviewing community youth about environmental changes they've witnessed and how science and traditional knowledge can address climate change's impact on the Arctic. The responses we collected were varied and thoughtful, touching on concerns about threats to animal populations, food security, thinning ice, endangered transportation routes and invasive species. Candace Pedersen (26 years old) addressed the spread of southern species in a warming Arctic Ocean.

> "I think there's going to be salmon here now and there's never been any salmon here, ever. Last year, there was three caught in nets. Now, killer whales come here every once in a while. So, with these waters getting warmer, what else are we going to see?"

Mia Otokiak (21 years old, right) was enlightening as she addressed the changing animal populations she has witnessed in her lifetime:

> "I remember being younger, the caribou would come right to the community and the muskox would go right to the river. And now you won't see them anywhere. If people want caribou or muskox, they have to travel one or two days outside of the community."

> "My Nanna, when she was younger, she was in the Cambridge Bay area, and she remembers seeing walrus around. And in my entire life I've never seen a walrus here."

These insights give Ocean Wise a greater understanding of Arctic experiences and concerns. Canada's North is warming faster than any other place in the world and this will have a profound impact on the traditional life, culture and food sources of Inuit. By interviewing community members, Ocean Wise can incorporate Inuit experiences and concerns into future research projects. Candace Pedersen touched on this topic briefly, mentioning how scientific methods can establish baseline information about the Arctic ecosystems. By diving and recording species in the Arctic Ocean, Ocean Wise contributes to this goal, building information about a changing Arctic ecosystem.

These interviews were also featured on the Ocean Wise storytelling site, ocean.org (https://ocean.org/stories/arctic-sea-ice/#arctic-community). By sharing Arctic experiences with a wider audience, Ocean Wise hopes to inspire change and expand ocean literacy.

Next Steps in Biodiversity Research

While traditional approaches to biodiversity research, such as 2017 AMEBP, have made important strides in characterizing Arctic nearshore ecosystems, these methods have some limitations. For instance, because transect surveys target specific species of interest and specific survey depths, they do not capture the full breadth of diversity present at a given location. In addition, taxonomic experts are rare and precise identification can be challenging, especially for very small, uncommon or cryptic species.

One way to bolster traditional survey methods is to apply emerging molecular technology to biodiversity research. DNA barcoding is an increasingly powerful technique that uses short sequences of DNA to identify organisms to the species level. Ocean Wise wants to continue to be the vanguard in this effort, and therefore recommends:

1. Refocusing on roving diver biodiversity surveys in the Cambridge Bay area in the summer of 2018 using CHARS as the centre of operations. Techniques and methodologies used will mirror those developed during the Nearshore Ecological Surveys of 2015 and 2016. We will give special emphasis to visiting previously undocumented sites.

2. Hand collecting samples of known species (identified using traditional taxonomic methods) during roving diver biodiversity surveys for DNA barcoding. DNA barcoding will take place after the field season, at Ocean Wise facilities and the University of Guelph. DNA barcoding enables the positive identification and cataloguing of marine diversity of Cambridge Bay in unprecedented detail. Supplementing traditional taxonomy with the precision of DNA barcoding will make future monitoring efforts (to track invasive species, for example) far more cost effective, accurate and efficient.
3. Adapting the AMEBP techniques and methodologies developed in 2017 to continue diver-conducted transect surveys at three new sites. This will continue to add to the quantitative data set for the region.
4. In addition to continuing the popular community open house and school-engagement events, organizing and hosting a workshop with Cambridge Bay stakeholders to determine the local priorities for collection, dissemination and use of the data collected by the Ocean Wise team, and brainstorm ways to offer "citizen science" opportunities.

These recommendations align with Canada's strategic priorities, including the Oceans Protection Plan[12] and the 2020 Biodiversity Goals and Targets for Canada[13], and aim to:

- **Preserve marine ecosystems vulnerable to increased marine shipping and development** by contributing to baseline environmental data to help detect changes in the ecosystem, with an emphasis on detecting invasive alien species. This work will help develop biodiversity indicators, monitoring protocols and strategy. By adding species to the DNA database[14] organisms can later be identified in the field by DNA sequencing alone, which opens up myriad possibilities for future monitoring, including environmental DNA (eDNA) sampling.
- **Engage coastal and Indigenous communities** by continuing to work with the community to identify matters that are most relevant (such as invasive species), facilitating greater understanding of the nearshore underwater environment and providing "citizen science" opportunities to document and collect samples for identification.
- **Enhance the accessibility biodiversity information** by making biodiversity information more accessible than ever before, even if taxonomic expertise is not immediately available. As DNA barcoding technology develops, the project will generate enhanced biodiversity and invasive species information for community leaders, scientists, policy-makers and the community at large to support conservation planning and decision-making.

12 https://www.tc.gc.ca/eng/oceans-protection-plan.html
13 http://www.biodivcanada.ca/default.asp?lang=En&n=9B5793F6-1
14 Barcode of Life Data Systems (BOLD), Canadian Centre for DNA Barcoding, University of Guelph, Ontario. www.boldsystems.org.

Acknowledgments

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Kitnuna Corporation for oxygen for specimen shipment.

Charlie Gibbs for assisting with species database development.

Our colleagues at the Ocean Wise Vancouver Aquarium who assisted in innumerable ways.

Appendix A

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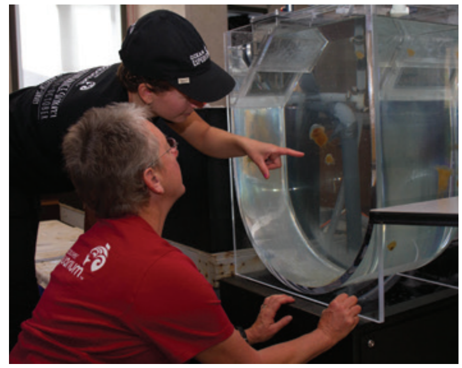
Appendix B

Location of Study Sites

Google map (https://www.google.com/maps/d/edit?hl=en&mid=1hBJ9tuY6Z1Ye2Xs-0x9WVXjYX1Y&ll=69.09249517054536%2C-105.68983763122554&z=10)

Appendix C

Live Specimen Holding



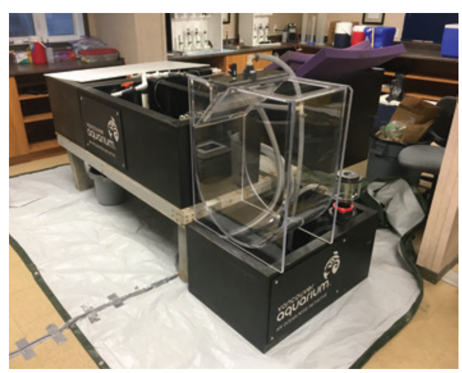
Live specimens were hand collected by divers, transported in bags then transferred to a chilled seawater holding system constructed at the Nunavut Arctic College laboratory.

The life support system (LSS) consisted of two insulated wet tables with dividers to isolate different species, a pseudokreisel tank (top right) to hold delicate planktonic animals such as jellies, a sump, numerous pumps, filters tubes and fittings, a protein skimmer and a chiller to keep the everything cold - between 2-4 degrees Celsius (bottom right and below).

The LSS was filled saltwater from the ocean, and proper salinity was confirmed using a hand-held refractometer. In case of low salinity (for example, if seawater was overly diluted with fresh water entering from the local river), Instant Ocean artificial reef salt could be added to keep the salinity at the optimal 20-25 parts per thousand.

Maintenance of the LSS included:

- Daily
  - temperature check
  - tank check to ensure specimens were healthy and the system was running properly
  - cleaning, which included, among other things, detritus siphoning, filter sock washing and protein skimmer cleaning
- Every other day
  - ten percent water change (with seawater bucketed-up from the beach) was done to ensure water quality.



The team felt that this LSS - which was a newly fabricated replacement of the old and tired system used in previous years - operated perfectly during the project. Water temperature held steady, even in the warm laboratory, all specimens fared very well and the open water tables provided easy viewing of specimens for visitors.

Appendix D

Additional Depth-Temperature Profiles

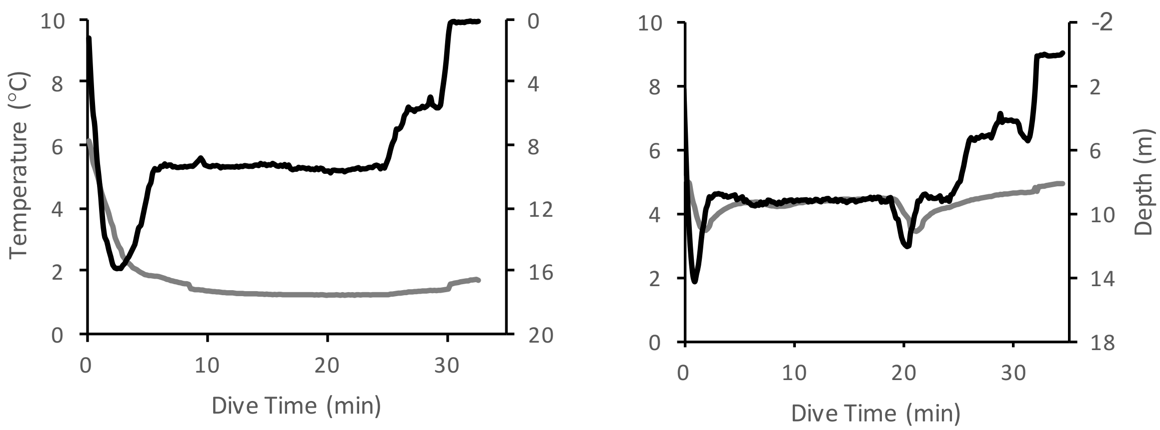


Figure AC1: Dive depth (black line) and water temperature (grey line) over the course of two dives at Old Camping Spot on July 26, 2017 (left) and July 29, 2017 (right).

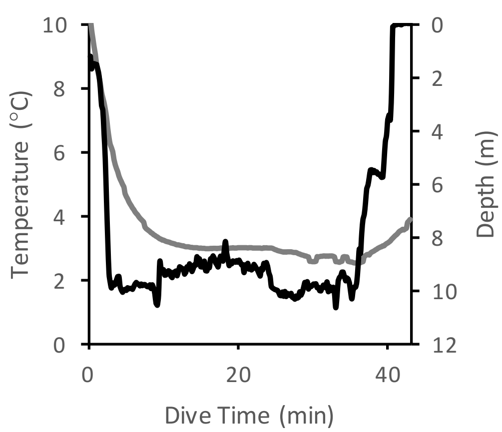


Figure AC2: Dive depth (black line) and water temperature (grey line) over the course of a dive at Northern Dock on July 26, 2017

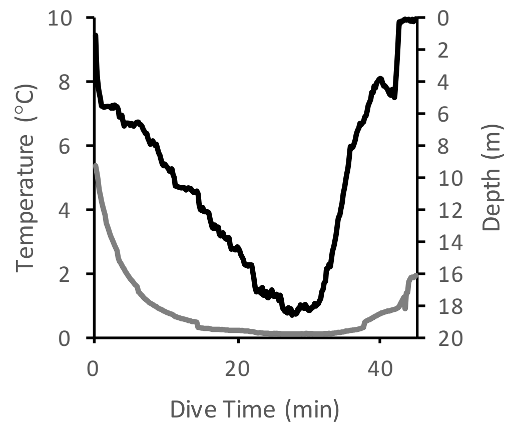


Figure AC3: Dive depth (black line) and water temperature (grey line) over the course of a dive at South Tip Unahitak Island on August 1, 2017.

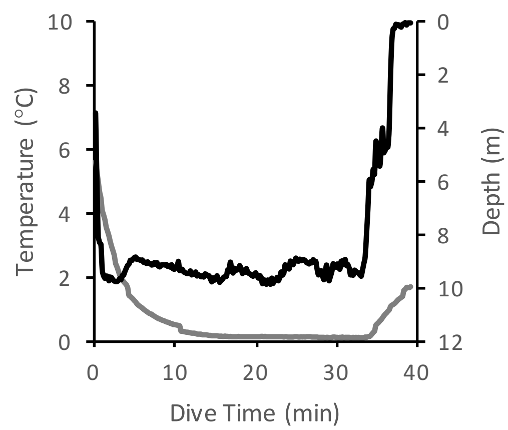


Figure AC4: Dive depth (black line) and water temperature (grey line) over the course of a dive at Starvation Cove Point on August 1, 2017.

Appendix E

Species Not Previously Noted in the Cambridge Bay Area

Table AE1, below, lists the 20 species newly noted by Ocean Wise divers during the 2017 AMEBP in Cambridge Bay. These species observations will be added to the ever-growing catalogue of marine life in and around the Cambridge Bay area.

filamentous green algae	undetermined green algae
diatoms	undetermined brown algae
warty sponge	Halichondria (Eumastia) sitiens
swimming anemone	Stomphia sp.
deep soft coral	possibly Alcyonium or Capnella
orange hydroid	possible Garveia spp.
muff hydroid	Lafoea sp.
Catablema jelly	Catablema sp.
stalked jelly	Manania sp.
red ribbon worm	Cerebratulus sp.
small purple ribbon worm	Cerebratulus sp.
double crowned white tubeworm	undetermined tubeworm
plant limpet	Testudinalia testudinalis
small ridged snail	undetermined snail
white dendronotid	possibly Dendronotus iris
orange aeolid nudibranch	possibly Cuthona sp.
dorid nudibranch	possibly Cadlina modesta
cephalopod	pelagic larvae
stocky sea spider	Nymphon sp. 1
delicate sea spider	Nymphon sp. 2

Appendix F

Cambridge Bay Taxonomy and Species Abundance

For each species observed an abundance score is recorded. This can be the actual number observed or one of the following estimates:

- few (≤10)
- some (≤25)
- many (≤50)
- very many (≤100)
- abundant (≤1000)
- very abundant (>1000)

Where estimation is used, its highest value is used for the calculation (for example a value of 25 would be used for the estimate "some"). For "very abundant" an arbitrary value of 3000 is used. These transformed values are then summed for each species for all dives in the summary and then divided by the total number of dives (to account for the sighting frequency of each species).

For example, if there are 100 dives in a year-based summary but the species was only observed on 50 of those dives with recorded abundance values for 43 of those dives, the summed value of those abundances will be divided by 50. That is, the average abundance ("Abun") is calculated from total dives with positive data. Zero represents no record for that year and an asterisk represents trace abundance. The column "Dive" indicates the number of dives on which the species was observed that year.

Table AF1, below, is based on data from 38 dives in the Cambridge Bay area (2015 and 2016 NES, 2017 AMEBP) for a total of 208 species.

		2015		2016		2017	
		Dive	**Abun**	**Dive**	**Abun**	**Dive**	**Abun**
	Total Number of Taxon Dives	**6**		**14**		**18**	
Common name	**Scientific name**						
Green algae	Chlorophyta						
green algae	*Ulva* spp.	0	.	1	2	0	.
filamentous green algae	undetermined green algae	0	.	0	.	1	3
Brown algae	Ochrophyta						
sugar kelp	*Saccharina latissima*	1	4	13	13	7	16
winged kelp	*Alaria esculenta*	0	.	2	1	2	3
rockweed	*Fucus* sp.	3	13	3	217	6	394
thread brown algae	possibly *Chordaria* sp.	3	513	8	88	10	397
branching brown algae	undetermined brown algae	0	.	0	.	1	6
clump brown algae	undetermined brown algae	0	.	0	.	1	3
encrusting brown algae	undetermined encrusting brown algae	4	17	5	2	5	.
diatoms	undetermined brown algae	0	.	0	.	1	1

		2015		2016		2017	
		Dive	Abun	Dive	Abun	Dive	Abun
	Total Number of Taxon Dives	6		14		18	
Common name	Scientific name						
filamentous diatom	undetermined brown algae	0	.	0	.	2	57
flat bladed brown algae	undetermined brown algae	0	.	5	5	1	3
brown algaes	undetermined brown algaes	0	.	0	.	2	3
walking kelp	possibly *Pterygophora* sp.	1	4	0	.	0	.
Red algae	Rhodophyta						
rose seaweed	possibly *Palmaria palmata*	0	.	0	.	2	3
false dulce	possibly *Dilsea carnosa*	0	.	0	.	1	1
bladed red algaes	undetermined bladed red algaes	3	13	9	15	4	7
branching red algae	undetermined branching red algae	0	.	0	.	1	1
filamentous red algaes	undetermined filamentous red algaes	1	4	0	.	2	3
encrusting coralline algaes	*Corallina* spp.	5	25	12	79	11	288
encrusting coralline algaes	undetermined smooth coralline algae	0	.	1	1	3	2
Sponges	Porifera						
pink thick finger sponge	*Haliclona* (Haliclona) cf. urceolus	0	.	3	1	2	*
shallow white finger sponge	*Pachychalina* sp.	0	.	1	*	1	*
deep white finger sponge	undetermined sponge	0	.	1	*	0	.
yellow blob sponge	*Suberites montalbidus*	1	*	5	2	0	.
warty sponge	*Halichondria (Eumastia) sitiens*	0	.	0	.	2	1
vase sponge	*Sycon* sp.	2	5	5	8	5	2
trumpet sponge	undetermined sponge	0	.	2	*	1	*
bread crumb sponge	*Halichondria* sp.	3	13	4	3	5	4
gray encrusting sponge	undetermined sponge	1	4	0	.	0	.
orange encrusting sponge	undetermined sponge	1	4	5	2	2	1
white encrusting sponge	undetermined sponge	0	.	1	2	3	2
sponge	undetermined sponge	0	.	0	.	1	.
Cnidarians	Cnidaria						
rugose anemone (with bumps)	*Hormathia nodosa*	2	8	10	13	1	1
rugose anemone (no bumps)	*Hormathia digitata*	1	4	1	1	1	6
rugose anemone	*Hormathia* spp.	0	.	0	.	7	67
dahlia or Horseman anemone	*Urticina eques*	0	.	8	14	1	.
anemone	*Urticina* sp.	0	.	1	.	2	1
anemone	*Urticina* spp.	3	13	2	2	0	.
Arctic crimson anemone	*Cribrinopsis similis*	2	8	8	7	10	69
stubby anemone	similar to *Urticina coriacea* sp.	0	.	5	5	6	2
snail-dwelling anemone	*Allantactis parasitica*	3	25	6	12	2	1
swimming anemone	*Stomphia* sp.	0	.	0	.	1	1
burrowing anemone	possibly *Halcampa arctica*	2	8	10	9	13	12
tube-dwelling anemone	possibly *Pachycerianthus borealis*	6	38	9	1289	15	632
red soft coral	*Gersemia rubiformis*	0	.	2	286	3	62
pale soft coral	*Alcyonium* sp.	1	4	1	1	1	*

		2015		2016		2017	
		Dive	Abun	Dive	Abun	Dive	Abun
	Total Number of Taxon Dives	6		14		18	
Common name	**Scientific name**						
deep soft coral	possibly *Alcyonium* or *Capnella*	0	.	0	.	1	1
orange hydroid	possible *Garveia* spp.	0	.	0	.	1	1
hedgehog hydroid	*Hydractinia* sp.	0	.	1	1	0	.
muff hydroid	*Lafoea* sp.	0	.	0	.	1	56
wine-glass hydroid	*Obelia* sp.	1	4	1	1	4	3
solitary hydroid	possibly *Tubularia* sp.	0	.	0	.	1	1
Arctic lion's mane	*Cyanea* sp.	3	6	2	*	9	61
four-tentacled jelly	*Aegina* sp.	0	.	3	1	6	2
jellyfish thimble	*Sarsia* sp.	2	8	0	.	3	8
hydromedusa	*Aglantha digitale*	0	.	7	3	8	9
double bubble jelly	*Halitholus cirratus*	4	13	10	6	8	58
folded stomach jelly	*Ptychogastria polaris*	3	521	4	75	2	1
Catablema jelly	*Catablema* sp.	0	.	0	.	1	6
stalked jelly	possibly *Haliclystus auricula*	0	.	1	*	0	.
stalked jelly	*Manania* sp.	0	.	0	.	2	6
jelly polyps	undetermined jelly	1	4	0	.	0	.
jelly plankton	undetermined jellies	3	521	0	.	0	.
translucent comb jelly	*Beroe cucumis*	1	4	10	4	8	12
purple Beroe	*Beroe abyssicola*	1	*	0	.	0	.
parachute ctenophore	*Dryodora glandiformis*	0	.	0	.	6	2
Arctic comb jelly	*Mertensia ovum*	6	38	14	89	7	16
sea gooseberry	*Pleurobrachia* sp.	1	4	1	4	2	1
Ribbon Worms	Nemertea						
red ribbon worm	*Cerebratulus* sp.	0	.	0	.	1	1
small purple ribbon worm	*Cerebratulus* sp.	0	.	0	.	1	56
gray ribbon worm	possibly *Cerebratulus* sp.	1	*	5	1	3	1
ribbon worm	undetermined *Nemertean*	0	.	0	.	1	*
Arrow Worms	Chaetognatha						
arrow worm	possibly *Parasagitta elegans*	2	8	9	6	4	3
Segmented Worms	Annelida						
lugworm	undetermined *Arenicolid*	1	*	1	*	0	.
leafy paddleworm	possibly *Phyllodoce groenlandica*	0	.	3	2	2	1
scale worm	possibly *Hormothoe imbricata*	1	*	2	*	4	1
scale worm	undetermined scale worm	0	.	2	*	2	*
polychaete worm	undetermined polychaete	0	.	0	.	2	*
polychaete worm	undetermined pelagic polychaete	0	.	1	*	0	.
dwarf calcareous tubeworm	possibly *Spirorbis borealis* or *Pileolaria* sp.	2	8	3	4	6	9
calcareous tubeworm	possibly *Serpula* or *Crucigera* sp.	0	.	1	.	0	.
double crowned white tubeworm	undetermined tubeworm	0	.	0	.	1	*
mop worm	undetermined cirratulid worm	0	.	0	.	1	*

		2015		2016		2017	
		Dive	Abun	Dive	Abun	Dive	Abun
	Total Number of Taxon Dives	6		14		18	
Common name	**Scientific name**						
spaghetti worm	undetermined terebellid worm	0	.	2	.	2	1
cone worm	undetermined pectinarid worm	3	13	12	17	9	134
featherduster tubeworm	possibly *Chone* sp.	0	.	4	4	0	.
tubeworm	possibly *Euchone papillosa*	1	4	7	795	7	503
Moss animals	Bryozoa						
branching bryozoan	undetermined branching bryozoan	1	4	0	.	1	*
encrusting bryozoan	undetermined encrusting bryozoan	5	17	4	4	5	7
Molluscs	Mollusca						
chiton	*Tonicella* sp.	0	.	1	*	0	.
chiton	*Tonicella* spp.	5	18	9	12	14	26
discordant mussel	*Musculus discor*	0	.	0	.	1	1
mussel	*Mytilus* sp.	0	.	2	*	3	1
Iceland cockle	*Clinocardium cilatum*	1	*	7	3	3	1
Greenland cockle	*Serripes groenlandicus*	0	.	1	1	2	1
chalky macoma	*Macoma calcarea*	2	8	3	1	0	.
truncated mya	*Mya truncata*	0	.	8	1004	11	571
Arctic saxicave or Nestler clam	*Hiatella arctica*	6	2333	13	1171	12	518
boreal astarte	*Astarte borealis*	0	.	1	*	1	1
plant limpet	*Testudinalia testudinalis*	0	.	0	.	1	6
limpet	*Tectura* spp.	5	25	10	9	11	25
wavy Buccinum snail	possibly *Buccinum angulosum*	3	6	1	.	0	.
ridged Buccinium snail	possibly *Buccinum scalariforme*	0	.	0	.	1	*
black footed Buccinum snail	*Buccinum* sp.	0	.	1	1	1	*
Buccinum snail	*Buccinum* spp.	0	.	7	7	4	2
small ridged snail	undetermined snail	0	.	0	.	3	3
margarite snail 1	*Margarites* sp.	5	18	5	6	1	*
margarite snail 2	possibly *Margarites costalis* or *sordidus*	0	.	0	.	1	1
margarite snails	*Margarites* spp.	0	.	0	.	5	10
velvet snail	*Velutina* sp.	1	*	7	4	3	1
velutinid snail	*Onchidiopsis* sp.	0	.	1	*	1	*
moon snail	undetermined moonsnail	0	.	2	*	2	*
snail with longitudinal ridges	undetermined snail	1	*	1	*	0	.
helicid pteropod	*Limacina helicina*	0	.	7	154	4	3
sea angel	*Clione limacina*	4	2	5	5	9	71
dendronotid nudibranch	possibly *Dendronotus frondosous*	4	13	5	2	8	5
white dendronotid	possibly *Dendronotus iris*	0	.	0	.	1	*
white dendronotid	*Dendronotus* sp.	0	.	1	*	0	.
orange aeolid nudibranch	possibly *Cuthona* sp.	0	.	0	.	1	1
aeolid nudibranch	undetermined aeolid	1	4	0	.	3	*
white nudibranch	possibly *Adalaria* sp.	0	.	2	*	0	.

		2015		2016		2017	
		Dive	Abun	Dive	Abun	Dive	Abun
	Total Number of Taxon Dives	6		14		18	
Common name	Scientific name						
dorid nudibranch	possibly *Cadlina modesta*	0	.	0	.	1	*
Arctic stubby squid eggs	*Rossia* sp.	0	.	1	.	0	.
cephalopod	pelagic larvae	0	.	0	.	1	*
Arthropods	Arthropoda						
hedgehog amphipod	*Paramphithoe hystrix*	0	.	0	.	1	*
amphipod	*Stegocephalus inflatus*	1	*	0	.	0	.
amphipods	*Onissimus* spp.	0	.	2	*	0	.
Gammarid amphipods	*Gammaraus* spp.	0	.	0	.	1	1
amphipod	*Gammarus wilkitzkii*	0	.	4	3	0	.
hyperid or jelly-riding amphipod	*Themisto abyssorum*	2	21	2	*	3	4
tube-dwelling amphipod	undetermined amphipod	0	.	0	.	2	167
amphipod	undetermined amphipod	2	*	1	*	1	.
calanoid copepod	possibly *Calanus* sp.	0	.	5	75	1	1
mysid	undetermined mysid	3	9	4	6	6	177
tank shrimp	*Sclerocrangon boreas*	0	.	1	1	2	*
spiny lebbeid	*Lebbeus groenlandicus*	0	.	2	1	2	*
polar lebbeid	*Lebbeus polaris*	4	21	11	16	6	10
punctate blade shrimp	*Spirontocaris phippsii*	0	.	2	1	1	*
blade shrimp	*Spirontocaris* sp.	0	.	3	2	0	.
circumpolar eualid shrimp	*Eualus gaimardii gaimardii*	1	4	0	.	4	1
shrimp	undetermined shrimp	2	8	1	*	0	.
Arctic lyre crab	*Hyas coarctatus*	5	13	9	11	9	2
Arctic lyre crab 2	*Hyas* sp.	0	.	0	.	1	*
barnacle	possibly *Balanus balanus*	0	.	0	.	1	3
barnacle	*Balanus* sp.	4	18	11	13	8	17
thatched barnacle black legs	possibly *Semibalanus* sp.	0	.	2	1	0	.
stalky sea spider	*Nymphon* sp. 1	0	.	0	.	1	*
delicate sea spider	*Nymphon* sp. 2	0	.	0	.	1	*
Echinoderms	Echinodermata						
polar sea star	*Leptasterias (Hexasterias) polaris*	0	.	0	.	1	1
sea star	*Leptasterias groenlandica*	0	.	1	*	1	*
red spiky sea star	*Icasterias panopla*	5	10	8	3	3	1
frilled sea star	*Urasterias lincki*	4	10	4	2	3	1
Arctic blood star	*Aleutihenricia beringiana*	1	4	0	.	0	.
blood star	undetermined seastar	0	.	0	.	1	*
blood star 1	undetermined seastar	0	.	1	*	0	.
blood star 2	undetermined seastar	0	.	1	*	2	*
wrinkled cushion star	*Pteraster militaris*	3	13	4	1	5	1
small yellow star with orange tips	*Poraniomorpha (Poraniomorpha) tumida*	4	6	3	2	5	1
rose star	*Crossaster papposus*	4	5	8	5	6	4

		2015		2016		2017	
		Dive	Abun	Dive	Abun	Dive	Abun
	Total Number of Taxon Dives	**6**		**14**		**18**	
Common name	**Scientific name**						
small brittle star	undetermined brittle star	4	525	12	1579	8	519
green urchin	*Strongylocentrotus droebachiensis*	5	46	14	1170	13	569
white urchin	possibly *Strongylocentrotus pallidus*	0	.	1	*	0	.
giant black sea cucumber	*Cucumaria frondosa*	0	.	4	75	6	2
sea cucumber	*Cucumaria* sp.	0	.	1	1	0	.
sea cucumbers	*Cucumaria* spp.	0	.	1	*	1	1
burrowing sea cucumber	*Cucumaria* sp.	0	.	1	*	0	.
white burrowing sea cucumber	undetermined *Cucumaria* sp.	0	.	1	.	0	.
speckled burrowing sea cucumber	possibly *Thyonidium* sp.	0	.	3	1	1	*
sea cucumber	possibly *Chiridota discolor*	0	.	2	1	5	2
scarlet sea cucumber	*Psolus fabricii*	3	6	10	16	13	62
peachy burrowing sea cucumber	*Psolus phantapus*	0	.	6	2	1	1
sea cucumber	possibly *Sclerodactyla* sp.	2	8	1	1	0	.
Tunicates	Urochordata						
pelagic tunicate	possibly *Oikopleura (Vexillaria) labradoriensis*	6	2171	13	947	10	629
leopard tunicate	undetermined tunicate	1	17	5	6	3	7
sea peach	*Halocynthia pyriformis*	0	.	0	.	2	1
undetermined bristly tunicate	possibly *Halocynthia igaboja*	0	.	2	2	2	3
Arctic sea blister	undetermined tunicate	1	4	1	1	2	1
undetermined tunicate	possibly *Cnemidocarpa* sp.	0	.	1	*	0	.
hairy tunicate	*Boltenia* sp.	0	.	2	1	0	.
long clear delicate tunicate	undetermined tunicate	0	.	3	*	0	.
warty tunicate	undetermined tunicate	0	.	2	1	0	.
tunicate	undetermined tunicate	0	.	0	.	1	1
encrusting tunicate	undetermined tunicate	0	.	1	*	0	.
Fishes	Vertebrata						
Arctic cod	*Boreogadus saida*	2	2	2	1	0	.
Polar cod	*Arctogadus glacialis*	0	.	1	*	2	1
Pacific cod	*Gadus macrocephalus*	4	5	8	1	3	*
saddled eelpout	*Lycodes mucosus*	0	.	1	*	0	.
eelpout	*Lycodes* sp.	0	.	1	*	0	.
cod	undetermined cod	0	.	0	.	1	1
eelpout	*Gymnelus* sp.	0	.	2	*	1	.
fish doctor	*Gymnelus retrodorsalisor G.viridis*	0	.	0	.	1	*
Arctic shanny	*Stichaeus punctatus*	5	14	7	1	9	2
fourline snakeblenny	*Eumesogrammus praecisus*	2	8	7	3	8	3
slender blenny	*Lumpenus fabricii*	2	4	5	3	6	3
banded gunnel	*Pholis fasciata*	2	8	5	1	8	1
ribbed sculpin	*Triglops pingelii*	0	.	4	*	4	1

		2015		2016		2017	
		Dive	**Abun**	**Dive**	**Abun**	**Dive**	**Abun**
	Total Number of Taxon Dives	**6**		**14**		**18**	
Common name	**Scientific name**						
sculpin	*Icelinus* sp.	0	.	0	.	2	1
shorthorn sculpin	*Myoxocephalus scorpius*	2	6	4	1	1	*
Arctic sculpln	*Myoxocephalus scorpioides*	0	.	1	*	0	.
four-horn sculpin	*Myoxocephalus quadricornis*	0	.	3	*	1	*
sculpin	*Myoxocephalus* sp.	2	4	0	.	2	1
Arctic staghorn sculpin	*Gymnocanthus tricuspis*	1	*	4	1	6	1
Atlantic spiny lumpsucker	*Eumicrotremus spinosus*	0	.	1	2	0	.
leatherfin lumpsucker	*Eumicrotremus derjugini*	0	.	3	*	0	.
unidentified juvenile lumpsucker	*Eumicrotremus* sp.	0	.	0	.	1	*
ninespine stickleblack	*Pungitius pungitius*	0	.	1	.	0	.

Appendix G

Taxon Dive and Rescued Dive Log Data from Three Arctic Locales

Table AG1, below, indicates what species were noted by scuba divers at three specific locales: Cambridge Bay, Resolute Bay and Pond Inlet. A total of 149 dives were completed at the three locations - 1 at Pond Inlet (PI), 66 at Resolute Bay (RB), 82 at Cambridge Bay (CB). A "0" on the table indicates that that species was not noted by the diver(s), "1" on the table indicates that is was.

Common name	Scientific name	CB	PI	RB
Green algae	Chlorophyta			
green algae	*Ulva* spp.	1	0	1
filamentous green algae	undetermined green algae	1	0	0
Brown algae	Ochrophyta			
sugar kelp	*Saccharina latissima*	1	1	1
sea collander	*Agarum clathratum*	0	0	1
winged kelp	*Alaria esculenta*	1	0	1
rockweed	*Fucus* sp.	1	0	1
thread brown algae	possibly *Chordaria* sp.	1	1	0
branching brown algae	undetermined brown algae	1	1	0
clump brown algae	undetermined brown algae	1	0	0
encrusting brown algae	undetermined encrusting brown algae	1	0	0
diatoms	undetermined brown algae	1	0	0
filamentous diatom	undetermined brown algae	1	0	0
flat bladed brown algae	undetermined brown algae	1	0	0
brown algaes	undetermined brown algaes	1	0	1
walking kelp	possibly *Pterygophora* sp.	1	0	0
Red algae	Rhodophyta			
Arctic sea oak	*Phycodrys rubens*	1	0	0
rose seaweed	possibly *Palmaria palmata*	1	0	1
false dulce	possibly *Dilsea carnosa*	1	0	0
bladed red algaes	undetermined bladed red algaes	1	0	0
branching red algae	undetermined branching red algae	1	0	0
filamentous red algaes	undetermined filamentous red algaes	1	0	1
encrusting coralline algaes	*Corallina* spp.	1	1	1
encrusting coralline algaes	undetermined smooth coralline algae	1	0	0
Sponges	Porifera			
pink thick finger sponge	*Haliclona (Haliclona)* cf. *urceolus*	1	0	0
shallow white finger sponge	*Pachychalina* sp.	1	0	0
deep white finger sponge	undetermined sponge	1	0	0
yellow blob sponge	Suberites montalbidus	1	0	0
warty sponge	*Halichondria (Eumastia) sitiens*	1	0	1
vase sponge	*Sycon* sp.	1	0	0

Common name	Scientific name	CB	PI	RB
trumpet sponge	undetermined sponge	1	0	0
bread crumb sponge	*Halichondria* sp.	1	0	1
gray encrusting sponge	undetermined sponge	1	0	0
orange encrusting sponge	undetermined sponge	1	0	0
white encrusting sponge	undetermined sponge	1	0	0
sponge	undetermined sponge	1	0	0
tennis ball sponge	undetermined sponge	1	0	0
scallop sponge	possibly *Mycale* sp.	0	1	0
conical sponge	undetermined sponge	1	0	0
Cnidarians	Cnidaria			
rugose anemone (with bumps)	*Hormathia nodosa*	1	0	1
rugose anemone (no bumps)	*Hormathia digitata*	1	0	0
rugose anemone	*Hormathia* spp.	1	0	0
dahlia or Horseman anemone	*Urticina eques*	1	1	1
anemone	*Urticina* sp.	1	0	1
anemone	*Urticina* spp.	1	0	1
Arctic crimson anemone	*Cribrinopsis similis*	1	0	1
stubby anemone	similar to *Urticina coriacea* sp.	1	1	0
snail-dwelling anemone	*Allantactis parasitica*	1	0	1
swimming anemone	*Stomphia* sp.	1	0	1
burrowing anemone	possibly *Halcampa arctica*	1	0	1
tube-dwelling anemone	possibly *Pachycerianthus borealis*	1	0	1
mystery anemone	undetermined anemone	0	1	0
clear white anemone	undetermined anemone	1	0	0
red soft coral	*Gersemia rubiformis*	1	1	1
pale soft coral	*Alcyonium* sp.	1	0	0
deep soft coral	possibly *Alcyonium* or *Capnella*	1	0	1
orange hydroid	possible *Garveia* spp.	1	0	1
hedgehog hydroid	*Hydractinia* sp.	1	0	1
muff hydroid	*Lafoea* sp.	1	0	0
wine-glass hydroid	*Obelia* sp.	1	0	1
pipecleaner hydroid	*Lafoeina maxima*	1	0	0
solitary hydroid	possibly *Tubularia* sp.	1	0	1
gnome's hat hydroid	possibly *Candelabrum* sp.	0	1	0
hydroid colony	undetermined hydroids	0	0	1
Arctic lion's mane	*Cyanea* sp.	1	0	1
northern sea nettle	*Chrysaora melanaster*	0	0	1
four-tentacled jelly	*Aegina* sp.	1	0	1
jellyfish thimble	*Sarsia* sp.	1	0	1
hydromedusa	*Aglantha digitale*	1	0	1
hydromedusa	undetermined hydromedusae	0	0	1
double bubble jelly	*Halitholus cirratus*	1	0	1
folded stomach jelly	*Ptychogastria polaris*	1	0	1

Common name	Scientific name	CB	PI	RB
Catablema jelly	*Catablema* sp.	1	0	0
stalked jelly	possibly *Haliclystus auricula*	1	1	1
stalked jelly	*Manania* sp.	1	0	0
Ephyra-like jelly	undetermined jelly	0	0	1
jelly polyps	undetermined jelly	1	0	0
jelly plankton	undetermined jellies	1	0	1
lobed sea gooseberry	*Bolinopsis infundibulum*	1	0	1
translucent comb jelly	*Beroe cucumis*	1	0	1
purple Beroe	*Beroe abyssicola*	1	0	0
parachute ctenophore	*Dryodora glandiformis*	1	0	0
Arctic comb jelly	*Mertensia ovum*	1	1	1
sea gooseberry	*Pleurobrachia* sp.	1	0	1
comb jelly	*Ctenophore* sp.	1	0	1
Flatworms	Platyhelminthes			
flatworm	undetermined flatworm	0	0	1
Ribbon Worms	Nemertea			
red ribbon worm	*Cerebratulus* sp.	1	0	1
small purple ribbon worm	*Cerebratulus* sp.	1	0	0
gray ribbon worm	possibly *Cerebratulus* sp.	1	0	1
brown ribbon worm	undetermined *Nemertean*	1	0	0
ribbon worm	undetermined *Nemertean*	1	0	1
Arrow Worms	Chaetognatha			
arrow worm	possibly *Parasagitta elegans*	1	0	1
Peanut Worms	Sipuncula			
peanut worm	*Sipunculid* sp.	0	0	1
penis worm	*Priapulida* sp.	0	0	1
Segmented Worms	Annelida			
striped giant leech	possibly *Notostomum cyclostomum*	0	0	1
lugworm	undetermined *Arenicolid*	1	0	1
leafy paddleworm	possibly *Phyllodoce groenlandica*	1	0	1
scale worm	possibly *Hormothoe imbricata*	1	0	1
scale worm	undetermined scale worm	1	0	1
Nereid worm	possibly *Alitta virens*	1	0	0
mud worm	*Polydora* sp.	0	0	1
polychaete worm	undetermined polychaete	1	0	0
polychaete worm	undetermined pelagic polychaete	1	0	0
dwarf calcareous tubeworm	possibly *Spirorbis borealis* or *Pileolaria* sp.	1	0	1
calcareous tubeworm	possibly *Serpula* or *Crucigera* sp.	1	0	0
double crowned white tubeworm	undetermined tubeworm	1	0	0
mop worm	undetermined cirratulid worm	1	0	0
spaghetti worm	undetermined terebellid worm	1	0	1
cone worm	undetermined pectinarid worm	1	0	1
featherduster tubeworm	possibly *Chone* sp.	1	0	1

Common name	Scientific name	CB	PI	RB
tubeworm	possibly *Euchone papillosa*	1	0	0
sabellid worm	undetermined worm	0	0	1
tubeworm	undetermined tubeworm	1	0	1
Moss animals	Bryozoa			
branching bryozoan	undetermined branching bryozoan	1	0	0
encrusting bryozoan	undetermined encrusting bryozoan	1	0	1
Molluscs	Mollusca			
mottled red chiton	*Tonicella marmorea*	0	0	1
chiton	*Tonicella* sp.	1	0	1
chiton	*Tonicella* spp.	1	0	0
discordant mussel	*Musculus discor*	1	0	1
mussel	*Mytilus* sp.	1	0	0
scallop	*Similipecten greenlandicus*	0	0	1
scallop	*Chlamys* sp.	0	1	0
scallop	undetermined scallop	1	1	0
Iceland cockle	*Clinocardium cilatum*	1	0	0
Greenland cockle	*Serripes groenlandicus*	1	0	1
chalky macoma	*Macoma calcarea*	1	0	1
truncated mya	*Mya truncata*	1	0	1
Arctic saxicave or Nestler clam	*Hiatella arctica*	1	0	1
boreal astarte	*Astarte borealis*	1	0	1
clam	*Modiolus* sp.	0	0	1
clam	undetermined clam	1	0	1
piddock	undetermined piddock	0	0	1
plant limpet	*Testudinalia testudinalis*	1	0	1
limpet	*Tectura* sp.	0	1	0
limpet	*Tectura* spp.	1	0	1
glacial Buccinum snail	*Buccinum glaciale*	1	0	1
flaky buccinum	*Buccinum hydrophanum*	0	0	1
wavy Buccinum snail	possibly *Buccinum angulosum*	1	0	1
ridged Buccinium snail	possibly *Buccinum scalariforme*	1	0	0
black footed Buccinum snail	*Buccinum* sp.	1	0	0
Buccinum snail	*Buccinum* spp.	1	0	1
small ridged snail	undetermined snail	1	0	0
snail	undetermined snail	1	0	1
hairy colus	*Colus pubescens*	0	0	1
margarite snail 1	*Margarites* sp.	1	0	1
margarite snail 2	possibly *Margarites costalis* or *sordidus*	1	0	1
margarite snails	*Margarites* spp.	1	0	0
snail	possibly *Neptunea* sp.	1	0	0
trichotropis snail	*Trichotropis* sp.	0	0	1
nassa	*Nassarius* sp.	1	0	0
top snail	undetermined snail	1	0	0

Common name	Scientific name	CB	PI	RB
velvet snail	*Velutina* sp.	1	0	0
velutinid snail	*Onchidiopsis* sp.	1	0	1
moon snail	undetermined moonsnail	1	1	0
snail whelk	undetermined univalve	1	0	1
snail with longitudinal ridges	undetermined snail	1	0	0
smooth snail	possibly *Buccinum hydrophanum*	0	0	1
helicid pteropod	*Limacina helicina*	1	0	1
sea angel	*Clione limacina*	1	1	1
dendronotid nudibranch	possibly *Dendronotus frondosous*	1	1	1
white dendronotid	possibly *Dendronotus iris*	1	0	0
white dendronotid	*Dendronotus* sp.	1	0	0
aeolid nudibranch	*Cuthona* sp.	1	0	1
orange aeolid nudibranch	possibly *Cuthona* sp.	1	0	1
aeolid nudibranch	undetermined aeolid	1	1	0
longhorn aeolid	undetermined aeolid	0	1	0
shag-rug nudibranch	*Aeolidia papillosa*	0	0	1
white nudibranch	possibly *Adalaria* sp.	1	0	1
dorid nudibranch	possibly *Cadlina modesta*	1	0	0
Arctic stubby squid	*Rossia* sp.	0	0	1
Arctic stubby squid eggs	*Rossia* sp.	1	0	1
cephalopod	pelagic larvae	1	0	0
Arthropods	Arthropoda			
ice amphipods	*Apherusa glacialis*	0	0	1
hedgehog amphipod	*Paramphithoe hystrix*	1	0	1
amphipod	*Stegocephalus inflatus*	1	0	1
common Arctic sea lice	*Onisimus* spp.	0	0	1
amphipods	*Onissimus* spp.	1	0	1
Gammarid amphipods	*Gammaraus* spp.	1	0	1
amphipod	*Gammarus wilkitzkii*	1	0	1
amphipod	*Gammaracanthus loricatus*	0	0	1
amphipod	*Anonyx nugax*	0	0	1
amphipod	*Eusirus* sp.	0	0	1
amphipod	*Rhachotropis aculeata*	0	0	1
hyperid or jelly-riding amphipod	*Themisto abyssorum*	1	0	1
skeleton shrimp	*Aeginina longicornis*	0	0	1
tube-dwelling amphipod	undetermined amphipod	1	0	0
amphipod	undetermined amphipod	1	0	1
orange amphipods	undetermined amphipod	0	0	1
Arctic isopod	*Arcturus baffini*	0	1	1
isopod	*Saduria sabini*	0	0	1
isopod	possibly *Stegocephalus inflatus*	1	0	1
isopod	possibly *Munnopsidae* sp.	1	0	0
calanoid copepod	possibly *Calanus* sp.	1	0	1

Common name	Scientific name	CB	PI	RB
mysid	undetermined mysid	1	0	1
tank shrimp	*Sclerocrangon boreas*	1	0	1
spiny lebbeid	*Lebbeus groenlandicus*	1	0	1
saddleback shrimp	*Rhynocrangon alata*	0	1	0
polar lebbeid	*Lebbeus polaris*	1	1	1
punctate blade shrimp	*Spirontocaris phippsii*	1	0	1
blade shrimp	*Spirontocaris* sp.	1	0	1
circumpolar eualid shrimp	*Eualus gaimardii gaimardii*	1	0	0
shrimp	undetermined shrimp	1	0	1
Arctic lyre crab	*Hyas coarctatus*	1	0	0
Arctic lyre crab 2	*Hyas* sp.	1	0	0
barnacle	possibly *Balanus balanus*	1	0	1
barnacle	*Balanus* sp.	1	0	1
barnacle	possibly *Cirripes* sp.	0	0	1
thatched barnacle black legs	possibly *Semibalanus* sp.	1	0	0
stalky sea spider	*Nymphon* sp. 1	1	0	1
delicate sea spider	*Nymphon* sp. 2	1	0	1
cumacean	undetermined cumacean	1	0	1
Echinoderms	Echinodermata			
polar sea star	*Leptasterias (Hexasterias) polaris*	1	1	1
sea star	*Leptasterias groenlandica*	1	0	0
red spiky sea star	*Icasterias panopla*	1	0	0
frilled sea star	*Urasterias lincki*	1	0	0
Arctic blood star	*Aleutihenricia beringiana*	1	0	1
blood star	undetermined seastar	1	0	1
blood star 1	undetermined seastar	1	0	0
blood star 2	undetermined seastar	1	0	0
wrinkled cushion star	*Pteraster militaris*	1	0	1
six-armed star	possibly *Lophaster* sp.	1	0	0
small yellow star with orange tips	*Poraniomorpha (Poraniomorpha) tumida*	1	0	0
rose star	*Crossaster papposus*	1	0	1
northern sun star	*Solaster endeca*	0	0	1
brittle star	*Ophiuira sarsi*	0	0	1
brittle star	*Ophiura* sp.	0	0	1
small brittle star	undetermined brittle star	1	0	1
brittle star	undetermined brittle star	1	0	1
basket star	possibly *Gorgonocephalus arcticus*	0	1	1
feather star	*Heliometra glacialis? Florometra?*	0	1	1
tan star	undetermined seastar	0	0	1
sea star	undetermined seastar	1	0	0
green urchin	*Strongylocentrotus droebachiensis*	1	1	1
white urchin	possibly *Strongylocentrotus pallidus*	1	0	0
giant black sea cucumber	*Cucumaria frondosa*	1	0	1

Common name	Scientific name	CB	PI	RB
sea cucumber	*Cucumaria* sp.	1	0	1
sea cucumbers	*Cucumaria* spp.	1	0	1
burrowing sea cucumber	*Cucumaria* sp.	1	0	1
white burrowing sea cucumber	undetermined *Cucumaria* sp.	1	0	0
pale yellow sea cucumber	undetermined sea cucumber	0	0	1
red sea cucumber	undetermined sea cucumber	0	0	1
speckled burrowing sea cucumber	possibly *Thyonidium* sp.	1	0	0
sea cucumber	possibly *Chiridota discolor*	1	0	1
scarlet sea cucumber	*Psolus fabricii*	1	0	1
peachy burrowing sea cucumber	*Psolus phantapus*	1	1	0
sea cucumber	possibly *Sclerodactyla* sp.	1	0	1
small long grey cucumber	undetermined sea cucumber	1	0	0
white cucumber	undetermined sea cucumber	0	0	1
sea cucumber	undetermined sea cucumber	0	0	1
Tunicates	Urochordata			
pelagic tunicate	possibly *Oikopleura (Vexillaria) labradoriensis*	1	0	1
undetermined tunicate	similar to *Styela* sp.	1	0	1
leopard tunicate	undetermined tunicate	1	0	0
sea peach	*Halocynthia pyriformis*	1	0	1
undetermined bristly tunicate	possibly *Halocynthia igaboja*	1	1	0
Arctic sea blister	undetermined tunicate	1	0	0
undetermined tunicate	possibly *Cnemidocarpa* sp.	1	0	0
hairy tunicate	*Boltenia* sp.	1	0	0
long clear delicate tunicate	undetermined tunicate	1	0	0
stalked tunicate	undetermined tunicate	0	0	1
warty tunicate	undetermined tunicate	1	0	1
tunicate	undetermined tunicate	1	1	1
encrusting tunicate	undetermined tunicate	1	0	0
Fishes	Vertebrata			
Arctic cod	*Boreogadus saida*	1	0	1
Polar cod	*Arctogadus glacialis*	1	0	0
Pacific cod	*Gadus macrocephalus*	1	0	1
saddled eelpout	*Lycodes mucosus*	1	1	1
Arctic eelpout	*Lycodes reticulatus*	0	0	1
eelpout	*Lycodes* sp.	1	0	1
Polar eelpout	*Lycodes polaris*	0	0	1
cod	undetermined cod	1	0	0
eelpout	*Gymnelus* sp.	1	0	1
fish doctor	*Gymnelus retrodorsalisor G.viridis*	1	0	1
Arctic shanny	*Stichaeus punctatus*	1	0	0
fourline snakeblenny	*Eumesogrammus praecisus*	1	0	0
slender blenny	*Lumpenus fabricii*	1	0	0
banded gunnel	*Pholis fasciata*	1	0	0

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ribbed sculpin	*Triglops pingelii*	1	0	1
bigeye sculpin	*Triglops nybelini*	0	0	1
sculpin	*Triglops* sp.	1	0	1
sculpin	possibly *Icelinus bicornis* or *spatula*	0	0	1
sculpin	*Icelinus* sp.	1	0	1
shorthorn sculpin	*Myoxocephalus scorpius*	1	0	1
Arctic sculpln	*Myoxocephalus scorpioides*	1	0	0
four-horn sculpin	*Myoxocephalus quadricornis*	1	0	1
sculpin	*Myoxocephalus* sp.	1	0	1
Arctic staghorn sculpin	*Gymnocanthus tricuspis*	1	1	1
snailfish	*Liparis* sp.	0	0	1
gelatinous snailfish	*Liparis fabricii*	0	0	1
kelp snailfish	*Liparis tunicatus*	0	0	1
Atlantic spiny lumpsucker	*Eumicrotremus spinosus*	1	0	1
leatherfin lumpsucker	*Eumicrotremus derjugini*	1	0	1
small Arctic lumpsucker	*Eumicrotremus* sp.	1	0	0
dock lumpsucker	*Eumicrotremus* sp.	0	0	1
unidentified juvenile lumpsucker	*Eumicrotremus* sp.	1	0	1
Arctic alligatorfish	*Aspidophoroides olrikii*	1	0	0
poacher	undetermined poacher	1	0	0
Pacific sand lance	*Ammodytes hexapterus*	1	0	0
ninespine stickleblack	*Pungitius pungitius*	1	0	0