

Expedition report for the summer and fall 2017 ecosystem surveys aboard the M/V Nuliajuk in support of the shrimp fishery in Davis Strait/Labrador Sea

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EXPEDITION REPORT FOR THE SUMMER AND FALL 2017 ECOSYSTEM SURVEYS
ABOARD THE *M/V NULIAJUK* IN SUPPORT OF THE SHRIMP FISHERY IN DAVIS
STRAIT/LABRADOR SEA

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ABSTRACT

Tremblay, P., Michel, C., Walkusz, W., Deslauriers, D., Hedges, K. 2021. Expedition Report for the summer and fall 2017 ecosystem surveys aboard the *M/V Nuliajuk* in support of the shrimp fishery in Davis Strait/Labrador Sea. Can. Manuscr. Rep. Fish. Aquat. Sci. 3221: viii + 37 p.

Fisheries and Oceans Canada (DFO) conducts multi-species trawling surveys in the Davis Strait region of the Eastern Canadian Arctic, primarily to support the management of commercially fished species, such as Greenland Halibut (*Reinhardtius hippoglossoides*) and Northern and Striped shrimp (*Pandalus borealis* and *P. montagui*, respectively). DFO has managed these fisheries with limited environmental or ecosystem data available to support stock assessments, but is currently striving to adopt an ecosystem approach to fisheries management and include environmental and ecosystem data in its assessments. The adoption of an ecosystem approach to fisheries management requires the collection of data on biological and environmental oceanographic conditions within fishing zones. These bioenvironmental datasets can be used to interpret fluctuations in fish and shellfish stock abundance and distribution at a regional scale and assess environmental drivers of population productivity. The 2017 Davis Strait/Labrador Sea ecosystem surveys aimed at providing a pilot dataset essential to the development and application of an ecosystem approach to fisheries management for this region. This report presents a summary of the methods used and sampling activities conducted during the Davis Strait/Labrador Sea summer and fall expeditions of 2017, which were carried out using the research vessel *M/V Nuliajuk* (Government of Nunavut, Fisheries and Sealing Division). During the field program in southwestern Davis Strait and the northwestern Labrador Sea, 20 stations were visited and characterized for physical, chemical and biological oceanographic conditions, and the benthic fish and invertebrate community was concomitantly assessed using a beam trawl. The data collected and results obtained in support of the science program's objectives are not included in this expedition report and will be provided elsewhere in future publications.

RÉSUMÉ

Tremblay, P., Michel, C., Walkusz, W., Deslauriers, D., Hedges, K. 2021. Expedition report for the summer and fall 2017 ecosystem surveys aboard the *M/V Nuliajuk* in support of the shrimp fishery in Davis Strait/Labrador Sea. Can. Manuscr. Rep. Fish. Aquat. Sci. 3221: viii + 37 p.

Le Ministère des Pêches et Océans Canada (MPO) effectue des suivis multi-espèces par chalutage dans la région du détroit de Davis, située dans l'est de l'Arctique canadien. Ces suivis sont effectués dans le but de soutenir la gestion des stocks d'espèces d'intérêt pour la pêche commerciale, telles que le flétan du Groenland (*Reinhardtius hippoglossoides*) et les crevettes nordique et ésope (*Pandalus borealis* et *P. montagui*, respectivement). Le MPO a, dans le passé, géré ces pêcheries avec une quantité limitée de données environnementales et écosystémiques disponibles pour supporter l'évaluation des stocks. Toutefois, le Ministère tente actuellement d'adopter une approche écosystémique pour la gestion des pêcheries en incluant des données environnementales et écosystémiques dans ses évaluations de stocks. L'adoption d'une approche écosystémique pour la gestion des ressources halieutiques nécessite la collecte de données bioenvironnementales au sein des zones de pêche. Les conditions biologiques et environnementales de l'océan peuvent être utilisées afin d'interpréter les fluctuations dans l'abondance et la distribution de crustacés et de poissons à l'échelle régionale, en plus d'identifier les facteurs environnementaux influençant la productivité des populations. Les relevés écosystémiques de 2017 dans le détroit de Davis et la mer du Labrador visaient à fournir une série de données pilote essentielle au développement et à l'application d'une approche écosystémique pour la gestion des ressources halieutiques de cette région. Le présent rapport fournit un sommaire des méthodes utilisées et des activités d'échantillonnage effectuées lors des expéditions de l'été et de l'automne 2017, réalisées à l'aide du navire de recherche *M/V Nuliajuk* (Gouvernement du Nunavut, Division des Pêches et de la Chasse au phoque). Durant le programme d'échantillonnage, effectué dans le sud-ouest du détroit de Davis et le nord-ouest de la mer du Labrador, 20 stations ont été visitées et caractérisées en termes des paramètres océanographiques physiques, chimiques et biologiques, tandis que les communautés de poissons et d'invertébrés benthiques ont été évaluées concomitamment à l'aide d'un chalut à perche. Les données récoltées et les résultats obtenus en lien avec les objectifs du programme de recherche ne sont pas inclus dans le présent rapport d'expédition et seront présentés ailleurs, dans le cadre de publications futures.

ACKNOWLEDGEMENTS

The 2017 Davis Strait/Labrador Sea survey was carried out with the support of the Government of Nunavut (Fisheries and Sealing Division) and would not have been possible without the support of the communities of Iqaluit and Pangnirtung. We thank all of the people involved in the program, particularly the crew of the *M/V Nuliajuk*. The ship's crew members provided outstanding logistical and technical support during the sampling expeditions as well as during the mobilization and demobilization of equipment. We also express special thanks to Brianne Kelly, Reba McIver and Zoya Martin for their participation and support during the expeditions. This project was supported in Canada by DFO (Fisheries Science and Ecosystem Research Program; Arctic Aquatic Research Division) and the Government of Nunavut (Fisheries and Sealing Division).

1.0 INTRODUCTION

1.1 History of shrimp fisheries in the Davis Strait/Baffin Bay region

Davis Strait, along with the adjacent Baffin Bay, are important regions of the Arctic for Indigenous subsistence fishing and hunting, as well as for commercial fisheries. In the Eastern Canadian Arctic, increased productivity and access to new fishing grounds have increased the opportunities for commercial fishing over the last decades (ArcticNet, 2019). The only large-scale commercial fisheries in the Canadian Arctic are currently located in the Hudson Strait, Davis Strait and Baffin Bay areas (Oceans North, 2021). Commercial fishing in this region started in the early 1970s, when an exploratory fishing survey led by DFO confirmed the presence of important shrimp stocks in the area. Later, in the 1990s, as Davis Strait shrimp stocks increased and the cod moratorium came into effect, the shrimp quotas were increased, with priority access granted in 1997 to local Indigenous organizations and community groups, who now share an important part of the fishery (DFO, 2009). Shrimp Fishing Areas (SFAs) were created to distribute the fishing pressure across the region but also to improve the effectiveness of management. SFA boundaries are the same for both science assessment and management purposes. The current science assessment and management areas for shrimp are shown in Fig. 1. Management units (MUs) refer to zones within a SFA, to which Total Allowable Catch (TAC) quotas of shrimp are allocated individually. Science assessment areas refer to large zones overlapping SFAs in which stock assessment surveys are conducted by DFO on a biannual basis (DFO, 2018a).

The two commercially-harvested shrimp species in the Davis Strait/Labrador Sea region are the Northern and Striped shrimp (*Pandalus borealis* and *P. montagui*, respectively). The spatial distributions of these two shrimp species spread across the Eastern Canadian Arctic and North Atlantic Ocean. The commercial Northern/Striped shrimp fishery in Canada currently extends from the Grand Banks of Newfoundland (47 °N) to Northern Baffin Bay (Fig. 2), with most fishing occurring in areas with depths ranging from 200 to 600 m, where the largest concentrations of shrimp are found (DFO, 2017, 2018a). In the Davis Strait/Labrador Sea region, *P. borealis* is the main commercial species harvested and *P. montagui* landings occur mostly as a common bycatch of the Northern Shrimp fishery (DFO, 2017).

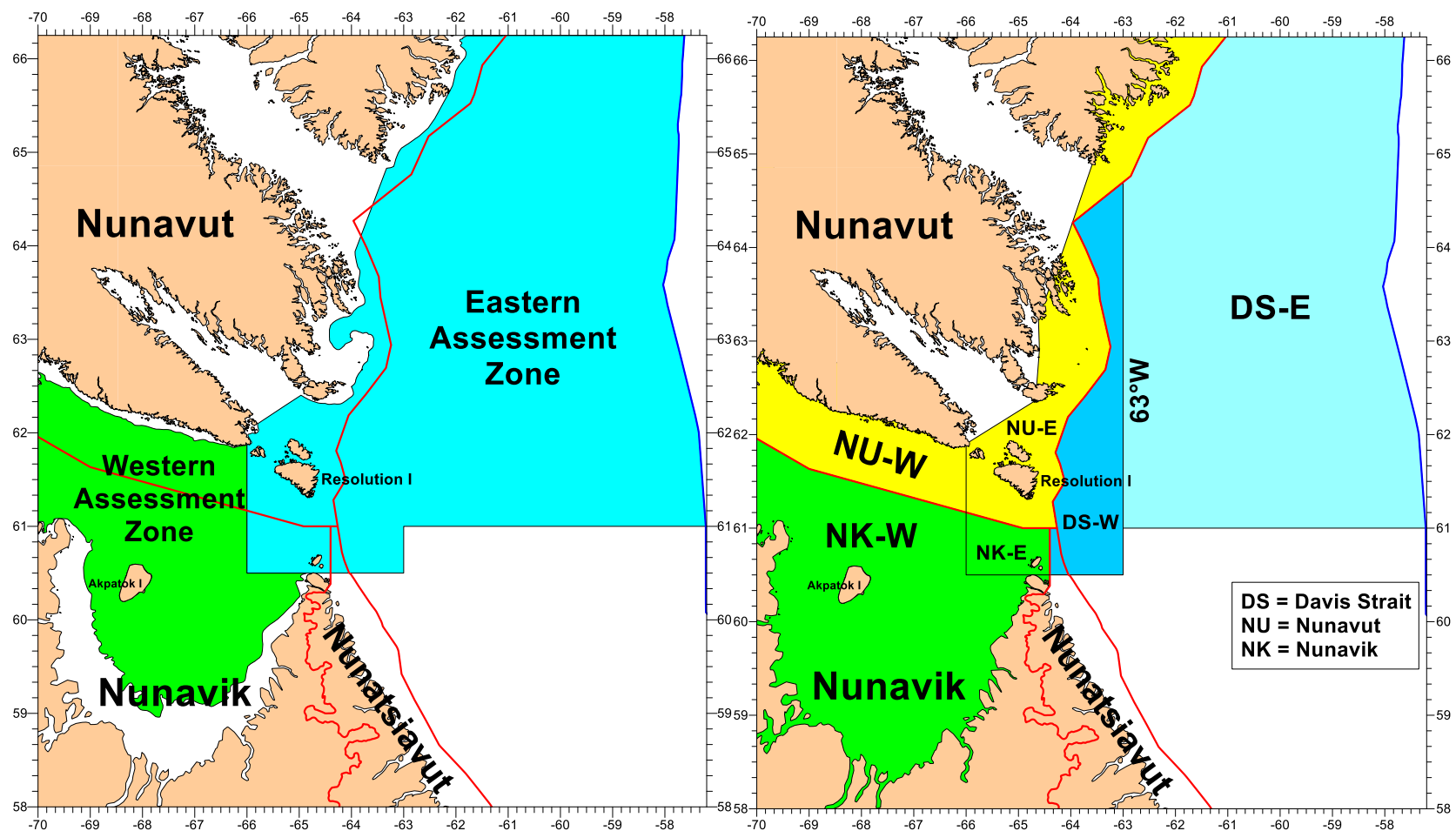


Figure 1: DFO's Northern and Striped shrimp Science Assessment Areas (left panel) and corresponding Management Units (right panel) (DFO, 2018a).

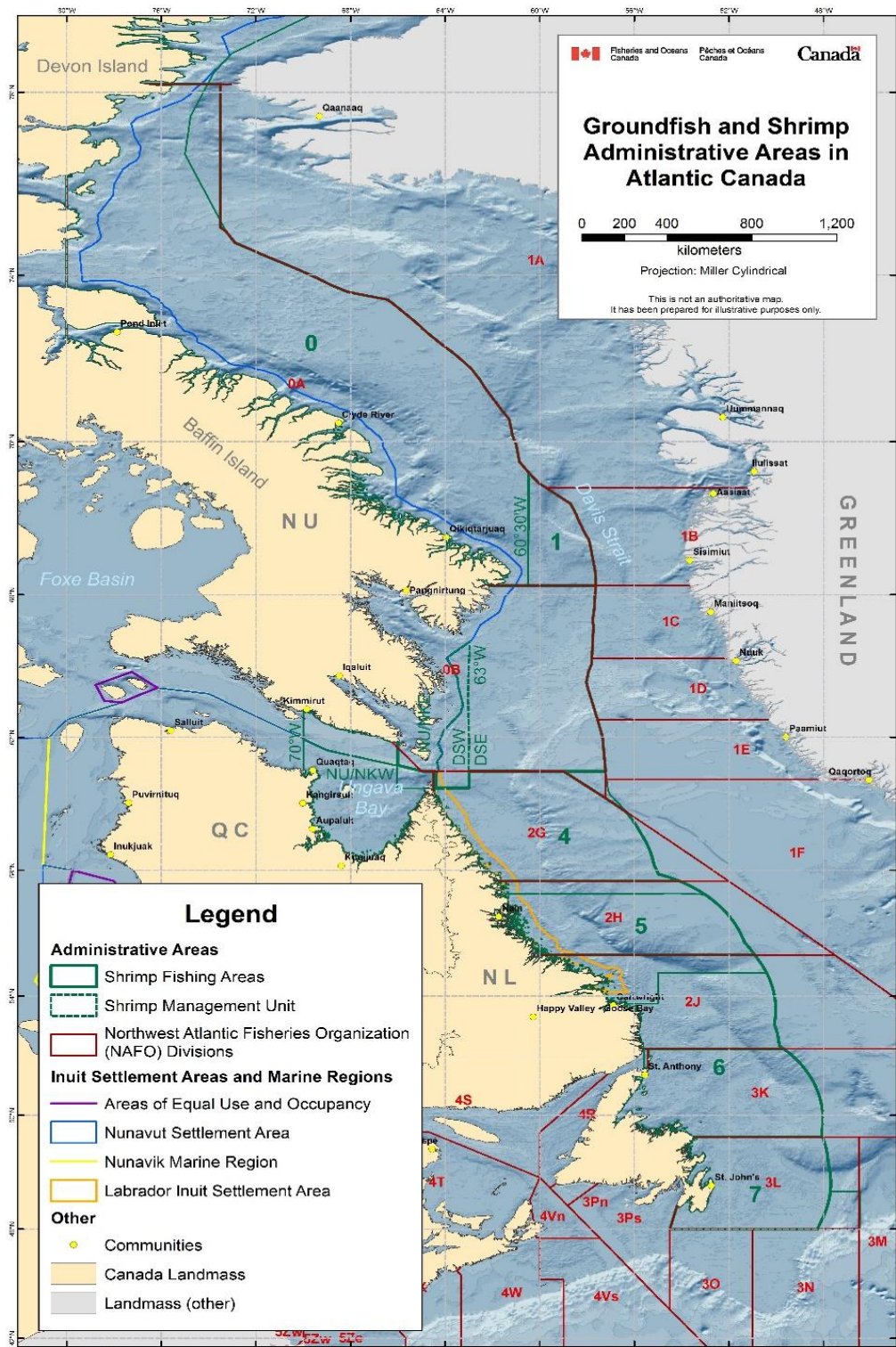


Figure 2: The Northern and Striped shrimp fishery throughout Atlantic Canada and Eastern Canadian Arctic, with Shrimp Fishing Areas (SFAs) and Management Units (MUs) in Baffin Bay, Davis Strait, Hudson Strait and the Labrador Sea (DFO, 2018a).

1.2 Shrimp stock assessment

The Davis Strait/Labrador Sea shrimp fishery is managed in accordance with an Integrated Fisheries Management Plan (IFMP) and under a Precautionary Approach (PA) Framework (DFO, 2017). Stock assessments for the Eastern and Western Assessment Zones (EAZ and WAZ, Fig. 1) use an index approach, calculating annual indices for spawning stock biomass and total biomass. The stock assessment qualitatively examines bottom temperature but bioenvironmental data are not included in the assessment analyses.

Significant interannual changes in shrimp survey indices have been observed to occur in the EAZ and WAZ without any ongoing trend, potentially due to the surveys overlapping with high density shrimp concentrations in some years and then missing these concentrations in other years, possibly due to spatial or interannual variability. Drivers of change in shrimp distribution among years are unknown but could include shrimp predators and biological and physical oceanographic conditions. Identification of causal relationships among these factors that may influence shrimp distributions would allow managers to account for an important component of variability in stock indices and facilitate incorporation of ecosystem information into the stock assessments.

1.3 Northern and Striped shrimp as part of the Davis Strait ecosystem

Hudson Strait and Western Davis Strait are part of a highly dynamic regional system with strong tidal currents and mixing. These mechanisms could transport shrimp over large distances in relatively short periods of time and could be among the main factors driving the observed fluctuations in shrimp biomass within the EAZ (DFO, 2017, 2018a). In addition, in adjacent areas along the Labrador Shelf, a warming trend in ocean temperatures, starting in the mid-1990s and culminating in 2010, has had a detectable negative impact on shrimp productivity by increasing metabolic demands in warmer waters (Koeller and Platt, 2007, DFO, 2018a). This trend was later followed by a cooling phase, which culminated in 2015, followed by a return to normal conditions in recent years (Cyr *et al.*, 2021). The high variability in local oceanographic conditions is likely to continue impacting shrimp stocks in the future.

Northern and Striped shrimp are high-energy forage species that sit in the middle of the food web and therefore play a vital role in the ecosystem of Davis Strait by transferring energy from lower to higher trophic levels. They experience high predation rates from various top predators found in the region, like Greenland Halibut (*Reinhardtius hippoglossoides*), skates (*Raja* spp.), wolffish (*Anarhichas* spp.), Harp Seal (*Pagophilus groenlandicus*), redfish (*Sebastes* spp.) and Atlantic Cod (*Gadus morhua*). Some of these species are targeted by local commercial fisheries (Greenland Halibut), while others, such as seals, are important for Indigenous subsistence and traditional fishing or act as a link to higher trophic levels (DFO, 2011, 2016, 2020a). Three predators of shrimp present in Davis Strait are currently listed in Canada's Species At Risk Act

(SARA): the Northern (*Anarhichas denticulatus*, Threatened), Spotted (*A. minor*, Threatened) and Striped (*A. lupus*, Special Concern) wolffish (DFO, 2018b, 2020b).

Northern and Striped shrimp recruitment and production rates are closely linked to ecosystem parameters and variability. For example, the phenology and abundance of their zooplanktonic food source is largely attributed to the spring phytoplankton bloom at high latitudes, and the duration of egg development is correlated with ocean temperatures (Koeller *et al.*, 2009, DFO, 2016). At high latitudes, the spring phytoplankton bloom is a crucial marine event and its timing plays a vital role in maintaining food web interactions and productive fisheries (Racault *et al.*, 2014, Marchese *et al.*, 2019). The Davis Strait region is characterized by strong variability in sea ice cover, environmental conditions and other processes that combine to influence the timing, intensity and extent of phytoplankton blooms and their interannual variability (Marchese *et al.*, 2019). Since the population dynamics of shrimp are closely linked to environmental forcing, stock assessment surveys should include coupled assessments of physical and biological oceanographic conditions. This is essential for a better understanding of ecosystem processes and interactions amongst physical and biological ocean variables and fisheries resources, in line with an ecosystem approach for the sustainable management of shrimp stocks in the Davis Strait region.

In this context, DFO worked in partnership with the Government of Nunavut in 2017 to carry out two field expeditions to support an ecosystem approach to shrimp fisheries assessment in the EAZ and WAZ (Fig. 1), focusing on shrimp and fish stocks found in the southwestern Davis Strait and northern Labrador Shelf regions. These expeditions took place in the summer and fall of 2017, in order to provide further data on Davis Strait shrimp and fish abundance, corresponding environmental conditions and phytoplankton availability. This report summarizes the activities conducted, their associated methods and the types of data collected during both expeditions.

1.4 Program objectives

The overarching goal of the 2017 Davis Strait expeditions was to collect information on the ecosystem inhabited by Northern and Striped shrimp (*Pandalus borealis* and *P. montagui*, respectively) and thereby support the application of an ecosystem approach to shrimp stock assessment and management in the Davis Strait region. To do so, the program provided a concomitant analysis of the physical, chemical and biological ocean conditions and seasonal variability, together with fishing activities, focusing on the two commercial species of cold water shrimp found in the region (Northern and Striped shrimp). The first objective was to evaluate spatial fluctuations in shrimp populations within the study area, which corresponded to Shrimp Fishing Area SFA-4 (Fig. 2) in northwestern Labrador Sea, and the Eastern Assessment Zone (EAZ), located in the southwestern portion of Davis Strait (Fig. 1). The second objective was to link shrimp distribution and abundances to local marine environmental factors, and to evaluate explanatory patterns. The program thus constituted an integrated assessment of shrimp and fish populations and oceanographic conditions, including indices of productivity.

Towards this goal, two sampling expeditions were conducted aboard the *M/V Nuliajuk* (Fig. 3), a multi-purpose research vessel owned by the Government of Nunavut (Government of Nunavut, 2015). The area sampled (located between 58-64 °N and 60-65 °W) (Fig. 4) was mostly part of southwestern Davis Strait, but also included the northern portion of the Labrador Sea (Labrador Shelf). Many of the sampling stations visited were located near Resolution Island, an area known to coincide with the bulk of the annual shrimp catch for the region (Siferd, 2015). The field expeditions included water column and beam trawl sampling components, and were conducted from July 19th to August 1st 2017 (Leg 1) and from September 20th to October 6th 2017 (Leg 2). During the program, a total of 20 sampling stations were visited over the course of 17 sampling days divided between both field expeditions. Leg 1 of the 2017 ecosystem surveys was scheduled for mid-July when sea ice conditions were suitable for navigation and sampling in Davis Strait (Fig. 5). Leg 2 was scheduled for late September, close to the sea ice minimum, in order to conduct sampling operations before the start of the sea ice growth season in October.



Figure 3: The *M/V Nuliajuk*, a research vessel used during the summer and fall 2017 Davis Strait/Labrador Sea expeditions (Government of Nunavut, Department of Environment, 2015).

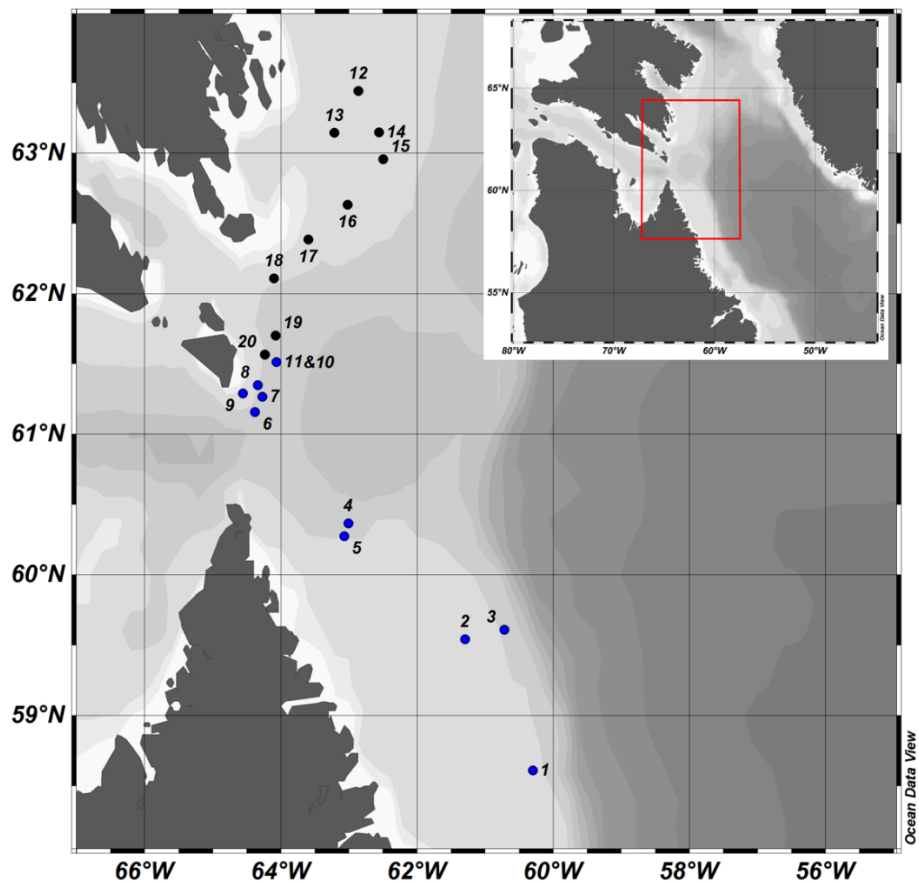


Figure 4: Map of stations visited during the summer (Leg 1, in blue) and fall (Leg 2, in black) 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk*. Each bar of the scale corresponds to 55.5 km (30 nm) for latitude and roughly 27.9 km (14.6 nm) for longitude (standard values at 60°N used). Figure created by J. Charette (DFO) using Ocean Data View (Schlitzer, 2018).

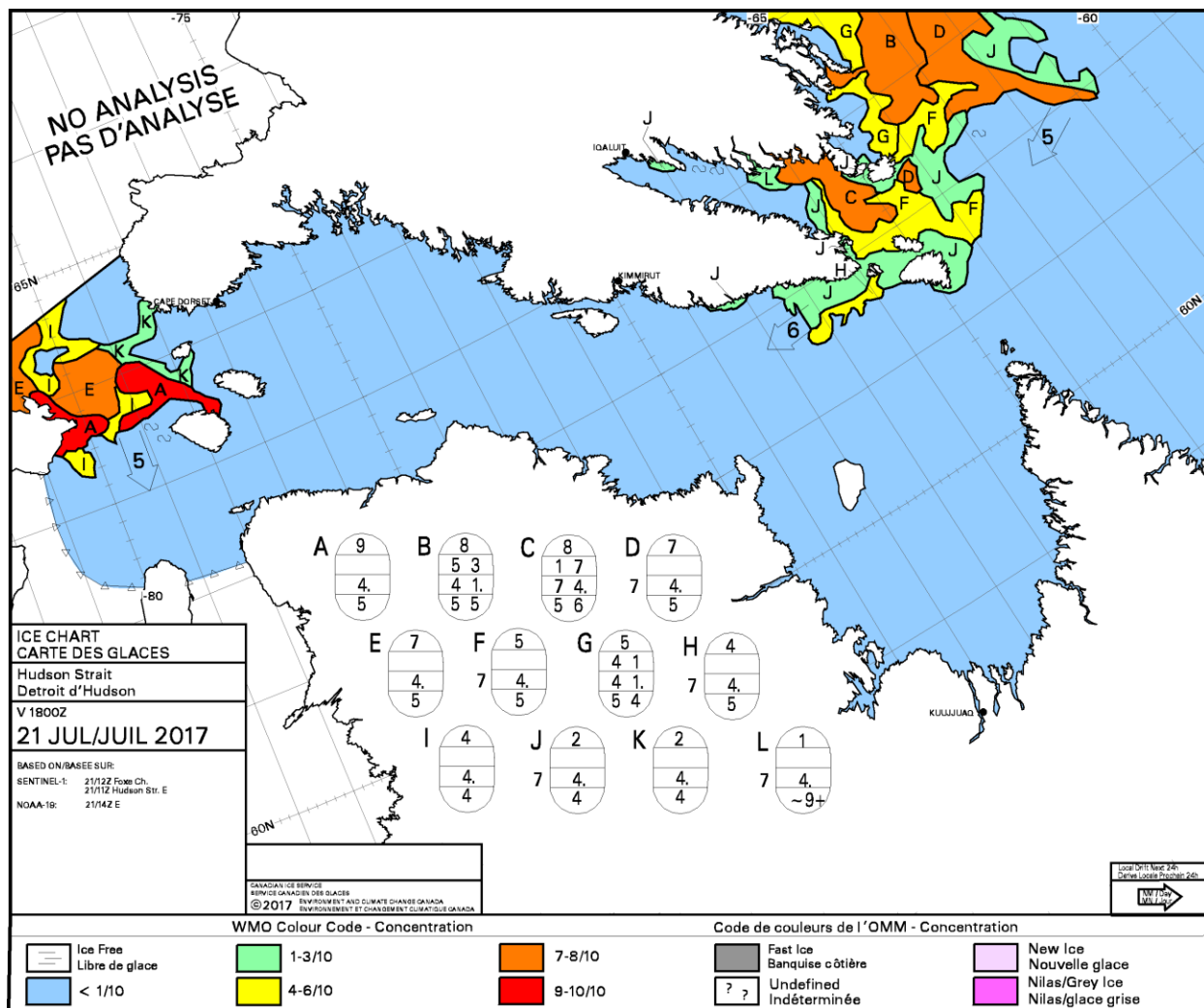


Figure 5: Map of sea ice conditions in Hudson Strait and Davis Strait for July 21st 2017, at the start of the summer 2017 (Leg 1) ecosystem survey aboard the *M/V Nulijuk*. Stations # 1 to 5 on the Labrador Shelf only had traces of sea ice (< 1/10). During Stations # 6 to 11 (July 26-30), east of Resolution Island, traces of sea ice (< 1/10) were present, but the ship was operating nearby small concentrations (< 2/10) of thick first-year sea ice (> 120 cm thickness) consisting of medium floes (100-500 m). All of Leg 2 stations (# 12 to 20) were ice-free (September 25-30). Source: Canadian Ice Service Archives, 417: Daily Ice Chart color WMO CT – Hudson Strait – WIS29CT – 2017/07/21.

2.0 EXPEDITION SUMMARY

The purpose of this expedition report is to outline the sampling activities, logistics and associated methods conducted during the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea. The data collected and results obtained in support of the science program's objectives are not included here and will be provided elsewhere in future publications.

2.1 Program participants

Kevin Hedges, Program Co-Lead, Research Scientist, DFO, Winnipeg

Christine Michel, Program Co-Lead, Senior Research Scientist, DFO, Winnipeg

David Deslauriers, Chief Scientist, Leg 2, Research Scientist, DFO, Winnipeg

Wojciech Walkusz, Chief Scientist, Leg 1, Biologist, DFO, Winnipeg

Brianne Kelly, Field Participant, Legs 1 & 2, Biologist, DFO, Winnipeg

Reba McIver, Field Participant, Leg 1, Biologist, DFO, Halifax

Pascal Tremblay, Field Participant, Leg 2, Technician, DFO, Winnipeg

2.2 General sampling summary

Sampling was carried out aboard the *M/V Nuliajuk* between July 19th and August 1st 2017 (summer: Leg 1) and between September 20th and October 6th 2017 (fall: Leg 2). Field participants boarded the ship on July 18th 2017 in Glovertown (NL) for Leg 1, and on September 22nd 2017 in Pangnirtung (NU) for Leg 2. During the summer and fall surveys combined, 20 out of 36 planned stations were sampled due to technical difficulties experienced with the ship's trawling equipment and unfavorable weather conditions (Appendix B, Table 6). Sampling operations consisted of water column vertical profiles of CTD (Conductivity, Temperature, Depth) and *in situ* fluorescence, followed by Rosette water sampling and bottom trawling for shrimp and benthic fish and invertebrates. Rosette sampling and CTD profiling were usually conducted simultaneously using a combined CTD/Rosette unit. However, strong winds and rough seas caused unsafe conditions for Rosette system deployments at 3 stations. At these stations, only CTD and fluorescence vertical profiles could be completed. Throughout both summer and fall surveys, downwelling Photosynthetically-Active Radiation (PAR) was continuously measured from the upper deck (3 m above sea level), and weather conditions were recorded upon arrival at each station.

During Leg 1 (summer), a total of 11 stations were visited over the course of 9 sampling days between July 21st and July 30th 2017 (Fig. 4, Table 1). Five stations were located on the Labrador Shelf (Stations # 1-5) and six stations were situated off the eastern coast of Resolution Island, near the entrance to Hudson Strait (Stations # 6-11). Station depth ranged from 156 to 420 m (Table 1). Vertical profiles of CTD and fluorescence were conducted at all (11) stations, Rosette sampling at 10 stations and bottom trawling at 9 stations (Table 1). A total of 125 Niskin bottle water column samples were collected at depths ranging from 5 to 300 m, using the Rosette sampler (Table 1, Appendix A, Table 5).

During Leg 2 (fall), a total of 9 stations were visited over the course of 5 sampling days between September 25th and September 29th 2017 (Fig. 4, Table 1). Five stations were located offshore of Hall Peninsula (Stations # 12-16), two stations were in the vicinity of Lok's Land Island (Stations # 17, 18), and two stations were situated just off the eastern coast of Resolution Island (Stations # 19, 20). Station depth ranged from 153 to 377 m (Table 1). Vertical profiles of CTD and fluorescence and bottom trawling were conducted at all (9) stations (Table 1). However, Rosette sampling was performed at 7 stations only due to adverse weather conditions. A total of 83 Niskin bottle water column samples were collected at depths ranging from 5 to 300 m, using the Rosette sampler (Table 1, Appendix A, Table 5).

Table 1: General characteristics of stations and sampling conducted during the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk*. "X" indicates that the sampling component was conducted.

Station #	Leg ID	Assessment Area ID	Date (dd/mm/yy)	Latitude (°N)	Longitude (°W)	Station Depth (m)	<i>In situ</i> Fluorescence	CTD Profile	Rosette Sampling Target Depths (m)	Beam Trawl
1	1	SFA-4	21/07/17	58.608	60.300	200	X	X	-	-
2	1	SFA-4	22/07/17	59.542	61.292	194	X	X	5-10-20-30-50-60-100-150	X
3	1	SFA-4	22/07/17	59.608	60.717	254	X	X	5-10-20-30-50-60-100-150-200	X
4	1	SFA-4	23/07/17	60.367	63.008	276	X	X	5-10-20-30-50-60-100-150-200-240	X
5	1	SFA-4	25/07/17	60.275	63.067	156	X	X	5-10-20-30-50-60-100-125	X
6	1	EAZ	26/07/17	61.157	64.378	400	X	X	5-10-20-30-50-60-100-150-200-300	X
7	1	EAZ	26/07/17	61.267	64.273	420	X	X	5-10-20-30-50-60-100-150-200-250	X
8	1	EAZ	27-28/07/17	61.347	64.335	296	X	X	5-10-20-30-50-60-100-150-200	X
9	1	EAZ	29/07/17	61.289	64.556	335	X	X	5-10-20-30-50-60-100-150-200	-
10	1	EAZ	30/07/17	61.565	64.237	235	X	X	5-10-20-30-50-100-150-200	X
11	1	EAZ	30/07/17	61.513	64.064	335	X	X	5-10-20-30-50-60-100-150-200-300	X
12	2	EAZ	25/09/17	63.441	62.864	260	X	X	5-10-20-30-40-50-60-100-150-200	X
13	2	EAZ	25/09/17	63.142	63.215	153	X	X	5-10-20-30-40-50-60-100	X
14	2	EAZ	26/09/17	63.145	62.558	253	X	X	-	X
15	2	EAZ	26/09/17	62.956	62.496	250	X	X	-	X
16	2	EAZ	27/09/17	62.630	63.021	225	X	X	5-10-20-30-40-50-60-100-150	X
17	2	EAZ	27/09/17	62.383	63.595	206	X	X	5-10-20-30-40-50-60-100-150	X
18	2	EAZ	28/09/17	62.107	64.101	351	X	X	5-10-20-30-50-60-100-150-200-300	X
19	2	EAZ	28/09/17	61.702	64.076	253	X	X	5-10-20-30-50-60-100-150-200	X
20	2	EAZ	29/09/17	61.565	64.237	377	X	X	5-10-20-30-50-60-100-150-200-250	X

2.3 Atmospheric and water data collection

Throughout the summer and fall ecosystem surveys, downwelling Photosynthetically-Active Radiation (PAR) was continuously measured at 15-minute intervals using a Li-COR Li-190 2Pi PAR sensor. The sensor was installed on the upper deck of the ship (ca. 3 m above sea level), away from shading, and linked to a Li-COR Li-1400 datalogger installed in the fish processing room on the main deck to record the collected data. Upon arrival at each station, a vertical profile of *in situ* fluorescence was obtained using an RBR Concerto profiler equipped with a Turner Cyclops fluorometer, deployed to a depth of ca. 60 m. Upon recovery of the instrument and initial assessment of data, the depth with the highest fluorescence signal was identified as the depth of the subsurface chlorophyll *a* maximum (chl *a* max). The instrument also included a PAR irradiance sensor (Li-COR Li-192), for further analysis of PAR attenuation profiles in the water column.

At each station, water was collected using a General Oceanics Mini Rosette water sampling system (model # 1018) equipped with 6 5-L Niskin bottles (Fig. 6), used in autonomous mode, where bottles were closed at specific pre-determined depths according to the depth of the station and to the depth of the chl *a* max previously identified upon arrival the station (see above). The first deployment of the Rosette sampler at each station was conducted with an Idronaut Ocean 304 CTD profiler attached to the array, to obtain a vertical profile of conductivity, temperature and depth from the surface to the near bottom (ca. 10-20 m over the seafloor). The Niskin bottles were then automatically closed during the upcast of the Rosette system at 8 to 10 targeted sampling depths per station (Table 1).



Figure 6: General Oceanics Mini Rosette Water Sampling System (6-bottle array, 5 L individual bottle capacity) used during the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk* (photo: P. Tremblay, DFO).

Two Rosette system deployments were performed at each station, with the first one ranging from the near-bottom to below the depth of the chl *a* max, and the second from the chl *a* max depth to the near-surface (ca. 5 m). The CTD profiler was removed from the Rosette system after the first deployment in order to upload the collected data. One Niskin bottle provided a sufficient volume of seawater for analyses at all depths except for the chl *a* maxima, where ca. 15 L of seawater (3 Niskin bottles) were required to complete all biochemical analyses (Table 2, Table 3).

2.4 Chemical and biological analyses of seawater samples

Seawater samples were collected directly from the spigot of the Niskin bottles, with the most sensitive chemistry samples being collected first. Dissolved Inorganic Carbon/Total Alkalinity (DIC/TA) samples were collected first, followed by macro-nutrients (nitrate + nitrite, $\text{NO}_3 + \text{NO}_2$; phosphate, PO_4 ; orthosilicic acid, $\text{Si}(\text{OH})_4$), and salinity/ O_{18} oxygen isotopic ratio samples. The remainder of the Niskin bottle water samples were filtered through a 350 μm mesh sieve to remove zooplanktonic grazers and then transferred to previously acid-washed isothermal containers, after three rinses with corresponding sample seawater, for further biological analyses. Triplicate DIC/TA samples were collected at the surface (ca. 5 m) and a single sample was collected at the other depths (Table 3). Samples were drawn from the Rosette's Niskin bottles directly into Corning 500 ml glass bottles, after abundant rinsing with sample seawater, and then capped with Corning glass stoppers. The samples were then neutralized with mercuric chloride (HgCl_2), gas-tight sealed with Apiezon M grease and secured using rubber bands and plastic hose clamps, and kept in the dark at ambient temperature (5-10 $^{\circ}\text{C}$) in the ship's cargo hold on the main deck. Duplicate macro-nutrient samples were collected in acid-washed Falcon polycarbonate 15 ml tubes after three sample rinses. The samples were flash-frozen at -80 $^{\circ}\text{C}$ but eventually transferred to a -20 $^{\circ}\text{C}$ freezer on the ship (due to the lack of available -80 $^{\circ}\text{C}$ freezer space) and subsequently stored at -80 $^{\circ}\text{C}$ at DFO's Marine Productivity Laboratory in Winnipeg until analysis. Salinity/ O_{18} samples were collected in 125 ml High-Density Polyethylene (HDPE) bottles after abundant rinsing with sample seawater. The sample bottles, which were tightly sealed with electrical tape, were stored in the dark at ambient temperature (ca. 5-10 $^{\circ}\text{C}$) in the ship's cargo hold.

The processing of the water column samples for biological analyses required between 2 and 4 hours per station and was conducted in the fish processing room, which served as a laboratory. Water samples were immediately processed after collection, for subsequent analyses of total ($> 0.7 \mu\text{m}$) and size-fractionated ($> 5 \mu\text{m}$) chl *a*, particulate organic carbon and nitrogen (POC/PN), $\delta^{13}\text{C}/\delta^{15}\text{N}$ stable isotopes, fatty acid biomarkers, genetic diversity/genomics (DNA), abundance of protist and bacterial cells by flow cytometry, bacterial abundance by nucleic acid staining technique (DAPI), phytoplankton species abundance and diversity (taxonomy) and High Performance Liquid Chromatography (HPLC) of suspended pigments. The methods used for sample processing and preserving follow established protocols in biological oceanography (e.g.,

Parsons *et al.* 1989, Knapp *et al.* 1996) and in DFO's Marine Productivity Laboratory (Michel and Niemi, 2009).

Total and > 5 µm chl *a* samples were filtered onto Whatman 25 mm GF/F filters and 5 µm Nuclepore membranes, respectively, and extracted in 90 % acetone for 18-24 h at 4 °C in the dark (Parsons *et al.*, 1984). Fluorescence was read aboard the ship using a Turner Design 10-AU-005-CE fluorometer previously calibrated using pure chl *a* extract (*Anacystis nidulans*, Sigma Chemicals).

Particulate organic carbon and nitrogen (POC, PN) and stable isotope ($\delta^{13}\text{C}/\delta^{15}\text{N}$) samples were filtered onto precombusted (450 °C for 24 h) 21 mm Whatman GF/F filters. The filtered subsamples were each placed in a cryovial and kept frozen at -80 °C until analysis. Blank filters were processed for each series of samples and were subtracted from sample values to obtain final carbon and nitrogen concentrations. Fatty acid samples were filtered onto precombusted (450 °C for 24 h) 47 mm Whatman filters and stored frozen in cryovials at -80 °C until analysis. DNA samples were filtered onto 47 mm 0.2 µm sterile Whatman Nuclepore filters. The filtration equipment, used uniquely for DNA, was regularly cleaned with ethanol 90 % and abundantly rinsed with Milli-Q water. The samples were kept frozen in sterile cryovials at -80 °C until analysis. Bacteria and protist abundance and cell size were determined by flow cytometry following a protocol adapted from Marie *et al.* (1997). Onboard the ship, duplicate 4 ml subsamples were fixed with 20 µl of glutaraldehyde Grade II (1 % final concentration; Sigma) for ca. 15 min, and then flash-frozen at -80 °C. Samples stored at -80 °C were then analyzed with an Epics Altra flow cytometer (Beckman Coulter) according to Belzile *et al.* (2008).

Samples for bacterial abundance by nucleic acid staining technique (DAPI) were preserved with formaldehyde (1 % V/V final concentration). The preserved samples were stored at 4 °C in the dark for later processing at the DFO Marine Productivity Laboratory (Winnipeg), where they were stained with DAPI to a final concentration of 1 µg L⁻¹ (Sherr *et al.* 1993) and filtered onto 0.2 µm black filters at low pressure (< 5 psi) using a backing membrane filter. The filters were then placed on a glass slide with a cover slip using Cargille Laboratories DF immersion oil, and were stored at -80 °C for analysis by epifluorescence microscopy.

Phytoplankton taxonomy samples were preserved with acidic Lugol's solution (0.4 % V/V final concentration) (Parsons *et al.* 1989) or formaldehyde (0.4 % V/V final concentration) for later identification and enumeration of phytoplankton cells with an inverted microscope (Leica DM IRB) according to Lund *et al.* (1958). Samples for HPLC analysis were filtered onto precombusted (450 °C for 24 h) 47 mm GF/F Whatman filters. The samples were then flash-frozen at -80 °C and stored at -80 °C until analysis. Samples were processed as duplicates or triplicates for specific depths or biochemical analyses (Table 3).

Table 2: Biochemical analyses conducted at each station during the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk* (n = number of depths sampled per analysis). Refer to Section 2.4 for acronym definitions.

Station ID	DIC/TA	Macro-Nutrients	Salinity/O₁₈	Total Chl <i>a</i>	> 5 µm Chl <i>a</i>	Flow Cytometry	DAPI	POC/PN	DNA	Fatty Acids	Taxonomy (Lugol)	Taxonomy (Formol)	HPLC
1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	5	9	9	7	7	7	3	1	1	1	1	1	1
3	5	10	12	7	7	6	1	1	1	1	1	1	2
4	6	10	10	6	6	6	3	1	1	1	1	1	2
5	5	8	8	6	6	6	3	1	1	1	1	1	2
6	6	10	10	6	6	6	3	1	1	1	1	1	2
7	6	10	10	6	6	6	3	1	1	1	1	1	2
8	6	9	9	6	6	6	-	1	1	1	1	1	2
9	4	9	9	6	6	6	3	1	1	1	1	1	2
10	6	9	9	6	6	6	3	1	1	1	1	1	2
11	6	10	10	6	6	6	3	1	1	1	1	1	2
12	6	10	10	6	6	6	-	1	1	-	1	1	-
13	5	8	8	7	7	6	-	1	1	-	1	1	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	8	8	6	6	6	-	1	1	-	-	-	2
17	-	9	9	7	7	7	3	1	1	-	1	1	2
18	6	10	10	6	6	6	-	-	1	-	1	-	2
19	4	9	9	6	6	6	-	1	1	-	1	1	2
20	6	10	10	6	6	6	-	1	1	-	1	1	2

Table 3: Summary of biochemical analyses and replication conducted for each water column sampling depth during the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk*.

Depth (m)	DIC/ TA	Macro- Nutrients	Salinity/ O₁₈	Total Chl <i>a</i>	Chl <i>a</i> > 5 µm	Flow Cytometry (Bacteria)	Flow Cytometry (Protists)	DAPI	POC/ PN	DNA	Fatty Acids	Taxonomy (Lugol)	Taxonomy (Formol)	HPLC
5	3x	2x	2x	2x	2x	2x	2x	2x	-	-	-	-	-	1x
10	-	2x	2x	2x	2x	2x	2x	-	-	-	-	-	-	-
20	1x	2x	2x	2x	2x	2x	2x	2x	-	-	-	-	-	-
30	-	2x	2x	2x	2x	2x	2x	-	-	-	-	-	-	-
Chl <i>a</i> max	1x	2x	2x	2x	2x	2x	2x	-	3x	2x	3x	1x	1x	1x
50	1x	2x	2x	2x	2x	2x	2x	2x	-	-	-	-	-	-
60	-	2x	2x	2x	2x	-	-	-	-	-	-	-	-	-
100	1x	2x	2x	-	-	2x	2x	-	-	-	-	-	-	-
150	-	2x	2x	-	-	-	-	-	-	-	-	-	-	-
200	1x	2x	2x	-	-	-	-	-	-	-	-	-	-	-
250	-	2x	2x	-	-	-	-	-	-	-	-	-	-	-
300	1x	2x	2x	-	-	-	-	-	-	-	-	-	-	-

2.5 Bottom trawl sampling and processing

Two stations were completed per day, weather and equipment permitting. The captain planned the trawling line and positioned the ship to sample in areas that were as flat as possible to avoid damaging the nets. The ship's deckhands then deployed the trawl net and trawling was conducted in a straight line at a speed of ca. 2-3 knots for 15 minutes upon making contact with the seafloor. Initial and final coordinates of the trawling line, trawling speed and time were taken from the ship's wheelhouse displays and recorded on Trawling Log Sheets (Table 4). After retrieving the trawl, all of the catch was emptied into fish bins and weighed together (Whole Catch Weight) (Fig. 7). Only large fish present in the whole catch (Fig. 8) were immediately counted for abundance, identified to the lowest possible taxonomic level (diversity), measured for length and bulk-weighed in taxonomic groups using a fish scale and a measuring board, before being released back into the water. The processing of the Whole Catch was conducted directly on the main deck of the ship.

Then, a subsample of the remaining whole catch (which excluded large fish previously processed), weighing ca. 8 kg (referred to as Mixed Catch), was randomly collected, after which the rest of the catch was released overboard. All organisms present in the Mixed Catch subsample were then counted, identified to the lowest possible taxonomic level (species level for most fish/shrimp/other invertebrates, genus level for occasional individuals difficult to identify, phylum level for echinoderms, sponges and incomplete organisms), then measured individually and bulk-weighed in taxonomic groups. Some unidentified specimens of various organisms were flash-frozen at -80 °C for further identification or for fatty acid biomarkers and stable isotopes analyses. The processing of the Mixed Catch subsample was conducted in the fish processing room using a ruler, taxonomic identification keys and a handheld scale. Length, bulk weights, counts and identifications of large fish, small fish, shrimp and invertebrates were recorded in Trawl Catch Log sheets. Pictures of each species found during the expeditions were taken using a digital camera. Then, Northern and Striped shrimp cephalothorax length was measured using a digital Vernier caliper and data were entered directly in a DFO digital database using a field laptop computer (no hardcopy dataset was recorded for this variable). Ovigerous females of Northern and Striped shrimp were counted and bulk-weighed separately from other individuals. Northern and Striped shrimp individuals found to host parasitic bopyrid isopods in their gills were also counted separately. Finally, a few individuals of Northern and Striped shrimp were collected opportunistically and flash-frozen at -80 °C for fatty acid biomarkers and stable isotopes analyses.

Table 4: Trawl Log of the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk*.

Station #	Leg ID	Date (dd/mm/yy)	Start Depth (m)	End Depth (m)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Time In (UTC)	Time Out (UTC)	Average Trawling Speed (kn)	Comments
1	1	21/07/17	200	-	-	-	-	-	-	-	-	No trawling conducted
2	1	22/07/17	194	193	59.5443	61.2988	59.5496	61.3111	12:14:30 PM	12:30:30 PM	2.0	-
3	1	22/07/17	255	257	59.6021	60.7031	59.6012	60.6890	9:43:50 PM	9:58:36 PM	1.9	-
4	1	23/07/17	275	281	60.3597	62.9573	60.3663	62.9653	2:49:30 PM	3:03:40 PM	2.0	Net entangled at 14 minutes but good tow
5	1	25/07/17	158	159	60.2803	63.6180	60.2866	63.6995	12:18:09 PM	12:33:14 PM	1.9	-
6	1	26/07/17	369	368	61.1646	64.4027	61.1695	64.3966	3:26:30 PM	3:36:30 PM	2.1	10 min tow; rough bottom
7	1	26/07/17	410	433	61.2904	64.1980	61.2893	64.1199	8:00:00 PM	8:10:00 PM	2.2	10 min tow; rough bottom
8	1	27-28/07/17	290	287	61.3405	64.3356	61.3382	64.3566	12:26:15 PM	12:41:15 PM	2.3	-
9	1	29/07/17	326	304	-	-	-	-	-	-	1.5	No trawling conducted
10	1	30/07/17	244	282	61.5621	64.2812	61.5571	64.2941	2:12:30 PM	2:26:13 PM	2.1	-
11	1	30/07/17	306	319	61.5001	64.1107	61.4934	64.1212	5:44:30 PM	5:49:30 PM	2.0	Trawl chain broke but was not bearing weight during tow; assumed successful
12	2	25/09/17	260	267	63.438	62.859	63.430	62.845	1:33:34 PM	1:48:34 PM	2.5	Trawl net got entangled at the end when reeling it back; still good tow
13	2	25/09/17	160	153	63.147	63.217	63.157	63.216	7:26:46 PM	7:41:46 PM	2.4	-
14	2	26/09/17	265	262	63.142	62.567	63.132	62.575	1:30:43 PM	1:45:43 PM	2.6	-
15	2	26/09/17	246	241	62.961	62.492	62.951	62.487	4:27:05 PM	4:42:05 PM	2.4	-
16	2	27/09/17	222	220	62.628	63.008	62.633	62.992	12:23:00 PM	12:38:00 PM	2.3	-
17	2	27/09/17	200	205	62.393	63.601	62.382	63.607	5:15:45 PM	5:30:45 PM	2.6	-
18	2	28/09/17	374	344	61.697	64.076	61.687	64.071	12:17:00 PM	12:32:00 PM	2.5	Started taking pictures of sounder display once trawling began to correlate with biomass caught
19	2	28/09/17	250	255	61.562	64.241	61.552	64.245	5:14:00 PM	5:29:00 PM	2.5	-
20	2	29/09/17	395	412	61.503	64.052	61.492	64.045	12:28:00 PM	12:43:00 PM	2.7	Trawl net got entangled at the end when reeling it back, still good tow



Figure 7: Fish bin containing the whole catch from the bottom trawl net being weighed together to measure Whole Catch Weight during the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk* (photo: P. Tremblay, DFO).



Figure 8: Fish-length measurement of a Spotted Wolffish, *Anarhichas minor* (SARA Status: Threatened), caught during Leg 2 of the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk* (photo: P. Tremblay, DFO).

3.0 LOGISTICAL ISSUES, TECHNICAL DIFFICULTIES AND RECOMMENDATIONS

Weather days: During Leg 1, there were some weather days (2.5 days) that resulted in missed sampling, since the ship cannot operate safely in waves exceeding 2 m in height. Neither trawling nor Rosette water sampling operations were possible with wind speeds over 25 knots (46 km/h or 13 m/s) for operational and safety reasons. For Leg 2, unfavorable weather occurred throughout most of the time spent steaming (September 23rd to October 2nd 2017), with waves frequently reaching over the main deck. However, the team managed to sample 9 stations in the time window between September 25th and 29th 2017. There were a total of 4 weather days, resulting in missed sampling.

Trawl deployment: Sampling in previously unsampled locations presents significant challenges; in many places the seafloor rocky substrate was not adequate for trawling, which resulted in multiple entanglements, tears or damage in the trawl nets. As a consequence, significant sampling time was lost (1.5 days) mending the damaged or entangled nets. Also, because of strong surface drift during Rosette sampling and processing, considerable steaming time was often required in order to return to the initial station coordinates after the Rosette sampling was completed, which caused important delays in beam trawl deployment.

Chl *a* max sampling with Rosette: The 3 Niskin bottles closed at the chl *a* max sometimes were not closed exactly at the same depth (Appendix A, Table 5), probably due to excessive upcast winch speed (the Rosette system cannot close multiple bottles simultaneously; a small delay between the firing of each bottle is required), which resulted in 1-6 m sampling depth difference between bottles in the chl *a* max. In the future, we recommend decreasing winch speed and maintain the Rosette unit at the chl *a* max to ensure consistent sampling of the target depth.

CTD sampling: Station 15, conducted on September 26th 2017, is the last station of Leg 2 to feature valid CTD data (Cast # 0074). There are no valid CTD data for Stations 16 to 20 (September 27th to September 29th 2017). When looking at the data from the last valid cast, it seems that the CTD profiler, after having been retrieved from the water at 16:19:38 UTC, was then turned off at 16:32:59 UTC. Then, when looking at the following cast (Cast # 0076), we see that the CTD profiler was turned on later in the evening of that same day at 22:22:55 UTC, probably for the daily data uploading and backup procedure (this CTD profiler must be enabled to establish communication with a computer and upload the data, which then creates a short cast during the uploading period). The variables of this cast file, which indicate values around 0 for pressure and salinity and around 1 °C for temperature, suggest that the CTD had indeed been turned on for data upload in the laboratory. Then, we see that the time stamps for the following 4 casts (Casts # 0077 to 0080) are continuous (each cast starts immediately at the time at which the previous cast ended), suggesting that the profiler was left running in the laboratory for a while after the uploading event of Cast # 0076 (from 22:22:55 to 22:57:38

UTC, 34 minutes and 43 seconds). Given this excessively long time span for a data upload, it seems that the user might have forgotten the CTD while it was enabled after the data upload. However, 34 minutes of sampling was not enough to drain the batteries of the profiler, which had just been replaced on September 24th prior to the first station of Leg 2. Rather, the low temperatures inside of the laboratory (the last temperature recorded by the profiler was $< 1\text{ }^{\circ}\text{C}$) might have been the cause of profiler malfunction, as this instrument is sensitive to freezing conditions. The freezing temperatures could also have contributed to the depletion of the batteries. It is also possible, although unlikely, that the absence of data could be due to the user not enabling the instrument prior to deployment for the following 5 stations (#16 to 20). Furthermore, the malfunction cannot have been due to internal pump line clogging, as this CTD profiler features a pump-free design (external conductivity cell and pressure transducer). Therefore, the cause of the malfunction could be due to voltage depletion between stations caused by cold storage temperatures at night. The missing samples are not likely to have been caused by instrument failure *per se*, as the profiler was calibrated and tested by the manufacturer in December 2017, shortly after the expedition, and no issues were reported (the instrument has operated properly ever since as well). As the actual cause of the missing data is still uncertain, several recommendations can be made. In order to avoid future data loss, it is recommended to upload the CTD cast data on a daily basis or after each station for quality-control of each collected profile, but also to store the instrument overnight away from freezing temperatures. Finally, the user must ensure, before and after each deployment, that the profiler has been properly enabled before profiling the water column and then disabled immediately after each deployment.

Internet connection: Although there was a wireless Internet connection available aboard the ship, it was difficult to connect using a personal computer or the bridge computer to receive emails and ice maps. In the future, improvement in Internet communication would be beneficial for the transmission of data and for communications while aboard the ship.

-80 °C portable freezer: When the team boarded the ship at the start of Leg 2 in September 2017, the -80 °C Sterling Ultracold ULT-25NE portable Shuttle freezer was found not to be in operation, even if still connected to the power source, resulting in the loss of HPLC samples, the latter which had been stored inside the freezer since the end of Leg 1 in August 2017. Resetting the unit did however solve the problem immediately and the freezer started operating normally again. A note had been left on the freezer at the end of Leg 1, requesting the next sampling team to repower the unit immediately if it ever needed to be moved and disconnected. Therefore, there is a possibility that the freezer may have overheated and shut down automatically (5-35 °C operating temperature range) because of high temperatures in the laboratory. This was likely the cause of the freezer shutdown, as the door of the laboratory is always kept shut when the ship is steaming. When the heater of this small laboratory is left running at maximum and the door is shut, room temperatures can get very high. Thus, the team

consistently monitored the lab temperature for the rest of the cruise during Leg 2 and turned down the heater every evening before leaving the premises, to prevent any overheating and further loss of samples. This portable freezer is highly reliable for the short-term storage of samples, but is not recommended for medium or long-term storage, especially in variable room temperature conditions. Since there is no other -80 °C storage present on the ship, it is therefore preferable to completely demobilize all -80 °C samples at the end of each leg and avoid any long-term storage in this unit, in order to prevent future loss of samples.

4.0 APPENDIX A – ROSETTE SAMPLING LOG

Table 5: Rosette Log of the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk*. Niskin bottle closing times and actual depths are from the Rosette's cast data files.

Station #	Leg ID	Date (dd/mm/yy)	Time (UTC)	Latitude (°N)	Longitude (°W)	Rosette Cast #	Niskin Bottle #	Niskin Target Depth (m)	Niskin Actual Depth (m)	Comments/Notes
1	1	21/07/17	-	58.608	60.300	1	-	-	-	Rosette did not function properly
1	1	21/07/17	-	58.608	60.300	2	-	-	-	Rosette did not function properly
1	1	21/07/17	-	58.608	60.300	3	-	-	-	Rosette did not function properly
2	1	22/07/17	10:34:19	59.542	61.292	4	1	30	30	-
2	1	22/07/17	10:34:23	59.542	61.292	4	2	30	29	Did not close at exact target depth
2	1	22/07/17	10:34:27	59.542	61.292	4	3	30	28	Did not close at exact target depth
2	1	22/07/17	10:34:48	59.542	61.292	4	4	20	20	-
2	1	22/07/17	10:35:21	59.542	61.292	4	5	10	10	-
2	1	22/07/17	10:35:39	59.542	61.292	4	6	5	5	-
2	1	22/07/17	11:06:28	59.542	61.292	5	1	150	150	-
2	1	22/07/17	11:08:58	59.542	61.292	5	2	100	100	-
2	1	22/07/17	11:10:03	59.542	61.292	5	3	60	60	-
2	1	22/07/17	11:10:16	59.542	61.292	5	4	50	50	-
2	1	22/07/17	11:10:46	59.542	61.292	5	5	30	30	Redid 30 m bottle for no reason
3	1	22/07/17	17:39:05	59.608	60.717	6	1	200	200	-
3	1	22/07/17	17:40:33	59.608	60.717	6	2	150	150	-
3	1	22/07/17	17:41:57	59.608	60.717	6	3	100	100	-
3	1	22/07/17	17:43:23	59.608	60.717	6	4	60	60	60 m bottle misfired
3	1	22/07/17	17:43:42	59.608	60.717	6	5	50	50	-
3	1	22/07/17	17:44:14	59.608	60.717	6	6	30	30	-
3	1	22/07/17	18:33:01	59.608	60.717	7	1	60	60	Redid 60 m bottle from Cast # 6
3	1	22/07/17	18:34:36	59.608	60.717	7	2	20	20	-
3	1	22/07/17	18:34:40	59.608	60.717	7	3	20	19	Did not close at exact target depth

3	1	22/07/17	18:34:44	59.608	60.717	7	4	20	17	Did not close at exact target depth
3	1	22/07/17	18:34:55	59.608	60.717	7	5	10	10	-
3	1	22/07/17	18:35:04	59.608	60.717	7	6	5	5	-
4	1	23/07/17	11:47:38	60.367	63.008	8	1	240	173	Did not close at exact target depth
4	1	23/07/17	11:47:42	60.367	63.008	8	2	200	171	Did not close at exact target depth
4	1	23/07/17	11:48:38	60.367	63.008	8	3	150	150	-
4	1	23/07/17	11:50:32	60.367	63.008	8	4	100	100	-
4	1	23/07/17	11:51:46	60.367	63.008	8	5	60	60	-
4	1	23/07/17	11:52:06	60.367	63.008	8	6	50	50	-
4	1	23/07/17	12:46:00	60.367	63.008	9	1	30	30	-
4	1	23/07/17	12:46:20	60.367	63.008	9	2	20	20	-
4	1	23/07/17	12:46:42	60.367	63.008	9	3	10	10	-
4	1	23/07/17	12:46:46	60.367	63.008	9	4	10	8	Did not close at exact target depth
4	1	23/07/17	12:46:50	60.367	63.008	9	5	10	6	Did not close at exact target depth
4	1	23/07/17	12:46:54	60.367	63.008	9	6	5	5	-
5	1	25/07/17	10:46:49	60.275	63.067	10	1	125	130	Did not close at exact target depth
5	1	25/07/17	10:47:38	60.275	63.067	10	2	100	100	-
5	1	25/07/17	10:48:47	60.275	63.067	10	3	60	60	-
5	1	25/07/17	10:49:01	60.275	63.067	10	4	50	50	-
5	1	25/07/17	10:49:30	60.275	63.067	10	5	30	30	-
5	1	25/07/17	10:49:43	60.275	63.067	10	6	20	20	-
5	1	25/07/17	11:34:22	60.275	63.067	11	1	10	10	-
5	1	25/07/17	11:34:26	60.275	63.067	11	2	10	10	-
5	1	25/07/17	11:34:30	60.275	63.067	11	3	10	9	Did not close at exact target depth
5	1	25/07/17	11:34:40	60.275	63.067	11	4	5	5	-
6	1	26/07/17	11:52:37	61.157	64.378	12	1	300	300	-
6	1	26/07/17	11:54:53	61.157	64.378	12	2	200	200	-
6	1	26/07/17	11:55:59	61.157	64.378	12	3	150	150	-
6	1	26/07/17	11:57:10	61.157	64.378	12	4	100	100	-
6	1	26/07/17	11:58:11	61.157	64.378	12	5	60	60	-

6	1	26/07/17	11:58:26	61.157	64.378	12	6	50	50	-
6	1	26/07/17	12:52:32	61.157	64.378	13	1	30	30	-
6	1	26/07/17	12:52:36	61.157	64.378	13	2	30	28	Did not close at exact target depth
6	1	26/07/17	12:52:40	61.157	64.378	13	3	30	26	Did not close at exact target depth
6	1	26/07/17	12:52:55	61.157	64.378	13	4	20	20	-
6	1	26/07/17	12:53:21	61.157	64.378	13	5	10	10	-
6	1	26/07/17	12:53:36	61.157	64.378	13	6	5	5	-
7	1	26/07/17	13:24:42	61.267	64.273	14	1	10	10	Redid 10 m bottle from Cast # 16
7	1	26/07/17	21:37:03	61.267	64.273	15	1	250	202	Did not close at exact target depth
7	1	26/07/17	21:37:07	61.267	64.273	15	2	200	198	Did not close at exact target depth
7	1	26/07/17	21:38:00	61.267	64.273	15	3	150	150	-
7	1	26/07/17	21:39:15	61.267	64.273	15	4	100	100	-
7	1	26/07/17	21:42:46	61.267	64.273	15	5	60	60	-
7	1	26/07/17	21:43:22	61.267	64.273	15	6	50	50	-
7	1	26/07/17	22:14:20	61.267	64.273	16	1	30	30	-
7	1	26/07/17	22:14:24	61.267	64.273	16	2	30	30	-
7	1	26/07/17	22:14:28	61.267	64.273	16	3	30	28	Did not close at exact target depth
7	1	26/07/17	22:14:49	61.267	64.273	16	4	20	20	-
7	1	26/07/17	22:15:18	61.267	64.273	16	5	10	10	Misfire at 10 m
7	1	26/07/17	22:15:35	61.267	64.273	16	6	5	5	-
8	1	27/07/17	12:03:30	61.347	64.335	17	1	200	200	-
8	1	27/07/17	12:04:37	61.347	64.335	17	2	150	150	-
8	1	27/07/17	12:05:30	61.347	64.335	17	3	100	100	-
8	1	27/07/17	12:06:09	61.347	64.335	17	4	60	60	-
8	1	27/07/17	12:06:18	61.347	64.335	17	5	50	50	-
8	1	27/07/17	12:06:46	61.347	64.335	17	6	20	20	-
8	1	27/07/17	12:39:30	61.347	64.335	18	1	30	30	-
8	1	27/07/17	12:39:34	61.347	64.335	18	2	30	28	Did not close at exact target depth
8	1	27/07/17	12:39:38	61.347	64.335	18	3	30	26	Did not close at exact target depth
8	1	27/07/17	12:40:13	61.347	64.335	18	4	10	10	-

8	1	27/07/17	12:40:53	61.347	64.335	18	5	5	5	-
8	1	28/07/17	11:47:56	61.347	64.335	19	1	200	200	Redid station 8 for DIC only
8	1	28/07/17	11:49:38	61.347	64.335	19	2	100	100	Redid station 8 for DIC only
8	1	28/07/17	11:50:31	61.347	64.335	19	3	50	50	Redid station 8 for DIC only
8	1	28/07/17	11:50:58	61.347	64.335	19	4	30	30	Redid station 8 for DIC only
8	1	28/07/17	11:51:12	61.347	64.335	19	5	20	20	Redid station 8 for DIC only
8	1	28/07/17	11:51:31	61.347	64.335	19	6	5	5	Redid station 8 for DIC only
9	1	29/07/17	12:19:23	61.289	64.556	20	1	200	200	-
9	1	29/07/17	12:20:41	61.289	64.556	20	2	150	150	-
9	1	29/07/17	12:21:56	61.289	64.556	20	3	100	100	-
9	1	29/07/17	12:22:52	61.289	64.556	20	4	60	60	-
9	1	29/07/17	12:23:07	61.289	64.556	20	5	50	50	-
9	1	29/07/17	12:23:38	61.289	64.556	20	6	30	30	-
9	1	29/07/17	12:57:23	61.289	64.556	21	1	20	20	-
9	1	29/07/17	12:58:20	61.289	64.556	21	2	10	10	-
9	1	29/07/17	12:59:00	61.289	64.556	21	3	5	5	-
9	1	29/07/17	12:59:05	61.289	64.556	21	4	5	5	-
9	1	29/07/17	12:59:09	61.289	64.556	21	5	5	4	Did not close at exact target depth
9	1	29/07/17	12:59:13	61.289	64.556	21	6	5	4	Did an extra 4th bottle at 5 m
10	1	30/07/17	12:57:38	61.565	64.237	22	1	200	200	-
10	1	30/07/17	12:59:08	61.565	64.237	22	2	150	150	-
10	1	30/07/17	13:00:38	61.565	64.237	22	3	100	100	-
10	1	30/07/17	13:01:37	61.565	64.237	22	4	60	60	-
10	1	30/07/17	13:01:53	61.565	64.237	22	5	50	50	-
10	1	30/07/17	13:02:25	61.565	64.237	22	6	30	30	-
10	1	30/07/17	13:39:19	61.565	64.237	23	1	20	20	-
10	1	30/07/17	13:40:12	61.565	64.237	23	2	10	10	-
10	1	30/07/17	13:40:16	61.565	64.237	23	3	10	10	-
10	1	30/07/17	13:40:20	61.565	64.237	23	4	10	9	Did not close at exact target depth
10	1	30/07/17	13:40:40	61.565	64.237	23	5	5	5	-

11	1	30/07/17	19:51:05	61.513	64.064	24	1	300	300	-
11	1	30/07/17	19:53:07	61.513	64.064	24	2	200	200	-
11	1	30/07/17	19:54:09	61.513	64.064	24	3	150	150	-
11	1	30/07/17	19:55:10	61.513	64.064	24	4	100	100	-
11	1	30/07/17	19:55:53	61.513	64.064	24	5	60	60	-
11	1	30/07/17	19:56:05	61.513	64.064	24	6	50	50	-
11	1	30/07/17	20:19:52	61.513	64.064	25	1	30	30	-
11	1	30/07/17	20:19:58	61.513	64.064	25	2	30	30	-
11	1	30/07/17	20:20:02	61.513	64.064	25	3	30	30	-
11	1	30/07/17	20:20:50	61.513	64.064	25	4	20	20	-
11	1	30/07/17	20:21:39	61.513	64.064	25	5	10	10	-
11	1	30/07/17	20:22:04	61.513	64.064	25	6	5	5	-
12	2	25/09/17	12:41:42	63.441	62.864	26	1	200	200	-
12	2	25/09/17	12:42:59	63.441	62.864	26	2	150	150	-
12	2	25/09/17	12:44:07	63.441	62.864	26	3	100	100	-
12	2	25/09/17	12:45:02	63.441	62.864	26	4	60	60	-
12	2	25/09/17	12:45:19	63.441	62.864	26	5	50	50	-
12	2	25/09/17	12:45:50	63.441	62.864	26	6	30	30	-
12	2	25/09/17	13:22:18	63.441	62.864	27	1	40	40	-
12	2	25/09/17	13:22:22	63.441	62.864	27	2	40	40	-
12	2	25/09/17	13:22:26	63.441	62.864	27	3	40	39	Did not close at exact target depth
12	2	25/09/17	13:23:27	63.441	62.864	27	4	20	20	-
12	2	25/09/17	13:23:50	63.441	62.864	27	5	10	10	-
12	2	25/09/17	13:24:03	63.441	62.864	27	6	5	5	-
13	2	25/09/17	18:59:16	63.142	63.215	28	1	100	100	-
13	2	25/09/17	19:00:00	63.142	63.215	28	2	60	60	-
13	2	25/09/17	19:00:11	63.142	63.215	28	3	50	50	-
13	2	25/09/17	19:00:28	63.142	63.215	28	4	40	40	-
13	2	25/09/17	19:00:32	63.142	63.215	28	5	40	40	-
13	2	25/09/17	19:00:36	63.142	63.215	28	6	40	39	Did not close at exact target depth

13	2	25/09/17	19:30:41	63.142	63.215	29	1	30	30	-
13	2	25/09/17	19:30:57	63.142	63.215	29	2	20	20	-
13	2	25/09/17	19:31:13	63.142	63.215	29	3	10	10	-
13	2	25/09/17	19:31:21	63.142	63.215	29	4	5	5	-
14	2	26/09/17	-	63.145	62.558	-	-	-	-	Bad weather – No rosette
14	2	26/09/17	-	63.145	62.558	-	-	-	-	Bad weather – No rosette
15	2	26/09/17	-	62.956	62.496	-	-	-	-	Bad weather – No rosette
15	2	26/09/17	-	62.956	62.496	-	-	-	-	Bad weather – No rosette
16	2	27/09/17	11:29:39	62.630	63.021	30	1	150	150	-
16	2	27/09/17	11:30:52	62.630	63.021	30	2	100	100	-
16	2	27/09/17	11:31:39	62.630	63.021	30	3	60	60	-
16	2	27/09/17	11:31:52	62.630	63.021	30	4	50	50	Spilled 50 m container in swell
16	2	27/09/17	11:32:17	62.630	63.021	30	5	30	30	-
16	2	27/09/17	11:32:27	62.630	63.021	30	6	20	20	-
16	2	27/09/17	12:21:35	62.630	63.021	31	1	40	40	-
16	2	27/09/17	12:21:39	62.630	63.021	31	2	40	39	Did not close at exact target depth
16	2	27/09/17	12:21:43	62.630	63.021	31	3	40	34	Did not close at exact target depth
16	2	27/09/17	12:22:23	62.630	63.021	31	4	10	10	-
16	2	27/09/17	12:22:34	62.630	63.021	31	5	5	5	-
17	2	27/09/17	16:35:23	62.383	63.595	32	1	150	150	-
17	2	27/09/17	16:36:26	62.383	63.595	32	2	100	100	-
17	2	27/09/17	16:37:22	62.383	63.595	32	3	60	60	-
17	2	27/09/17	16:37:41	62.383	63.595	32	4	50	50	-
17	2	27/09/17	16:38:10	62.383	63.595	32	5	30	30	-
17	2	27/09/17	16:38:22	62.383	63.595	32	6	20	20	-
17	2	27/09/17	17:10:13	62.383	63.595	33	1	40	40	-
17	2	27/09/17	17:10:17	62.383	63.595	33	2	40	38	Did not close at exact target depth
17	2	27/09/17	17:10:20	62.383	63.595	33	3	40	35	Did not close at exact target depth
17	2	27/09/17	17:11:00	62.383	63.595	33	4	10	10	-
17	2	27/09/17	17:11:12	62.383	63.595	33	5	5	5	-

18	2	28/09/17	11:25:27	62.107	64.101	34	1	300	217	Did not close at exact target depth
18	2	28/09/17	11:25:45	62.107	64.101	34	2	200	200	-
18	2	28/09/17	11:26:41	62.107	64.101	34	3	150	150	-
18	2	28/09/17	11:27:43	62.107	64.101	34	4	100	100	-
18	2	28/09/17	11:28:31	62.107	64.101	34	5	60	60	-
18	2	28/09/17	11:28:43	62.107	64.101	34	6	50	50	-
18	2	28/09/17	11:54:41	62.107	64.101	35	1	30	30	-
18	2	28/09/17	11:54:45	62.107	64.101	35	2	30	28	Did not close at exact target depth
18	2	28/09/17	11:54:49	62.107	64.101	35	3	30	26	Did not close at exact target depth
18	2	28/09/17	11:54:57	62.107	64.101	35	4	20	20	-
18	2	28/09/17	11:55:15	62.107	64.101	35	5	10	10	-
18	2	28/09/17	11:55:28	62.107	64.101	35	6	5	5	-
19	2	28/09/17	16:47:13	61.702	64.076	36	1	200	200	-
19	2	28/09/17	16:48:13	61.702	64.076	36	2	150	150	-
19	2	28/09/17	16:49:05	61.702	64.076	36	3	100	100	-
19	2	28/09/17	16:49:43	61.702	64.076	36	4	60	60	-
19	2	28/09/17	16:49:53	61.702	64.076	36	5	50	50	-
19	2	28/09/17	16:50:22	61.702	64.076	36	6	20	20	-
19	2	28/09/17	17:10:21	61.702	64.076	37	1	30	30	-
19	2	28/09/17	17:10:25	61.702	64.076	37	2	30	29	Did not close at exact target depth
19	2	28/09/17	17:10:29	61.702	64.076	37	3	30	26	Did not close at exact target depth
19	2	28/09/17	17:10:57	61.702	64.076	37	4	10	10	-
19	2	28/09/17	17:11:06	61.702	64.076	37	5	5	5	-
20	2	29/09/17	11:45:51	61.565	64.237	38	1	250	175	Did not close at exact target depth
20	2	29/09/17	11:45:55	61.565	64.237	38	2	200	172	Did not close at exact target depth
20	2	29/09/17	11:46:21	61.565	64.237	38	3	150	150	-
20	2	29/09/17	11:47:33	61.565	64.237	38	4	100	100	-
20	2	29/09/17	11:48:35	61.565	64.237	38	5	60	60	-
20	2	29/09/17	11:48:51	61.565	64.237	38	6	50	50	-
20	2	29/09/17	12:14:36	61.565	64.237	39	1	30	30	-

20	2	29/09/17	12:14:40	61.565	64.237	39	2	30	28	Did not close at exact target depth
20	2	29/09/17	12:14:44	61.565	64.237	39	3	30	24	Did not close at exact target depth
20	2	29/09/17	12:14:49	61.565	64.237	39	4	20	20	-
20	2	29/09/17	12:15:03	61.565	64.237	39	5	10	10	-
20	2	29/09/17	12:15:11	61.565	64.237	39	6	5	5	-

5.0 APPENDIX B – WEATHER LOG

Table 6: Weather Log from the ship during the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk*. Wind speeds were noted in the field using units of the Beaufort Scale, and then converted to knots for this table using the maximum wind speed of each Beaufort Scale unit.

Station ID	Leg ID	Date (dd/mm/yy)	Time (UTC)	Skies	Seas/Waves	Air Temperature (°C)	Sea Surface Temperature (°C)	Wind (° or Cardinal)	Wind Speed (kn)
1	1	21/07/17	-	Cloudy	Wavy	-	-	-	-
2	1	22/07/17	11:00	Overcast	-	2	-	38	6
3	1	22/07/17	18:00	Overcast	-	3	-	40	6
4	1	23/07/17	13:40	Overcast/Foggy	-	3	-	41	10
5	1	25/07/17	11:30	Sunny	-	2.8	-	262	6
6	1	26/07/17	11:16	Sunny	Calm	2.5	-	263	16
7	1	26/07/17	22:00	Foggy	Strong current	2.1	-	58	10
8	1	27/07/17	11:50	Foggy	High swell & current	2	-	235	27
9	1	29/07/17	12:00	Foggy	-	0	-	-	-
10	1	30/07/17	12:00	Foggy	-	-	-	-	-
11	1	30/07/17	19:00	Foggy	-	-	-	-	-
12	2	25/09/17	12:00	Overcast	Windy	0.8	1.3	NW	16
13	2	25/09/17	17:00	Overcast	-	1.0	-	NW	16
14	2	26/09/17	13:00	Overcast	Very wavy	0.6	1.1	NW	27
15	2	26/09/17	16:00	Overcast	Very wavy	0.9	1.7	NW	21
16	2	27/09/17	11:00	Mostly overcast	High swell	0.9	1.8	NW	16
17	2	27/09/17	16:30	Mainly sunny	High swell	0.5	1.9	W	6
18	2	28/09/17	11:00	Overcast	-	0.0	1.9	W	21
19	2	28/09/17	16:40	Overcast	-	0.6	1.9	W	16
20	2	29/09/17	11:00	Overcast	High waves (6m)	0.3	1.8	NW	16

6.0 APPENDIX C – CTD, ROSETTE AND CONCERTO FLUOROMETER CAST LOG

Table 7: CTD, Rosette and Concerto fluorometer Cast Log of the summer and fall 2017 ecosystem surveys in Davis Strait/Labrador Sea aboard the *M/V Nuliajuk*. In/out times are from the internal log files of the instruments.

Station ID	Leg ID	Date (dd/mm/yy)	Concerto Time in (UTC)	Concerto Time Out (UTC)	Rosette Cast #	Rosette 1 Time In (UTC)	Rosette 1 Time Out (UTC)	Rosette 2 Time In (UTC)	Rosette 2 Time Out (UTC)	CTD Cast #	CTD Time In (UTC)	CTD Time Out (UTC)	Comments /Notes
1	1	21/07/17	19:12	19:16	1-2-3	-	-	-	-	0034	19:33	19:48	Rosette did not function properly
2	1	22/07/17	10:10	10:14	4-5	10:28	10:55	10:57	11:11	0036	10:55	11:05	-
3	1	22/07/17	17:00	17:03	6-7	17:25	17:45	18:16	18:35	0037	17:27	17:38	-
4	1	23/07/17	11:19	11:22	8-9	11:37	11:54	12:17	12:47	0038	12:27	12:40	-
5	1	25/07/17	10:21	10:25	10-11	10:40	10:50	11:20	11:35	0039	10:36	10:44	-
6	1	26/07/17	10:43	10:56	12-13	11:16	11:59	12:18	12:53	0045	12:31	12:47	Concerto was deployed to 328 m
7	1	26/07/17	21:08	21:14	14-15-16	13:17	13:25	21:29	21:45	0046	21:24	21:39	Rosette Cast # 16 Time In: 22:07; Time Out: 22:15
8 (1 st)	1	27/07/17	11:21	11:23	17-18	11:50	12:07	12:32	12:41	0047	11:50	12:01	-
8 (2 nd)	1	28/07/17	-	-	19	11:41	11:51	-	-	0048	11:37	11:45	2 nd CTD cast to go with 3 rd Rosette cast (DIC only)
9	1	29/07/17	11:49	11:53	20-21	12:11	12:24	12:46	12:59	0050	12:06	12:18	-
10	1	30/07/17	12:29	12:34	22-23	12:50	13:03	13:22	13:40	0051	13:17	13:34	-
11	1	30/07/17	19:23	19:27	24-25	19:42	19:57	20:14	20:22	0052	19:37	19:51	-
12	2	25/09/17	12:08	12:11	26-27	12:27	12:46	13:13	13:24	0069	12:29	12:40	-
13	2	25/09/17	18:29	18:32	28-29	18:52	19:01	19:25	19:31	0070	18:50	18:55	Concerto: 2 downcasts & 2 upcasts (winch error)
14	2	26/09/17	12:51	12:55	-	-	-	-	-	0071	13:05	13:11	No Rosette (bad weather) – Concerto deployed to 96 m
15	2	26/09/17	16:03	16:06	-	-	-	-	-	0074	16:08	16:19	No Rosette (bad weather) – Concerto deployed to 93 m
16	2	27/09/17	11:01	11:03	30-31	11:24	11:33	12:03	12:22	-	-	-	CTD was deployed but no data were recorded
17	2	27/09/17	16:12	16:15	32-33	16:30	16:39	16:57	17:11	-	-	-	CTD was deployed but no data were recorded
18	2	28/09/17	10:56	10:59	34-35	11:18	11:30	11:47	11:55	-	-	-	CTD was deployed but no data were recorded
19	2	28/09/17	16:24	16:27	36-37	16:41	16:51	17:05	17:11	-	-	-	CTD was deployed but no data were recorded
20	2	29/09/17	11:18	11:20	38-39	11:38	11:50	12:07	12:15	-	-	-	CTD was deployed but no data were recorded

7.0 APPENDIX D – FIELD LOGBOOKS

7.1 Leg 1 and mobilization field logbook (2017)

- **June 21st:** The scientific equipment for the program (17 boxes, 4 pallets) was shipped from DFO in Winnipeg (MB) to Glovertown (NL) shipyard.
- **July 4th:** Scientific equipment was received by Glovertown Shipyard.
- **July 12th:** Leg 1 team flew from Winnipeg to St. John's (NL).
- **July 13th:** Leg 1 team flew from St. John's to Gander (NL).
- **July 14th:** Team traveled by car from Gander to Glovertown, carried out the mobilization of the oceanographic equipment aboard the ship and boarded the *M/V Nuliajuk* in Glovertown shipyard and participated in the sea trials off the coast of Glovertown.
- **July 19th:** Ship left Glovertown and headed for Saglek Bay (NL) for mooring deployment.
- **July 20th:** Crew deployed a mooring in Saglek Bay (58° 27.5' N; 62° 47.17' W) at 20 m depth, with Styrofoam marker left at surface for later recovery.
- **July 21st:** Station 1: The CTD profiler and Concerto fluorimeter were deployed; however no Rosette or trawl sampling were conducted due to bad weather conditions.
- **July 22nd:** Stations 2-3: Full sampling of both stations was completed.
- **July 23rd:** Station 4: Completed Rosette sampling. Attempted trawl sampling but damaged the trawl net, forcing the crew to steam inshore to mend the net in calmer seas.
- **July 24th:** Because of high swell (3-4 m), no sampling was conducted.
- **July 25th:** Stations 4-5: Completed trawl sampling of Station 4 (previously aborted on July 23rd). Full sampling of station 5 was completed.
- **July 26th:** Stations 6-7: Full sampling of the two stations was completed.
- **July 27th:** Station 8: Water column sampling only was completed, as it was too windy to deploy the trawl.
- **July 28th:** Station 8: Steamed back to Station 8 and completed trawl sampling aborted on the previous day. Station 9: trawl sampling was attempted but trawl doors got entangled, requiring 2 hours to mend. Trawling postponed to next day.
- **July 29th:** Station 9: trawl sampling attempted twice more. At the first attempt, the trawl did not make contact with the seafloor. On the second attempt the trawl net got entangled and required 2 hours to mend, so trawling at this station was aborted. Due to both trawling attempts being unsuccessful, only the water column sampling was completed at Station 9.
- **July 30th:** Station 10-11: Full sampling of both stations was completed. Station 10: chain from the trawl broke while trawling so recovering the net took 1 hour more than usual.
- **July 31st:** Steaming back in direction of Iqaluit (NU).
- **August 1st:** Arrival in Iqaluit, followed by the disembarking of the sampling team.
- **August 2nd:** Arrival at DFO in Winnipeg, followed by the transferring of frozen samples (excluding HPLC samples, which were left onboard the ship) to the -80 °C freezer of the DFO Marine Productivity Laboratory for long term storage.

7.2 Leg 2 and demobilization field logbook (2017)

- **September 20th**: Flew from Winnipeg to Ottawa (ON) at 10:25 CST. The sampling team had lunch and dinner in Ottawa, with an overnight stay at the Days Inn Airport Hotel.
- **September 21st**: Flew from Ottawa to Iqaluit at 9:15 EST. Team had lunch and dinner in Iqaluit (NU), with an overnight stay at the Frobisher Inn.
- **September 22nd**: Flew from Iqaluit to Pangnirtung (NU) at 8:00 EST. Arrived at 9:05 EST in Pangnirtung airfield and had a discussion with Kevin Hedges and his team, who had just disembarked the *M/V Nuliajuk*. Boarded the ship at 10:30 EST, met with ship's crew and started cleaning and setting up the lab. Team finished setup in the evening. Discussed with captain about travel plan. Spent the day and night docked in Pangnirtung.
- **September 23rd**: Ship departure delayed because of missing meat cargo arriving from Newfoundland, so spent the day docked in Pangnirtung. Later on, the crew received a phone call informing that the extra meat cargo would not arrive, so the captain decided to leave at 14:30 EST. 25-hour steaming time estimated to reach the first station (Station 12).
- **September 24th**: Slow progress due to headwind. Went over sampling procedures with the team, charged the Rosette battery, replaced the batteries of the CTD profiler and set up the fish scale on the main deck. Ship arrived at Station 12 at 16:30 EST. Delayed sampling to the next day due to bad weather. Ship drifted all night around Station 12.
- **September 25th**: 1.5 hours steaming time required to get back to Station 12 after drifting all night. Arrived at 8:00 EST and started sampling. Trawl doors got entangled during trawling and required 2 hours to mend. The complete sampling of Stations 12-13 was conducted and finished at 18:30 EST. Very few shrimp were present in the trawl catches.
- **September 26th**: Woke up to 3 m waves and 16 kn winds. Captain decided to delay sampling until next weather forecast. Team started sampling at 8:30 EST, but only with CTD profiler, Concerto fluorometer and trawl. No Rosette deployment was conducted to avoid damage against the hull of the rocking ship. Thus, Stations 14-15 were only sampled partially. Team finished sampling at 16:00 EST. Very few shrimp found in trawl catches.
- **September 27th**: Started sampling at 7:00 EST. The complete sampling of Stations 16-17 was conducted. However, no DIC/TA samples were collected at both stations due to high swell (breakable glass bottles). Very few shrimp found in trawl catches. The ship headed for next station, near Resolution Island, where important shrimp densities were expected.
- **September 28th**: Started sampling at 7:00 EST. The complete sampling of Stations 18-19 was conducted. However, the DIC/TA sample from 20 m at Station 19 was not collected.
- **September 29th**: The team started sampling at 7:00 EST in very rough weather conditions, including high swell and strong winds. Thus, the team completed the sampling for Station 20 only. The captain cancelled Station 21 due to worsening weather and forecast. The ship headed to the mouth of Frobisher Bay (NU) for temporary shelter until weather cleared.

- **September 30th**: Woke up at 6:00 EST and the ship was still heading for shelter, as the weather forecast was worsening for the next 4 days. The crew anchored in Jackman Sound (NU) at the mouth of Frobisher Bay until further notice.
- **October 1st**: The ship remained anchored in Jackman Sound, as the weather forecast was not improving. The captain decided to cancel all remaining stations (# 21 to 26) and leave for Iqaluit at 18:00 EST, as the last forecast was worsening with gale warning (7 m waves and 40 kn winds). The crew experienced 4-5 m waves on the way to Iqaluit during the night. The laboratory equipment had to be secured again.
- **October 2nd**: Steaming to Iqaluit with slow progress, as the wind and waves were hitting the bow of the ship (average speed: 2 kn). The ship arrived in Iqaluit only at 22:00 EST.
- **October 3rd**: Anchored just outside of Iqaluit. Spent the day packing up all scientific equipment and made a new box list for the upcoming demobilization.
- **October 4th**: Spent most of the day packing the rest of the equipment and cleaning the lab. The ship was moved to the dock later in the evening for refueling. David Deslauriers went ashore at 15:40 EST to meet DFO Iqaluit colleague Zoya Martin, get three 100 L coolers and drop off 2 boxes packed with Kevin Hedges' scientific equipment.
- **October 5th**: The team filled up three 100 L coolers with frozen fish from the previous expedition. A fourth cooler was packed with water column and trawl frozen samples to bring back to the FWI (DFO, Winnipeg). Disembarked from the *M/V Nuliajuk* for Iqaluit with 2 zodiac trips to the nearest beach, where the team met with Zoya Martin at 13:00 EST to load the luggage and coolers in the DFO truck. Zoya dropped David at the Capital Suites Hotel and Brianne at the Discovery Inn. Pascal left with Zoya to ship the three coolers filled with fish to Windsor as per Kevin Hedges' request.
- **October 6th**: Flew from Iqaluit to Ottawa at 13:35 EST. Flight from Ottawa to Toronto (ON) and then to Winnipeg. Made it to the FWI (DFO, Winnipeg) by 02:00 CST on the 7th. The Rosette and trawl frozen samples were transferred from the cooler to the -80 °C freezer in the Marine Productivity Laboratory.
- **November 7th**: Pascal Tremblay flew from Winnipeg to St. John's (NL) for the demobilization of oceanographic equipment from the program. Arrived around 20:00 NST.
- **November 8th**: Pascal Tremblay met a collaborator at DFO in St. John's and traveled by truck to Holyrood (NL), where the ship was docked. The team of 2 successfully demobilized all equipment from the ship during the day, by loading the truck and completing two trips back and forth between St. John's and Holyrood for offloading.
- **November 9th**: Pascal Tremblay relabeled all shipping boxes, since many had lost their labels at sea during the ship's return from Davis Strait to Newfoundland. Shipping pallets were assembled, weighed and then shipped from DFO St. John's via Day & Ross carrier.
- **November 10th**: Travel by commercial aircraft from St. John's to Winnipeg, with arrival around 00:00 CST.
- **November 22nd**: Scientific equipment from the program (17 boxes, 4 shipping pallets) was received at DFO in Winnipeg (FWI).

8.0 REFERENCES

- ArcticNet. 2019. ArcticFish: Fisheries resources in the changing Canadian Arctic Ocean. <http://www.arcticnet.ulaval.ca/project/arcticfish-fisheries-resources-changing-canadian-arctic-ocean>
- Belzile, C., Brugel, S., Nozais, C., Gratton, Y., Demers, S. 2008. Variations of the abundance and nucleic acid content of heterotrophic bacteria in Beaufort Shelf waters during winter and spring. *J. Mar. Syst.* 74, 946–956.
- Cyr, F., Snook, S., Bishop, C., Galbraith, P.S., Pye, B., Chen, N., Han, G. 2021. Physical oceanographic conditions on the Newfoundland and Labrador Shelf during 2019. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2021/017. iv + 52 p.
- Government of Nunavut, Department of Environment. 2015. Research. <https://www.gov.nu.ca/environment/information/research>
- DFO. 2009. Northern Shrimp (SFAs) 0-7 and the Flemish Cap. <https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2007-eng.html#n2>
- DFO. 2011. 2011-2015 Integrated Fisheries Management Plan for Atlantic Seals. <https://www.dfo-mpo.gc.ca/fisheries-peches/seals-phoques/reports-rapports/mgtplan-planges20112015/mgtplan-planges20112015-eng.html>
- DFO. 2016. Northern Shrimp. <https://www.dfo-mpo.gc.ca/species-especes/profiles-profils/northern-shrimp-crevette-nordique-eng.html>
- DFO. 2017. Assessment of Northern Shrimp, *Pandalus borealis*, and Striped Shrimp, *Pandalus montagui*, in the Eastern and Western Assessment Zones, February 2017. *DFO Can. Sci. Advis. Sec. Sci. Advis. Rep.* 2017/010. (Erratum: April 2017).
- DFO. 2018a. Northern Shrimp and Striped Shrimp – Shrimp Fishing Areas 0, 1, 4-7, the Eastern and Western Assessment Zones and North Atlantic Fisheries Organization (NAFO) Division 3M. <https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2018-002-eng.html#n1>
- DFO. 2018b. Wolffish: What you need to know. <https://www.dfo-mpo.gc.ca/species-especes/publications/sara-lep/wolffish-loup/index-eng.html>
- DFO. 2020a. Greenland Halibut - Northwest Atlantic Fisheries Organization Subarea 0. <https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/2019/halibut-fletan-eng.htm#toc1>
- DFO. 2020b. Recovery Strategy for Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*), and Management Plan for Atlantic Wolffish (*Anarhichas lupus*) in Canada. Fisheries and Oceans Canada, Ottawa. vii + 81 p

- Knap, A., Michaels, A., Close, A., Ducklow, H., and Dickson, A. 1996. Protocols for the Joint Global Ocean Flux Study (JGOFS) Core Measurements JGOFS Report No. 19, Reprint of the IOC Manuals and Guides No. 29, UNESCO, Bergen.
- Koeller, P., Platt, T. 2007. Decreasing shrimp (*Pandalus borealis*) sizes off Newfoundland and Labrador - Environment or fishing? Fisheries Oceanography. 16. 105 - 115. 10.1111/j.1365-2419.2006.00403.x.
- Koeller, P., Platt, T., Sathyendranath, S., Richards, A., Ouellet, P., Orr, D., Skúladóttir, U., Wieland, K., Savard, L., Aschan, M. 2009. Basin-scale coherence in phenology of shrimps and phytoplankton in the North Atlantic Ocean. Science (New York, N.Y.). 324. 791-3. 10.1126/science.1170987.
- Lund, J.W.G., Kipling, C., Le Cren, E.D. 1958. The inverted microscope method of estimating algal number and the statistical basis of estimations by counting. Hydrobiologia 11, 143–170.
- Marchese, C., Castro de la Guardia, L., Myers, P.G., Bélanger, S. 2019. Regional differences and inter-annual variability in the timing of surface phytoplankton blooms in the Labrador Sea. Ecological Indicators 96 (2019) 81-90.
- Marie, D., Partensky, F., Jacquet, S., Vaultot, D., 1997. Enumeration and cell cycle of natural populations of marine picoplankton by flow cytometry using the nucleic acid stain SYBR Green I. Appl. Environ. Microb. 63, 186-193.
- Michel, C., and Niemi, A. 2009. Field and laboratory methods for biogeochemical analyses of sea ice, seawater and particle interceptor trap samples. Can. Tech. Rep. Fish. Aquat. Sci. 2852: v + 24 p.
- Oceans North. 2021. Baffin Bay & Davis Strait. <https://oceansnorth.org/en/where-we-work/baffin-bay-davis-strait/>.
- Parsons, T.R., Maita, Y., Lalli, C.M. 1984. A manual of chemical and biological methods for seawater analysis. Pergamon, Oxford.
- Racault, M.-F., Platt, T., Sathyendranath, S., Agirbas, E., Martinez-Vicente, V., Brewin, R.J.W. 2014. Plankton indicators and ocean observing systems: support to the marine ecosystem state assessment. J. Plankton Res. 36, 621–629. <https://doi.org/10.1093/plankt/fbu016>.
- Schlitzer, R. 2018. Ocean Data View. <http://odv.awi.de>.
- Sherr, E.B., Caron, D.A., and Sherr, B.F. 1993. Staining of heterotrophic protists for visualization via epifluorescence microscopy. In: Kemp, P.F., Sherr, B.F., Sherr, E.B., and Cole, J.J. (Eds). Handbook of methods in aquatic microbial ecology. Lewis Publications, Boca Raton, FL, p. 213-227.
- Siferd, T.D. 2015. 2015 Assessment of Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in the Eastern and Western Assessment Zones (SFAs Nunavut, Nunavik and Davis Strait). DFO Can. Sci. Advis. Sec. Res. Doc. 2015/010. v + 70 p.