

URI Northwest Passage Project 2018

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Scientific Research

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Period of operation: from 0001-01-01 to 0001-01-01

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$\gamma_{\text{H}_2\text{O}} \Delta^{\text{C}} \dot{\rho}_{\sigma}^{\text{b}}$ $\Lambda_{\text{F}} \rho_{\text{d}} \Delta^{\text{f}} \text{b}^{\text{f}} \sigma_{\text{d}} \Delta^{\text{a}} \text{L}^{\text{a}} \sigma^{\text{b}}$

The Northwest Passage Project (NPP) is a U.S. National Science Foundation funded program to explore the changing Arctic through an innovative expedition that will engage diverse audiences through real time interactions from sea, a high definition 2-hour documentary, and related community events. The expedition will be conducted onboard the Akademik Ioffe, operated by One Ocean Expeditions. Telepresence technologies will allow for shore-based participation in the project. Expedition participants include undergraduate and graduate students, scientists, historians, journalists, and a documentary film crew. The NPP Akademik Ioffe expedition will depart Resolute Bay August 23, 2018, arriving in Iqaluit on September 13 (Fig. 1). Science activities will be primarily ship-based and occur continuously or on an event basis throughout the expedition. Conductivity, Temperature, Depth rosette (CTD) casts and zooplankton net tows will occur every 100 nm or approximately daily, whichever comes first. Other activities, including air sampling, flowing seawater analysis, and seabird census counts will occur throughout. The main science goal is to understand how waters of the Canadian Arctic Archipelago (CAA) have changed as a consequence of the secular warming trend over the Arctic Circle, using an interdisciplinary ocean-based research program to explore the changes in four (4) thematic areas. Theme 1: Water mass properties and circulation inside CAA. Scientists will investigate the increased freshwater storage in and export from the upper Arctic Ocean due to a warming Arctic. Increased melting, river discharge, as well as changing wind patterns have led to increased freshwater accumulation in the western Arctic. The CAA, and particularly the Northwest Passage, is one of the principle conduits for freshwater transport from the Arctic Ocean to the North Atlantic, however, there are uncertainties in the magnitude of transport and water properties. The currents in the CAA will be studied with Acoustic Doppler Current Profiler (ADCP) data, an autonomous glider (Fig. 2), and the CTD. Theme 2: Microscopic Communities in Transition. As Arctic waters warm and sea ice cover decreases, the surface ocean ecosystem is changing, and species distributions and abundances may change rapidly. To examine habitats along the cruise track, zooplankton nets will be periodically towed in the upper water column ($\leq 100\text{m}$). Net contents will be catalogued. This data will be augmented by a laboratory bench-top FlowCam, which can identify and quantify 'particles' in seawater (Fig. 3). These particles can be sediments, phytoplankton, or zooplankton. We will re-occupy the long time series station in Lancaster Sound (Station 323: Lancaster Sound, 74.2, -79.75). Theme 3: Distributions of Marine Birds in Canadian Arctic Waters. Marine bird abundance and distribution can be used to monitor changes and variability in marine ecosystems. NPP will characterize the distribution and abundance of marine birds along the survey route. Associations between the marine bird community and the physical and biological properties of their marine environment will be identified and compared to past results. The cruise will use a standard non-invasive, observational method to perform seabird counts. Theme 4: Water Column Chemistry Affecting Greenhouse Gas Fluxes. The concentration and isotopic composition of

methane and carbon dioxide in the Arctic Ocean and atmosphere are of great interest as both are greenhouse gases, and the sources and flux of both between the ocean and atmosphere are important components of the climate system. Measuring carbon dioxide and its isotopic composition can provide information about the carbon system sources and fluxes of carbon to the atmosphere. The Arctic appears to be an ever growing source of methane to the atmosphere. Some microbes in ocean water use methane as a food source. If microbial breakdown of methane is rapid enough, it may serve to offset the methane that escapes to the atmosphere. The NPP will study the concentrations and isotopes of carbon dioxide and methane by analyzing samples of the air and water with onboard laser spectroscopy instruments, as well as incubation of water to study microbial activity.

Open Data Policy We will disseminate scientific data and results through the NPP website. All processed measurements will be stored in the NSF-supported Arctic Data Portal (<https://arcticdata.io>) and all appropriate Canadian and Inuit science databases, such as the Canadian Wildlife Service seabird database.

Acoustic Instrumentation The NPP science team will use two scientific Acoustic Doppler Current Profiler (ADCP) sonar systems: a hull mounted ADCP operating at 38kHz and an ADCP operating at 300kHz, attached to the CTD. The 38kHz sonar will be operating when the ship is underway, except under these conditions when the sonar will be off when: 1) marine mammals are detected within 500m of the ship. 2) within 5 km of any Nunavut community. 3) East of Bylot Island. The sonar will only be used when greater than 5km from land and will not be used in any harbor, bay, fjord, or channel. 4) in Navy Board Inlet, Eclipse Sound, and Pond Inlet, out of respect for concerns about the sonar in regard to a group of narwhals that moves between the Arctic Bay and Pond Inlet areas. 5) in restricted waters of the Bylot Island Migratory Bird Sanctuaries or Parks Canada Waters.

The Northwest Passage Project (NPP) est un programme financé par la National Science Foundation (NSF – Fondation nationale pour la science) des États-Unis visant à observer l'évolution de l'Arctique. Celui se présente sous la forme d'une expédition innovante grâce à son interactivité en temps réel avec l'environnement marin, à un documentaire en haute définition et à des événements communautaires liés à l'expédition. Celle-ci sera menée à bord de l'Akademik Ioffe, affrété par One Ocean Expeditions. Des technologies de téléprésence permettront une participation à partir de la terre ferme. Les participants sont des étudiants de 2e et 3e cycle, des scientifiques, des historiens, des journalistes et une équipe réalisant le documentaire. L'Akademik Ioffe quittera Resolute Bay le 23 août et arrivera à Iqaluit le 13 septembre 2018 (Fig. 1). Les activités scientifiques auront principalement lieu à bord et se dérouleront en permanence ou en fonction des événements. Des profils de conductivité, température et profondeur et de zooplanctons seront effectués avec la rosette océanographique CTD tous les 100 milles nautiques ou approximativement tous les jours, selon ce qui se présente en premier. D'autres activités, incluant des échantillonnages d'air, une analyse des courants marins et le comptage des oiseaux de mer auront lieu pendant toute la durée de la campagne. Le principal objectif est de comprendre quels ont été les changements survenus dans les eaux de l'Archipel arctique canadien (AAC) du fait de la tendance au réchauffement climatique au-delà du cercle polaire arctique, en quatre grands thèmes. Thème n° 1 : Propriétés de la masse d'eau et sa circulation L'augmentation de la fonte des glaces, du débit des rivières, ainsi que les changements dans les caractéristiques des vents du fait du réchauffement du pôle ont entraîné une accumulation d'eau douce dans l'Ouest de l'Arctique. L'AAC, et notamment le Passage du Nord-Ouest, est l'une des voies principales de transport de l'eau douce depuis l'océan Arctique vers l'Atlantique nord; toutefois, l'ampleur de ce mouvement et les propriétés de l'eau sont mal connues. Les courants circulant à l'intérieur de l'AAC seront étudiés à l'aide des données de profileur de courant à effet Doppler (ADCP), un planeur sous-marin autonome (Fig. 2) et une CTD. Thème n° 2 : Communautés microscopiques en transition L'écosystème de la surface des océans évolue avec le réchauffement des eaux arctiques et la diminution de leur couverture glacielle; la répartition et l'abondance des espèces pourraient changer rapidement. Des filets à zooplanctons seront traînés dans la colonne d'eau supérieure (≤ 100 m) pour examiner les habitats le long de la route de campagne. Le contenu des filets sera répertorié dans un catalogue. Ces données seront agrandies à l'aide d'un FlowCam de laboratoire, un appareil permettant d'identifier et de quantifier les « particules » (sédiments, phytoplancton ou zooplancton) présentes dans l'eau de mer (Fig. 3). Nous occuperons l'ancienne station d'étude du détroit de Lancaster (Station 323 : latitude de 74,2, longitude de -79,75). Thème n° 3 : Répartitions des oiseaux de mer dans les eaux arctiques canadiennes L'abondance et la répartition des oiseaux de mer peuvent servir à la surveillance des changements et de la variabilité des écosystèmes marins. Les associations entre les groupes d'oiseaux de mer et les propriétés biologiques de leur environnement marin seront identifiées et comparées aux données antérieures. La campagne utilisera une méthode non invasive pour le comptage. Thème n° 4 : Chimie de la colonne d'eau affectant les flux de gaz à effet de serre

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Lancaster Ikirahak, 74.2, -79.75). Ilitturniq 3: Auladjutinit Taryurmiuttat Tingmiat iluani Kanatamiunit Ukiuqtaqtumi Imangit Taryurmiuttat tingmiat amihuuningit auladjutingillu parnautilaatqangit amiqhailugu aallannguqtihimaningit aallatqiillu taryurmiuttat avatiqatigiingnit. NPP ilitquhirilaatqangit auladjutingillu amihuuningillu taryurmiuttat tingmiat nalunaiqhiivlutik. Katudjigiiktut ukunanngat taryurmiuttat tingmiat ilagiiktut unalu qaanganit ilitquhiriyangit haffumani taryurmiuttat avataita naunaiyainiaqhutik ilittpkaihimalugiktauq nalunaiqhigaluangit. Una umiaryuaq pulaaqtaqtuq malikhimaniaqtangit ayurnaittumik, tautungnaqtumik maligautaanit nalunaiqhiinahuarlugit taryurmiuttat tingmiat naunaiqhiyut. Ilitturniq 4: Imaup Ilitquhiita Ilaurutingit Aktuqhimayangit Puyum Anianailaqtataa Hakugingnia Hakuirningalu Una ihuqhiniit ilahimagamit unalu ilaurutilgit iluaniittuni naimannaittut anianailaqtutit akhaluutim puyungillu iluani Ukiuqtaqtum Taryuata nunapta anirniqautiit ikiariit ihumaaluutaulluaqtangit tamarmiuyuk puyum anianailaqtataa, ilanganillu hakugingnia hakuirninga ukunani taryum unalu nunapta anirniqautiit ikiariit aturnaqtut ilagiyangit hilaup uunnakpallianingit. Ihivriuqtangit akhaluutit puyungit naimannaittuq anianailaqtutit ilitturnaqlaqtuq ihingit hakugingnia hakuirningalu uvunga nunapta anirniqautit ikiariitnut. Hamna Ukiuqtaqtuq takunnaqtuq hiammakpalliaqtuq uumani naimannaittuq anianailaqtutit nunapta anirniqautit ikiariinni. Ilangit iyingnut takunnaqtuq iluani taryum imangit naimannaittumik anianailaqtutit niqinut ilagiyat. Taamna iyingnut takunnaqtuq hiaminningit naimannaittut anianailaqtutit amihuukpat, taimaa hiamittilaqhuni nunapta anirniqautit ikiariinni. Una NPP ilitturnaqhuni hamna ihuqhiyuq ilahimagami unalu ilaurutilgit akhaluutim puyungit uumanilu naimannaittut anianailaqtutit naunaqhiyangit ihivriuqhutik anurim imarmilu iluaniittumi naunaiyainikkut ingilrutaanit, uumanilu imap puuqpiaqhimayut ilittuqhaiyut iyyungnut takunnaittut huliyaqhanit. Angmaumayuq Naunaiyainingit Atuagaq Nalunaiqhiinahuaqtavut qauiyaqhimayangit naunaiyaiyut kiuvingillu uumani NPP qaritauyakkut turaarutaata qunnialaqtangit. Tamaat nalunaiqhiyangit ihivriuqtangit tutquumahimaniaqtangit iluani NSF-ikayuqtauhiyuq Ukiuqtaqtumi Naunaiyaivingat (<https://arcticdata.io>) tamaita nalaumattiaqtumik Kanatamiunut Inuinnaillu qauiyaqhimayangit qaritauyami iliuraiviannit, uumanilu Kanatamiunut Uumayuliqiyit taryurmiunit tingmiat iliuraiviannit qaritauyami. Tuhaumalaqtut Ingilrutingit Una NPP qauiyaqtut ikayuqtigiiktut aturniaqtangit malruk qauiyaqturnikkut Tuhaumalaqtut Ilittuqhiyut (ADCP) nalunairvikhat: iliuraqhimayuq ADCP aulapkaiyuq uvanngat 38 kHz unalu ADCP aulapkailaqtuq uvanngat 300 kHz, katilviuhimayuq uvunga CTD. Una 38 kHz nalunairvik aulapkaihimaniaqtuq umiaq ikaaliqqat, kihimi malikhimayakhaat naunaiyarvinga umikhimaniaqtuq imailiuaqtut: 1) Taryurmiuttat amaammaktittiyuktut niryuutit ilitturnaqqat iluani 500 m ungahingnia umiarmit. 2) Iluani 5 km ungahingnia quyanginnaq Nunavut nunalingni. 3) Kivataanit hamnangat Bylot Qikiqtami. Una naunaiyaivik atuinnaqhunnguya at anginitqiyaanit 5 km ungahingnia nunamit atulaittangit kangiqhunnuami, kangiqhurmi, takiyaaqtut kangiqhuit, ikirahailu. 4) Iluani Navy Board Kangiqhua, Eclipse Ikirahaa, Mittimataliglu, ihumagivlugit maligahuaqhugit ihumaaluutingit naunaiyaivinga amihuaryuit tuugaaliit ingilravakkamik uvanngat Ikpiarjungmit Mittimatalingmut. 5) Amirilluaqhimayangit imait haffumani Bylot Qikiqtaq Utiqtaqtut Tingmidjat Unaguqhirvingit uuminngaluuniit Minnguivrit Kanatam Imangit.

Personnel

Personnel on site: 36

Days on site: 21

Total Person days: 756

Operations Phase: from 2018-08-23 to 2018-09-20

$$\Lambda \subset \mathbb{N} \setminus \{1\} \rightarrow \mathbb{N} \setminus \{1\}$$

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Proposed Glider Operations Area - region where the autonomous glider would operate.	Scientific/International Polar Year Research	Marine	NA	NA	The communities closest to the glider operations area are Pond Inlet and Arctic Bay to the south and Resolute to the west. The Bylot Island Migratory Bird Sanctuary (PLIMBS) is just south of the area and the Prince Leopold Island Migratory Bird Sanctuary (PLIMBS) is in the operations area. The glider will not approach too close to PLIMBS.
Proposed Transect 1 - cross channel transect to measure ocean flow.	Scientific/International Polar Year Research	Marine	NA	NA	Resolute is approximately 20km straight line distance from the northern end of transect 1.
Proposed Transect 2 - cross channel transect to measure ocean flow.	Scientific/International Polar Year Research	Marine	NA	NA	Arctic Bay is approximately 100km straight line distance from the southern end of Transect 2.
Proposed Transect 3 - cross channel transect to measure ocean flow.	Scientific/International Polar Year Research	Marine	NA	NA	Transect 3 is more than 300km south of Resolute and more than 300km north of Gjoa Haven.
Proposed	Scientific/International	Marine	NA	NA	Transect 4 is

Transect 4 - cross channel transect to measure ocean flow.	Polar Year Research				about 150km from Gjoa Haven and more than 175km from Cambridge bay.
Station 323 - long term science station. NPP will reoccupy to contribute and compare to past measurements.	Scientific/International Polar Year Research	Marine	Station 323	NA	Arctic Bay is about 140km straight line distance from Station 323 and Pond Inlet is about 170km straight line distance from Station 323.
Proposed NPP Cruise Track - an approximation of the path the ship will take.	Scientific/International Polar Year Research	Marine	NA	NA	The cruise track will take the ship to or near or for visits to these communities: Resolute, Arctic Bay, Pond Inlet, Gjoa Haven, Cambridge Bay, Clyde River, Qikiqtarjuaq, Pangnirtung, Iqaluit.
Prince Leopold Island - project filming location & bird observation location	Scientific/International Polar Year Research	Crown	Prince Leopold Island is a Migratory Bird Sanctuary.	NA	Prince Leopold Island is a Migratory Bird Sanctuary.

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Information is not available			

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ΔL⁹⁶ ΔD⁹⁶ CD⁹⁶ ΔL⁹⁶ ΔD⁹⁶

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$$\Delta^b C d \leq \rho \sigma \Delta^a \sigma^a$$

$\Delta^{\circ}G_{\text{f}}^{\circ}(\text{C}_6\text{H}_6) = -123.4 \text{ kJ mol}^{-1}$

The transient nature of this expedition, and the short duration of sampling stops (3 hours or less at each sampling station), should result in minimal environmental impact. Because only small samples will be collected, the impacts of the actual sampling procedures will also be minimal. However, the science team does recognize that the operating frequencies of the hull-mounted TRDI 38kHz Acoustic Doppler Current Profiler (ADCP) could have an impact on the behavior of marine mammals that are in the vicinity of the ship (when the sonar is active) and can perceive the sound produced by the ADCP. To mitigate these potential behavioral impacts, the proposed standard operating procedure for the NPP 2018 expedition will be to have the hull mounted 38kHz sonar operating when the ship is underway, except under these conditions: 1) Sonar operation will cease when marine mammals are detected within 500m of the ship. 2) The sonar will be off when within 5 km of any Nunavut community. 3) East and South of Bylot Island, the sonar will only be used when greater than 5km from land and will not be used in any harbor, bay, fjord, or channel. 4) Out of respect for concerns about the sonar in regard to a group of narwhals that moves between the Arctic Bay and Pond Inlet areas, the sonar will be off while in Navy Board Inlet, Eclipse Sound, and Pond Inlet. 5) When in restricted waters of the Bylot Island Migratory Bird Sanctuaries or Parks Canada Waters, the sonar will be off.

Additional Information

SECTION A1: Project Info

SECTION A2: Allweather Road

SECTION A3: Winter Road

SECTION B1: Project Info

SECTION B2: Exploration Activity

SECTION B3: Geosciences

SECTION B4: Drilling

SECTION B5: Stripping

SECTION B6: Underground Activity

SECTION B7: Waste Rock

SECTION B8: Stockpiles

SECTION B9: Mine Development

SECTION B10: Geology

SECTION B11: Mine

SECTION B12: Mill

SECTION C1: Pits

SECTION D1: Facility

SECTION D2: Facility Construction

SECTION D3: Facility Operation

SECTION D4: Vessel Use

SECTION E1: Offshore Survey

SECTION E2: Nearshore Survey

SECTION E3: Vessel Use

SECTION F1: Site Cleanup

SECTION G1: Well Authorization

SECTION G2: Onland Exploration

SECTION G3: Offshore Exploration

SECTION G4: Rig

SECTION H1: Vessel Use

The URI NPP expedition will use the Akademik Ioffe, operated by One Ocean Expeditions. The ship will serve as the science platform for the NPP science activities. The ship will also have tourists on board and will make stops and put people ashore for those tourist activities. The NPP project's use of the Akademik Ioffe was arranged after One Ocean Expeditions had submitted their permitting proposals.

SECTION H2: Disposal At Sea

One Ocean Expeditions has a complete waste management plan for the Akademik Ioffe's operations in the Arctic. The One Ocean Expeditions plan is included as a project document.

SECTION 11: Municipal Development

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NA

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NA

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NA

Miscellaneous Project Information

உடையவர்களுக்கும் அருள்கூர்ந்து உதவி செய்து கொடுப்பதற்காகவே இவ்வாறு உத்தேசித்துள்ளார்.

The transient nature of this expedition, and the short duration of sampling stops (3 hours or less at each sampling station), should result in minimal environmental impact. Because only small samples will be collected, the impacts of the actual sampling procedures will also be minimal. However, the science team does recognize that the operating frequencies of the hull-mounted TRDI 38kHz Acoustic Doppler Current Profiler (ADCP) could have an impact on the behavior of marine mammals that are in the vicinity of the ship (when the sonar is active) and can perceive the sound produced by the ADCP. To mitigate these potential behavioral impacts, the proposed standard operating procedure for the NPP 2018 expedition will be to have the hull mounted 38kHz sonar operating when the ship is underway, except under these conditions: 1) Sonar operation will cease when marine mammals are detected within 500m of the ship. 2) The sonar will be off when within 5 km of any Nunavut community. 3) East and South of Bylot Island, the sonar will only be used when greater than 5km from land and will not be used in any harbor, bay, fjord, or channel. 4) Out of respect for concerns about the sonar in regard to a group of narwhals that moves between the Arctic Bay and Pond Inlet areas, the sonar will be off while in Navy Board Inlet, Eclipse Sound, and Pond Inlet. 5) When in restricted waters of the Bylot Island Migratory Bird Sanctuaries or Parks Canada Waters, the sonar will be off.

Cumulative Effects

The transient nature of this expedition, and the short duration of sampling stops (3 hours or less at each sampling station), should result in minimal environmental impact. Because only small samples will be collected, the impacts of the actual sampling procedures will also be minimal.

Impacts

$a \rightarrow a \Delta^{9b} C D \sigma^{-9b} r^C$ $\nabla \leq n \Gamma D C \dot{\sigma}^C D^C$ $\nabla b \Delta^{9b} C D r L \dot{r}^C$

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Scientific/International Polar Year Research		-	-	-	-	-	-	-	-	-	-	-	N		-	-	-	N	U		-	-	-	-	-
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$$(P = \langle b \rangle \Delta \langle \rho \rangle \cap \langle \lambda^a \rangle \langle \mathfrak{b} \rangle^c, N = \langle b \rangle \Delta \langle \rho \rangle^* \langle \lambda \rangle \langle \lambda^a \rangle \langle \mathfrak{b} \rangle^c \langle \lambda \rangle \langle \rho \rangle^* \langle \lambda \rangle \langle \mathfrak{b} \rangle^c \langle \lambda \rangle \langle \lambda^a \rangle \langle \mathfrak{b} \rangle^c, M = \langle b \rangle \Delta \langle \rho \rangle^* \langle \lambda \rangle \langle \lambda^a \rangle \langle \mathfrak{b} \rangle^c \langle \lambda \rangle \langle \rho \rangle^* \langle \lambda \rangle \langle \mathfrak{b} \rangle^c, U = \langle b \rangle \Delta \langle \rho \rangle^* \langle \lambda \rangle \langle \lambda^a \rangle \langle \mathfrak{b} \rangle^c)$$