

Northwest Passage Project Science Summary 2019

The Northwest Passage Project (NPP) is a US National Science Foundation funded program to investigate the changing Arctic Ocean through an 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 *RVIB Oden*. Undergraduate and graduate students will participate in the expedition along with scientists, historians, journalists, Nunavut students, a young Nunavut scientist, and a documentary film crew.

The science activities are motivated by the overarching goal to understand how waters of the Canadian Arctic Archipelago (CAA) have changed as a consequence of the secular warming trend over the Arctic Circle. We approach this goal 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

The project 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 a Lowered Acoustic Doppler Current Profiler (LADCP) data, and a CTD. NPP will conduct Shore-to-shore CTD/LADCP cross-sections at 6 locations marked on the cruise track (X01 to X06). These will involve high-resolution CTD casts to resolve water mass properties along with the CTD rosette mounted LADCP.

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 which can be sediments, phytoplankton, or zooplankton. In addition, a high frequency sonar system will observe zooplankton and fish in the water column. Combining these approaches to ecosystem studies will make the results more robust.

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 have growing sources in the Arctic. Measuring isotopic composition of carbon dioxide can provide information about the carbon system sources and fluxes of carbon 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 methane consuming microbial activity.

Atmospheric gas sampling: air will be continuously analyzed for the stable isotopic ratio of hydrogen and oxygen ($^2\text{H}/^1\text{H}$ and $^{18}\text{O}/^{16}\text{O}$) of seawater and water vapor and the stable isotopic ratios (^{13}C) of CO_2 and CH_4 .

Seawater sampling: ^{13}C - CH_4 , and ^{13}C - CO_2 will be continuously sampled from the underway seawater system and from discrete bottle samples from the water column sampling. Additional analysis of the underway seawater and bottle water samples will include salinity, temperature, chlorophyll a fluorescence, colored dissolved organic matter (cDOM) fluorescence, partial pressure of carbon dioxide (pCO_2), pH, the $\delta^{18}\text{O}$ of seawater, particulate organic carbon and nitrogen (concentration and isotopic fractionation), nutrients (NO_3 , PO_4 , and $\text{Si}(\text{OH})_4$). Opportunistic sampling of floating ice will also be carried out.

Water column profiling/sampling: Every 24 hours or 100 nautical miles, a vertical “profile” of water properties and water samples will be collected using a CTD Rosette.

Research sonar

The NPP expedition is aware of concerns about the potential for scientific acoustic sources to have a behavioral impact on marine organisms, particularly marine mammals. The methodologies proposed for this expedition should minimize any potential disruption.

The proposed standard procedure for the NPP 2019 expedition will be to have the hull mounted 18kHz echosounder (or potentially 38kHz or 70kHz) and the hull mounted 12kHz multibeam 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) Due to concerns about a group of narwhals that moves between the Arctic Bay and Pond Inlet areas, the sonars will be off while in Navy Board Inlet, Eclipse Sound, and Pond Inlet. This includes turning off the CTD mounted LADCP during the hydrographic station at CTD Station 02.
- 4) Due to the potentially high concentration of marine mammals in Bellot Strait, research sonars will not be used in Bellot Strait or within 5 km of the entrance on either side.
- 5) When in restricted waters of the Price Leopold Island and Bylot Island Migratory Bird Sanctuaries or Parks Canada Waters, the sonars will be off.
- 6) If marine mammals are detected within 200m of the ship the LADCP will not be deployed.

Open Data Policy

The project will disseminate scientific data and results through the NPP website. All processed measurements will be stored in the NSF-supported Arctic Data Portal and all appropriate Canadian and Inuit science databases.

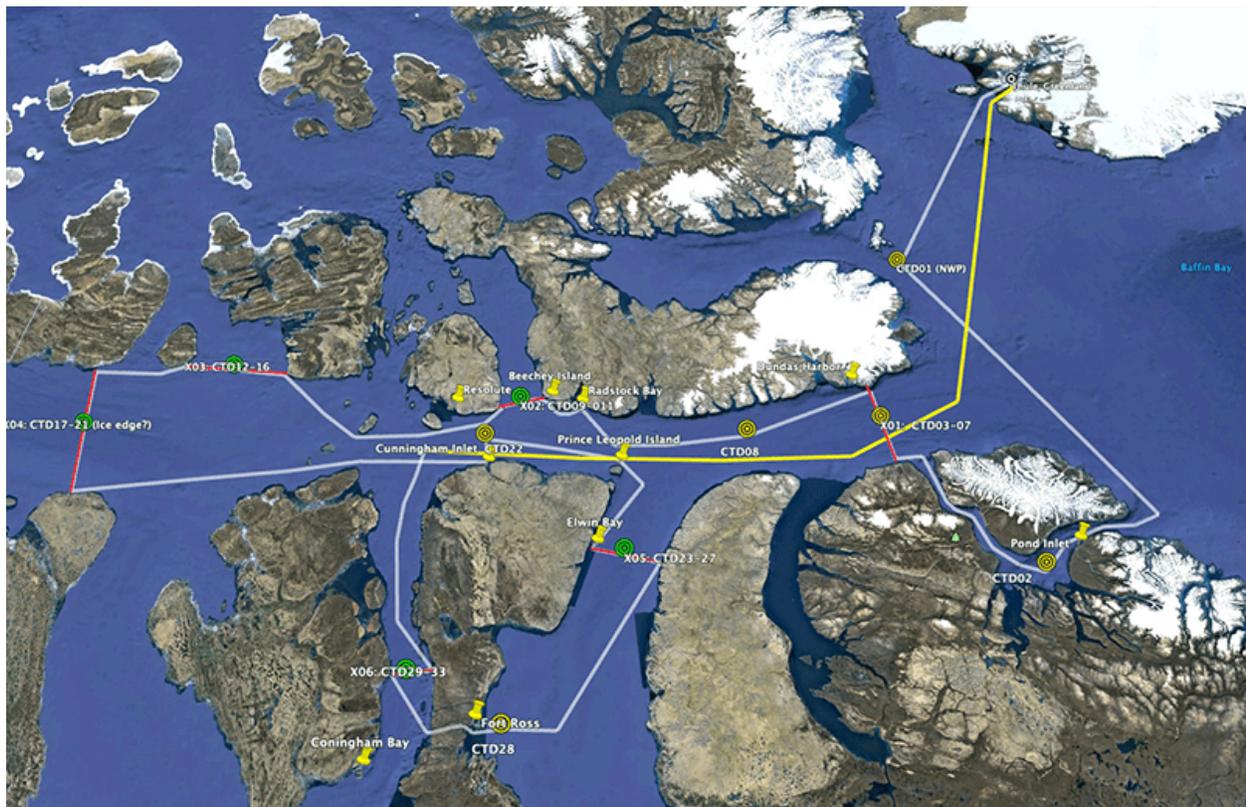


Figure 1. Proposed 18 day cruise track for the 2019 NPP expedition. The cruise track including six cross sections to map water mass properties (indicated in red). Water sampling stations are indicated with a bullseye symbol.