



## Nunavut Research Institute

### License Holder Reporting requirements

For research undertaken in the 2024 calendar year (commencing January 01, 2024 and ending December 31, 2024)

#### Project Title:

Kitikmeot Sea Science Study

**Project Leader(s):** Full name, affiliation, and contact information (address, phone number, email) of each project leader (principle investigator and co-PIs)

Project Lead: Bill Williams, Fisheries and Oceans Canada, Institute of Ocean Sciences, Email: bill.williams@dfo-mpo.gc.ca

Co-PI: Kristina Brown, University of Manitoba, Email: kristina.brown@umanitoba.ca

**Project Team:** Full name, affiliation, and address (name of city/community and province/territory/state) of each member of the project team

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**Abstract:** A concise summary of what was done, found, and concluded to date, and how the results/information will be used. This summary must be translated into the appropriate dialect of Inuktitut. Suggested length: 250-300 words. **\*This section will be published in the NRI's annual compendium of licensed research**

The Kitikmeot Sea is unique in the Arctic Ocean due to massive freshwater input from large mainland watersheds combined with shallow bounding sills that restrict the entry of salty, nutrient-rich oceanic waters into the basin. Low primary productivity results, as restricted inflow of nutrient-rich, salty water at the shallow bounding sills becomes confined underneath fresher, river-influenced surface waters. Our research builds on this basic description of the sea to understand the large-scale circulation and overall geochemical balance that supports the food web. We also focus on narrow and shallow tidal straits and near the mouths of rivers where we anticipate mixing provides nutrients that increase biological production locally.

Ongoing since 2015, the Kitikmeot Sea Science Study (K3S) has brought together an international team of oceanographers in collaboration with local Traditional Knowledge Holders to explore the Kitikmeot Sea in the southern Northwest Passage and to evaluate the sensitivity of its ecosystems to a changing climate. Our research program includes the collection of ship-based, moored, and community-led physical, geochemical and biological oceanographic observations with three core goals:

- i) To establish a baseline of year-round physical, biological and geochemical oceanographic information.
- ii) To develop the oceanographic understanding necessary to assess the impacts of climate change on Kitikmeot marine ecosystem processes.
- iii) To provide data and information to modellers and char fishery researchers, and assessments of environmental impacts.

Collaboration with local Traditional Knowledge Holders is a central component of this research and community organizations in Kugluktuk and Gjoa Haven, NU, have been engaged throughout, and are actively involved in our research program. As we have an overall goal of understanding the structure and function of the region's ecosystem, this research will provide the Nunavut Research Institute (NRI) and the Canadian High Arctic Research Station (CHARS) with a scientific basis for long-term ecological ocean monitoring and research.

**Key messages:** Concise, plain language summary of key take-away messages of work to date, findings and conclusions. Preferably 3-5 points, in bullet form.

1. The shallow sills of Dolphin and Union Strait and Victoria Strait restrict the inflow nutrient-rich, salty Pacific-origin water to the Kitikmeot Sea. Nutrient levels inside the Kitikmeot Sea are approximately half that of outside the Kitikmeot Sea.
2. Sunlight and nutrients are needed for phytoplankton to grow. In the Kitikmeot Sea, river inflow from large mainland watersheds, together with sea-ice melt, keeps the nutrient-rich salty water away from the surface, and so also away from the sunlight, leading to low biological production.
3. There is significant tidal mixing in the region which is focussed in straits and narrow passageways. These straits are locations where the tides mix nutrients towards the surface and are likely places of higher biological production.
4. We have found surprising amounts of kelp in the tidal straits in the region, and are progressively mapping its locations.

**Objectives:** Project objectives, preferably in bullet form.

We aim to develop an oceanographic understanding and conceptual model of the Kitikmeot Sea to characterize and quantify the factors that constrain marine ecosystem function and their sensitivity to ongoing climate change. K3S seeks to:

- i) develop a baseline oceanographic understanding and conceptual model of the Kitikmeot Sea that characterizes, and quantifies, the physical and geochemical factors that constrain marine ecosystem structure and function and their sensitivity to climate change, including cascading impacts on primary producers through to resident char and seal populations important to local subsistence fisheries.
- ii) characterize controls on ocean mixing and stratification across the region, including rivers, tides, wind and sea-ice, and their impact on nutrient distributions, phytoplankton, zooplankton, benthic invertebrates, and fish.
- iii) evaluate the importance of narrow straits as biological hotspots due to tidal mixing.
- iv) characterize the physical, geochemical, and biological impacts of the riverine freshwater flux to the coastal region, including the importance of terrestrially-sourced nutrients;
- v) provide data and oceanographic context to on-going char fishery research and modelling efforts to better predict the responses of the Kitikmeot Sea to a changing climate

**Annual activities:** A description of activities and methods carried out during the current reporting period. This section should answer the questions: What? Where? When? Who? How? Include dates team members conducted research at remote field sites or collected data (including interviews) in communities; append a map with locations and/or coordinates of remote field sites, if applicable.

Our ship-based oceanographic programs took place between 5 August 2024 and 30 September 2024, aboard the CCGS Louis S. St. Laurent and RV Martin Bergmann. Activities included:

Ship-based Oceanographic Sampling, CCGS Louis S. St. Laurent (LSSL): We carried out mooring recovery/deployment and water sampling activities across the Kitikmeot region, including: the Finlayson Islands, Coronation Gulf, Queen Maud Gulf, and Victoria Strait. Observational activities aboard the CCGS LSSL included: a) recovery and re-deployment of long-term moorings; and, b) measurement of physical and geochemical properties of seawater via electronic instruments deployed from the ship and via water sample collection. As described in our original permit, mooring instrumentation will be mounted on recoverable sub-surface moorings that reach from the bottom to within 15m of the surface. Pairs of moorings include sensors for measuring currents and ice thickness and sensors measuring temperature and salinity and optically observed biological parameters (fluorescence, light intensity, turbidity, etc).

Ship-based Oceanographic Sampling, R/V Martin Bergmann (MB): Our 2024 program aboard the RV MB focused on water column and benthic sampling activities in the vicinity of Sherman Inlet and Sherman Basin. Observations included: a) measurement of physical and geochemical properties of seawater via electronic instruments and via water sample collection; (b) sampling zooplankton; (c) sampling of bottom sediment and benthic organisms; (d) underwater camera recordings and photos of the benthic sea life; and (e) river-to-ocean transects from the Kaleet River into Sherman Basin using a small aluminum skiff. We also deployed two tilt-current meter moorings in the narrow channels between islands outside of Sherman Inlet, these systems will measure the current direction and bottom water temperature over the year and be recovered in 2025. As in 2023, the 2024 sampling program aboard the RV MB was informed by Youth and Elders in Gjoa Haven through community meetings in Winter & Spring 2024.

Our Community-Based Oceanographic Sampling program was carried out year-round. As in previous years, we worked closely with the Kugluktuk Hunters and Trappers Organization and the Canadian Rangers Ocean Watch (CROW) program to collect physical and geochemical observations from the freshwaters of the Coppermine River into the marine waters of Coronation Gulf. This past year, CTD and water sampling transects were completed in January, February, March, May, and December. This sampling program has contributed to training three community members to collect water samples and deploy instruments from small local boats (summer) and from the sea ice (winter). Wintertime transects were conducted by snow machine and summertime transects were conducted by small boat. This program is overseen by the Kugluktuk Hunters and Trappers Organization.

We anticipate continuing our community-based oceanographic sampling activities and ship-based oceanographic activities aboard the CCGS Sir Wilfrid Laurier again in 2025 (as detailed in the Appendix). As our program covers the entire year, we request that our research license allow sample collection activities in the above-mentioned regions from January 2025 to December 2025.

**Results and Achievements:** Findings and results to date of the above activities, highlighting any key research achievements (see guide below for formatting tips regarding tables and figures).

Please see these 3 papers, upon which the Key Messages are based:

For the general oceanography of the Kitikmeot Sea:

William J. Williams, Kristina A. Brown, Lina M. Rotermund, Bodil A. Bluhm, Seth L. Danielson, Michael Dempsey, Fiona A. McLaughlin, Svein Vagle, Eddy C. Carmack; Processes in the Kitikmeot Sea estuary constraining marine life. *Elementa: Science of the Anthropocene* 3 January 2025; 13 (1): 00031. doi: <https://doi.org/10.1525/elementa.2024.00031>

Tidal propagation in the Kitikmeot Sea:

Rotermund, L. M., Williams, W. J., Klymak, J. M., Wu, Y., Scharien, R. K., & Haas, C. (2021). The effect of sea ice on tidal propagation in the Kitikmeot Sea, Canadian Arctic Archipelago. *Journal of Geophysical Research: Oceans*, 126(5), e2020JC016786. <https://doi.org/10.1029/2020JC016786>

Kelp distribution in the Kitikmeot Sea:

Bluhm, B. A., Brown, K., Rotermund, L., Williams, W., Danielson, S., & Carmack, E. C. (2022). New distribution records of kelp in the Kitikmeot Region, Northwest Passage, Canada, fill a pan-Arctic gap. *Polar Biology*, 45(4), 719-736. <https://doi.org/10.1007/s00300-022-03007-6>

**Challenges/Obstacles:** In this section, please comment on any challenges/obstacles (if any) that you experienced during this project year. If there were any actions to mitigate or resolve these challenges, please list them here. Were any concerns raised regarding the conduct of research team members or the impacts of the project?

Our Kitikmeot mooring operations proposed for 2024 were originally set to take place aboard the CCGS Sir Wilfrid Laurier, however an unexpected extended dry-dock kept the vessel out of the Canadian Arctic in 2024. Through accommodations by the CCGS, we were instead able to perform proposed mooring recovery and re-deployment activities aboard the CCGS Louis S. St. Laurent. This allowed all proposed activities to continue as planned (as detailed above). We anticipate continuing our mooring program aboard the CCGS Sir Wilfrid Laurier for operations in 2025.

**Expected Project Completion Date:** Provide month and year of expected completion date of the project.

Ongoing

**Project website (if applicable):** If your project has a presence on the internet, including a website and/or social media page, please provide the link and/or account handle.

N/A

**Citations:** Please append a complete reference list if citations are used anywhere in the document.

#### **POLICY RELEVANCE**

Does this research support policy development or decision-making in Nunavut? If yes, please describe.

The Kitikmeot Sea is currently inadequately studied to make long-term assessments of the impacts of development in the region. Prior to K3S, oceanographic data from the region was largely limited to opportunistic sampling from transiting icebreakers and community-based efforts such as the Canadian Rangers Ocean Watch. By positioning the RV Martin Bergmann in Cambridge Bay, the Arctic Research Foundation provided, for the first time, cost-effective logistics to support interdisciplinary oceanographic programs in the Kitikmeot, enabling new, ecosystem-based information via K3S. Our ship-based (spatial) and mooring (temporal) observations provide critical data to characterize the seasonal and inter-annual cycles of the Kitikmeot Sea. These observations will be used to understand how climate change drives increased variability and change in the physical, geochemical and biological system. Observations collected as part of K3S support DFO ocean modelling activities (Dr. Steiner and Dr. Wu) and Arctic char fishery research (Dr. Harris), and have enhanced DFO's ability to predict the consequences of climate change and improve plans for sustainability of northern marine resources.

## RESEARCH OUTCOMES: BENEFITS

**Community engagement:** Briefly list and describe any community consultation, engagement, collaboration and outreach activities that you have undertaken for the project; describe the role(s) that community members and/or specific organizations have played in research co-design and activities.

Activities carried out aboard the RV Martin Bergmann in 2024 were co-designed with the community of Gjoa Haven.

Spring Community Meetings (February 6-7, 2024): On February 7th, 2024, Bill Williams and Kristina Brown presented the results from the 2023 field program aboard the RV Martin Bergmann to community members in Gjoa Haven, about 35 people were in attendance, including 14 Elders who were given honoraria for their insights and participation. The Arctic Research Foundation was instrumental in facilitating and supporting this meeting.

Youth and Elder discussions focused on similar themes as previous meetings, including:

- concerns with environmental change, sea water temperature, currents, sea ice
- youth noted that the Elders say Sherman Basin is "special" and was their homeland,
  - o what makes it special?
  - o why are the seals so big and the fish so healthy?
  - o why are there so many caribou and muskoxen?
  - o is this going to change?

After a request from community members to learn more about currents in the region, a special meeting of an Elders (5) and youth committee was convened by the Arctic Research Foundation on April 6th, to review a proposal to deploy tilt current meter moorings in the narrow straits between islands around Sherman Inlet. The committee approved the proposal for two tilt current meter moorings to be deployed in 2024 and recovered in 2025.

Community-based oceanographic sampling activities in Kugluktuk are coordinated and carried out by community samplers from the Kugluktuk Hunters and Trappers Organization, in collaboration with the Canadian Rangers Ocean Watch (CROW) program.

**Youth engagement:** Briefly list and describe any outreach, school or classroom activities that you have undertaken for the project; describe the role(s) that youth have played in your research activities.

Activities carried out aboard the RV Martin Bergmann in 2024 were co-designed with the community of Gjoa Haven. Two youth from the community (Barbara Porter and Gibson Porter) have been leading collaborative activities within the community, liaising between the science team and community members.

Spring Community Meetings (February 6-7, 2024): On February 6th, 2024, project team members Barbara Porter and Gibson Porter organized and led a workshop with six (6) other youth from the community of Gjoa Haven to discuss and further develop the research questions to be investigated by the ship-based program on the RV Martin Bergmann in August 2024. Bill Williams and Kristina Brown summarized results from the 2023 field program and fielded questions from the youth about the ocean ecosystem.

The two youth co-leads (Barbara Porter and Gibson Porter) were also able to attend the ArcticNet Annual Science Meeting in Ottawa in December 2024 to learn more about other research activities being carried out throughout Nunavut. Funding for their participation came from ArcticNet and National Geographic.

**Training and Employment:**

How many Nunavummiut received training from team members? Please describe training and/or compensation provided.

Four (4) Nunavummiut were directly trained through this research program. Training included CTD deployment and water sampling onboard the RV Martin Bergmann (1 youth participant) and during community based monitoring activities in Kugluktuk (3 employed samplers).

How many team members received training from Nunavummiut? Please describe training received and/or what knowledge sharing and/or skills exchange took place.

All of the science team! Our team has learned so much from our Nunavummiut partners. Specifically, Kristina Brown and Bill Williams co-developed the sampling program aboard the RV Martin Bergmann with youth and Elders from Gjoa Haven. Youth from Gjoa Haven (Barbara Porter) joined the RV Martin Bergmann cruise this summer and supported K3S Science team members (4 people) as well as the RV Bergmann crew (4 people) in better understanding the importance of Sherman Inlet and Sherman Basin to the community of Gjoa Haven.

How many Nunavummiut received employment? Please describe employment type and length, role(s) and responsibilities, and compensation provided.

Five (5) Nunavummiut are directly employed through this research. One of the youth co-leads from Gjoa Haven was hired to participate on the RV Bergmann cruise in August, 2024. A translator was also hired to translate during community meetings in Gjoa Haven in February and April, 2024. Three samplers are employed in Kugluktuk to carry out sampling, they are employed year-round through the Kugluktuk Hunters and Trappers Organization and complete sampling activities over 3-day intervals, 5 to 6 times per year.

How many Nunavummiut received honoraria as research participants? Please describe method of participation (interview, observation, sample, survey, etc.), including compensation provided.

As well, two youth in Gjoa Haven receive honoraria for their contributions to co-developing the research program on the RV Martin Bergmann and for organizing community meetings in Gjoa Haven. Honoraria was provided to six (6) youth participants for their contributions to co-developing the science program for the RV Martin Bergmann in a youth-focused community meeting in Gjoa Haven (Feb 6, 2024); fourteen (14) Elders were provided with honoraria for their participation in community meetings and discussions to co-develop the 2024 RV Martin Bergmann program (Feb 7, 2024); and five (5) Elders were given honoraria for the follow-up community meeting to seek their approval and guidance for the deployment of two tilt-current meter moorings (April 6, 2024).



Please explain how the project directly benefited Nunavut organizations and/or businesses (e.g., through contract services, local purchases, equipment donations, etc.)

Community organizations who were contracted with for the use of facilities, accommodations, or to oversee community based monitoring activities in 2024 included: Kugluktuk Hunters and Trappers Organization, Gjoa Haven Hamlet, Betty Kogvik (translation services), Gjoa Have Co-op & Northern Store (community meeting food & beverages), CAP Contracting in Gjoa Haven and Coppermine Inn in Kugluktuk (accommodations).

**OPTIONAL: Nunavut Team Members, hires, and/or trainees (excluding research participants e.g., interviewees)**

*The NRI is creating an inventory of Nunavummiut who are skilled and/or interested in research. The information provided below will not be shared publicly but will support long-term capacity sharing by connecting local and visiting researchers with research talent in each community.*

Name	Expertise/skills	Training/interest areas	Contact Info	Community

**Academic Mobility**

If you are affiliated with an academic institution, please answer the following question: For which Level of Project(s) will the data be used? (Check all that may apply)

- ☒ Research
- ☒ Post-Doctoral Research
- ☒ PhD Thesis
- ☐ Masters (Major Research Paper)
- ☒ Masters (Thesis)
- ☐ Graduate Course Project
- ☒ Staff/Administration Research
- ☒ Undergraduate Honours Thesis

Other



## BUDGET

Please complete the table below to detail your projected and actual research expenditures during the reporting period.

Category	Planned/Approved Expenditure	Actual Expenditure
Travel and Accommodation		64,000
Equipment, Materials and Supplies		15,000
Salaries/Wages for Nunavut residents		17,078
Salaries/Wages for non-Nunavut resident researchers		
Professional Fees and services in Nunavut		200
Professional Fees and Services outside of Nunavut		
<b>TOTAL EXPENDITURES</b>		*note

\*Note: Here and below we have included only the budget for the field portion of the program, including technician salaries. Non-Nunavut resident researcher salaries (DFO, UM) have not been included.

List the total \$ amount of funding from each funding source for your full research program, including in-kind support

Fisheries and Oceans Canada, 2024 CASH = \$105,000  
Fisheries and Oceans Canada, 2024 In Kind = \$30,000  
Canadian Coast Guard, 2024 In Kind = \$80,000  
Polar Knowledge Canada, 2024 In Kind = \$11,800  
National Geographic Explorer Fund, 2024 CASH = \$84,000  
ArcticNet, 2024 CASH = \$10,000 (ArcticNet ASM participation for youth)

## RESEARCH OUTPUTS / REPORTING TOOLS

What research outputs were generated? Please list below and append copies of each. Specify which outputs (if any) may be made public on the NRI research licensing database.

Williams, WJ, et al. 2025. Processes in the Kitikmeot Sea estuary constraining marine life. Elem Sci Anth, 13: 1. DOI: <https://doi.org/10.1525/elementa.2024.00031>

Have peer-reviewed manuscripts been published as a result of your project? If Yes,  
complete the following table:

Full citation	Publicly accessible/ free to access (Y/N)	Link (if available) and DOI (if available)
Williams, W.J., K. A. Brown, L.M. Rotermund, B.A. Bluhm, S. L. Danielson, M. Dempsey, F. A. McLaughlin, S. Vagle, and E.C.	Y	<a href="https://doi.org/10.1525/elementa.2024.00031">https://doi.org/ 10.1525/elementa.2024.00031</a>

If No, do you intend to submit a manuscript (or manuscripts) for peer reviewed publication?

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Were non-peer reviewed materials produced to either communicate or synthesize results to the public? Examples of these materials include (but are not limited to): websites, reports, brochures, podcasts, webinars, presentations, non-peer reviewed publications, etc.

If Yes, complete the following table:

Title	Description of Materials	Link (if available)	DOI (if available)
Adventures on small(er) boats: Insights from the Kitikmeot Sea S	DFO seminar presentation (K.Brown)		
Processes in the Kitikmeot Sea estuary constraining marine life	Poster presentation at Arctic Change 2024 (B. Williams)		

Did your project develop a communications plan? Please describe communications/reporting tools used, and list the target audience for each and/or who requested which.

N/A

How were Nunavummiut credited and/or acknowledged in all project outputs, such as co-authorship, participant biographies, article acknowledgements, etc.

Co-authorship & Acknowledgment on presentations; Acknowledgment in published materials. Future publication of our research program in Sherman Inlet and Sherman Basin will include youth co-leads of the program as co-authors, and will include Elders and Youth from Gjoa Haven in the results interpretation process.

## DATA AND INTELLECTUAL PROPERTY

Did you enter into a research agreement, data-sharing agreement and/or intellectual property rights agreement with a community and/or designated Inuit organization (DIO)? If yes, please explain.

Do intellectual property rights apply to your research? If yes, please explain.

Who owns the data? Has the raw data been shared with the appropriate community and/or DIO? If yes, how? How is data security and storage handled by community-based co-owners?

Observations collected and data generated from this research is owned by the Federal Government of Canada, and is publicly available upon request, or as described below.

Where is the data stored and will the data be destroyed within a set timeframe?

- Raw instrument data will be stored and processed data will be placed in the DFO-IOs Ocean Science Division data archive
- Physical samples (e.g., zooplankton, water samples) that are not analyzed in-house will be stored at the Institute of Ocean Sciences until analysis at off-site labs is possible
- Biological data will be archived at the Norwegian Marine Data Center (<https://dataverse.no/dataverse/uit>).
- Benthic biological samples will be stored in archives at UiT, Norway

Is the data trackable and/or available in a public data repository? If yes, please provide the appropriate information and/or link to ensure the findability and accessibility of the data.

Physical and geochemical data are available from Fisheries and Oceans Canada's Marine Environmental Data Section Archive (<https://meds-sdmm.dfo-mpo.gc.ca>) by request at: <https://isdmm.gc.ca/isdmm-gdsi/request-commande/form-eng.asp>

Please append a copy of your data management plan.

## **CLIMATE CHANGE**

Is your research about climate change (causes, impacts, mitigation, adaptation, etc.)? If yes, explain.

Our research uses a suite of oceanographic tools and year-round moorings to investigate the oceanography of the Kitikmeot Sea, including the flow of river water to the sea, and the tidally influenced narrow straits. Our primary objective is to develop a baseline oceanographic understanding and conceptual model of the Kitikmeot Sea that characterizes, and quantifies, the physical and geochemical factors that constrain marine ecosystem structure and function and their sensitivity to climate change, including cascading impacts on primary producers through to resident char and seal populations important to local subsistence fisheries. Observations gathered as a part of this research will be used to understand how climate change drives increased variability and change in the physical, geochemical and biological system, in particular supporting DFO ocean modeling activities and Arctic char fishery research. Overall results from this study will better position DFO to predict the consequences of climate change and improve plans for sustainability of northern marine resources.

## PHOTOGRAPHS

*If possible, please provide high-resolution photos of licensed research activities that NRI may use in communication materials, organizational reporting, and other promotional purposes. The photographer and all recognizable people in each photo must sign the attached Photo and Video Release form. Please also complete the table below for each photo provided and submit to NRI along with all required NRI photo release forms. The photographer/owner will be credited in all uses of the photograph(s).*

File Name	Location	Description	Subjects	Photographer/Owner	Date

Would you like your project to be considered for a research profile and promotion by the NRI? **Yes**

## **FORMATTING TIPS**

### ***Main text:***

Please supply report in a standard manuscript format (**Microsoft Word format is required**).

### ***Tables:***

Any number of tables can appear in one file (as long as they are clearly marked). Tables prepared using simple table formats as provided in word processing programs such as WordPerfect are preferred. Each table should be numbered according to its appearance in the text (e.g., Table 1, Table 2) and each should have a brief descriptive heading.

### ***Figures:***

Each figure or graphic element should be submitted as a separate file. Black & white and colour graphics are both acceptable. We can accommodate most standard graphic file formats, however, please indicate in which format the graphic was prepared.

### ***References:***

Please use the APA or MLA Citation Style while referencing throughout the report.

### ***Size:***

The size of the electronic document must not exceed 4MB (if larger than 4MB, please send attachments separately and number the emails).