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ᐅᓂᕐᕈᑦ: Evolutionary history of Arctic species and geological history of the High Arctic Love Dalén – Stockholm University This application concerns the land research activities of the North Green Earth Ocean Ecosystem Observatory (GEOEO) expedition endorsed by the Swedish Polar Research Secretariat (SPRS). The main goal is to study prehistoric changes in Greenland, but depending on sea-ice conditions, some activities might be needed in Canada. The Arctic has a complex history of species colonization and extinction. We hope to uncover more of this history, such as the arrival and disappearance of muskox, and how climate changes affected marine ecosystems. One aspect of the project will use a palaeogenomic approach, where DNA from ancient materials is analyzed to explore ecosystem changes in marine and terrestrial environments. We will mainly focus on DNA from sediments, especially from lake bottoms, as well as ancient and recent plant and animals remains (bones and teeth). The objective is to investigate the biogeography and evolutionary history of the muskox and other wild animals. This will enable us to assess the genetic variation and structure in comparison with populations from other parts of Greenland as well as northern Canada, such as earlier work on muskox we have been involved in (Pečnerová et al. 2024, Molecular Ecology). This type of study provides insights on how an animal population can survive population threats such as small population sizes and low genetic diversity. Such knowledge can help improve predictions of how ecosystems might change in the future and allow for proactive management strategies. Sampling lake sediment cores will be done using a custom-built raft and Nesje coring system. Initial DNA analyses will be done onboard Oden, with more in depth DNA sequencing done after the end of the expedition at the Centre for Palaeogenetics in Stockholm. Initial DNA analyses will be done onboard Oden, with more in depth DNA sequencing done after the end of the expedition at the Centre for Palaeogenetics in Stockholm. Another objective of our study is to create a database of high-resolution sensitive proxies using driftwood and shrub samples, and to use this data to provide a novel field reconstruction of temperature for the northernmost land latitudes. We plan to use driftwood samples, as well as deciduous and evergreen Arctic tundra dwarf shrub species samples to evaluate annual growth. This will allow us to determine plants growth rate as well as the impact of anomalously high summer temperatures on growth. By doing this, we aim to provide new and accurate data on how temperatures have fluctuated over many years in the Arctic, helping us better understand climate patterns and their impacts on these sensitive regions. In a context of climate change, such information is essential to implement effective management strategies. Another part of the project focuses on long-term geological history. The region has a unique and undisturbed Proterozoic-Paleozoic section of the so-called passive margin of the palaeocontinent Laurentia (proto-northern America), which we aim to study to understand how continental margins form. We will collect sedimentary and metamorphic rocks from this northern region, sampling loose rocks to minimize landscape disturbance. We will use various analytical techniques, including light microscopy and mass spectrometry, to analyze these rocks and create a crust-mantle model of the region. Sampling locations will depend on the icebreaker Oden's route and weather conditions. All activities will be carried on the northern tip of Ellesmere Island, using the icebreaker Oden as our base, with short helicopter trips to the terrestrial sites. Various trips (up to 15) could be taken between August 1, 2024, and September 30, 2024, depending on sea-ice conditions and Oden's route, and will involve up to 10 of the researchers onboard Oden. There will be no overnight stays and no camp will be established. The nearest community of Grise Fjord is approximately 500km from the suggested field sites; therefore, no community should be affected by our activities. We will avoid sensitive areas such as the Quttinirpaaq National Park and designated polar bear denning areas. However, we anticipate that there will naturally be a broad general interest for the expedition, and we should provide entertaining and factual information, when possible, made available online to the general public. We feel that the best format for this is a blog, where we can provide sufficient information in short (three or four paragraphs)but frequent posts that we upload at least several times per week. The blog will cover specific occurrences and conditions that will be of interest and relevance to Nunavut communities. Other types of social media such as X (previously Twitter) and Facebook will also be used. Results and progress will also be shared with all regulatory agencies in Nunavut.

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Operations Phase: from 2024-08-01 to 2024-09-30

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| ᐃᕐᓂᐃᕐᓂ | Government of Nunavut - Department of Culture and Heritage - Archaeology and Paleontology Research Permit, Class II | Not Yet Applied | | |

Project transportation types





| Transportation Type | ᑕᐃᕐᓂᕐᓂ ᐱᕐᓂᐃᕐᓂ ᐃᕐᓂᐃᕐᓂᐃᕐᓂ | Length of Use |
|---------------------|---------------------------------|---------------|
| Air | helicopter | |
| Water | modified raft for lake sampling | |
| Land | on foot | |

Project accomodation types

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| Chainsaw | 1 | 2 cubic meters | Will be used to cut up disk samples of driftwood |
| Coring raft | 1 | 10 x 10 m | Used for lake sediment coring, consist of 2 zodiac boats, a platform, a tripod, a winch system, and a Nesje coring system (6m x 10cm rod) |

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The environmental impacts of the proposed project, which involves collecting small samples of rocks, shrubs, driftwood, sediments, and animal remains (no live animal captures or sampling), are expected to be minimal due to the non-invasive nature of the activities. However, potential impacts could include minor disturbances to the local ecosystem and wildlife habitats, particularly through human presence and movement within the area. To mitigate these potential impacts, we will avoid sensitive areas, specifically the Quttinirpaaq National Park and designated polar bear denning areas, to minimize disturbances to protected habitats and species. The field teams will operate with a minimal physical footprint, ensuring that collection activities are discreet and do not disturb the surrounding environment. All sampling sites will be restored to their original state post-collection. Any generated waste will be carried out of the field.

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

SECTION H2: Disposal At Sea

SECTION I1: Municipal Development

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The project area is adjacent to Quttinirpaq National Park, a significant protected area. No activity will be carried in the National Park. The region may include sites of cultural and historical importance, which will be respected and avoided. Sensitive areas such as polar bear denning areas are present south of the study area and will also be avoided to prevent disturbance. While remote, the area might be occasionally used for scientific and limited recreational activities; sport and commercial fishing areas are generally absent in this remote Arctic region, but any known areas will be noted and avoided. Certain locations might serve as breeding or nursery grounds for Arctic fauna, including birds and marine mammals. If detected, these areas will be avoided. The area lies within the range of the Peary caribou. All measures will be taken to avoid disturbance. Eskers and other glacial formations are prominent and won't be disturbed. The region shows some evidence of minor ground, slope, or rock instability, typical of Arctic terrains. Thermokarsts and ice lenses are present, indicative of the dynamic permafrost conditions in the region. The geology includes diverse surface formations and exposed bedrock. The topography is varied, with mountainous areas, plateaus, and low-lying tundra. Permafrost is extensive, with varying stability, depth, and continuity, influencing soil and landscape processes. Soils are typically thin and nutrient-poor, with unique sediment compositions resulting from glacial and post-glacial processes. The region features several watersheds, lakes, streams, and related hydrological features, important for local biodiversity and ecosystem function. Coastal areas exhibit tidal processes, with varying bathymetry supporting different marine habitats. Freshwater resources are generally pristine, but sensitive to contamination due to the fragile Arctic environment. Air quality is typically high, given the remote location, though sensitive to changes from external pollution sources. The region experiences extreme Arctic climate conditions, with long, harsh winters and short, cool summers. Predicted future climate trends indicate potential for significant environmental changes. Noise levels are minimal due to the remote and undeveloped nature of the area.

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The vegetation in the project area is typical of High Arctic tundra ecosystems, characterized by specialized plant communities. Terrestrial vegetation includes hardy species such as Arctic willows, mosses, lichens, and small flowering plants adapted to the harsh climate. Freshwater vegetation in lakes and streams includes algae and submerged aquatic plants, while marine vegetation, where applicable, includes seaweeds and marine algae. Wildlife in the area is adapted to extreme Arctic conditions. Key terrestrial mammals include Peary caribou, Arctic hares, Polar bears, Arctic foxes, and muskox. Migration patterns for the Peary caribou involve seasonal movements between winter feeding grounds with less snow and summer ranges with abundant vegetation. Bird species in the region include migratory and resident birds adapted to the Arctic environment. Notable species include the snowy owl, Arctic tern, and various species of seabirds such as kittiwakes and guillemots. These birds utilize the region for breeding and feeding during the summer months, with many migrating to lower latitudes during the harsh winter. Some species in the region are listed under the Species at Risk Act (SARA), including the Peary caribou and polar bear. Peary caribou are listed as endangered, with critical habitats identified to ensure their protection. Polar bears, listed as a

species of special concern, are known to use the coastal areas and sea ice for hunting and denning. Aquatic life in the region's freshwater systems includes Arctic char, which is a crucial species for both ecological balance and local subsistence fishing. These fish have specific spawning and migration patterns, typically moving between freshwater and marine environments. Marine species include various fish and invertebrates, which form the basis of the Arctic marine food web.

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The project area is extremely remote, with no nearby permanent settlements. The nearest community, Grise Fiord, is approximately 500 km away on the southern coast of Ellesmere Island. Due to this distance, direct interactions with local communities are minimal, but the broader environmental stewardship and subsistence activities in the region are still relevant. Even in remote areas, there could be archaeological and culturally significant sites, such as ancient hunting camps or temporary shelters used by Inuit during their historical migrations. The surface and bedrock geology of the area may include important palaeontological sites with fossils that offer insights into the ancient environments and climatic conditions of the High Arctic. While, to our knowledge, no current subsistence activities take place directly in the study area due to its remoteness, understanding the broader patterns of subsistence harvesting in the High Arctic is essential. Communities like Grise Fiord rely on hunting, fishing, and gathering in regions where access is feasible. Tourism in the High Arctic is limited but includes eco-tourism and adventure tourism, focusing on the unique landscapes and wildlife. The study area may be of interest to scientific expeditions and specialized tourism. Local residents may engage in guiding operations, particularly for scientific or adventurous expeditions visiting remote parts of the High Arctic. Traffic patterns in the region are sparse and consist mainly of small aircraft, boats, and snowmobiles, used primarily for scientific research and occasional tourism. The remoteness of the study area means that it experiences minimal traffic. Human health in the broader region includes considerations of physical, social, psychological, and spiritual well-being, particularly for the Inuit communities. These aspects are closely tied to the environment, traditional lifestyles, and access to natural resources. The preservation of traditional knowledge and practices is vital, even in areas not directly used by local communities.

Miscellaneous Project Information

See attached documents

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The project involves collecting small samples of rocks, shrubs, driftwood, sediments, and animal remains. This activity may cause minor disturbances to vegetation and soil. Mitigation measures include avoiding sensitive areas and minimizing the footprint of the sampling activities. Any waste produced during fieldwork could negatively impact the pristine environment. Leave no trace principles will be strictly followed, with all waste carried out of the field. The project aims to improve understanding of the High Arctic environment, providing positive benefits through enhanced scientific knowledge. Data will be shared with local communities to support regional planning and conservation efforts. Direct impact on human health should be minimal due to the remote location. However, the project will respect and consider the overall well-being of local communities, including any indirect effects through environmental changes. The project will respect culturally significant sites and involve local communities in identifying areas of concern to protect cultural heritage. The remote location and the nature of the project activities mean that transboundary effects are unlikely. The project is small-scale and localized, with minimal potential for broader environmental impacts extending beyond the immediate area. Listed as endangered under the SARA, Peary caribou are present in the region. The project will avoid critical habitats and minimize disturbance through careful planning and scheduling. Listed as a species of special concern, polar bears use coastal areas and sea ice for hunting and denning. The project will avoid known denning areas and minimize human presence in key habitats. Specific measures include scheduling fieldwork outside sensitive periods, avoiding critical habitats, and consulting with wildlife experts to ensure minimal impact. Monitoring will involve regular assessments of wildlife presence and behavior, with adjustments made as necessary. Critical habitats, denning areas, and culturally significant sites will be mapped and avoided. Strict leave no trace principles will be followed, ensuring all waste is removed from the field and properly disposed of. Ongoing consultation with local communities will ensure that their concerns are addressed, and traditional knowledge is integrated into project planning and execution. Regular monitoring of environmental conditions and wildlife will be conducted, with adaptive management practices implemented to mitigate unforeseen impacts.

Cumulative Effects

In the High Arctic region near Quttinirpaaq National Park, the project's activities, like sample collection, may cause minor disturbances to vegetation and wildlife habitats. These impacts interact with past and ongoing research efforts, potentially cumulatively affecting soil integrity, wildlife behavior, and local ecosystems over time. Coordination among projects, strict adherence to minimalistic practices, and robust environmental monitoring are essential to mitigate these cumulative impacts. Engaging stakeholders will also be vital in ensuring the sustainability of the Arctic environment.

Impacts

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List of Project Geometries

| | | |
|---|----------|---------------------------|
| 1 | polyline | Northern tip of Ellesmere |
| 2 | polyline | Coast of Ellesmere |