Long-term Ecological Monitoring Program: Executive Summary

It is well established that temperatures in the Arctic have risen at almost twice the rate of temperatures elsewhere. However, studying the effects of climate change on wildlife is challenging; unlike physical processes that generally respond to increased temperature in predictable ways (e.g., permafrost, glacial erosion and oceanic winds, tides and densities), animals can respond in surprising ways, and assessing environmental change that results from natural and anthropogenic drivers in ecosystems that are inherently variable exacerbates these challenges.

Ecosystem change is expected to be significant and ongoing. Shifts in the distribution and demography of tundra-breeding wildlife, such as barren-ground caribou, are expected to occur with climate-induced increases in vegetation growth and range expansion, potentially benefitting species associated with shrub-dominated habitats, and harming species more reliant on tundra habitat, through climate-induced habitat loss. Similarly, pathogens and parasites currently excluded from the Arctic are expected to become established through range expansion and warming. Novel relationships among hosts and parasites can increase the prevalence of infectious diseases, increase host morbidity and mortality, and have cascading impacts on food webs and ecosystem functioning. Similarly, over the long-term, the frequency of extreme weather events, outside of historical range in variation, is likely (e.g., rain on snow, summer storms, temperature highs and lows, snow cover and depth). The ecological consequences of these events include changes to food webs and timing of key ecological relationships, shifts in species distribution and community composition, and changes in demography.

To address two primary concerns (documenting long-term changes associated with climate change, and documenting baseline conditions in a region of high interest for economic development, the Government of Nunavut, Department of Environment (DOE) established the Long-Term Ecological Monitoring Program (LTEMP) in 2012. The goal of the program is to undertake annual monitoring at spatial and temporal scales relevant to monitoring ecosystem components within the Kivalliq region. Within the calving grounds of the Qamanirjuaq herd, extensive monitoring has been conducted periodically at 16 permanent locations since 2012, and starting in 2019, intensive annual monitoring was initiated near the community of Rankin Inlet. The intensive monitoring near Rankin Inlet incorporates multiple ecosystem components across three trophic levels (primary producers to tertiary consumers), while the extensive monitoring in the summer range of the Qamanirjuaq herd focuses on vegetation and pellet counts.

To address research and staffing capacity issues associated with the LTEMP, and to ensure the continuity of the project, the DOE decided to collaborate with academic partners. A Memorandum of Understanding with the University of Alberta, Department of Biological Sciences, and Dr. Alastair Franke was developed to facilitate the partnering of academic researchers with Government of Nunavut-led research projects, such as LTEMP. The main purpose of the LTEMP is to maintain a long-term (i.e., decades), field-based study to monitor ecosystem changes and incorporate the results into wildlife management practices. Specifically, this involves site-specific, standardized data collection for terrestrial (scat counts, bird surveys, small mammal surveys, invertebrate sampling, and vegetation surveys) and physical (temperature, precipitation, land cover) ecosystem components.

Intensive research site monitoring was conducted during the summer near the community of Rankin Inlet (Figure 1) in 2019. The study area represents approximately 2500 km^2 of coastal tundra and marine habitat typical of the low Arctic, containing a diversity of wet meadows, dwarf shrubs, dry eskers, rocky ridges, tidal flats and sea cliffs. The landscape consists of low rolling hills, interspersed with ponds and lakes. Rock outcrops are common throughout the area, and are well-developed as barrier islands. Ridge tops, upland areas, and well-drained slopes support lichens, moss, and low shrubs. Dominant vascular plants are Labrador tea (*Ledum palustre*), mountain cranberry (*Vaccinium vitisidaea*), and crowberry (*Empetrum nigrum*). Bell heather (*Cassiope tetragona*) occurs in low-lying areas and rock crevices. Vegetation on most slopes and hillsides consists of heath patches comprising *Dryas integrifolia*, Carex spp., Cassiope, and lichens.

We have structured our study design to incorporate monitoring of multiple ecosystem components across three trophic levels (primary producers to tertiary consumers). Monitoring of vegetation, including a warming experiment (starting in 2020), is central to the overall study design. To monitor plant species composition, and vegetation structure, five stations each comprising four replicates (two control and two treatment) were selected based on distribution and proximity of three vegetation types, shrub, heath, and graminoid. For each replicate, three 1m X 1m point-framing-plots (PFPs) have been permanently established within uniform patches of three vegetation types (shrub, heath, and graminoid), resulting in a total of 60 PFPs (30 control and 30 treatment). To monitor plant phenology, we have established a 50-m transect to monitor three species, *Dryas integrifolia* (mountain avens), *Eriophorum vaginatum* (cottongrass), and *Salix arctica* (Arctic willow), respectively. Other ecosystem components (small mammals, arthropods, avian community, and raptors) are monitored simultaneously, along with abiotic variables associated with weather, snow-cover, freeze-up and thaw. For arthropods, one pitfall trap was placed in each vegetation type (graminoid, shrub, and heath) at each control and treatment plot (4 plots total) at each PFP site (5 sites total), for a total of 60 pitfall traps. In addition, we documented pollinator diversity using pan traps. Two small mammal trapping stations were established each comprising effort no less than 720 trap-nights per trapping session.

Extensive, short-term monitoring was also conducted within the calving grounds of the Qamanirjuaq herd (Figure 2) in the summer of 2019. Sixteen permanent sampling sites have been established along a gradient of historical intensity of use by caribou, as determined by collar data collected between 1993 and 2012. Each of the 16 sampling locations contain three vegetation plots, one each for shrub, graminoid, and heath dominated micro-environments. Vegetation sampling occurs at all plots, and can be broken down into two main categories: (i) visual estimation of percent cover, and, (ii) species presence/richness. In addition, we record species-specific pellet counts annually as an index of animal use.

Data collection, back-up and storage, and preliminary data analysis has been conducted for vegetation community sampling (n = 15 locations), carabid and spider sampling (n = 15 locations), passive songbird sampling (n = 13 locations), active songbird sampling (n = 60 locations), historical shrub growth sampling (n = 7 locations), rainfall measurements (n = 4 locations), and raptor monitoring (study site wide) for the Rankin Inlet study area. Historical data collected (i.e., prior to 2018) in the calving grounds has similarly been backed-up and stored, and basic analysis of the pellet count data (e.g., site-specific counts per species for each habitat type) has been completed.

Figures

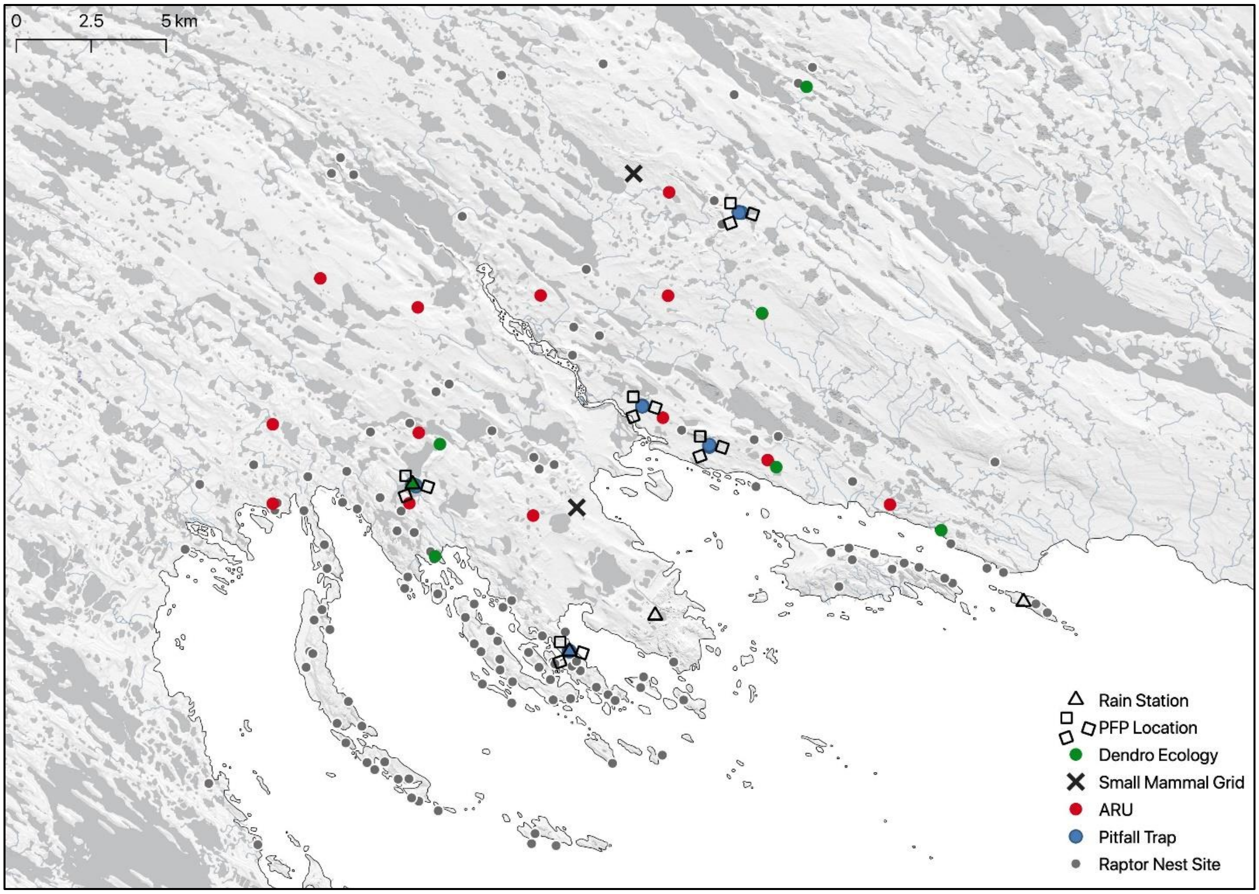

Figure 1 Sampling locations (2019 – ongoing) for rain gauges, community vegetation plots (PFP), dendro-ecology, small mammals, songbirds (ARU passive sampling), arthropods (pitfall traps), and raptors nesting sites monitored near Rankin Inlet.

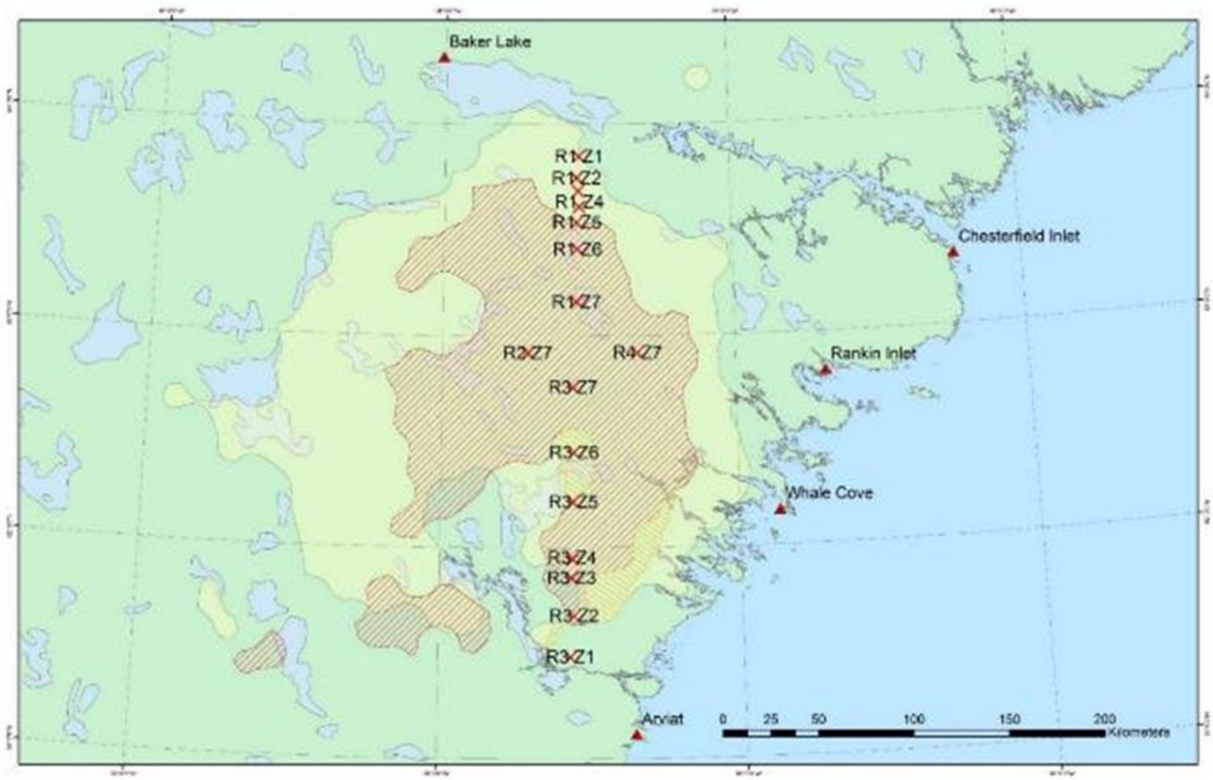

Figure 2 Four permanent site locations were established within the core, and 12 permanent sites were established extending northward (N=6) and southward (N=6) from the core calving grounds resulting in a total of 16 permanent sampling sites distributed from south to north within the Qamanirjuaq caribou herd calving grounds. The southernmost site is located approximately 260 km from the northernmost site.