Assessment of population dynamics of lesser snow geese and Ross's geese in the central Arctic, 2025-2029

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Request for Funding and Endorsement

Key words: Anderson Bay, arctic ecosystem impacts, Karrak Lake, population dynamics, productivity, Queen Maud Gulf, Ross's geese, lesser snow geese, vegetation response

17 September 2024

Amount requested for each FY 2025-2029 (USD): $60,000
Annual match provided (USD): $156,000

Problem/Issue Statement
While overabundance of lesser snow geese and Ross's geese resulted in a spring conservation order, harvest has not lowered survival or population size. Populations of both species are collapsing, requiring continued study of juvenile and adult survival, and breeding biology to understand contributions to population decline and their environmental drivers.

Arctic Goose Population Targeted
This project will focus on the midcontinent population of lesser snow geese and Ross's geese. Midcontinent snow geese and Ross's geese breed in the Arctic and subarctic, stage during migration from the Canadian prairies to Kansas, and winter in the southern US. A portion of Ross's geese winter in California. Abundance of midcontinent snow geese and Ross's geese increased rapidly from the 1980s to 2000s but since about 2010 has declined at a greater rate than the increase (USFWS 2022). The population decline is believed to be due to poor reproductive success, not declining adult survival, but patterns in these demographic rates have not been evaluated in a holistic modeling framework. Further, the environmental drivers behind poor productivity are understood for only the La Pérouse Bay/James Bay and Queen Maud Gulf subpopulations. In the Queen Maud Gulf subpopulation, poorer pre-breeding nutrition in adult females and increased mismatch between spring phenology of snowmelt and timing of nesting has resulted in lower recruitment and gosling survival (Ross et al. 2017, 2018). Estimating productivity and survival would be very useful for contextualizing the population decline.

Justification
High abundance of light geese, particularly midcontinent lesser snow geese, has led to concern about large-scale change of Arctic ecosystems (Batt 1997), and their effects on other species. A broad-based consensus among waterfowl managers and scientists emerged across North America that a reduction in midcontinent snow geese would benefit reversal of Arctic habitat change due to overgrazing. While reduced survival rate should result from increased harvest, the measure of success by management action should be a reduction in numbers of light geese, particularly of breeding adults. However, harvest increases to date appear to have had little effect on adult survival and have been insufficient to reduce adult survival or population growth rate of either Ross's geese or midcontinent lesser snow geese.

Growth rate in the population of breeding adults is a function of adult survival and production of young that reach breeding adulthood. Thus to fully understand response of Ross's geese and snow goose populations to increased harvest, all three variables (survival, recruitment, and population growth rate) should be monitored annually. Historically, Karrak Lake was the largest breeding colony of Ross's geese and midcontinent lesser snow geese in North America, with breeding numbers peaking at ~1.3 million in 2009. Since 1991, work at Karrak Lake has provided much of the foundation for understanding demography of Ross's geese and midcontinent lesser snow geese. Monitoring at Karrak Lake also provided an important independent annual estimate of population growth rate unavailable from other colonies.

Although data about the population dynamics of Ross's geese and lesser snow geese at Karrak Lake have been invaluable for understanding the ecology of these birds and informing management decisions, there are emerging challenges associated with working there. Due to COVID-19 and logistical issues, no field work at Karrak Lake was conducted during 2020-2023. Our crew completed a full field season collecting data during summer 2024 and estimated most birds nested 8-12 km north of the main research camp, requiring 2-3 hours of travel time to and from the nesting colony each day. We estimated 230,907 nesting light geese this year. Karrak Lake is a remote and thus expensive place to work, where field seasons now cost $221-295K USD annually. Meanwhile, there are several large and growing light goose colonies on the southeastern portion of Victoria Island, near Cambridge Bay. The nearest colony is at Anderson Bay, about 40 km from the town of Cambridge Bay, and this breeding colony was estimated at ~300,000 nesting birds (Baldwin et al. 2023). Another large colony of potential similar size is located further to the east of the Anderson Bay colony. There is not a robust estimate of the total number of birds comprising those colonies, but it could be 500,000+ (~12% of the current midcontinent population; Baldwin et al. 2023). Because of the low numbers of light geese at Karrak Lake and increasing numbers near Cambridge Bay, the CWS changed their light goose banding operation in 2023 to base out of Cambridge Bay instead of banding near the Karrak Lake area. I am hoping to study the population dynamics of light geese for several decades to come and am concerned about basing inferences on fewer birds nesting at Karrak Lake or potential abandonment of light geese from the colony in the years ahead, and the increased cost and complexity of conducting monitoring and research there given the distance of the nesting area from camp. With these factors in mind, I propose to move the primary research and monitoring location that focuses on population dynamics of light geese in the central Arctic from Karrak Lake to Anderson Bay, to begin in summer 2025. Additionally, this move in location will better couple nesting/breeding biology research and monitoring with ongoing, annual banding, similar to the past. I propose to collect all "core" Karrak data sets at Anderson Bay (see Objectives below). The Karrak Lake research station is owned by Environment and Climate Change Canada (ECCC). They may continue funding work at Karrak about Arctic ecology, and if so, I hope to collaborate with their scientist(s) to continue data collection about light geese (e.g., nest initiation, nest fate) and goose impacts to habitat and other species. Periodic habitat monitoring at Karrak Lake, for example every 5 years, could be useful in learning more about goose impacts on habitat, particularly under lower colony size, as in recent years. I anticipate contributing a modest amount of AGJV funds ($5-8K per year) to support a scaled-back operation at Karrak Lake, led by ECCC, and contributing a similar amount from Central Flyway Council and Mississippi Flyway Council funds.

This research proposal addresses the following 3 of 6 AGJV Focus Areas:

- Habitat degradation caused by populations of snow and Ross's geese
- Impacts of climate change and resource development on Arctic geese
- Development and improvement of population monitoring

In addition, several **high-priority** information needs from the AGJV matrix will be met:

- Population status or assessment of midcontinent snow geese
- Harvest assessment of Ross's geese
- Habitat concerns for midcontinent snow geese
- Habitat concerns for Ross's geese

Objectives/Hypotheses

This proposal seeks support during 2025–2029 to begin field work at Anderson Bay, a continuation of research and monitoring on both Ross's and snow geese in the central Arctic. We will continue monitoring nesting ecology and demographics of these populations to better understand population trajectories and important factors driving demography during continuing efforts to reduce these populations through hunter harvest. Work to date at Karrak Lake has included nesting studies for population size and recruitment estimation, and banding studies for survival estimation.

There are proportionally fewer Ross's geese believed to be nesting at Anderson Bay compared to Karrak Lake, but robust assessment of nesting densities for each of the two species will occur during the funding period to more accurately estimate these proportions. Importantly, we anticipate that annual estimates of colony size, nest initiation and fate, as well as age ratio of young to adults will be comparable to previous decades of Karrak Lake data, for joint inference about Ross's and snow geese in the central Arctic, beginning in 1993. This scale of inference provides a most valuable and unique long-term record from which assessments of management actions can be evaluated.

Annual objectives ("core datasets") will include estimation of:

- body composition (fat and protein reserves) of adult female Ross's and lesser snow geese during arrival at Anderson Bay
- spatial extent (km^2 of terrestrial habitat) occupied by nesting geese at Anderson Bay
- variation in nest density of Ross's and lesser snow geese at Anderson Bay
- nest initiation date, clutch size, nest success, and egg success for Ross's and lesser snow geese at Anderson Bay
- daily and annual weather onsite at Anderson Bay to assess spring phenology and localized conditions
- nesting population size of Ross's and lesser snow geese at Anderson Bay
- total production of both Ross's and lesser snow goose goslings at Anderson Bay
- gosling survival from hatch to banding for both Ross's and lesser snow geese
- survival of young Ross's and lesser snow geese from banding until 1 year old
- survival of adult Ross's geese and lesser snow geese
- impact of light goose grazing around vegetation exclosures in the colony and on brood rearing areas every 15, 30, 45, and 60 km from the nesting colony
- impact of light goose nesting on vegetation inside the colony at Anderson Bay
- population size, survival and recruitment of arctic fox at Anderson Bay
- population indices for small mammals at Anderson Bay.

Specific hypotheses include:

- There is a relationship between management efforts to reduce light geese and

(A) spring body composition of Ross's and lesser snow geese during arrival to Anderson Bay
(B) nesting population size of Ross's and lesser snow geese at Anderson Bay
(C) recruitment of young Ross's and lesser snow geese at Anderson Bay
(D) juvenile and adult survival or Ross's and lesser snow geese

- There is an interplay between local Arctic climate/habitat conditions and spring body composition on production of Ross's and lesser snow goose goslings at Anderson Bay
- There is density dependence between abundance/habitat conditions and the production of both Ross's and lesser snow goose goslings at Anderson Bay.

These strategic research questions will continue to address and estimate relative contributions of (i) Arctic climate, (ii) arrival body composition, (iii) harvest rate and (iv) density dependence on (1) population growth rate, (2) recruitment and (3) survival in both Ross's and lesser snow geese at Anderson Bay.

Study Area
The research will be conducted in the large colony of light geese nesting at Anderson Bay, Nunavut (68°55'N, 103°59'W), about 40 km southeast of Cambridge Bay. The Anderson Bay colony is relatively poorly studied. Kerbes et al. (2014) estimated 21,500 nesting light geese in 2006. Groves and Mallek (2012) estimated 130,000 light geese nesting in southeast Victoria Island, including Anderson Bay. Baldwin et al. (2023) estimated 300,000 nesting light geese. Canadian Wildlife Service initiated banding light geese at Anderson Bay in 2023 and intends to continue there annually for the foreseeable future. Thus, by pairing breeding biology and banding data, we anticipate development of long-term information about nesting population size, recruitment and survival of lesser snow and Ross's geese and the spatial extent of the colony, comparable with Karrak Lake (Alisauskas et al. 2012). We also anticipate development of a long-term monitoring programs to assess habitat conditions at the local scale of the nesting colony as well as over a broad geographic area (southeast Victoria Island) important to geese, sea ducks and shorebirds.

Experimental Design
Population and recruitment estimation during nesting.- Nesting studies will be conducted at Anderson Bay in Canada's central Arctic. Anderson Bay was chosen because it comprises a large and growing light goose nesting colony. We anticipate establishing a camp in the center of the colony. Methods will be a continuation of those used to date for Karrak Lake (Alisauskas et al. 2012). To estimate population size of nesting geese at Karrak Lake (1993-2011), nest densities were calculated from a grid of sample plots within the colony boundary. The boundary was determined annually by flying in a helicopter along the perimeter and marking it on a topographic map. We will establish the same protocol at Anderson Bay.

Sample plots will be either (1) initiation plots (visited about every 4 days during nesting to establish chronology of nesting and once after hatch to determine nest success) or (2) incubation plots (visited once during incubation and once after hatch to determine nest success). When plots are visited, length and breadth (±0.1 mm) of each egg in each nest within 30 m of a permanent marker will be measured. To improve precision of population estimates, the radius of sample plots was increased to 30 m in 1997 at Karrak Lake and will be used at Anderson Bay. During visits to nest plots, species of nest was virtually impossible to determine reliably because of absence of parents from nests and mixing of nesting birds in areas of high density. Instead, length (±0.1 mm) and width (±0.1mm) of eggs from nests of known species were acquired outside of sample plots; these data, averaged by nest, were used to construct a discriminant function (Alisauskas et al. 1998) which allowed classification of nests from sample plots to species; rate of correct classification using this discriminant function was 98% for Ross's geese and 96% for snow geese. Nests from sample plots with egg dimensions unrecorded will be classified as unknown.

Sample plots will be selected from a grid system of coordinates spaced 0.5 to 1.0 km apart. The sampling grid will be aligned following Universal Transverse Mercator coordinates. Number of sample plots will vary annually depending on spatial extent of nesting by geese and availability of personnel for sampling of plots. To reduce any bias associated with sampling, and to improve precision, annual populations will be calculated with an estimator for stratified random sampling (Thompson 1972:101-106). Three strata will be used: islands, high-density mainland, low-density mainland. Stratum size will be calculated as sum of terrestrial areas contained within each polygon within island, inner mainland and outer mainland strata. Besides population size, a large amount of information will be collected on clutch size and nest success for both Ross's and snow geese (Alisauskas et al. 2012).

Annual Variation in Nutrient Reserves. Each spring, up to 60 Ross's geese have been collected in Western Saskatchewan (25 April to 15 May, since 1993) and up to 50 female Ross's geese and 50 female snow geese have been collected in the Arctic during arrival to the Karrak Lake breeding colony since 1991. These data provide information about nutritional status of geese potentially in response to increased hunting pressure, particularly during spring migration. Both species of geese are known to rely heavily on nutrient reserves acquired during spring migration for successful reproduction, including for the production of eggs and incubation. If hunting pressure is sufficiently high during spring migration, then reduced nutrient reserves could result in reduced production even though survival appears not to have declined sufficiently to cause population decline in either Ross's geese (Alisauskas et al. 2006) or snow geese (Alisauskas et al 2011). Traylor (2010) found that spring body condition has declined in both species, but declined much more in snow geese; the evidence suggested that this decline was better explained by density dependence at Arctic and subarctic staging areas than by increased hunting opportunities. To continue these important datasets, we propose to harvest the same annual samples sizes of light geese in Saskatchewan during spring and upon their arrival to Anderson Bay to assess nutrient reserves and body composition.

Anticipated Output

- Data to support future graduate students at the University of Saskatchewan
- Peer-reviewed publications in ecological or ornithological journals
- Presentations at 16th North American Arctic Goose Conference, Oct. 2025

Management Implications

Concern about effects of habitat alteration by light geese on other species is the major justification for current management practices directed at midcontinent lesser snow and Ross's geese. Understanding the demographic mechanisms for population declines, as well as their environmental drivers, will be important in informing management actions among flyways, federal agencies, and provincial/state partners. Actions are contingent on a fuller understanding of the impacts of light geese on Arctic ecosystems and biodiversity, which is the focus of this research proposal.

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Principal Investigator

Mitch D. Weegman is the Ducks Unlimited Canada Endowed Chair in Wetland and Waterfowl Conservation, and an Associate Professor, at University of Saskatchewan (U of S; 2021-present). For this proposed project, Mitch will serve as Principal Investigator to lead establishment of a camp at Anderson Bay, and advise in all aspects of project completion. Mitch has been co-leading work at Karrak Lake since 2023, and has experience leading large teams on projects across North America, Europe, Asia, and South America. He also has experience developing, coding and interpreting results for a variety of bird populations. Current research in his group is based on population- and individual-level questions for improved conservation planning of other Arctic-nesting geese (e.g., Atlantic brant, Greenland white-fronted geese, midcontinent white-fronted geese, western Arctic and Wrangel Island snow geese, barnacle geese), dabbling ducks, shorebirds, and upland game birds.

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Logistical Requirements
We are partnering with the Central Flyway Council, Mississippi Flyway Council, Canadian Wildlife Service, Polar Knowledge Canada, and Polar Continental Shelf Program to assist with logistical requirements for establishing a camp at Anderson Bay.

Timing
We will prepare during late 2024 and early 2025 for a field season at Anderson Bay in June-July 2025. We anticipate annually hiring a crew of 4-6 members to collect data at the Anderson Bay light goose colony. We will recruit a PhD student to help lead this work, to begin in fall term 2026 or winter term 2027, based at the University of Saskatchewan with M. Weegman. We anticipate a temporary camp for 2 years, and will construct more permanent camp buildings once logistics and costs, as well as future partner contributions, are better known. The proposed budget is adequate to achieve the project objectives during the next 5 years if working at a temporary camp. Over the next 5 years, I will learn efficiencies in operating camp to potentially save resources to build a permanent camp, and will update the AGJV as we learn more.

Conflict of Interest Disclosure
At this time, we do not have or anticipate any conflicts of interest on this project. Should one arise, we will notify the sponsor immediately to disclose and take appropriate action.

Overlap/Duplication Statement
There is no overlap between the proposed project and any other active or anticipated projects in terms of activities, costs, or time commitment of key personnel. The proposal submitted is in no way duplicative of any proposal that was/will be submitted for funding consideration to any other potential funding source (Federal or non-Federal).

Budget
Notes: Annual budget in US Dollars

Category	AGJV Request	Central Flyway Council	Mississippi Flyway Council	Polar Knowledge	Polar Continental Shelf Program
Stipends for crew $1250/wk per person, 10 weeks (4 people)	50,000				
Total Personnel	**50,000**				
Travel/accommodation					
Commercial flights, staying in Cambridge Bay, food	4545			23,000	
Chartered aircraft					40,000
Aircraft fuel		28,909	19,091		
Equipment and food		12,000	16,909	3000	
Total travel/accommodation	**4545**	**40,909**	**36,000**	**26,000**	**40,000**
Total Direct Costs	**54,545**	**40,909**	**36,000**	**26,000**	**40,000**
IDC (10% for USFWS and MFC, 25% for CFC)	5455	4091	9000	0	0
Total	**60,000**	**45,000**	**45,000**	**26,000**	**40,000**

Funding source (USD)	2025	2026	2027	2028	2029	Total
AGJV	**60,000**	**60,000**	**60,000**	**60,000**	**60,000**	**300,000**
Central Flyway Council	**45,000**	**45,000**	**45,000**	**45,000**	**45,000**	**225,000**
Mississippi Flyway Council	**45,000**	**45,000**	**45,000**	**45,000**	**45,000**	**225,000**
Polar Knowledge Canada	**26,000**	**26,000**	**26,000**	**26,000**	**26,000**	**130,000**
Polar Continental Shelf Program	**40,000**	**40,000**	**40,000**	**40,000**	**40,000**	**200,000**
Annual totals	**216,000**	**216,000**	**216,000**	**216,000**	**216,000**	**1,080,000**

Matching Funds
We anticipate $156,000 USD annually in matching funds for this project, from the Central Flyway Council, Mississippi Flyway Council, Polar Knowledge Canada and Polar Continental Shelf Program.

Budget Justification

Request

Stipends
We request stipends to support four crew members for a 10 week period annually ($1250 per week, 10 weeks, $50,000 total).

Travel/accommodation
We request a portion of commercial flights and accommodation/food in Cambridge Bay be paid for with AGJV funds.

Indirect Costs
The University does not have a negotiated indirect rate with USFWS. Therefore, we have applied a 10% de minimus rate. The Mississippi Flyway Council has a 10% maximum on overhead charges, the Central Flyway Council will pay full U of S overhead (25%). Polar Knowledge Canada and Polar Continental Shelf Program are providing in-kind support, those funds are not going to U of S.

Match

Matching support is provided according to the letters included in this application, detailed by the contributors.

Travel/accommodation
Travel and accommodation includes support for the four crew members to fly commercially to Cambridge Bay and stay/eat there before and after camp dates. Matching support includes chartered aircraft and fuel, as well as equipment and food for establishing a camp at Anderson Bay (e.g., temporary camp structures, sampling equipment, food for camp meals).