Arctic Ecosystem Research in the Queen Maud Gulf Migratory Bird Sanctuary

Annual Report

December 2015

Ray Alisauskas[1], Jim Leafloor[2], and Dana Kellett[3]

[1]*Science and Technology Branch*

Environment Canada

and

Department of Biology, University of Saskatchewan

Prairie & Northern Wildlife Research Centre

Saskatoon, Saskatchewan

Ray.Alisauskas@Canada.ca

[2]*Canadian Wildlife Service*

Environment Canada

Winnipeg, Manitoba

Jim.Leafloor@Canada.ca

[3]*Science and Technology Branch*

Environment Canada

Prairie & Northern Wildlife Research Centre

Saskatoon, Saskatchewan

Dana.Kellett@Canada.ca

Project Summary and Objectives

Long-term research on the population ecology of arctic nesting waterfowl, specifically lesser snow (*Chen caerulescens*, hereafter, snow), Ross's (*Chen rossii*), white-fronted (*Anser albifrons*) and cackling geese (*Branta hutchinsii*), king eiders (*Somateria spectabilis*) and long-tailed ducks (*Clangula hyemalis*), has occurred annually in Queen Maud Gulf Migratory Bird Sanctuary (QMGMBS) since 1991. The primary field sites are (1) Karrak Lake, the site of one of the largest (currently estimated at just under 1 million birds) known snow and Ross's goose (collectively referred to as light geese) nesting colonies in the Sanctuary, and (2) Perry River. Every year, the abundance of each of the above-mentioned species nesting in the Karrak Lake area is estimated, and/or metrics associated with population dynamics, such as clutch size, egg survival, nest survival, and adult survival. These metrics are crucial for addressing management concerns of harvested species, both within Canada and internationally within North America. Further, factors thought to influence reproductive ecology, such as spring chronology, meteorological conditions, and small mammal abundance, are monitored in order to explain annual variation in productivity. From a conservation aspect, burgeoning populations of light geese are a priority research focus in North America. High populations have caused alteration of arctic vegetation in arctic and subarctic regions, and concern exists for the potential impact habitat alteration may have on other species, and research in QMGMBS is addressing these concerns. In addition to habitat surveys within the nesting colony at Karrak Lake and the Sanctuary, surveys of small mammals, passerines, and shorebirds are conducted to determine if abundance and occupancy differs between intact tundra habitats and those that have been converted to exposed peat by removal of vegetation by geese. Research on population ecology of arctic fox is also conducted, as well as less-intensive studies on gulls, arctic terns, loons, shorebirds, and passerines. In collaboration with Dr. Emily Jenkins (University of Saskatchewan), dynamics of various pathogens are investigated in arctic foxes, small mammals, and geese.

Results

To date, over 70 publications and theses have resulted from this research, and in addition to the highlights from the 2015 field season, a few of the most recent publications and results presented at scientific conferences are listed and briefly summarized in this report. We welcome interest in all aspects of our research, and will gladly provide scientific publications or additional information upon request.

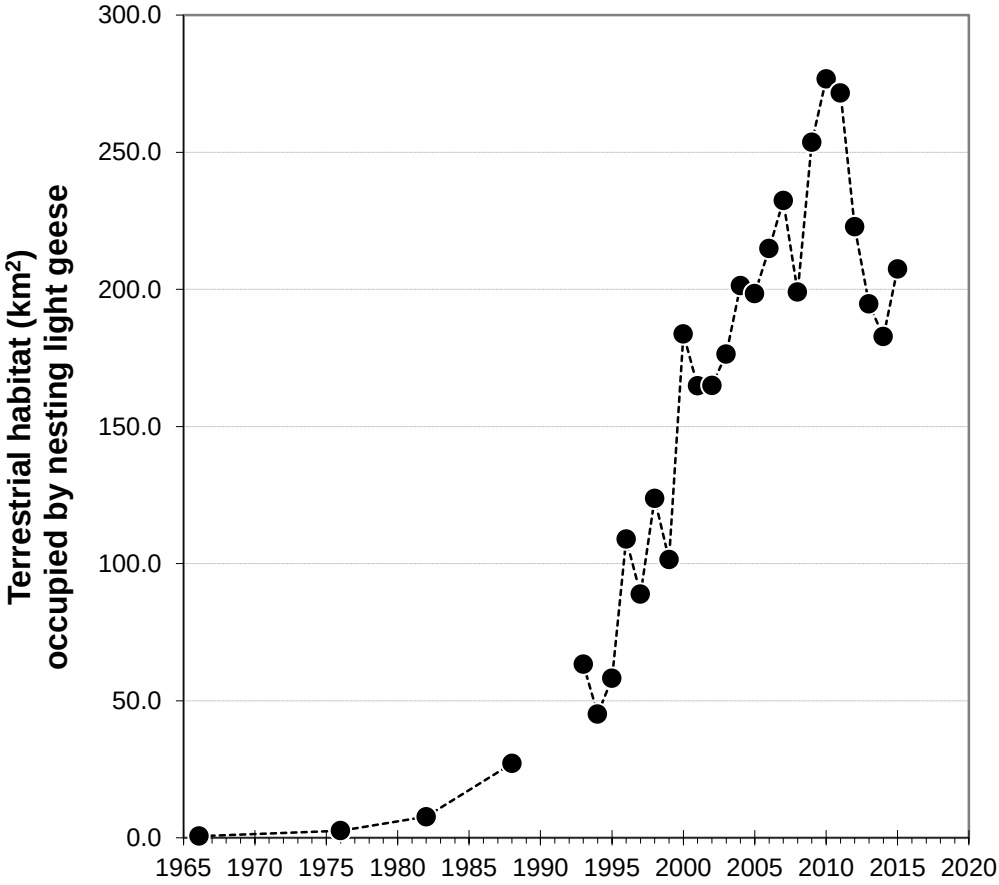

Figure 1. Terrestrial habitat (square kilometers) occupied by nesting snow and Ross's geese at the Karrak Lake colony, 1966-2015.

Ross's and snow geese: abundance and spatial size of the nesting colony at Karrak Lake

The amount of terrestrial habitat (water not included) occupied by nesting snow and Ross's geese has grown substantially over time (Fig. 1), as has the number of nesting geese (Fig.

2). Until 2006, the proportion of Ross's and snow geese nesting at Karrak Lake were about equal, but since that time, Ross's geese have outnumbered snow geese.

Within the colony boundary, 252 nest plots were sampled in 2015, from which nest initiation date, clutch size, nest success, and nesting population size were estimated. Although

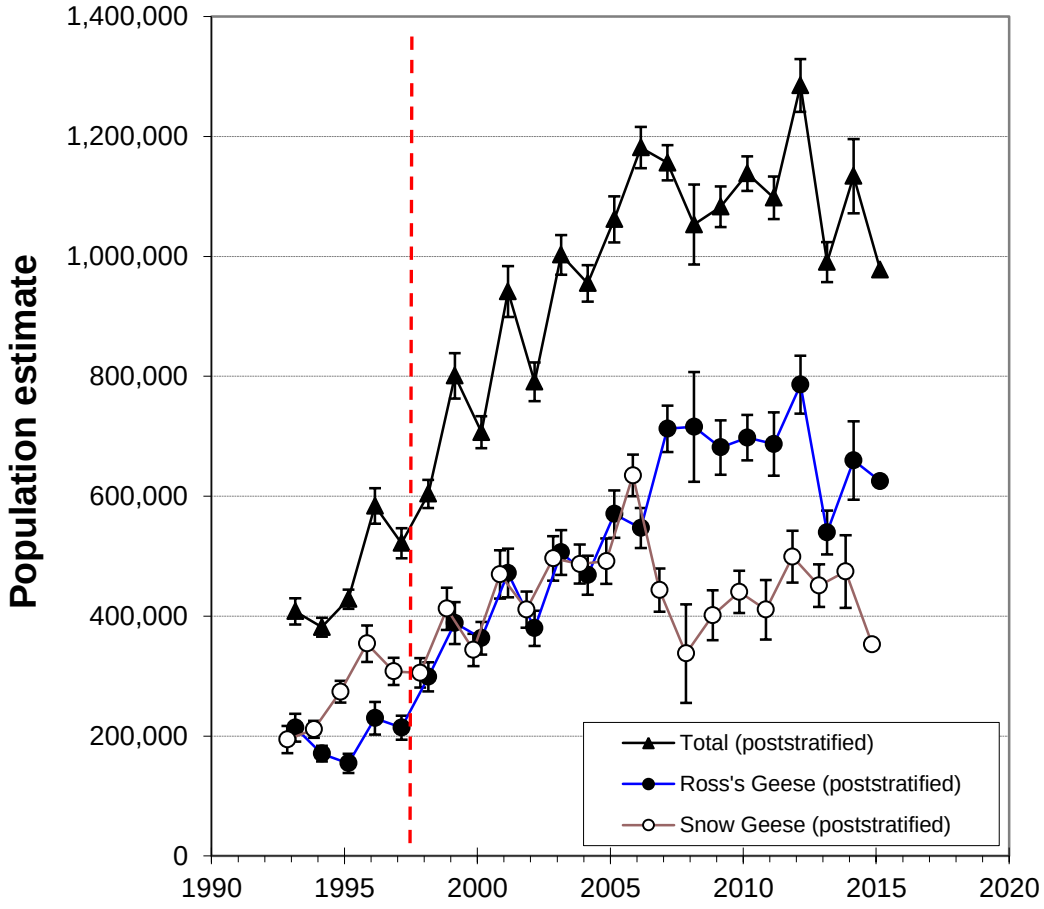

Figure 2. Estimated numbers of snow and Ross's geese nesting at the Karrak Lake colony, 1993-2015. The red dotted line indicates the start of the Conservation Order, which included liberalized harvest regulations aimed at reducing abundance of light geese.

the spatial size of the colony was slightly larger in 2015 than in 2014, the number of nesting light geese at Karrak Lake in 2015 dropped slightly to 977,900 birds. Nest success of both species at Karrak Lake exhibits annual variation (Fig. 3), but is typically high (long-term means

(1991-2015) were 77% and 83% for snow and Ross's geese, respectively). In 2015, estimates of nest success for both species were less than the long-term average, at 72% and 74% for snow and Ross's geese, respectively (Fig. 3).

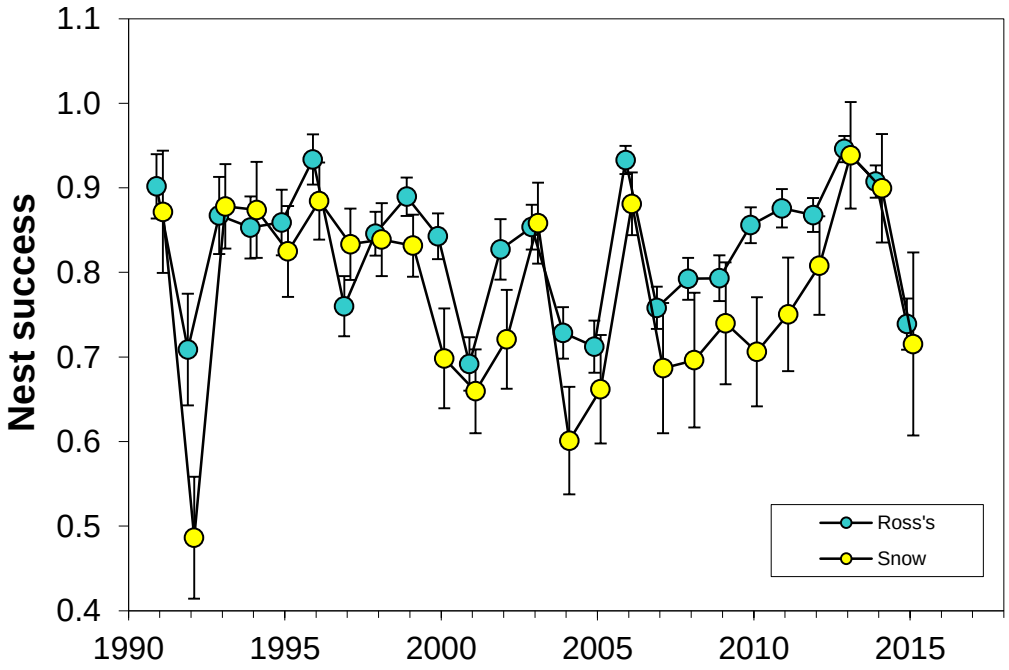

Figure 3. Estimated apparent nest success (number of successful nests divided by total number of nests) of snow and Ross's geese nesting at the Karrak Lake colony, 1991-2015.

The rate of population growth at Karrak Lake appears to have attenuated over the last decade, but did not stabilize or decline immediately following the implementation of the Conservation Order, which included liberalized hunting regulations beginning during the 1998-1999 hunting season. Instead, the decline in number of nesting snow geese in 2007 appeared to be related most to the lateness of snow melt and nesting delays in that year, and for a few years following 2007. Snow geese at Karrak Lake tend to have poorer nest success than Ross's geese, and seem to be more negatively influenced by late springs. Overall, numbers of both species nesting at Karrak Lake have stabilized since 2005, and this most likely is due to reduced recruitment into the Karrak Lake nesting population.

Snow, Ross's, greater white-fronted, and cackling geese: capture-mark-recapture/recovery

To date, over 257,000 geese have been marked with uniquely-identifiable leg bands in QMGMBS during 1989-2015. Many of these individuals have been recaptured in subsequent years, or recovered by hunters throughout North America. This continues to be unique and important data critical for evaluation of management practices of these harvested species, and in particular, for evaluation of efforts implemented to reduce midcontinent lesser snow goose populations.

Annual survival probability for midcontinent lesser snow geese has been estimated for those marked in Canada's arctic for two strata: northern lesser snow geese (from Queen Maud Gulf, Southampton Island and Baffin Island) and southern lesser snow geese (from La Perouse Bay, Cape Henrietta Maria, and Akimiski Island). Survival estimates suggest that harvest of lesser snow geese, even with virtually completely liberalized hunting regulations, has been insufficient to reduce survival to less than 0.80. Although survival of southern birds, which only contribute 10% of the midcontinent population, had declined somewhat from 1989 to 2006 (from about 0.89 to 0.83), survival of northern birds has not declined and has remained at about 0.88. Because southern birds nest at lower latitudes, they migrate sooner and face greater harvest pressure than northern geese. Harvest of southern birds occurs about 10 days earlier than that of the much more numerous northern population.

These banding data were used to estimate emigration of Ross's and snow geese from the brood-rearing area north of Karrak Lake. Snow geese had higher rates of emigration than did Ross's geese, and emigration was higher for males in both species. In both species, emigration increased in years following high nesting abundance at Karrak Lake, but then with a subsequent decline in nesting abundance the following year, emigration declined. Emigration also increased when nesting success was poor during the previous year. We tested whether the large decline in number of snow geese nesting at Karrak Lake in 2007-2008 (Fig. 2) was related to a mass emigration event, but found no change in emigration during those years, and instead suggested that the decline in snow geese was likely an outcome of temporary non-breeding, rather than emigration or death.

In August 2014, GPS satellite transmitters were deployed on 10 snow and 10 Ross's geese in QMGMBS, and locations (up until late December 2014 when most transmitters ceased to function) are depicted in Figure 4. Snow and Ross's geese departed tundra regions on 9 September ± 3 days, used taiga habitat until 13 September ± 3 days, and arrived in prairie Saskatchewan on 11 September ± 3 days. The average departure date from southern Saskatchewan and was 12 November ± 3.4 days, with mean arrival in the Mississippi Alluvial Valley on 13 November ± 3.8 days, where birds settled for at least a portion of the winter in either Arkansas or Mississippi. To summarize, birds used the following habitats during fall migration (beginning 1 August): 42.2 days in the arctic, 2.4 days in taiga , 0.4 days in boreal, and 59 days in prairie habitat. The most time on the prairies was spent in Canada, with very little spent in the northern U.S. (North and South Dakota). Geese relied heavily on agricultural lands in prairie Canada and the Mississippi Alluvial Valley. Use of arctic habitats was important before southward migration to the prairies, while boreal and taiga habitats were little used.

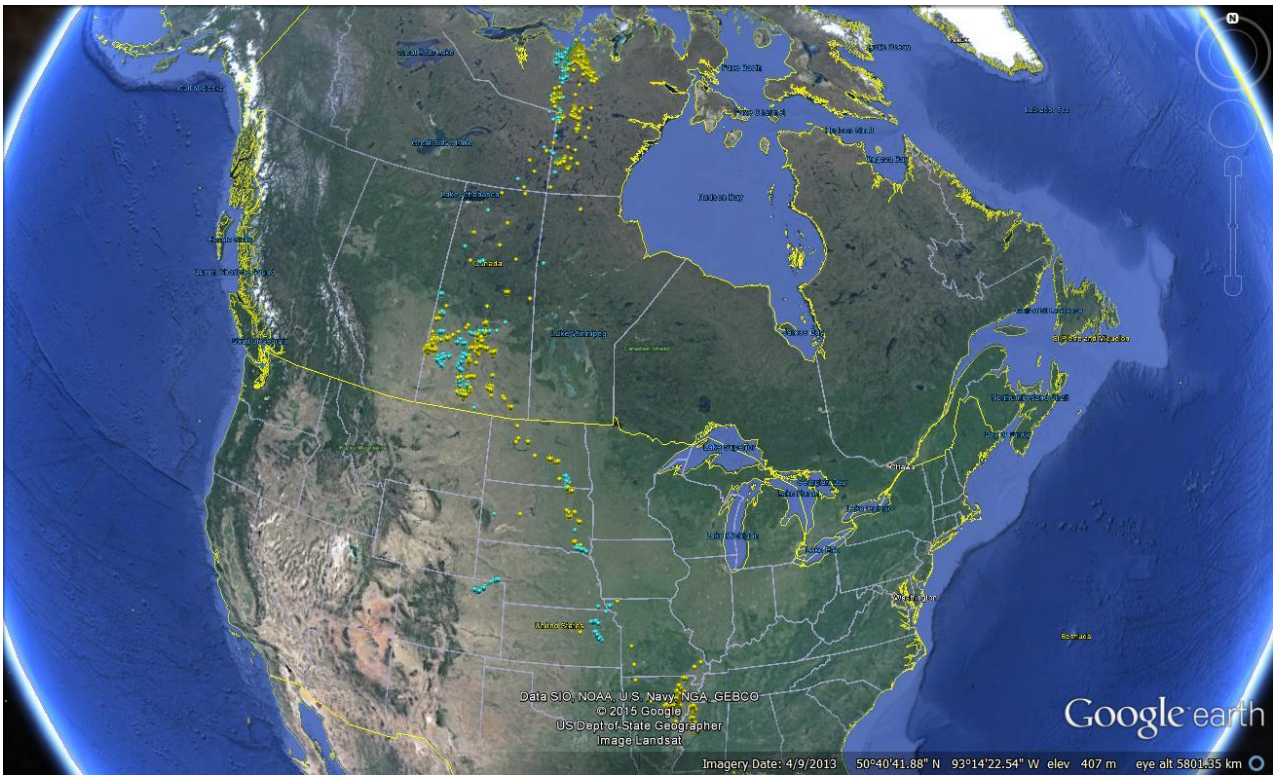

Figure 4. Locations of snow geese (yellow circles) and Ross's geese (blue circles) generated by GPS satellite transmitters deployed in QMGMBS in August 2014.

King eiders and long-tailed ducks: nesting ecology and capture-mark-recapture

In 2015, 258 king eider and 36 long-tailed duck nests were monitored on the islands of Karrak and Adventure Lakes. However, grizzly bears depredated many nests in 2015, and as a result, nest success for king eiders and long-tailed ducks was only 4.7% and 6.9%, respectively, substantially lower than long-term averages of 38.7% for king eiders and 21.2% for long-tailed ducks.

Also as a result of depredation by grizzly bears, very few adults and ducklings were captured at nests and marked with leg bands (16 adult and 16 duckling king eiders, and zero adult and duckling long-tailed ducks). Since 1995, 595 individual adult female and 2795 duckling king eiders have been captured on nests, and 74 ducklings have been recaptured as nesting females in subsequent years. Since 1998, 81 adult female and 89 duckling long-tailed ducks have been captured at nests, but no ducklings have ever been recaptured as breeding adults in subsequent years.

These nesting and capture-mark-recapture data are important in estimation of clutch size, nest survival, adult survival, age of recruitment, and fidelity to nesting areas. For example, these data were used to estimate mean age of first recruitment into the breeding population at Karrak Lake at 4.08 years. Further, ducklings were more likely to recruit into the breeding population if their mothers nested early relative to the annual mean date of nesting.

Habitat alteration by light geese

Within QMGMBS, the extent of habitat altered by light geese has increased within the large nesting colonies and also more widely within brood-rearing areas. A comparison of LANDSAT imagery between 1986-1992 and 2010-2011 (Fig. 5) revealed the increase of exposed peat at the Karrak Lake colony. Exposed peat results from the removal of overlying vegetation (typically graminoids), which reveals the underlying layer of *Sphagnum* spp. (moss), which can further erode and lead to desertification. However, as long as some peat remains, the existing seed bank and remaining rhizomes appears to allow for recovery as soon as grazing pressure subsides. Within the eastern portion of the QMGMBS that contains the major nesting colonies and moulting and brood-rearing areas, exposed peat increased by 411% from 1986-1992 to

2010-2011, from 269 km^2 to 1373 km^2. A large percentage (25%) of exposed peat occurred in areas previously classified as wet sedge meadow, and coincided with a decrease in wet sedge meadow habitat.

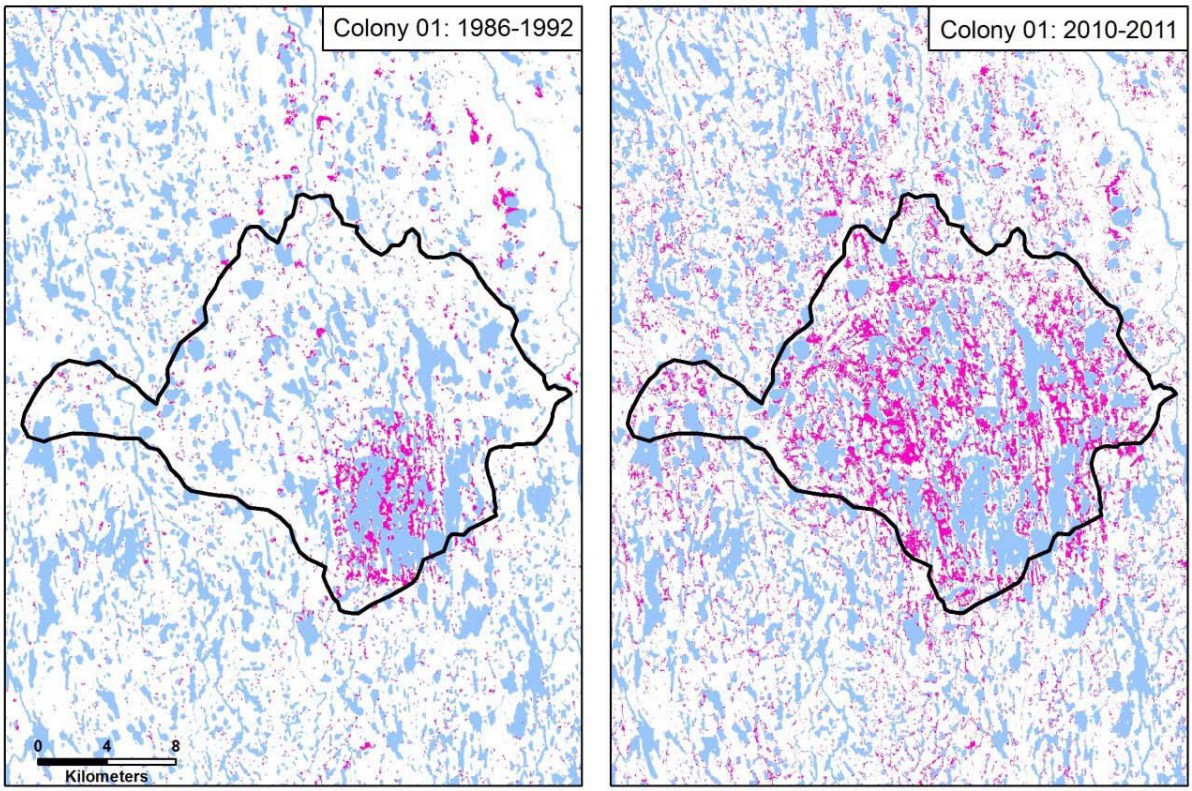

Figure 5. Expansion of exposed peat at Karrak Lake colony from 1986-1992 to 2010-2011. The 2011 colony boundary is outlined in black, exposed peat is indicated in pink, and water bodies in blue.

Vegetation enclosures have been maintained at intervals of 0, 15, 30, 45, and 60 km north of the Karrak Lake colony since the mid-1990s (Fig. 6). In 2013, 50 enclosures were constructed in lowland habitats (preferred by geese) throughout the northerly portion of the Sanctuary (Fig. 7), and surveys indicating extent of use by geese (indexed by number of goose droppings) and vegetation surveys were conducted in 2013-2014. Analyses are ongoing, but preliminary investigations suggest that geese preferentially use the eastern part of the Sanctuary (Fig. 7), and vegetation height is reduced in these regions (Fig. 8).

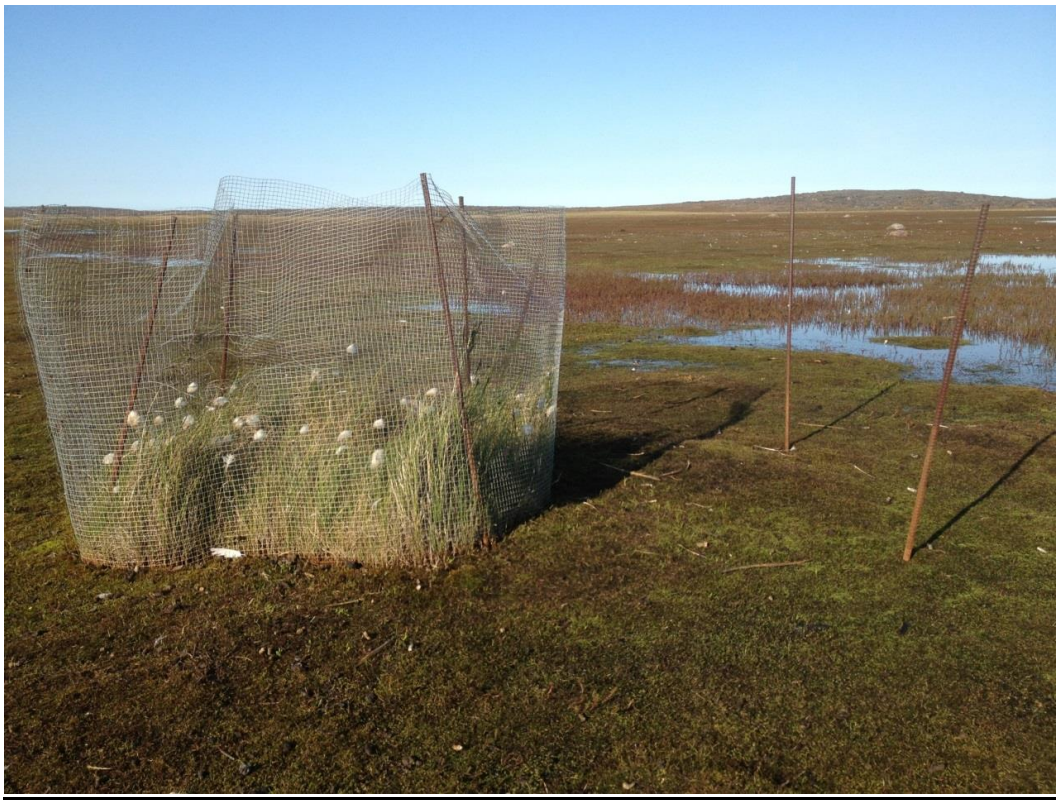

Figure 6. A vegetation enclosure located at 60 km north of the Karrak Lake colony.

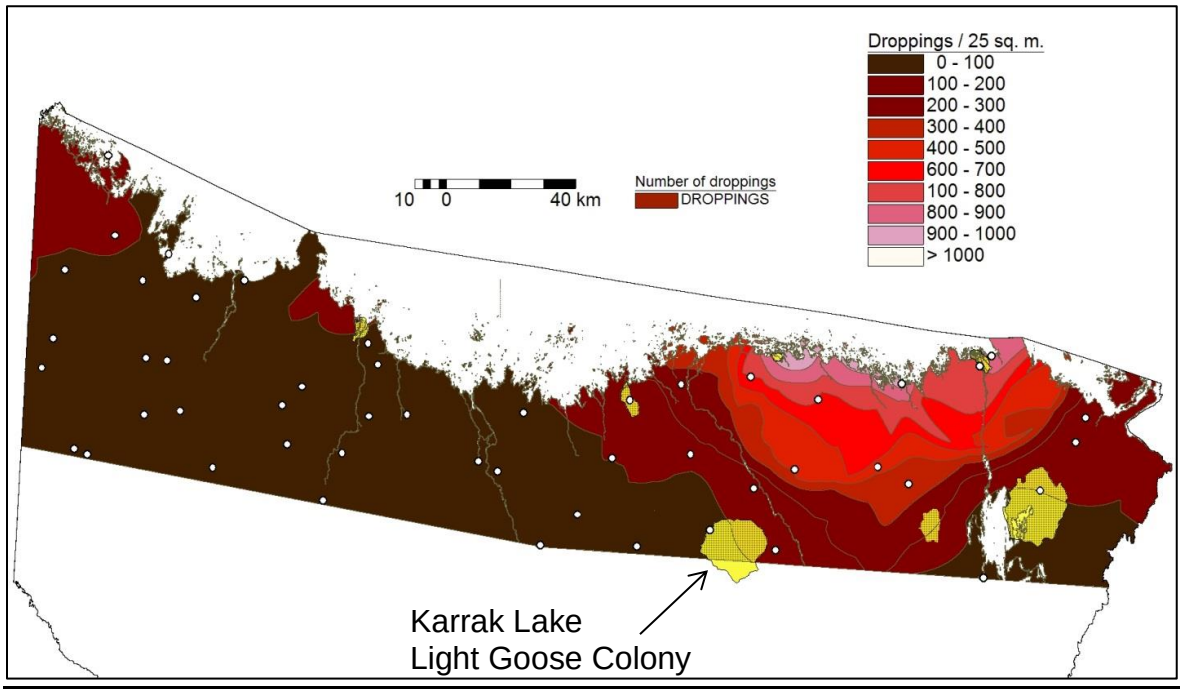

Figure 7. Variation in number of goose droppings throughout the northern portion of the QMGMBS. Major nesting colonies are denoted in yellow.

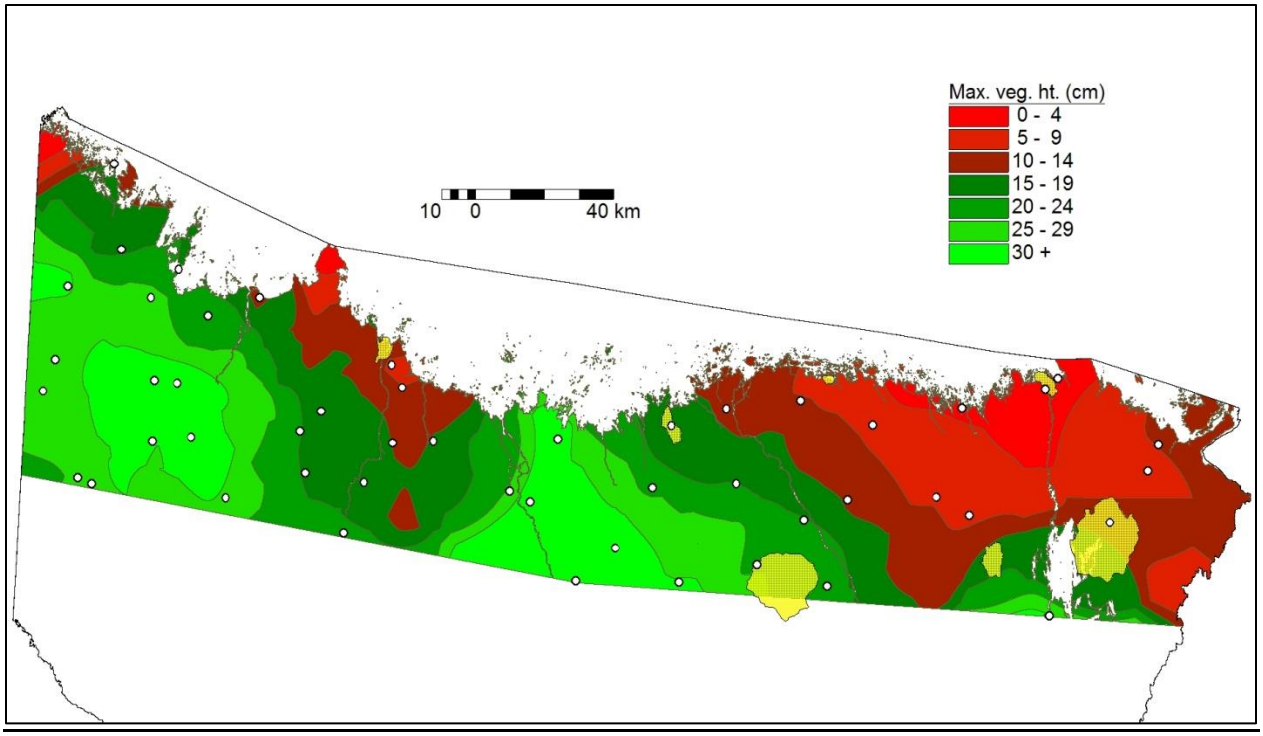

Figure 8. Variation in height of vegetation throughout the northern portion of the QMGMBS. Major nesting colonies are denoted in yellow.

Non-waterbird avian surveys

Surveys for non-waterfowl species were conducted on 296 and 342 nest plots in 2014 and 2015, respectively, and over 7100 observations were recorded. Most of these were of passerines (5405 in total, including 4742 lapland longspurs, 341 snow buntings, 187 horned larks, 109 savannah sparrows, plus others), but other observations included rock ptarmigan (224), shorebirds (374, primarily semipalmated sandpipers), jaegars (124), and raptors (39). These data will be used to investigate the impact of habitat alteration by nesting light geese on terrestrial bird communities by estimation of abundance and occupancy in various habitats. Results are forthcoming.

Small mammal abundance

Small mammal abundance at Karrak Lake varied considerably during 1994-2015. Peaks in small mammal abundance occurred every 3-5 years (Fig. 9). We caught 232 small mammals

during 14,320 trap-nights to date; red-backed voles were most common with 137 captures (59%), followed by collared lemmings with 69 captures (30%), and brown lemmings with 26 captures (11%).

Population dynamics of arctic foxes appeared to be closely linked to variation in small mammal abundance whereas nesting success of waterfowl appeared to be unrelated to small mammal abundance. We suggest that the large number of geese nesting at Karrak Lake acted as a buffer against arctic fox predation at Karrak Lake.

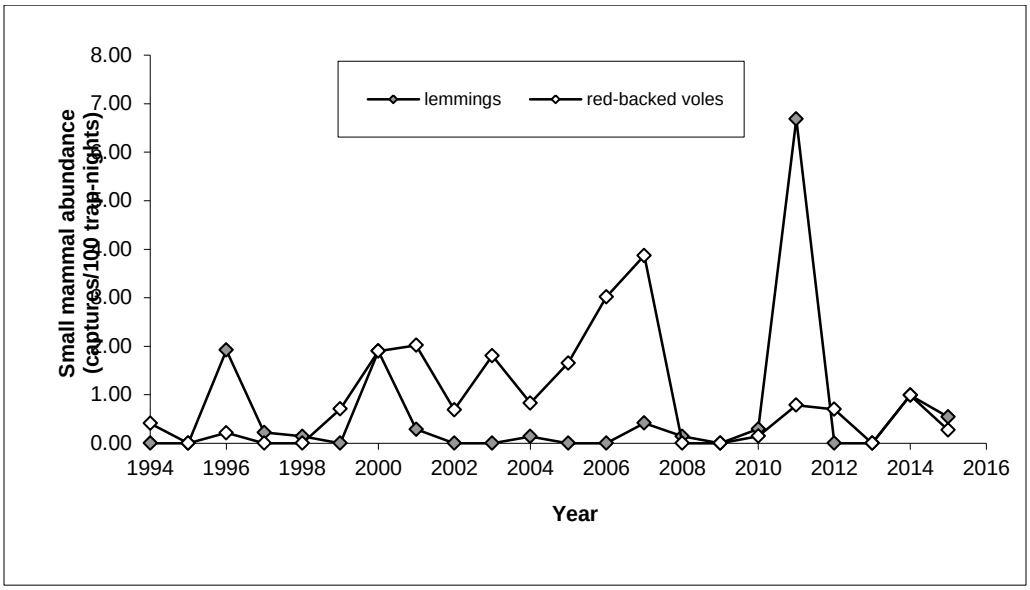

Figure 9. Abundance (number of captures per 100 trap nights) of lemmings and red-backed voles within the Karrak Lake colony, 1994-2015.

Capture-mark-recapture of lemmings on live-trapping grids in four different habitats (intact lowland tundra, inside and outside the light goose colony and altered lowland tundra inside and outside the colony) will allow the investigation of the impact of habitat alteration by nesting light geese on small mammal abundance and population dynamics. In 2015, 74 lemmings (73 brown and one collared) were captured on 352 occasions. Results are forthcoming.

Arctic fox: capture-mark-recapture and prevalence of pathogens

During 2000-2015, 148 and 159 individual adult and juvenile foxes, respectively, have been captured and marked at Karrak Lake. Many of these individuals have been recaptured in subsequent years. In addition to foxes encountered at Karrak Lake, individuals marked at Karrak Lake have been encountered in Resolute Bay, Cambridge Bay, Coppermine, and Taloyoak. Analyses of capture-recapture data of arctic foxes from 2000-2015 at Karrak Lake demonstrated that survival probability of adults increased slightly over this time period (from 0.40 to 0.50), likely due to the local superabundance of food provided by high goose densities. Adult survival was relatively stable compared to recruitment, which fluctuated considerably over the same time period. Estimates of recruitment were correlated with fluctuations in lemming abundance and climate variation.

In collaboration with Dr. Emily Jenkins and her graduate students at the University of Saskatchewan, several parasites including *Toxoplasma gondii, Neospora caninum, Toxascaris* spp., *Cryptosporidium* spp., *Giardia* spp., *Echinococcus multilocularis*, taeniids, and unidentified tapeworms have been detected in arctic foxes at Karrak Lake. The occurrence of the protozoan parasite *Toxoplasma gondii* on arctic fox populations is known from only a few regions, but has been reported to cause mortality. Elmore et al. (2016) reported *Toxoplasma gondii* in arctic foxes at Karrak Lake, documenting a new geographical record for this parasite in arctic foxes. Further, Elmore et al. (2014) reported that snow and Ross's geese migrating to Karrak Lake are routinely exposed to *Toxoplasma gondii* as well, and are likely intermediate hosts of this parasite.

2014-2016 Publications and Presentations at Scientific Meetings

Publications:

Alisauskas, R. T., and D. K. Kellett. 2014. Age-specific in situ recruitment of female king eiders estimated with mark-recapture. Auk 131:129-140.

Elmore, S. A. 2015. The occurrence and ecology of *Toxoplasma gondii* in a terrestrial arctic food web. PhD thesis, University of Saskatchewan.

Elmore, S. A., K. P. Huyvaert, L. L. Bailey, J. Milhous, R. T. Alisauskas, A. A. Gajadhar, and E. J. Jenkins. 2014. *Toxoplasma gondii* exposure in arctic-nesting geese: a multi-state occupancy

framework and comparison of serological assays. International Journal for Parasitology: Parasites and Wildlife 3:147-153.

Elmore, S. A., G. Samelius, B. Al-Adhami, K. P. Huyvaert, L. L. Bailey, R. T. Alisauskas, A. A. Gajadhar, and E. J. Jenkins. 2016. Estimating *Toxoplasma gondii* exposure in arctic foxes while navigating the imperfect world of wildlife serology. Journal of Wildlife Diseases 52:000-000.

Gesy, K. M., J. M. Schurer, A. Massolo, S. Liccioli, B. T. Elkin, R. Alisauskas, and E. J. Jenkins. 2014. Unexpected diversity of the cestode *Echinococcus multilocularis* in wildlife in Canada. International Journal for Parasitology: Parasites and Wildlife 3:81-87.

Mascarelli, P. E., S. A. Elmore, E. J. Jenkins, R. T. Alisauskas, M. Walsh, E. B. Beitschwerdt, and R. G. Maggi. 2014. Vector-borne pathogens in arctic foxes, *Vulpes lagopus*, from Canada. Research in Veterinary Science. doi:10.1016/j.rvsc.2014.12.011.

Wilson, S., R. T. Alisauskas, and D. K. Kellett. 2015. Factors influencing emigration of Ross's and snow geese from an arctic breeding area. Journal of Wildlife Management 9999:1-10. doi:10.1002/jwmg.960.

Presentations:

Alisauskas, R. T., and D. K. Kellett. 2014. Diet and nutrition of king eiders and long-tailed ducks arriving to breed at Karrak Lake. Oral presentation at the 5th International Sea Duck Conference, Reykjavik, Iceland.

Alisauskas, R. T., D. K. Kellett, and J. O. Leafloor. 2015. Satellite transmitters and fall migration by snow and Ross's geese from Canada's central and eastern arctic. Oral presentation at the 13th North American Arctic Goose Conference, Winnipeg, Canada.

Alisauskas, R. T. Goose-vegetation relationships south of Queen Maud Gulf: case vs. effect with implications for carrying capacity? 2015. Oral presentation at the 13th North American Arctic Goose Conference, Winnipeg, Canada.

Alisauskas, R. T. 2015. What's up with midcontinent light geese. Invited plenary presentation at the 13th North American Arctic Goose Conference, Winnipeg, Canada.

Bouchard, É., S. A. Elmore, R. T. Alisauskas, G. Samelius, A. A. Gajadhar, and E. J. Jenkins. 2015. *Toxoplasma gondii* – transmission dynamics in the Canadian Arctic. Poster presentation at the Annual Meeting of The Wildlife Society, Winnipeg, Canada.

Bouchard, É., S. A. Elmore, R. T. Alisauskas, G. Samelius, B. Al-Adhami, A. A. Gajadhar, and E. J. Jenkins. 2015. *Toxoplasma gondii* – Transmission Dynamics in the Canadian Arctic. Oral presentation at the 6th Student Workshop of the European Wildlife Disease Association, Veyrier-du-Lac, France.

Bouchard, É., S. A. Elmore, R. T. Alisauskas, G. Samelius, B. Al-Adhami, A. A. Gajadhar, and E. J. Jenkins. 2015. *Toxoplasma gondii* – transmission dynamics in the Canadian Arctic. Poster presentation at the Annual Meeting of the Canadian Section of The Wildlife Society, Saskatoon, Canada.

Conkin, J. A., and R. T. Alisauskas. 2015. Increases in exposed peat from 1992 to 2010 in association with increased light goose populations in the Queen Maud Gulf Migratory Bird Sanctuary. Poster presentation at the 13th North American Arctic Goose Conference, Winnipeg, Canada.

Elmore, S., K. Huyvaert, and E. Jenkins. 2014. *Toxoplasma gondii* in a terrestrial arctic food web: Who brings what to the table and uncertainty in diagnostics. Oral presentation at the 63rd International Conference of the Wildlife Disease Association, Albuquerque, USA.

Jenkins, E., J. M. Schurer, and S. A. Elmore. 2015. Toxoplasmosis in wildlife and people in the Canadian Arctic. Oral presentation at the 6th International Congress on Circumpolar Health, Oulu and Rokua, Finland.

Kellett, D. K., and R. T. Alisauskas. 2014. Population ecology of long-tailed ducks at Karrak Lake, Nunavut. Poster presentation at the 5th International Sea Duck Conference, Reykjavik, Iceland.

Kellett, D. K., and R. T. Alisauskas. 2015. Is apparent nest success a useful metric of nest survival in colonial light geese nesting at high densities? Oral presentation at the 13th North American Arctic Goose Conference, Winnipeg, Canada.

Ross, M. V., and R. T. Alisauskas. 2015. Ecological effects on midcontinent light goose recruitment. Poster presentation at the 13th North American Arctic Goose Conference, Winnipeg, Canada.

Wilson, S., R. Alisauskas, and D. Kellett. 2015. Permanent emigration by Ross's and snow geese from an arctic breeding area: the roles of prior nest success, environmental conditions and local abundance. Poster presentation at the 13th North American Arctic Goose Conference, Winnipeg, Canada.

Acknowledgements

This research is currently or has been funded by Arctic Goose Joint Venture, California Department of Fish and Game, Central Flyway Council, Delta Waterfowl Foundation, Ducks Unlimited Canada, Environment Canada, Mississippi Flyway Council, Northern Ecosystems Initiative, Northern Scientific Training Program, Nunavut Wildlife Management Board, Polar

Continental Shelf Project, Sea Duck Joint Venture, and University of Saskatchewan. To date, nearly 200 assistants have contributed to field research in QMGMBS, and we are greatly indebted to their efforts and enthusiasm.