Chapter 4**:**

INTERACTION WITH ARCTIC AND SUBARCTIC HABITATS

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Considerable study and evaluation has been conducted on the effects of lesser snow geese upon coastal wetland habitats in the La Perouse Bay region of northern Manitoba, along the coastline of Hudson Bay to Cape Henrietta Maria, along the shores of James Bay, Ontario, and Akimiski Island, Northwest Territories (Abraham and Jeffries 1997). Habitat damage by lesser snow geese in these areas is considered to be primarily caused by foraging activities during early spring and the nesting period. Damage is caused by both locally nesting snow geese and by large numbers of transient snow geese which can concentrate in and near nesting colonies for variable periods of time in the spring. Grubbing activity by snow geese (i.e., foraging by uprooting plant roots and rhizomes) can be particularly destructive to vegetative swards. Increasing numbers of lesser snow geese have been associated with intensified reduction in extent and biomass of graminoid vegetation in these areas. The impacts of Ross's geese on vegetation has received considerably less attention than has that of snow geese. In this chapter, we review what currently is known about the effects of Ross's geese on Arctic and subarctic habitats.

The long bill of the lesser snow goose has been considered an adaptation for excavating below-ground portions of plants (Alisauskas 1998). The shorter bill of the Ross's goose may be less effective for grubbing, however Ross's geese do grub during nest building (Fig. 1) and during spring when a large portion of their diet is sedge and grass roots (Ryder and Alisauskas 1995). The bills of Ross's geese may also enable them to graze on shorter or already closely cropped vegetation which can prevent or retard vegetation recovery in degraded areas. Thus, Ross's geese may contribute to impacts on northern wetland habitats.

Most Ross's geese nest in the Queen Maud Gulf Migratory Bird Sanctuary (QMGBS) in the central Arctic and along the west coast of Hudson Bay in Nunavut. Some also nest along the southern coast of Southampton Island, the western coast of southwest Baffin Island, and at La Perouse Bay near Churchill, Manitoba (Barry and Eisenhart 1958, Ryder and Cooke 1973, Caswell et al. 1997). Since both lesser snow geese and Ross's geese nest and raise broods in close proximity, attributing impacts on vegetation to one or the other species is difficult. Habitats, habitat use, goose numbers, and goose distribution vary among nesting areas. Activities of geese, and the types and degree of impacts upon habitat also vary among different portions of the reproductive period**.** Assessment of the relative impacts of lesser snow and Ross's geese on habitats at

these areas must include consideration of the proportion and abundance of species using each site and their distributions during the portions of the breeding season.

QUEEN MAUD GULF MIGRATORY BIRD SANCTUARY, NUNAVUT

Photographic inventories indicate populations of breeding Ross's geese at colonies within the QMGBS have increased from 77,000 to 475,000 from 1976 to 1998 (R. H. Kerbes, Canadian Wildlife Service, unpublished data). Snow goose populations in these areas are similar in number to those of Ross's geese and have shown similar increases over time. As of 1998, Ross's geese comprised 42% of the total light goose population of the QMGBS (Alisauskas et al. 1998).

Pre-nesting Period

At nesting colonies, there is about a 3-day lag between peak arrival of breeding geese and the peak of nesting. Nonbreeders may settle temporarily in colonies and mix with breeding geese, or form large flocks of nonbreeders outside or on the periphery of colonies. Upon arrival, both lesser snow geese and Ross's geese grub for roots and rhizomes of wetland vegetation.

Knowledge of Ross's and lesser snow geese foraging area distribution during the pre-nesting period is limited so it is not known if possible impacts on vegetation are restricted to nesting areas. There is very little impact by transient geese since there are very few light geese traveling north to more northerly nesting areas (e.g., Jenny Lind Island).

Nesting Period

Most of the information regarding Ross's goose populations and their effects upon habitat has been collected at the Karrak Lake colony. At this colony, recent studies indicate that the Ross's goose spring population has increased to 395,000 in 2000 and comprises about 50% of the total population of nesting light geese (Alisauskas and Rockwell, this report).

Ross's and snow geese strip and grub vegetation to build and maintain their nests (Fig. 1). Where geese nest in lowland habitats, with grasses, sedges and various herbs on shallow peats, almost all of the vegetation is stripped or grubbed, biomass is extremely low, and underlying peat is exposed. In upland habitats (e.g., gravel ridges) biomass is also removed but this impact is less evident because peat is at most a thin veneer and vegetative biomass is low. In rock and boulder outcrops, where vegetative biomass is naturally limited, impact by nesting geese is also less evident although most of the edible plant biomass is also removed.

Land-cover mapping from satellite images in 1989 showed the extent of exposed peats in lowland habitats at Karrak Lake (Didiuk and Ferguson in press). The extent of

exposed peats corresponded well with the limits of the nesting colony at that time. Loss of vegetative biomass in upland habitats (gravel ridges and rock/boulder outcrops) cannot be adequately assessed from satellite imagery, but it is reasonable to assume most of the edible vegetative biomass in these habitats within the nesting colony has been removed by nesting and foraging geese. Mapping of land cover from satellite images in 1996 indicated an increased area of nesting geese, and a corresponding increased area of exposed peats with very little vegetative biomass (A. Didiuk, Canadian Wildlife Service, unpublished data).

At Karrak Lake, detailed comparative studies of Ross's and snow goose diets and foraging behavior during spring 1993 showed that Ross's geese foraged for 9.2 h/day compared to 7.1 h/day by snow geese before incubation (Gloutney et al. 2001). Despite these high rates of foraging, little food is ingested during egg-laying (Ross's geese: 12.4 g/day, snow geese: 9.6 g/day on a dry mass basis) or during incubation recesses (Ross's geese: 2.9 g/day, snow geese: 6.5 g/day). Much of the diet is composed of mosses and other foods of poor quality such as woody roots, bearberry leaves, and cranberry leaves. Before incubation, dry mass of more nutritious foods such as fine shoots of chickweed (*Stellaria* spp.) and sedges (*Carex* spp.) constituted 38% (dry mass) of Ross's goose diets and 33% of snow goose diets. Gloutney et al. (2001) suggested that the similarity between species in low quantity and quality of diets was the result of the cumulative removal of vegetation by high populations of geese over the previous 3 decades.

The relative impacts of lesser snow geese and Ross's geese presumably can be gauged by their relative proportions within the nesting colonies. At Karrak Lake, Ross's geese comprise about 50% of the total population of nesting geese. However, Ross's geese mainly nest in lowland habitats, and lesser snow geese mainly nest in upland habitat. Much of the removal of vegetation of lowland habitats is the result of not only foraging by Ross's geese, but also of their nest building activities (Fig. 1).

Charlwood and Alisauskas (unpublished ms) showed that the oldest areas of the goose colony had the lowest estimate of vegetation diversity compared to areas where geese had not yet nested. Similarly, species richness was highest in areas devoid of nesting geese and contained an average of 7 (150%) more species than the oldest areas of the colony. Also, the proportion of damaged habitat (i.e., the sum of exposed substrate, exposed peat, and *Senecio congestus*) was greatest (0.386) in the oldest parts of the colony (Fig. 2) and declined at locations away from the colony (0.085) in areas with no nesting geese. Most differences in damage occurred between areas which had nesting geese for <10 years versus ≥ 11 years. The foregoing analysis did not consider the composition of goose species. However, the number of Ross's goose nests/sample plot was correlated positively with the proportion of exposed peat/sample plot and the number of lesser snow goose nests/sample plot was not. This appeared to be related to the fact that Ross's geese nest in low-lying areas, zones with an accumulation of peat formerly covered by a layer of live vegetation; whereas snow geese arrive earlier and nest earlier in the higher, rockier areas which become snow-free first. Thus combined foraging and nest-building activities by Ross's geese have altered wet low-lying areas that formerly supported live sphagnum moss/sedge communities to areas of exposed peat. This segregation of fine-scale nesting

habitat by Ross's and snow geese at Karrak Lake allows assessment of the separate effects of foraging and nest-building by each species.

Therefore, during recent years when Ross's geese have increased greatly, they may have caused much of the loss of vegetation biomass in lowland areas of the Karrak Lake colony, and at other nesting colonies in the QMGBS.

Brood-rearing Period

After hatch, both lesser snow geese and Ross's geese disperse from nesting colonies and are often found in mixed-species flocks of adults and young. Many geese of both species travel all the way to the coastline of Queen Maud Gulf, a distance of about 70 km. During these movements, geese forage in lowland habitat, particularly along the various drainages leading to the coastline. Mean dispersal distances toward the coast from Karrak Lake by Ross's geese were about 45 km, whereas snow geese moved an average of about 15 km to brood-rearing areas, although there was considerable overlap between species (Slattery 1994). This mixing during brood rearing makes it difficult to separate species-specific impacts of foraging.

Slattery (2000) used goose exclosures to deduce that the combined effects of vegetation removal by Ross's and snow geese were large (Fig. 3). Moreover, standing crop and protein density of plants increased with increasing distance toward the coast from the colony at Karrak Lake. Above-ground biomass in exclosures increased linearly with distance from the coast, whereas that in control plots showed no increase until about 60 km from Karrak Lake. By taking the difference in biomass, Slattery (2000) was able to calculate the grazing intensity along this continuum from the colony to the coast. The combined effect of both species showed that about 50% of the above-ground biomass had been removed over an area of about 5,000 km^2. Because Ross's geese constituted about 50% of the light geese in this area, they could have removed as much as 25% of the total above-ground biomass within this large study area. Slattery (2000) suggested that reduced biomass within preferred habitats close to the colony was suggestive of a biodeterioration zone from cumulative annual grazing pressure nearer the colony where density of geese was greatest. These observations were consistent with density-dependent effects on goslings; structural size and body condition of captured goslings increased with distance from the colony.

Land-cover mapping from satellite imagery in 1989, and field surveys in 1991-93 did not reveal any significant exposure of peats due to foraging by geese away from nesting colonies. Mapping from satellite imagery in 1996 revealed some areas of exposed peats which may have been related to reduced water levels in lowland wetlands or foraging by geese (A. B. Didiuk, Canadian Wildlife Service, unpublished data). Vegetation sampling has confirmed exposed peat areas are present outside of, but very near, the nesting colony (Charlwood and Alisauskas, unpublished ms). Further work is required to explain and quantify these changes.

Grazing of shoots and fruiting bodies of grasses and sedges are the primary feeding activities of adult light geese and their goslings during brood rearing (Fig. 3). Grubbing also occurs in brood-rearing areas by nonbreeding flocks, particularly in wet sedge meadows.

Post-fledging Period

Fledged goslings and adults stage on brood-rearing areas of QMGBS after the brood-rearing period. Although little work has been done at this time of year, there is likely a shift in diet from green vegetation (high in protein for tissue growth) to below-ground portions of plants (which are high in carbohydrates) to increase fat reserves for migration. At this time, sedges and grasses relocate nutrients to below-ground storage organs. Hence grubbing activity may increase again during this period. Few migrant geese from more northerly regions join locally breeding and molting geese during this period. The effects of late summer/early fall grubbing by lesser snow geese or Ross's geese upon wetland vegetation is unknown.

MCCONNELL RIVER MIGRATORY BIRD SANCTUARY AND WEST HUDSON BAY, NUNAVUT

Ross's geese occasionally have been reported within this sanctuary since the 1960s. By 1994, a large number of Ross's geese established a nesting colony within the existing lesser snow goose colony at McConnell River, and in 1997, 24,000 nesting Ross's geese were counted in this area. Ross's geese comprised about 16% of all light geese nesting along the west coast of Hudson Bay, Nunavut in 1997. Thus, large numbers of Ross's geese in this region are a relatively recent occurrence and probably contributed little to previous large-scale habitat deterioration here. The recently increased numbers of Ross's geese may contribute to habitat degradation additive to that of snow geese, retardation or prevention of habitat recovery if snow goose use decreases, limited localized effects, or have little impact.

Nesting density differs between lesser snow geese and Ross's geese here. In 1997, at the McConnell River nesting colony, the 24,000 Ross's geese nested within a 3.4 km^2 area, and 22,000 lesser snow geese nested within a 250 km^2 area. The area occupied by nesting Ross's geese in 1997 represented 1.4% of the area occupied by nesting light geese at the McConnell River nesting area.

There may be additional Ross's geese nesting in small numbers elsewhere west of Hudson Bay, but the known area of nesting Ross's geese at McConnell River was only 0.4% of the total area occupied by nesting light geese within this region (783 km^2).

Pre-nesting Period

After spring arrival to nesting areas, lesser snow geese and Ross's geese may have to wait for several days for snow to disappear from nesting sites. Transient geese,

en route to more northern nesting sites may also concentrate in some areas of coastal wetlands within and near nesting colonies. Wetland habitat degradation through grubbing can occur at this time (reduction in turf size of coastal sedges and reduced shoot frequency of inland fresh-water sedges and grasses).

The lower marsh zone along the coastline is currently limited in extent, with only small patches widely distributed along the coastline. The role that resident and transient light geese have played in this is not clear but is under investigation (Kerbes et al. 1990, A. B. Didiuk, Canadian Wildlife Service, unpublished data).

The upper marsh zone along the coastline varies from 50 to 200 m in width, and is heavily grazed. Measures of plant biomass are similar to the heavily grazed turfs at La Perouse Bay, Manitoba. Dicotyledons are greatly reduced, also indicative of heavy grazing. There is no evidence of significant replacement of graminoids by mosses in this habitat, and goose exclosure studies demonstrate rapid regrowth and seed set of grass species. Although heavily grazed, there is no evidence that the extent of upper marsh zone has been significantly reduced by the foraging activities of geese. This habitat may not be available for foraging and nest establishment in the early spring due to potentially later snow melt. Aerial photography of nesting colonies of light geese show that there are fewer nests in this zone immediately adjacent to the coastline. The upper marsh is heavily grazed. However, it is a continuous strip for most of the 200 km from the Manitoba/Nunavut border to Maguse River. Flocks of geese likely move up and down this very extensive strip of habitat.

Inland from the upper marsh is a broad zone which previously was low-shrub tundra. Low-shrub tundra typically is a mosaic of sedge and grass fens interspersed with hummocks covered by shrubs. Hummocks in these areas provide early nesting sites for lesser snow geese. Land-cover mapping with satellite imagery in 1987, and annual aerial and ground surveys since that time indicate this low-shrub tundra has been replaced by extensive areas of exposed peats. It is reasonable to assume that some of this habitat change is due to spring grubbing by lesser snow geese. Whether grubbing by nesting and migrant lesser snow geese and Ross's geese was the only or the major cause of these exposed peats is currently unknown.

If migrant Ross's and lesser snow geese occasionally are delayed in the southern portion of this coastal region due to extensive snow cover farther north, then both lesser snow geese and Ross's geese may grub in these habitats and contribute to degradation. The frequency of such delays and the concentrations of migrant and resident lesser snow geese and of Ross's geese in these areas is unknown. Large numbers of Ross's geese were not observed nesting in this region until 1994; however, the abundance of transient Ross's geese prior to that is unknown.

Nesting Period

Ross's geese at McConnell River are distinctly colonial with very high nest densities in specific portions of the overall nesting area of light geese. Most geese appear

to be concentrated in areas with relatively well-defined borders (i.e., abrupt transition from high-density Ross's geese to lower-density lesser snow geese). Ross's geese at the colony north of McConnell River are concentrated in a lowland depression with limited micro-relief and large areas of exposed peat. They are surrounded by lesser snow geese which nest in lower densities, most often on hummocks with low shrubs. Ross's geese arrive later, and nest in lower areas where snow cover disappearance is delayed; similar to the high proportion of Ross's geese that nest in lowland areas at QMGBS (Charlwood and Alisauskas ms). Some Ross's geese are concentrated on islands, peninsulas, and portions of the shorelines of a lake complex.

Brood-rearing Period

Banding and aerial surveys indicated most light geese disperse inland with their broods after hatch in early July (McLaren and McLaren 1982). Some broods disperse 1-8 km inland in a region of former low-shrub tundra where exposed peat is characteristic, and where grass and sedge growth is extremely limited. A smaller number of broods disperse farther inland, from 5 to 25 km or more, to forage in patches of intact sedge and grass fens beyond the coastal plain. Other broods remain within 1 km of the coastline where they concentrate their foraging on the upper marsh zone within 200 m of the coastline.

Prior to 1994 most of the light goose broods probably were lesser snow geese. Since the establishment of the large Ross's goose nesting colonies at McConnell River, large numbers of Ross's goose broods forage during the summer along the immediate coastline (usually less than 1 km from the coastline). Banding and survey data indicate Ross's geese are usually restricted to this immediate coastal area, except possibly in the McConnell River region where Ross's goose broods may travel several km inland along the north and south channels of the river. Banding and survey data also suggest Ross's goose broods are abundant as far south as the Thaane River, and it is assumed that most of these broods originate from the McConnell River nesting colonies. However, some broods may be associated with low densities of nesting Ross's geese among lesser snow geese south of McConnell River. Banding and survey data suggest Ross's goose broods may now comprise the majority of light goose broods from Wolf Creek to the Thaane River, within 1 km of the coastline, whereas only lesser snow geese are found farther inland (A. B. Didiuk, Canadian Wildlife Service, unpublished data).

During the summer brood-rearing period, both lesser snow geese and Ross's geese primarily graze on above-ground vegetation, although grubbing increases as the habitat quality deteriorates. In the upper marsh, turfs of sedges and grasses are maintained at a very low height by "picking" of short growing stems of these plants. The very long strip of upper marsh, from the Manitoba/Nunavut border to the Maguse River, tends to distribute foraging by light geese over a fairly large expanse of habitat. Flocks of broods can move long distances north and south through this habitat. Summer grazing effects by Ross's geese are primarily restricted to the upper marsh zone from Wolf Creek to the Thaane River, except in the McConnell River region where Ross's goose broods

travel up the north and south channels of the river. The precise role of lesser snow and Ross's geese on habitat degradation in this region is not clear.

In more inland areas, lesser snow geese primarily graze the upper portions of sedges and grasses, and their fruiting bodies. Some grubbing for rhizomes does occur but it appears to be very limited.

Post-fledging Period

After fledging in late August, locally breeding light geese and migrant geese from more northerly nesting areas forage in the coastal wetlands. There is no information available to determine the extent, timing, or impacts of fall foraging by light geese during this period. Grubbing for rhizomes likely begins again in the fall when grasses and sedges transfer nutrients to below-ground storage organs. Ross's geese grub for roots in the spring and probably continue to grub during the post-breeding period as well.

LA PEROUSE BAY, MANITOBA

Ross's geese historically have been observed at the La Perouse Bay colony, both as pairs and mated to lesser snow geese (usually male Ross's mated to female lesser snow geese) but their numbers have been exceptionally small. As such, their contribution to documented damage on the marsh has been proportionally minor. During the past 3 years, increasing numbers of Ross's goose families (now > 50) have been observed feeding on the long-term study marsh at the mouth of the Mast River during the brood-rearing period. Over the same time period, use of this formerly intact feeding sward by lesser snow geese has declined.

Intensive behavioral observations indicate that the light goose families feed throughout the daylight hours and often into the twilight periods (B. Pezzanite, American Museum of Natural History, unpublished data). Historically, the snow geese fed in a more crepuscular fashion with peaks near dawn and dusk. The grasses and sedges in this region have been reduced drastically both in terms of overall above-ground biomass and stem density. It appears, however, that the few Ross's geese currently using this degraded salt marsh are able to survive quite well as brood size does not decline during the season and condition of juveniles is good.

Biologists at La Perouse Bay are currently examining the impact of Ross's goose foraging on the marsh. We are particularly concerned over the impact on the revegetation potential of the degraded marsh. The numbers of snow geese raising their broods and feeding in the traditional brood-rearing areas have declined, partly due to a general shift of broods southward along the coast to other foraging areas. This decline may also be due to the stem density and sizes of remnant vegetation at La Perouse Bay being below that which will sustain them, or which is "attractive" to them. Before the Ross's geese showed up, the marsh was actually showing some increase in vegetative cover. Now that the Ross's geese are also using the area, that recovery has been

reversed. It is not clear whether the Ross's geese have different behaviors that allow them to use the reduced forage, whether they have different thresholds for foraging (from an optimal foraging view), or whether this is a coincidence.

SOUTHAMPTON ISLAND AND BAFFIN ISLAND, NUNAVUT

Although Ross's geese have been reported from both Southampton and Baffin Islands, banding and survey data suggest their numbers are small and they are relatively uncommon compared to the large numbers of lesser snow geese breeding in both these areas (Caswell et al. 1997). Similarly, there is little information available on habitat conditions and potential habitat degradation by light geese at these two islands. Given the relatively small numbers of Ross's geese on both islands, it is unlikely that Ross's geese contribute significantly to light goose foraging impacts.

SUMMARY

The large numbers of Ross's geese at QMGBS, particularly at large colonies such as Karrak Lake, result in significant impacts upon wetland vegetation. Impacts are concentrated in the actual nesting areas, which are a small proportion of the entire QMGBS. At West Hudson Bay, increasing numbers of Ross's geese at two nesting colonies result in significant impacts upon wetland vegetation. This is restricted to nesting areas in a portion of the coastal plain of West Hudson Bay, Nunavut. Low to very low numbers of Ross's geese at Southampton Island, west Baffin Island, and La Perouse Bay result in minor overall impacts on wetland vegetation by Ross's geese, particularly in comparison to the much larger numbers of lesser snow geese in those areas. There is potential, however, for Ross's geese to have a disproportionate per capita impact on already degraded habitat.

Fig. 1. Ross's goose nest at Karrak Lake (mid-June, 1997) in former sphagnum-birch habitat. Note (1) use of peat substrate for nest construction, (2) extensive barrens of exposed peat surrounding nest, and (3) absence of grasses or sedges. Photo by R. T. Alisauskas.

Fig. 2. Habitat in the center of Ross's/lesser snow goose colony at Karrak Lake after goose hatch (late July, 1999). Note (1) invasion of ragwort (*Senecio congestus*), a pioneer species associated with disturbed or damaged habitats, (2) moss carpets between ground birch (*Betula glandulosa*) typically found in low wet areas, cranberry (*Vaccinium vitis-idaea*), and Labrador tea (*Ledum decumbens*), and (3) absence of grasses and sedges. Photo by D. K. Kellett Warner.

Fig. 3. Vegetation enclosure 60 km north of Karrak Lake near the coast of Queen Maud Gulf showing cumulative impact of grazing during summer by gosling and adult Ross's and lesser snow geese on a stand of *Carex aquatilis* (mid-August, 1998). Area is used by geese originating from Karrak Lake. Photo by R. T. Alisauskas.

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