Snow Geese in Polar Bear Provincial Park: Implications of a Trophic Cascade

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Abstract

The snow goose population in Polar Bear Provincial Park has increased exponentially since the park's establishment. Over 400,000 adults were present in June 1996 and 1997 at the major nesting colony at Cape Henrietta Maria (CHM). This colony currently occupies over 400 km^2 and nearly 100 km of the coastline during nesting and 290 km during brood rearing. A second colony consisting of about 4600 adults in June 1997 has established itself at the park's western end near the Shell Brook. Another area at the park's southern end along several small rivers flowing into James Bay is used intermittently for nesting (7000 adults in June 1997). From late June to mid-August, 1993 - 1997, approximately 65% of the park's Hudson Bay and James Bay coastline was occupied by snow geese during the brood rearing period. Based on these colony counts, over 1,000,000 geese including non-breeders and young of the year would have been present in the park in early August. Cumulative effects of severe grazing and grubbing in salt marsh plant communities were abundantly evident, and the geese increasingly have used the vegetation of fresh water sedge fens and tundra as a food source. Snow goose die-offs indicative of starvation or disease were recorded in 1996 and 1997. Although no recent intensive ground studies of fauna have been made at CHM, Shell Brook, or northwest James Bay, long-term research at another expanding snow goose colony in the Hudson Bay Lowland (La Perouse Bay, Manitoba) indicated local declines in several species of shorebirds, invertebrates and vascular plants. The same is likely to have occurred at the long occupied Ontario colonies. Of significance is the fact that this snow goose population growth is driven by off-site factors, especially the use by the birds of agricultural foods from September to April during migration through prairie Canada and the U.S. and on the wintering grounds in the southern U.S. The move to agricultural foods and expansion of winter and migration range began just after World War II and accelerated in the 1960s. This has permitted increasingly higher survival of adults outside the nesting period. The cumulative and continuing habitat damage has significant and immediate implications for other plant and animal species and long-term implications for the survival of some biological communities of this wilderness park

Introduction

The lesser snow goose (*Anser caerulescens caerulescens*) population in the mid-continent region of North America has reached a record high number after a

sustained increase averaging 5% per year since the late 1960s (Abraham et al., 1996). The unprecedented increase has resulted in a substantial geographic expansion of most extant nesting colonies; the establishment and rapid growth of several new nesting colonies (Kerbes, 1994; Abraham and Jefferies, 1997); and, a terrestrial trophic cascade on nesting and spring staging (migration) areas in southern Hudson Bay (Jefferies, 1988; Kerbes et al., 1990). Trophic cascade, here, means the runaway consumption by a herbivore – the snow goose – of the primary plant species in the salt marsh community (*Puccinellia phryganodes, Carex subspathacea*). This results in a positive feedback system with subsequent degradation of soils (salinity, microbial activity), deterioration of water quality and quantity (higher evaporation rates, eutrophication) and loss of other ecosystem components (Srivastava and Jefferies, 1996).

Over-consumption has led to loss of vegetation in other habitats including fresh-water marshes. When these are heavily grazed, or suffer from selective 'shoot-pulling' of grasses and sedges, a moss carpet or other simplified plant community with very different functional characteristics develops. The consequences to geese are many, both to the individual and to the colony. Consider the example of a lesser snow goose nesting colony at McConnell River, West Hudson Bay, NWT, which was established in about 1940 (Kerbes, 1975). After growing to a peak of over 500,000 breeding individuals during the late 1970s and 1980s, the colony declined to about 150,000 individuals by 1997. This decline was accompanied by a contracted nesting area and a major northward shift of the occupied area (MacInnes and Kerbes, 1987; Abraham and Jefferies, 1997; Kerbes, unpublished data). During this period, serious goose mortality was documented (Gomis et al., 1996).

More importantly, plant communities along West Hudson Bay have been destroyed (Kerbes et al., 1990), exposing extensive peat lands devoid, or nearly devoid, of vegetation in an area about 10 km wide and 60 km long (Andrew Didiuk, pers. comm, 1997). This area is unlikely to recover quickly. Recovery time will be in the order of decades. New plant communities are unlikely to resemble the original communities. Already the plant communities found along a succession gradient from inter-tidal mud to inland fresh-water sedge assemblages is missing a seral stage: the salt-marsh plant community has been lost as a result of the foraging activities of geese (Kerbes et al., 1990; Jefferies, unpublished data).

In this paper, we describe the history and current status of snow geese nesting in Polar Bear Provincial Park, a wilderness park in the Hudson Bay Lowland of Ontario, and outline the implications of the trophic cascade to the park's ecological values.

Snow Geese in Polar Bear Provincial Park

Polar Bear Provincial Park (PBPP) was established in 1969. It contains substantial and representative areas of the Hudson Bay Lowland physiographic region, including coastal salt marshes, beach ridges and sand dunes, eskers, tundra heath and fresh-water sedge and shrub fens. The importance of the Hudson Bay Lowland for geese has long been recognized (Thomas and Prevett, 1982) and the park has been designated a Ramsar Wetland of International Importance. The park includes a maritime-tundra biome which has unique

ecological characteristics for Ontario, associated with the presence of an arctic fauna and flora, that occur near their southern limit of distribution in North America.

Nesting

At the time of establishment, the park contained a significant nesting colony of lesser snow geese of about 20,000 nesting pairs (Hanson et al., 1972) just west of Cape Henrietta Maria (CHM). By 1973, the colony reached an estimated 25,000 – 30,000 nesting pairs, and the area occupied by nesting birds was 69.1 km^2 (Kerbes, 1975). By 1979, it contained about 60,000 nesting pairs and occupied 80 km^2 (Anghern, 1979). The colony's size has not been tracked annually, but from 1994 to 1997 we undertook new surveys of the geographic size and number of nesting pairs. Our results show that the colony occupied from 350 – 450 km^2 and contained a minimum of 160,000 – 178,500 nesting pairs. A second colony became established in the early 1980s near Shell Brook at the western end of the park. In 1997, it contained approximately 2,300 nesting pairs. A third area in the park along the northwest James Bay coast, that incorporates several small river mouths from Nowashe Creek to Lakitusaki River, has had intermittent nesting for many years (Hanson et al., 1972; OMNR, unpublished data). In 1994, and again in 1997, several hundred to a few thousand pairs (up to 3750) nested in this area.

Brood Rearing

Even more startling has been the area occupied by broods for the 6 – 8 weeks after hatch and before goslings from the colony reached their flight stage. Although no exact numbers are given, Hanson et al. (1972) indicated that the 1957 brood range was concentrated in three relatively small areas, the total being less than 20 linear km of coastline. Other isolated broods were also recorded in the park between 1957 and 1970, especially near river mouths along the James Bay coast, but in total numbered only a few hundred birds (Hanson et al., 1972). During surveys in the CHM area from 1993 – 1997, we found broods along the coast from Wachi Creek on Hudson Bay (55^0 14' N, 85^0 34' W) to Nowashe Creek on James Bay (54^0 06' N, 82^0 18' W) – a distance of 290 km (a 15 fold increase since 1957). In the Shell Brook area, broods were spread from Shagamu River (55^0 52' N, 86^0 45' W) to Partridge Island, Severn River (56^0 03' N, 87^0 30' W) – a distance of 55 km.

Migration

Surveys of spring migration have been sporadic and infrequent. Surveys in 1972 and 1973 (Curtis, 1973; 1976) and later research on the bioenergetics and diets of geese (Wypkema and Ankney, 1979; Prevett et al., 1985) indicated that the northwest James Bay coast, north of Ekwan Point, had very high numbers of snow geese during the spring migration. From 1994 to 1997, our surveys throughout May documented hundreds of thousands of snow geese, small Canada geese and brant concentrated in a 125 km strip of coastal marshes between Ekwan Point and Lake River, 15% of which is in the park. In addition to birds that nest at CHM, some of the birds are destined for Baffin Island, Northwest Territories (Prevett et al., 1983). Surveys of waterfowl during fall migration along the Hudson Bay and James Bay coasts (OMNR, unpublished data, 1971 – 1986) have revealed areas of varying importance to snow geese, Canada geese, and tundra swans. In the case of snow geese, the relative value

as a staging area of PBPP in fall is lower than any other segment of the James Bay and Hudson Bay coasts of Ontario as a staging area. It has the lowest density of geese and the lowest proportion of young-of-the-year in flocks that stop over. We speculate that the situation is explained by the previously mentioned high use by spring staging birds, by the breeding birds (i.e., up to 84 million goose-days of use) and by populations of moulting Canada geese – all activities which have resulted in poor foraging conditions.

Habitat use and foraging resources

Above ground biomass is used as an index of plant production in arctic salt marshes (Cargill and Jefferies, 1984). We sampled the above-ground biomass in salt-marsh plant communities in 1993, 1994 and 1995 along the Hudson Bay and James Bay coasts from just north of Moosonee to the Manitoba-Northwest Territories border. The values from PBPP from late June and mid-July were among the lowest we found (ranging from six to 88, with most below 35 dry weight per m^2) (Jefferies and Abraham, unpublished data). Values below 35 gm per m^2 of dry above-ground biomass indicated high herbivore pressure (Hik et al., 1992) and represent a threshold that is likely to lead to adverse changes in community structure and composition. Values below 35 gm per m^2 also indicate damage to the productive capacity of the salt-marsh graminoid community (Jefferies, unpublished data).

Other quantitative measures of plant community condition have not yet been conducted in PBPP, but visual reconnaissance during our biomass sampling and during goose banding operations have confirmed the presence of several other features associated with the trophic cascade as documented at La Perouse Bay. These include a high percentage of bare ground which results from grubbing, algal mats on the soil surface, moss carpets, widespread occurrence of some indicator plant species such as *Senecio congestus,* (weedy species) and a shortage of fresh water (see below).

Implications of the Trophic Cascade

Several direct consequences arise from the high snow goose population. The most obvious is the greatly altered coastal plant communities from the period when the park was first inventoried and identified for protection. While we are not aware of the loss of any plant species from the park because no intensive surveys have been carried out, species composition has undoubtedly shifted, as is the case in other areas along the Hudson Bay coast. In addition, certain successional stages, such as the salt-marsh communities, have been lost or are badly damaged. As long as the populations of geese remain high, little recovery of any kind is likely. In addition, because the coastal salt marshes have an increasingly reduced capacity to support broods due to the loss of vegetation (see below), the geese are moving long distances, many tens of kilometres, in search of forage after hatch. They are making increasing use of more inland sedge meadow communities. Unlike salt-marsh plants, many of the dominant fresh-water plants do not have the growth characteristics such as the regrowth of leaves that allow them to compensate when intense grazing occurs. As in other areas, such as at McConnell River (Kerbes et al., 1990; Didiuk, unpublished data) and Queen Maud Gulf (Didiuk and Ferguson, 1998), these inland communities may suffer rapid and severe damage. A drop in water level in ponds devoid of vegetation in summer is accompanied by a rapid drying-out of the

exposed peaty sediment surface due to removal of the vegetation by geese. Wind erosion of this dried material may lead to the exposure of the underlying mineral layer, and where this occurs there is little likelihood of the re-establishment of aquatic vegetation. In intertidal areas, vegetation removal by geese and high evaporation leads to increasing soil salinity, and at some sites the soils become hypersaline (Srivastava and Jefferies, 1996; Abraham and Jefferies, 1997). Where geese in intertidal vernal ponds deposit large quantities of fecal material, extensive algal mats develop. When these ponds begin to dry out in the summer, dead algal mats decay. This results in anoxic conditions and loss of graminoid vegetation. Aquatic and terrestrial soil invertebrates, which are the primary foods for many shorebirds and passerines that nest and migrate throughout the park, can decrease in density and species diversity (Milakovic, unpublished data). Although no recent intensive ground studies of fauna have been made at CHM, Shell Brook, or northwest James Bay, long-term research studies at another expanding snow goose colony in the Hudson Bay Lowland (La Perouse Bay, Manitoba) indicate local declines in several species of shorebirds (Rockwell et al., 1997).

The geese suffer from the degradation of these coastal ecosystems. Declines in adult and gosling body size and high gosling mortality near the end of brood rearing have been implicated in low recruitment at La Perouse Bay (Cooch et al., 1991a, 1991b, 1993). On August 13, 1996, several hundred dead snow geese were discovered in a limited area near Mukatahship River, also known as Black Duck River, in the heart of the CHM colony (Hudson Bay Project, unpublished data). We examined about 50 carcasses, which were fairly uniformly distributed at about 20-30 m apart, rather than clustered. Gulls and foxes had scavenged some carcasses but many were intact. Both adults and goslings were found. Wing feather development showed adults to be in late stages of moult and replacement, thus the deaths had occurred just before that date. The month of July, and the two weeks prior to our observation were extremely hot and dry, with temperatures consistently over 30^{o}C. We noted the virtual absence of fresh surface water over the entire area, with the exception of a few small pools in the river bed. This drying of the salt marsh is an indirect consequence of the degradation of the plant communities, as higher evaporation rates occur where vegetation has been stripped or grazed to the surface. We speculate that the deaths resulted from over-heating and dehydration in combination with other factors such as starvation and renal coccidiosis. Bruce Batt (pers. comm.) returned to this location in early August 1997 and recorded another high mortality event, but reported that only dead goslings were found. Many appeared to have died from starvation.

Research Recommendations for Polar Bear Provincial Park

Recommendations for snow goose population reduction have been made in a report of the Arctic Goose Joint Venture (AGJV) (Batt, 1997) and endorsed by several groups: National Audubon Society; Canadian Snow Goose Coordinating Committee; and International Stakeholder's Committee (International Association of Fish and Wildlife Agencies). The recommendations emphasize broadly based and multi-agency, multi-partner involvement. They do not emphasize individual colony reductions, because nesting birds alone may not irrevocably alter the ecosystem. Instead, it is recognized that the additive pressure of destructive

foraging (grubbing) in spring and perhaps late summer by migrating and staging birds pushes the system beyond a threshold of sustainability.

As part of the monitoring of the success of any management actions, an evaluation and monitoring program is being established by the AGJV. There are three information priorities concerning the health and integrity of these coastal ecosystems in Polar Bear Provincial Park that could contribute directly to the overall evaluation and monitoring program. The first involves an investigation of the current plant and animal species composition and abundance in the park. The park's establishment phase included several life science investigations of birds and plants. The records of these studies exist in internal reports and files that have been retained at several Ontario Ministry of Natural Resources offices. Subsequent faunal surveys – primarily of birds – occurred in 1981 - 1985 (Cadman et al., 1987) and 1990 - 1991 (Wilson and McRae, 1993).

We recommend that a trends analysis of these data be attempted, and that a new investigation be implemented, one designed to capitalize on the available historic information in a context of comparing the most damaged to the least damaged –hopefully even undamaged – areas within the park. The focus would be on birds, but where feasible, invertebrates would be included. The design of such biodiversity studies has been suggested as part of the AGJV monitoring initiative.

The second priority involves intensive surveys of plant communities along the coastline of the park, systematically encompassing important snow goose migration and nesting areas, and non-snow goose areas. Included are studies of the species composition as well as the physical conditions within the coastal zone plant assemblages, productivity estimates, use and impact of the geese by and on different plant assemblages, and soil and water conditions. In part, these studies will provide a current data baseline, which is sorely needed for the park. In part, these studies will allow a tracking of the recovery of plant communities following a reduction of snow goose populations. A sampling framework and standard protocol is being prepared for the AGJV monitoring initiative.

The third priority is the periodic re-surveying of the Cape Henrietta Maria, Shell Brook and northwest James Bay snow goose nesting colonies. These surveys would be designed to detect changes in population over time, using current estimates from Hudson Bay Studies in progress as the baselines. The Hudson Bay Project Team and the Moosonee Area office, along with the Canadian Wildlife Service, are well positioned to coordinate this work and undertake some components for the Ontario Ministry of Natural Resources and Ontario Parks.

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