# EFFECT OF POPULATION REDUCTION EFFORTS ON SURVIVAL OF MIDCONTINENT LESSER SNOW GEESE.

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**Abstract:** We estimated annual survival probability of midcontinent Lesser Snow Goose (LSG) adults marked with only legbands near Queen Maud Gulf, NU ($n$ > 19,000), and La Pérouse Bay, MB ($n$ > 35,000), from 1989 to 2002. Our objectives in this talk were to (1) review annual harvest of midcontinent Lesser Snow Geese since 1989 both during the regular season and resulting from the conservation order in the U.S. or from spring seasons in Canada, (2) determine whether annual survival was negatively related to annual harvest of lesser snow geese, (3) establish whether probability of annual survival has declined since initiation of such additional harvest opportunities starting in 1998-99, and (4) assess whether survival rate has declined sufficiently to cause population decline. Results to date suggest that increased harvest was insufficient to cause a decline in either survival of most midcontinent LSG, or in population size of either Ross's Geese or midcontinent LSG that nest at Karrak Lake near Queen Maud Gulf. Our findings imply that management objectives for reduction of midcontinent LSG populations with the goal of arresting or reversing deterioration of arctic habitats should be reviewed.

# IMPACTS OF SPECIAL CONSERVATION MEASURES ON DEMOGRAPHIC PARAMETERS IN GREATER SNOW GEESE (*CHEN CAERULESCENS ATLANTICA*)

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**Abstract :**In order to stop population growth of Greater Snow Geese and protect their natural habitats from overgrazing, special conservation measures were introduced in 1998-1999 in Canada and the US. Hunting regulations were liberalized during regular fall and winter seasons and a new spring conservation harvest was introduced in Québec. Using data from our long-term study on Bylot Island, Nunavut, we evaluated the impact of these measures on demographic parameters by comparing the periods 1990-1998 vs 1998-2003. We calculated adult and juvenile kill rates and survival rates using band-recovery analyses, and also estimated reproductive rates (breeding propensity, laying date, clutch size, nesting success and fall age ratios). Kill rate more than doubled with the new measures for adults, and increased slightly in juveniles. Higher kill rates were due to the new spring harvest and the more liberal regulations in winter in the US, though not due to fall regulations changes in Québec. Annual survival decreased with the new measures in adults (from 83% to 73%) but not in juveniles. The spring harvest had a negative impact on productivity, with fall age-ratios on average 35% lower since its implementation. This was due to a reduced breeding propensity, delayed laying and reduced clutch size. Overall, the special conservation measures had a greater impact on the demography of this population than originally anticipated.

# NECKBANDS, HARVEST, AND SURVIVAL OF ROSS'S GEESE FROM CANADA'S CENTRAL ARCTIC.

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**Abstract:**We studied harvest of Ross's geese in North America by examining recoveries from 30,774 Ross's geese marked from 1989 to 2001 in Queen Maud Gulf Migratory Bird Sanctuary (QMGMBS), Nunavut, in Canada's central arctic. Continental harvest of Ross's geese began to increase in 1994 due to liberalization of hunting regulations in the Canadian Prairie provinces and the Central and Mississippi Flyways. Harvest from further liberalization of hunting regulations for light geese as part of the U.S. conservation order has accounted for < 17% of continental harvest annually since 1998. Nevertheless, continental increases in harvest of Ross's geese from ~8,000 during the 1989 hunting season to ~90,000 during the 2001 season best accounted for annual variation in adult survival probability. Survival of adults was >0.91 before 1994 but was ~0.80 by 1998-2000 hunting seasons. We found mortality probability of adults marked with neckbands was 1.94 to 2.62 times higher than for adults without neckbands. Adjustment of harvest regulations for Ross's geese in Canada is advised, with the dual objective of reducing mid-continent snow geese while conserving populations of Ross's geese on their traditional winter areas in the Pacific Flyway.

# LESSER SNOW GOOSE POPULATION TRENDS ACROSS THE NESTING COLONIES – AN UPDATE.

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**Abstract:** In 1998, the Arctic Goose Joint Venture outlined a program to monitor population trends at nesting colonies by using photo inventories at five year intervals. Although photo inventories of snow goose colonies have been done since the 1970's, intervals between surveys have ranged from 5 to 20 years at individual colonies. Photo inventories conducted in the western (1995), eastern (1997) and central (1998) arctic not only documented dramatic increases, but also established base line breeding population estimates to assess the success of subsequent management programs intended to reduce the mid-continent population of lesser snow geese. Completed portions of the latest surveys are reported, other types of surveys on various arctic colonies are described, and options for future monitoring are discussed.

# HARVEST AND CLIMATE INFLUENCES ON ANNUAL SURVIVAL AND BREEDING PROPENSITY OF EMPEROR GEESE

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**Abstract:** Numbers of emperor geese have remained depressed for 20 years, as compared to historical numbers. In life histories of geese, perturbations of adult survival have disproportionately large effects on population trends. Thus, to understand the demography contributing to these trends, we estimated the magnitude and variability of annual apparent survival among adult females. We captured, marked, and resighted emperor geese from 1994 to 2004 during nesting in June. Annual survival of geese marked with plastic tarsal bands averaged 80%, with a substantive portion of annual variation being of biological origin (i.e., not sampling error). We examined whether such variation was related to reported levels of spring subsistence harvest and weather during winter (precipitation, wind, and temperature). Winter wind and precipitation were positively associated with survival, whereas models with reported harvest fit poorly. Breeding propensity is one of several variables that collectively constitute annual resighting probability. By using ancillary data and some assumptions, we derived an index of breeding propensity. Breeding propensity appeared to vary across years and a significant fraction of the adult population apparently was not breeding. Overall, these data suggest that large scale climate variations may be contributing to the population stasis of emperor geese.

# SEASONAL ESTIMATES OF SURVIVAL, DETECTION, AND OBSERVABILITY FOR DUSKY CANADA GEESE.

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***Abstract:*** Resighting effort of marked arctic geese commonly occurs on both breeding and wintering areas. It is seldom possible to observe geese throughout breeding or wintering ranges, therefore, some individuals are unobservable during either resighting period. Estimating the probability an individual is observable is important in estimating survival and in determining movements of individuals. We demonstrate novel methods for estimating seasonal survival, detection, and observability for female dusky Canada geese (*Branta canadensis occidentalis*) collared on the Copper River Delta, Alaska from 1997-2004. We employed a seasonal multi-state survival estimator where states related to whether birds were observable during summer and winter resighting periods. We estimated seasonal survival rates of 0.823 from pre-breeding to mid-winter and 0.937 from mid-winter to pre-breeding. We estimated permanent emigration from our study area on the breeding grounds to be 0.015 annually. During winter resighting periods, the probability a bird was observable depended on observability during the previous year. Over the course of the study, birds were more likely to move into the observable state during winter leading to an overall increase in the proportion of birds that were observable. Results concerning the population biology of the Copper River Delta population are discussed.

# NECKBAND HUNTING - CAN IT AFFECT SURVIVAL ESTIMATES?

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**Abstract:** Colored neckbands reduce survival rates of geese, but the underlying cause is unknown. We tested the hypothesis that hunters selectively harvest neckbanded geese, thus lowering their survival, by comparing direct recovery rates of adult Ross's geese (*Chen rossii*) marked with various marker types. Direct recovery rates are influenced by reporting rates, so we used $100 reward bands (n=1,997) as a control sample that represented 100% reporting rates. We also marked geese with leg bands only (n=2,775), leg bands and colored neckbands (n=2,806), and leg bands with white/white neckbands (n=1,727). White neckbands were 'invisible' to hunters, but were identical to the colored neckbands in all other respects. Direct recovery rates with only leg bands was 1.4%, with reward bands 2.3%, with colored neckbands 3.6%, and with white/white neckbands 3.8%. These data suggest that (1) hunters did not selectively harvest Ross's geese with colored neckbands, (2) recovery rates of all neckbanded geese were higher than for geese marked with leg bands only, and (3) higher direct recovery rates for neckbanded birds was not caused by higher reporting rates for this marker type. We suggest that increased vulnerability to hunting plays a role in reduced survival rates of neckbanded geese, but not because the markers are visible.

# A GENERAL MODEL FOR THE ANALYSIS OF MARK-RESIGHT, MARK-RECAPTURE, AND BAND RECOVERY DATA UNDER TAG LOSS.

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**Abstract:** Estimates of waterfowl demographic parameters often come from resighting studies. In these studies, birds fit with individually identifiable neck collars are resighted at a distance. Questions have been raised about the effects of collar loss on parameter estimates, and the reliability of extrapolating from collared individuals to the population. Models have been proposed to account for collar loss, but do not allow survival or harvest parameters to depend on neck collar presence or absence. Also, few models have incorporated recent advances in mark-recapture theory that allow for multiple states or auxiliary encounters such as band recoveries. We propose a multi-state model for tag loss in which the presence or absence of a collar is considered a state variable. In this framework, demographic parameters are corrected for tag loss and questions related to collar effects on survival and recovery rates can be addressed. Encounters of individuals between formal sampling periods also can be incorporated in the analysis. We discuss data requirements for answering questions related to tag loss, and sampling designs which lend themselves to this purpose. We illustrate the application of our model using a study of lesser snow geese (*Chen caerulescens caerulescens*).

# SPATIAL AND TEMPORAL VARIATION IN BODY MASS OF PREFLEDGING EMPEROR GEESE: EFFECTS OF INTERSPECIFIC GOOSE DENSITIES AND GRAZING LAWN AVAILABILITY

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**Abstract:** The abundance of emperor geese has changed little since 1985 and remains at levels below management goals, despite efforts intended to increase this population. Estimates of adult survival obtained during this period show little variation, but estimates of recruitment have declined over the last eight years compared to the previous eleven. Previous research has shown that survival and subsequent recruitment of prefledging geese is influenced by body mass prior to fledging. Body mass of prefledging emperor geese collected at multiple locations on the Yukon-Kuskokwim Delta show both a temporal decline and evidence of spatial variation. We hypothesize that an increase in the numbers of sympatrically nesting goose species (cackling Canada geese and black brant), and subsequent competition for grazing lawn habitat has affected body mass of prefledging emperor geese. To investigate this hypothesis, we used aerial videography to sample grazing lawn habitat in 1999, 2003, and 2004 at six locations across the coastal zone of the Yukon-Kuskokwim Delta. Exclosures deployed in similar locations in 2003 and 2004 were used to estimate apparent offtake in grazing lawns. At these same locations we captured juvenile emperor geese prior to fledging from 1990 – 2004. We describe relationships between spatial and temporal variation in availability of grazing lawn habitat, trends in densities of the composite goose community, and body mass of prefledging emperor geese.

# BREEDING DISPERSAL BY ROSS'S GEESE IN THE QUEEN MAUD GULF METAPOPULATION.

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**Abstract:** We estimated rates of breeding philopatry and complementary dispersal within the Queen Maud Gulf metapopulation of Ross's Geese (*Chen rossii*). We used multistate modeling of neckband observations made at five breeding colonies, 1999-2003. Probability of philopatry was female-biased, but varied among colonies. Colony-specific dispersal probabilities ranged from 0.023 to 0.344 for females and from 0.122 to 0.376 for males. We applied movement probabilities to colony-specific population estimates and demonstrate that several thousand individuals move among colonies in a given year. Our findings (1) underscore the potential for dispersal to alter breeding distribution, (2) demonstrate that the influence of immigration on colony-specific rates of population growth is nontrivial, and (3) provide behavioral evidence for extensive gene flow. Estimates of apparent survival ranged from 0.631 to 0.682 for females, and from 0.489 to 0.546 for males. Estimates of female apparent survival from this study correspond with true survival estimates from band recovery models and suggest that the probability of permanent emigration by females was close to zero during our study. We propose that sex differences in apparent survival resulted from a combination of higher rates of neckband loss by males, and higher rates of permanent emigration by males from our study area.

# POPULATION STRUCTURE OF A GREATER SNOW GOOSE COLONY

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**Abstract** Snow geese nest in large colonies but we have little information on the degree of population structuring at the scale of the colony. Females are phylopatric to their nesting area; however, whether or not this translates into genetic differentiation on a small geographic scale is unknown. We examined the genetic structure within a Greater Snow Goose (*Chen caerulescens atlanticus*) colony on Bylot Island (Nunavut, Canada) in 2003. Most geese nest in one colony (>10,000 nests over 100 $km^2$) but move to distinct brood-rearing areas scattered over the island after hatch. We developed AFLP (Amplified Fragment Length Polymorphism) markers from blood samples to run individual-based population assignment tests to detect cryptic population structure within the colony. Both Bayesian analyses and population allocations tests revealed no genetic differentiation among 3 geographic clusters (n = 20 to 30 nests/cluster) located 3 km apart. However, a sample of 29 individuals scattered throughout the colony but previously marked on the same brood-rearing site were misassigned compared to the rest of the sampled population, which presumably included birds using different brood-rearing sites on the island. We suggest that genetic structuring may exist based on brood-rearing sites used rather than on nesting sites. We collected more samples in 2004 to confirm this pattern.

# GENETIC ANALYSIS OF NORTH AMERICAN BRANT (*BRANTA BERNICLA*) POPULATIONS

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**Abstract:** Uncertainty about subspecific and stock designations for brant (*Branta bernicla*) has the potential to influence management, including harvest. At issue is the relationship among subspecies, among breeding populations within putative subspecies, and links between breeding populations and molting, staging and wintering aggregations. To address these issues, we collected genetic data from brant sampled from representative populations from the eastern Canadian High Arctic (Light-bellied Brant, *B. b. hrota* Müller), western and northern Alaska (Black Brant, *B. b. nigricans* Lawrence), and the western Canadian High Arctic "Grey-bellied Brant". Genetic markers include 12 autosomal and 2 sex-linked microsatellite loci and the mitochondrial DNA (mtDNA) control region and cytochrome b gene. Preliminary results from mtDNA confirm the distinctness of the Grey-bellied Brant and the two nominal subspecies, whereas nuclear microsatellite data suggest connectivity among some populations representing different subspecies or stocks. For example, mtDNA data suggest the Grey-bellied Brant, while distinct, shares more recent ancestry with *B. b. hrota* than with *B. b. nigricans*; however, nuclear markers suggest connectivity with *B. b. nigricans*. These genetic markers appear to be useful in some cases for assessing the breeding source of individuals in admixed groups and help clarify links among breeding, molting, staging and wintering areas.

# WINTER FIDELITY AND APPARENT SURVIVAL OF LESSER SNOW GOOSE POPULATIONS IN THE PACIFIC FLYWAY

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**Abstract:** The western arctic contains two large populations of lesser snow geese which follow separate migration routes between the breeding areas on Wrangel Island, Russia and Banks Island, Canada to their wintering areas in the Pacific Flyway. The Wrangel Island population is composed of two subpopulations with sympatric breeding areas. The Northern subpopulation winters in the Fraser and Skagit River deltas of British Columbia and Washington and the Southern subpopulation migrates through southern Oregon and northern California and winters in the Central Valley of California where it mixes with the birds breeding on Banks Island. From 1993 to 1996 we neckbanded molting birds at their breeding colonies and resighted birds on the wintering grounds. We used multi-state capture recapture models to evaluate relative survival rates and winter fidelity and potential exchange among these populations. Our results showed similar annual survival rates between subpopulations of Wrangel Island snow geese and lower relative survival for the Banks Island birds. Fidelity to wintering areas was extremely high ($\geq$98%) in all populations with equal movement between northern and southern wintering areas for the Wrangel Island birds. Our results imply that population factors outside the wintering period may be important drivers of trend among these populations.

# RECENT CHANGES IN NUMBER AND DISTRIBUTION OF THE TAIGA BEAN GOOSE *ANSER FABALIS FABALIS* IN NORTHWESTERN EUROPE.

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**Abstract:** The Bean Goose is widely distributed in the arctic and subarctic areas of northern Eurasia from Scandinavia to eastern Russia. In the west it is represented by one tundra form *fabalis rossicus* and one taiga form *fabalis fabalis*. The Taiga Bean Goose breeds in Fennoscandia and northwest Russia and winters around the western part of the Baltic and the North Sea countries. During autumn staging the population is concentrated to a number of sites with approx. 60-75% in Sweden, whereas much smaller numbers migrate through Sweden in spring. As most European goose populations the Taiga Bean Geese increased since the early sixties to a peak of about 110 000 individuals in the late eighties – early nineties, after that in contrast to most other European Goose populations showing a decrease. During the same period there were marked changes in autumn distribution with new staging places established further north and a changed temporary pattern for the migration. The timing of spring migration also changed during the study period. The situation of the species in relation to hunting and exploitation of staging areas will also be discussed.

# POOR BREEDING CAUSES PERSISTENT DECLINE IN DARK-BELLIED BRENT GEESE.

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**Abstract:** After the spectacular recovery in numbers in the 1970s and 1980s Dark-bellied Brent (Branta b. bernicla) wintering in western Europe show a persistent decline in numbers from 314,000 in 1991-92 to less than 197,000 in 2002-03.
The average proportion of first-winter birds over this 11-year period is only 10 %, while the average annual mortality rate is 15 %. The characteristic boom years that coincided with lemming peak years on the Taimyr peninsula in northern Siberia no longer occur.
In 2004 field work in the Russian arctic showed a further increase in the number of breeding birds on small islands in the Pyasina delta, despite the overall population decline. It is hypothesized that increased predation pressure on the mainland tundra leaves these small islands where Brent nest in between Taimyr gulls (Larus heuglini) as a last resort.
Possibly lemming peak years no longer occur because of global warming affecting prolonged snow cover, on which lemmings depend for safety. Therefore nesting within ‘safe havens’ on the mainland tundra created by nesting Snowy owls could be lost as an option for Dark-bellied Brent to nest.

# EXPENSIVE MANAGEMENT: QUANTIFYING THE COSTS OF AN ACTIVE HAZING PROGRAM IN ALEUTIAN CANADA GEESE

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**Abstract:** By minimizing energy expenditure and maximizing caloric intake, spring staging geese can achieve a net surplus of energy necessary for migration and breeding. Surplus energy acquisition is influenced by uninterrupted feeding time and the quality and quantity of available foraging areas. If individuals cannot achieve sufficient reserves, they should move on to more profitable areas. Aleutian Canada geese (*Branta canadensis leucopareia*) may be shifting to more profitable spring staging areas. They have colonized two novel spring staging areas 150 km south of the traditional area where an active hazing program was implemented. We hypothesized that this shift could be due to either 1) a disparity among the traditional and novel areas in foraging opportunity and energy expenditure or 2) a disparity in forage quality and foraging habitat quantity. We calculated foraging opportunity and energy expenditure, taking into account daily time-budgets, disturbances, and commutes from the roost. We calculated the daily energetic costs of staging in each area. We analyzed forage quality from collected grass samples and quantity from GIS map imagery. We found similar foraging opportunity among areas; however, geese in the traditional area had lower abdominal fatness and higher energy expenditure. Forage quality and quantity was not different among areas.

# MULTI-SPECIES PATTERNS OF AVIAN CHOLERA MORTALITY IN NEBRASKA'S RAINWATER BASIN

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**Abstract:** Nebraska's Rainwater Basin (RWB) is a spring migration area for millions of waterfowl. Avian cholera outbreaks have occurred in the RWB since the 1970s and in some years tens of thousands of waterfowl have died. Lesser snow geese (*Chen caerulescens caerulescens*) have been associated with outbreaks in the RWB and are carriers of *Pasteurella multocida*, the causative agent of avian cholera. We used cumulative mortality curves to characterize patterns of avian cholera mortality in several waterfowl species using the RWB. Mortality patterns changed between the years prior to (1976-1988) and coincident with (1989-1999) dramatic increases in snow goose abundance and mortality. Although snow geese appeared to be disproportionately impacted by avian cholera during 1989-1999, annual mortality in several other waterfowl species was positively correlated with snow goose mortality. Coincident with increased snow goose mortality, was a significantly earlier annual onset and termination of outbreaks compared to 1976-1988. Dense concentrations of snow geese likely facilitate intraspecific disease transmission through bird-to-bird contact and wetland contamination. Rates and mechanisms of interspecific cholera transmission within the waterfowl community are more difficult to determine. Avian cholera outbreaks at spring staging areas provide an ideal system for further research into disease transmission in multi-host communities.

# RESERVOIRS FOR AVIAN CHOLERA: WETLANDS VS. BIRDS

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**Abstract:** Avian cholera, caused by the bacterium Pasteurella multocida, is the most important infectious disease affecting North American geese. However, the reservoir for the bacteria that causes the disease remains uncertain. We investigated alternative hypotheses that wetlands or waterfowl were the most likely reservoir for P. multocida and thus play an important role in maintaining the disease. Our studies provide the strongest evidence to date that wetlands are not the primary reservoir for P. multocida serotypes that cause avian cholera. In contrast, we found that some goose species, both lesser snow and Ross's geese, were carriers of the disease agent; however, greater white-fronted geese did not appear to be carriers. Serological studies indicate that enzootic avian cholera is likely occurring year-round in snow goose populations. Future research and management on avian cholera should focus on the potential role of different waterfowl species in maintenance and transmission of this disease.