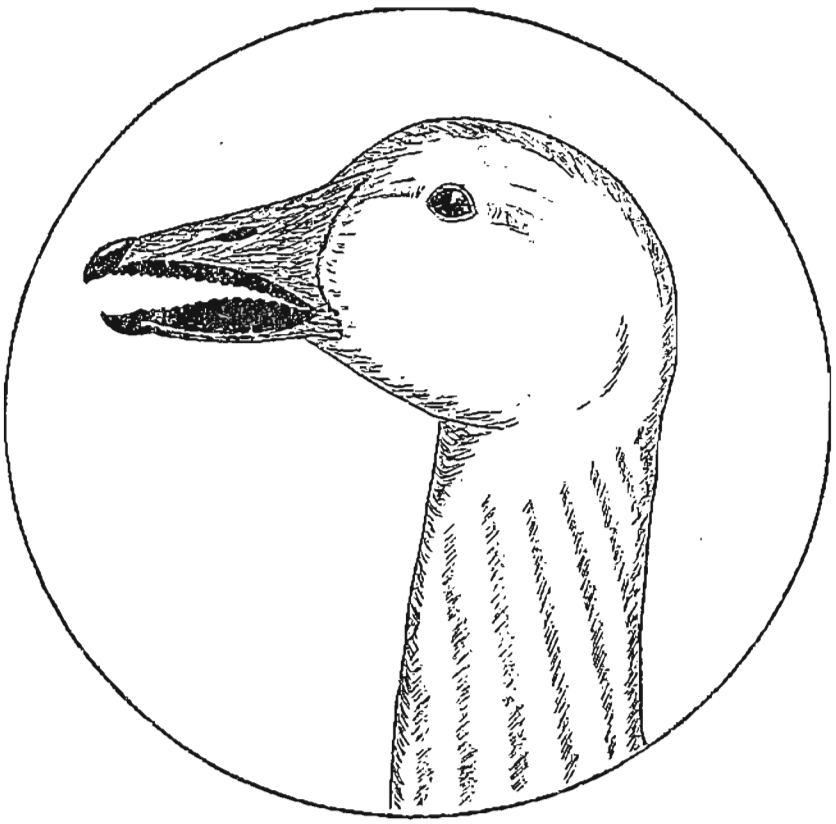
7th North American Arctic Goose Conference and Workshop

CALIFORNIA MARITIME ACADEMY

VALLEJO, CALIFORNIA

JANUARY 7-12



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DEDICATED TO THE MEMORY OF

Dennis G. Raveling
University of California
Davis, California
(1939 -- 1991)

CONFERENCE STAFF

Chairpersons

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San Luis Nat. Wildl. Refuges

Joseph G. Silveira
U. S. Fish and Wildlife Service
San Luis Nat. Wildl. Refuges

Transportation

Dan R. Yparriguirre
Calif. Dep. of Fish and Game

Laurie M. Barthman
California Waterfowl Association

Banquet

Fritz Reid
Ducks Unlimited

Workshops

Scott R. McWilliams
Univ. of Calif. at Davis

David Zezulak
California Department of Fish and Game

Field Trips

Joseph P. Fleskes
U. S. Fish and Wildlife Service
Northern Prairie Wildl. Res. Cen.

J. Gregory Mensik
U. S. Fish and Wildlife Service
Sacramento Nat. Wildl. Refuges

Daniel P. Connelly
Calif. Dep. of Fish and Game

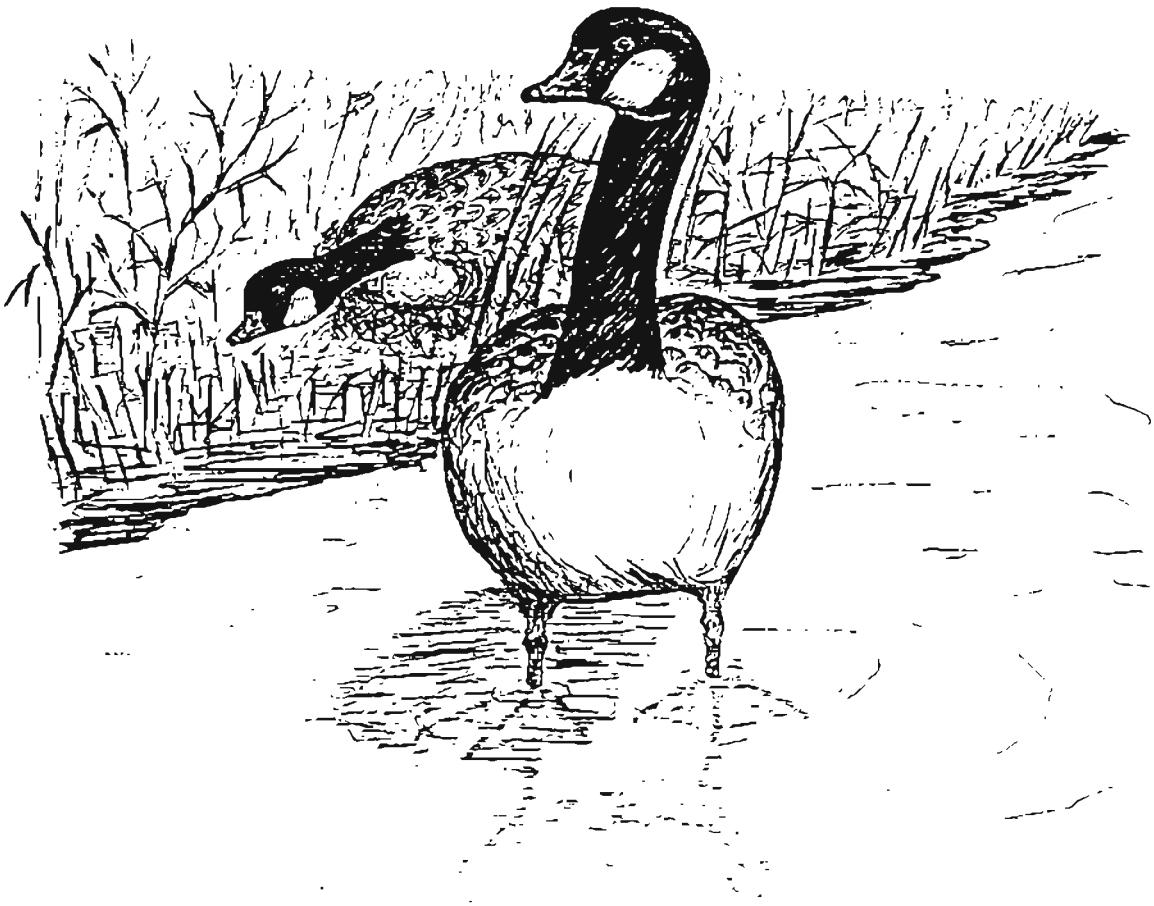
Plenary Speakers

Erwin E. Klaas
U. S. Fish and Wildlife Service
Iowa Coop. Fish and Wildl. Res. Unit

Graham Cooch
New Mexico State University

Vendors

Dennis L. Orthmeyer
U. S. Fish and Wildlife Service
Northern Prairie Wildl. Res. Cen.



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WELCOME STATEMENT

Over the past 40 years, knowledge about waterfowl ecology has progressed at a rapid pace. This knowledge has resulted from research that is stimulated by the public's desire to maintain large populations of ducks, geese, and swans. Much of the progress is understanding waterfowl has come from studies of geese. Their widespread distribution, adaptability, and conspicuous habits have generated widespread fascination and fruitful research efforts. Many of the findings from studies of geese have produced insights and successful management, now only of geese, but other more elusive species of waterfowl as well.

The Seventh North American Arctic Goose Conference and Workshop (formerly the North American Snow Goose Conference) marks a significant step forward in the world of waterfowl. It is the first time the conference has been held outside of Canada, and the first attempt to promote broad scale interaction between scientists and the waterfowl managers of the Arctic Goose Joint Venture. The Golden State is a fitting place for this landmark meeting; nowhere else are the issues facing waterfowl so complex and so urgent to address as they are in this state. This is the battleground where the future of waterfowl and wetlands will be determined.

WELCOME TO CALIFORNIA!!!

In Memory...

Dr. Dennis Raveling, of Davis, California, died of cancer on August 12, 1991 at the age of 52. He was a professor of wildlife specializing in waterfowl ecology at the University of California at Davis. In addition to being a leader in the development of the nationally respected Wildlife and Fisheries Biology Department at the University of California at Davis, Dr. Raveling was intimately involved with research and management of waterfowl throughout North America.

The passing of Dr. Raveling followed an arduous two years of suffering, throughout which he managed to remain actively involved in the scientific profession, working to assure his dreams for a sound future for waterfowl. During his lifetime, Dr. Raveling was the recipient of several awards for his scientific endeavors; he was given The Wildlife Society's Special Recognition Service Award in 1990, and most recently Dr. Raveling was presented the 1991 California Waterfowl Award from the California Department of Fish and Game.

Dr. Raveling's dedication and skill, recognized worldwide, have inspired students and professionals alike in the quest for enlightened approaches in examining waterfowl ecology and developing solutions to management challenges. Although best known for his research on Canada Geese, "Rav" fostered a tireless pursuit of truth on many waterfowl issues. Often running contrary to entrenched approaches, Dr. Raveling's thinking has served as a vital catalyst to meet current waterfowl challenges. His thoughts remain with the many graduate students and colleagues he left behind. His favorite sayings have special meaning for all of us: "Keep the faith" and "Forge ahead".

In memory of Dr. Raveling, any excess funds from the Arctic Goose Conference will be donated to the Dennis Raveling Scholarship Fund (managed by the California Waterfowl Association).

GENERAL INFORMATION

INFORMATION

Welcome to the 7th North American Arctic Goose Conference and Workshop! The staff of the California Maritime Academy (CMA) and volunteers from other organizations are here to help you. If you have any questions regarding any aspect of the conference, do not hesitate to ask someone. Official staff members helping with the conference will be wearing blue name tags so they should be easy to find.

REGISTRATION

Registration will be open 7-8 January in the Foyer of the Auditorium from 12:00 noon to 10:00 p.m., and 9 January from 7:30 a.m. to 1:00 p.m.

NAME TAGS

Your name tag is your pass for admittance to all activities and meal service except the banquet at Marine World Africa, USA (tickets required, space is limited).

EVENTS AND FACILITIES

Please see the Schedule of Events on the following pages for specific times of events. The CMA campus map is included in this booklet for your convenience. The majority of conference activities will be scheduled for the Admiral Rizza Auditorium, Main Dining Room, or Main Parking Lot (for off campus trips). The Napa Valley Poster Session will be held at Robert Mondavi Winery, Rutherford, California. Please make sure you are on time for all events.

Banquet tickets for Marine World Africa, USA will be on sale at the registration desk in the Foyer of the Auditorium. However, space is limited so sign-up early. The Red and White Fleet Ferry Service is available for trips to San Francisco. The departure area in Vallejo is approximately 10 minutes from CMA. A ferry schedule will be available upon request from the registration desk.

FOOD SERVICE

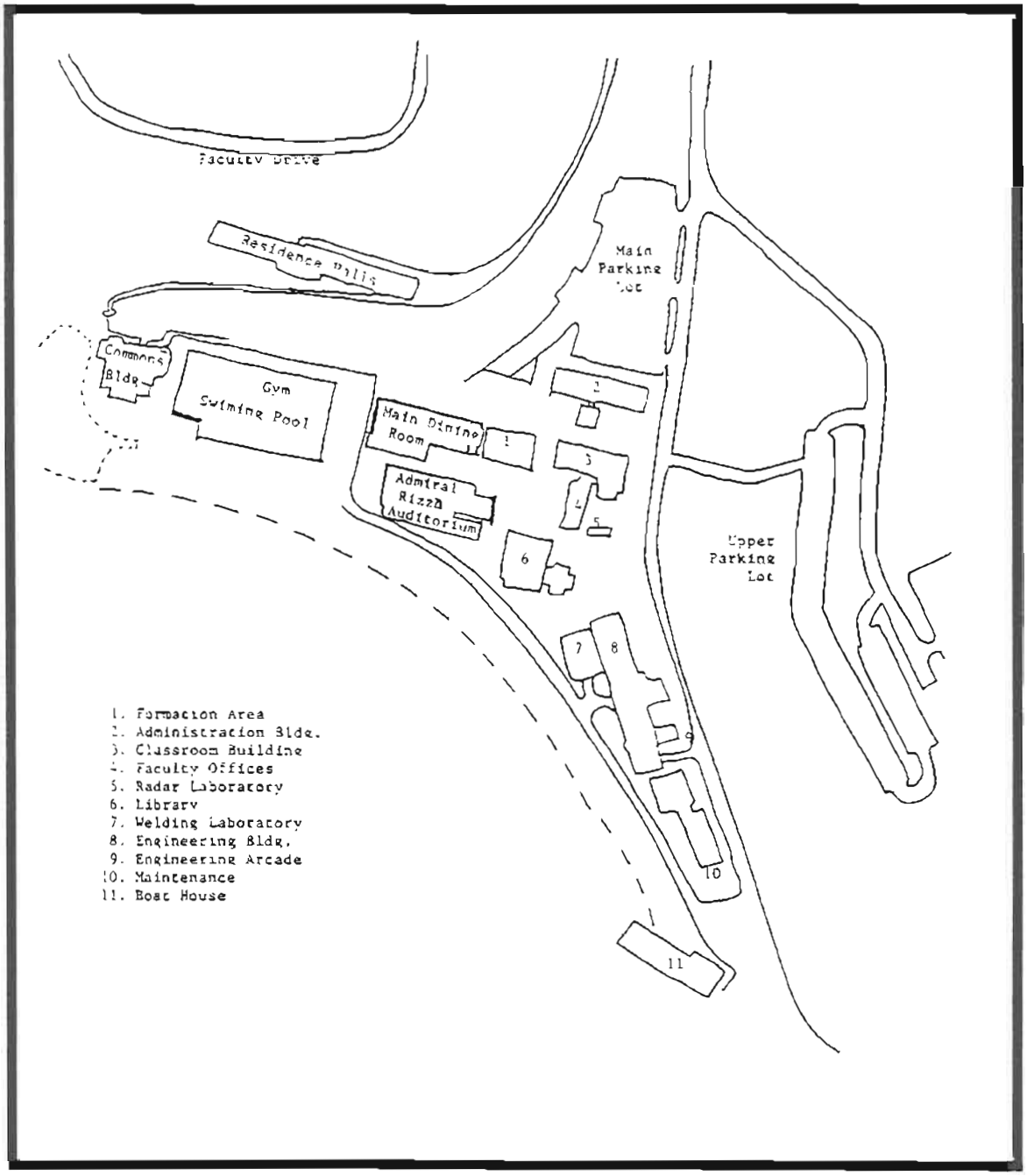
All food service will be provided in the CMA Main Dining Facility. Sack lunches and continental breakfast will be served on Saturday and Sunday.

TELEPHONE AND MAIL SERVICES

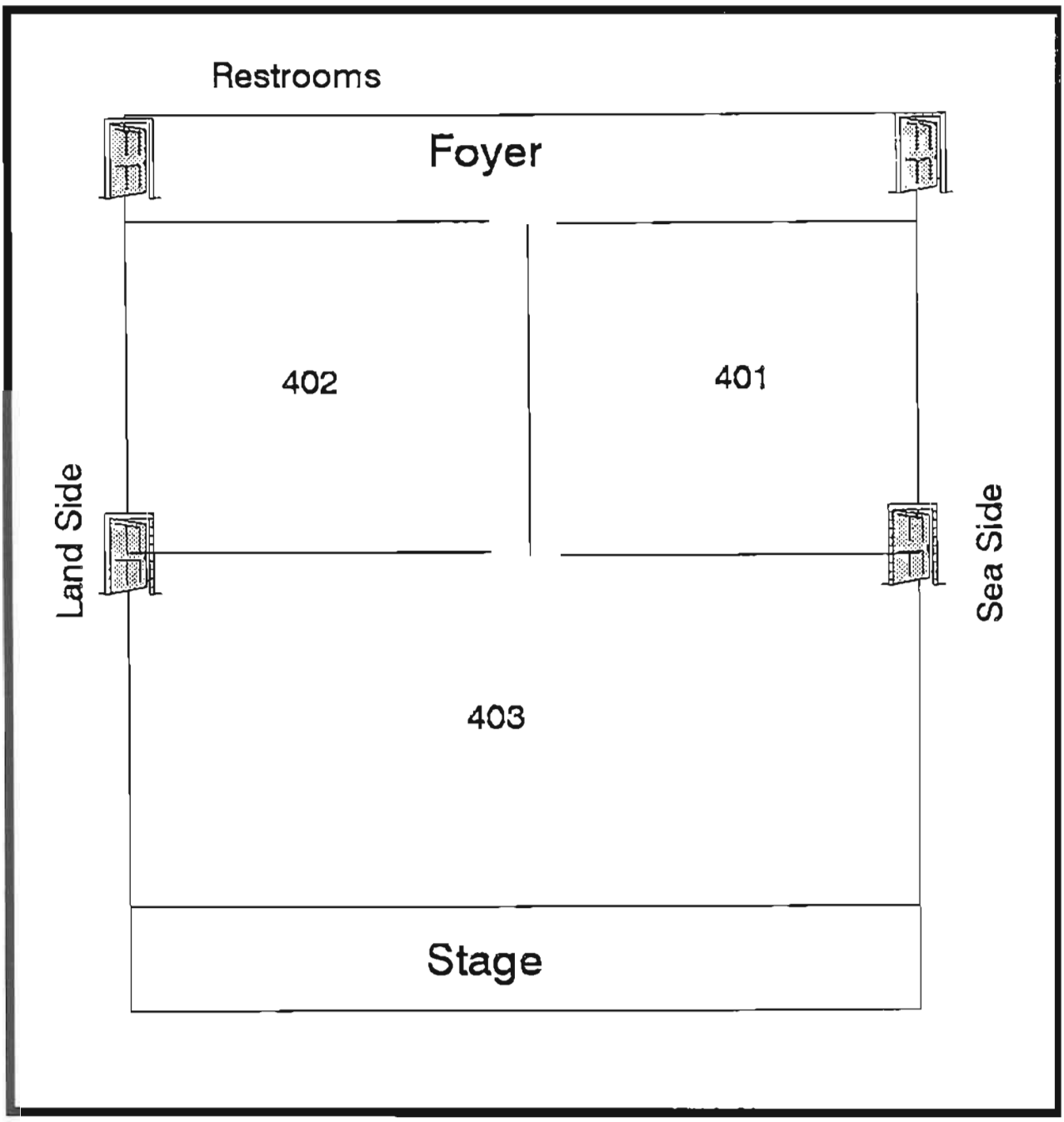
The CMA Residence Halls have a pay phone on each floor. A pay phone is also located in the Main Dining Facility. A mail box is available behind the Main Administration Building.

CMA Telephone Numbers: 707/648-4150 (daytime)
707/648-4200 (emergency)
707/648-4204 (FAX)

CALIFORNIA MARITIME ACADEMY CAMPUS MAP



ADMIRAL RIZZA AUDITORIUM MAP



SCHEDULE OF EVENTS
(Overview)

Tuesday, January 7

12:00 - 10:00 . . . . . Registration
5:30 - 6:30 . . . . . Dinner
7:00 - 11:00 . . . . . Mixer (Host: California Waterfowl Association)

Wednesday, January 8

6:00 - 6:45 . . . . . Continental Breakfast
7:00 - 5:30 . . . . . Sacramento Valley Field Trip
5:30 - 6:30 . . . . . Dinner
8:00 - 11:00 . . . . . Welcome Reception

Thursday, January 9

7:00 - 7:45 . . . . . Breakfast
8:00 - 8:30 . . . . . Welcome and Introduction
8:30 - 9:50 . . . . . Plenary Session I
9:50 - 10:10 . . . . . Break
10:10 - 11:30 . . . . . Plenary Session II
11:30 - 12:30 . . . . . Lunch
12:30 - 2:00 . . . . . Paper Session I
2:00 - 2:30 . . . . . Break
2:30 - 4:00 . . . . . Paper Session II
4:00 - 4:30 . . . . . Arctic Goose Joint Venture - Special Session
5:30 - 6:30 . . . . . Dinner
8:00 - 10:00 . . . . . Workshops: I - III

Friday, January 10

7:00 - 7:45 . . . . . Breakfast
8:30 - 10:00 . . . . . Paper Session III
10:00 - 10:30 . . . . . Break
10:30 - 12:00 . . . . . Paper Session IV
12:00 - 1:00 . . . . . Lunch
(Sack Lunch for Poster Session Participants)
1:00 - 5:00 . . . . . Napa Valley Poster Session
5:30 - 6:30 . . . . . Dinner
8:00 - 9:00 . . . . . Workshop IV

Saturday, January 11

7:00 - 7:45 . . . . . Breakfast
8:30 - 10:00 . . . . . Paper Session V
10:00 - 10:30 . . . . . Break
10:30 - 12:00 . . . . . Paper Session VI
12:00 - 1:00 . . . . . Lunch
1:00 - 3:00 . . . . . Paper Session VII
3:00 - 3:30 . . . . . Break
3:30 - 5:30 . . . . . Paper Session VIII
7:00 - 11:00 . . . . . Dinner Banquet & Farewell Ceremonies

Sunday, January 12

6:00 - 6:45 . . . . . Continental Breakfast
7:00 - 6:00 . . . . . Delta Field Trip

DETAILED SCHEDULE OF EVENTS

Tuesday, January 7

12:00 - 10:00 **Registration**, California Maritime Academy
Admiral Rizza Auditorium foyer

5:30 - 6:30 **Dinner** - Main Dining Room
7:00 - 11:00 **Mixer** - Wardroom, rear of Main Dining Room
(Host: California Waterfowl Association)

Wednesday, January 8

6:00 - 6:45 **Continental Breakfast** - Main Dining Room
7:00 - 5:30 **Sacramento Valley Field Trip** (All day) - This all-day trip to Sacramento, Delevan, and Colusa National Wildlife Refuges, Gray Lodge State Wildlife Area, and Butte Sink duck clubs will be on tour buses. Biologists working in the Sacramento Valley will serve as tour guides to provide informed commentary and respond to questions. **Lunch is included**. Meet at main parking lot at 6:45.

5:30 - 6:30 **Dinner** - Main Dining Room
8:00 - 11:00 **Welcome Reception** - Wardroom, rear of Main Dining Room

Thursday, January 9

7:00 - 7:45 **Breakfast** - Main Dining Room
8:00 - 8:30 **Welcome and Introduction** - North American Arctic Goose Conference co-chairmen, M. Robert McLandress (California Waterfowl Association) and John Y. Takekawa (U. S. Fish and Wildlife Service - Northern Prairie Wildlife Research Center), will open the conference and provide information regarding conference events (Admiral Rizza Auditorium, Room 403).

8:30 - 11:30 **Plenary Session: A Holarctic View of Arctic Nesting Geese** (Main Auditorium)
Chair - James S. Sedinger, University of Alaska

8:30 Myrfyn Owen and Jeffrey Black. The Svalbard barnacle goose - lessons from a nonconsumptive study. The Wildfowl and Wetlands Trust, United Kingdom

9:10 Evgeni V. Syroechkovski. Adaptations of the Euroasian geese and swans to Arctic conditions, Academy of Sciences, Ringing Centre, Russian Commonwealth

9:50 - 10:10 **Break**

10:10 Rudolf Drent. Energy balance and Arctic geese: balance in relation to the green wave hypothesis. University of Groningen, Netherlands

10:50 Fred Cooke. The snow geese of La Perouse Bay: the fourth decade. Queen's University, Canada

11:30 - 12:30 **Lunch** - Main Dining Room

12:30 - 2:00 **Paper Session I: Reproductive Effort - Proximate and Ultimate Factors**
Chair - Ray T. Alisauskas, Canadian Wildlife Service

12:30 Gauthier, G. Diet, food quality and food intake of pre-laying and laying greater snow geese.

12:45 Choiniere, L. and G. Gauthier. Reproductive energetics of female greater snow geese (*Chen caerulescens atlantica*) on Bylot Island (N.W.T.), Canada.

1:00 Cooch, E. G., D. B. Lank, R. F. Rockwell, and F. Cooke. Is there a relationship between body size and fecundity in lesser snow geese?

1:15 Reed, A., and J. Hughes. Incubation behavior and body weights of female greater snow geese.

1:30 Rockwell, R. F., E. G. Cooch, C. B. Thompson, and F. Cooke. Do older birds also do less well?

1:45 Bousfield, M. A. and D. B. Lank. Evidence for higher mortality of successfully nesting snow geese following severe weather during brood-rearing on Wrangel Island.

2:00 - 2:30 **Break**

2:30 - 4:00 **Paper Session II: Gosling Growth and Survival - Roles of Habitat, Behavior, and Hatch Date**
Chair - Evan G. Cooch, University of Pennsylvania

2:30 Hughes, J., A. Reed, and G. Gauthier. Habitat use by brood-rearing greater snow geese.

2:45 Manseau, M. and G. Gauthier. Brood-rearing habitats in greater snow geese: a comparative study based on the animal perception of its environment.

3:00 Laing, K. K., and D. G. Raveling. Habitat and food selection by emperor goose goslings.

3:15 Williams, T. D. Fidelity to feeding area: costs or benefits in brood-rearing lesser snow geese?

3:30 Lindholm, A. and G. Gauthier. Hatch date, food quality and growth of juvenile greater snow geese.

3:45 Flint, P. L., and J. S. Sedinger. Factors affecting survival of black brant goslings.

4:00 - 4:30 **Special Session: The Arctic Goose Joint Venture**

Ladd, W. Overview and status of the Arctic Goose Joint Venture.

5:30 - 6:30 **Dinner** - Main Dining Room

8:00 - 10:00 **Workshop Session: Arctic Nesting Goose Population Issues**

A choice of three concurrent two-hour workshops are available. During the first hour of each workshop, short presentations will be given by researchers active in the field (listed below). The remainder of each workshop will be either panel or question/answer format.

1) Jeffries, R. L., R. Drent, and J. Bedard. Reciprocal interactions between geese and their food plants.

This workshop will examine how geese are affected by their food plants and how the plant community is affected by foraging geese.

Researchers from a variety of nesting and wintering locations will present data. Management implications of recent findings and innovations in research methods will be discussed.

2) Nichols, J. D., and J. Hestbeck. Survival analysis.

The topic of this workshop will be estimating survival rates for geese marked with leg bands, neck collars, and radio transmitters. Recent survival models and computer packages that are available for analysis of leg band, neck collar, and radio telemetry data will be discussed. The panel will focus on selection of methods which best accomplish study objectives, including in-depth discussion of data collection methods and analysis techniques.

3) Jarvis, R. L., M. Owen, G. V. Byrd, J. G. Mensik, A. X. Dzubin, I. Kostin, and V. V. Baranyuk. Where have all the geese gone?

The status of selected threatened or rare geese (i.e. Aleutian Canada, red-breasted, barnacle, tule greater white-fronted) will be examined with a case-study approach. A round table discussion on research priorities and creative strategies for population enhancement will take place.

Friday, January 10

7:00 - 7:45 **Breakfast** - Main Dining Room

8:30 - 10:00 **Paper Session III. Goose-Environment Interactions Outside the Breeding Season I**
Chair - W. Sean Boyd, Canadian Wildlife Service

8:30 Taylor, E. J. Mass and condition of molting Pacific black brant on the Arctic coastal plain, Alaska.

8:45 Hupp, J. W., and D. G. Robertson. Forage site selection by lesser snow geese in an arctic tundra ecosystem.

9:00 Dau, C. P. The fall migration of Pacific Flyway brant (*Branta bernicla*) in relation to climatic conditions.

9:15 Frederick, R. B., W. R. Clark, and J. Y. Takekawa. Migrating white-fronted geese in the Klamath Basin: application of a computer simulation model.

9:30 Leyva, R. I., J. Y. Takekawa, and E. E. Klaas. Movement and habitat use by greater white-fronted geese wintering in Mexico.

9:45 Hill, M. R. and R. B. Frederick. Movements and habitat use of wintering greater snow geese on the Delmarva Peninsula.

10:00 - 10:30 **Break**

10:30 - 12:00 **Paper Session IV. Goose-Environment Interactions Outside the Breeding Season II**
Chair - Scott R. McWilliams, University of California at Davis

10:30 Miller, D. L., F. E. Smeins, and J. W. Webb. Influence of lesser snow goose herbivory on mid-Texas coastal marsh dynamics.

10:45 Boyd, W. S. Interaction between Wrangel Island snow geese and their winter habitat on the Fraser (B.C.) and Skagit (Wash.) Deltas.

11:00 Alisauskas, R. T., and K. Hobson. Determination of snow goose diets and distribution during winter using stable isotope analysis.

11:15 Dunn, J. P., S. R. McWilliams, B. Obst, and D. G. Raveling. Comparisons of apparent metabolizabilities and nutrient uptake for cackling Canada geese fed grass or alfalfa.

11:30 Giroux, J. F., R. de Koster, and R. Bergeron. Use of a new staging area by greater snow geese in Quebec.

11:45 Prop, J. Individual variation in feeding behavior and body reserves in spring staging geese.

12:00 - 1:00 **Lunch** - Main Dining Room
Sack Lunch for Poster Session Participants - Depart at 12:00.

1:00 - 5:00 **Poster Session. Robert Mondavi Winery, Napa Valley.** Buses will be provided for transportation to the winery. Please meet at the main parking lot at 12:45.
Chair - Craig R. Ely, U. S. Fish and Wildlife Service

1. Kerbes, R. H., K. M. Meeres, and H. Boyd. Some unexpected results of the international snow and Ross' goose project.

2. McKelvey, R. W., R. H. Kerbes, J. G. Silveira, and V. V. Baranyuk. Migration patterns of lesser snow geese nesting on Wrangel Island, USSR.

3. Takekawa, J. Y. Documenting the fall migration route of Wrangel Island lesser snow geese with a miniature satellite transmitter.

4. Schwitters, M. T. Observations of neckbanded white geese at Freezeout Lake, Montana.

5. Oates, R. M. Observations of leg-banded and neck-collared western mid-continent white-fronted geese from Alaska.

6. Silveira, J. G., and J. G. Mensik. Where have all the geese gone?

7. Woolington, D. W., and J. G. Silveira. Current habitat acquisition programs in the northern San Joaquin Valley, California.

8. Poyarkov, N. D. On the recent state of the swan-goose population in Russia.

9. Gerasimov, N. The present status of bean geese present on Kamchatka peninsula: current research and conservation problems.

10. Krechmar, A. V. Distribution and ecological aspects of the white-fronted goose (*Anser albifrons*) in the Russian Far East.

11. Eldridge, W. D., J. I. Hodges, Jr., and R. M. Malecki. Goose surveys of the Chukotka Peninsula, USSR: potential and problems.

12. Bocharnikov, V. N., and Yu. N. Gluschenko. Khanka Lake wetlands and their use by goose populations.

13. Gurtovaya, E. Population differences in the nesting behavior of lesser snow geese.

14. Litvin, K. The role of arctic fox predation in the nesting success of arctic geese.

15. Burgess, R., and R. J. Ritchie. Nest censuses and nest distribution in the snow goose colony on Howe Island, Alaska, 1984-1990.

16. Burgess, R. M. The relative influence of oil-development related disturbance and environmental factors on activity budgets of nesting snow geese at Howe Island, Alaska.

17. Wilkinson, R. C., and K. Kertell. Modelling snow goose habitat for impact assessment.

18. Butler, W. I., Jr., R. A. Stehn, G. R. Balogh, F. Gerhardt, and R. Platte. An aerial survey-GIS for developing waterfowl distribution and density maps.

19. Anthony, R. M., W. Anderson, J. S. Sedinger, and L. L. McDonald. Estimating brant populations with airborne video.

20. Sojda, R. Field biologists' need for goose neck-band information.

21. Gregoire, P. Arctic Goose Joint Venture.

22. West, R. L., and T. C. Rothe. The Yukon-Kuskokwim Delta goose management plan.

23. Wilson, D. J., and R. L. Jefferies. Plant growth and the availability of nitrogen in a grazed arctic salt marsh.

24. Gadallah, F., and R. L. Jefferies. Forage quality and gosling nutrition in the lesser snow goose.

25. Srivastava, D. S., and R. L. Jefferies. The foraging activities of lesser snow geese and the degradation of arctic salt marshes.

26. Hik, D. S., R. L. Jefferies, and A. R. E. Sinclair. Effects of isostatic uplift and grazing by lesser snow geese on the dynamics of salt marsh communities.

27. Jefferies, R. L. Grazing and plant growth.

28. Bazely, D. R., R. H. McCleery, and H. H. T. Prins. Does the grazing optimality model have any relevance for wintering Barnacle geese?

29. Miller, D. L., F. E. Smeins, and J. W. Webb. *Scirpus olneyi* recovery following utilization by wintering lesser snow geese on a Mid-Texas coastal marsh.

30. Sloat, T. R., and S. R. McWilliams. Using prescribed burning to manage habitat for spring migrating arctic nesting geese.

31. Black, J. M., C. Carbone, R. L. Wells, and M. Owen. Foraging dynamics in goose flocks: the cost of living on the edge.

32. Reed, A., R. Lalumiere, and R. Benoit. Use of eelgrass meadows by brant on the northeast coast of James Bay: a progress report.

33. Ganter, B. Activity budgets of lesser snow geese prior to incubation.

34. Babcock, C. A., and R. E. Gill, Jr. Activity budgets of cackling Canada geese during fall staging on the Alaska Peninsula.

35. Slattery, S. M., and R. T. Alisauskas. Brood dispersal in Ross' and lesser snow geese: does the brood rearing distance influence gosling growth and survival?

36. Cooch, E. G., R. L. Jefferies, R. F. Rockwell, and F. Cooke. Local variation in growth rates of lesser snow goose goslings.

37. Choudhury, S., and J. M. Black. Mate choice in barnacle geese: an experimental design.

38. Warren, S. M., A. D. Fox, A. Walsh, H. J. Wilson, and P. O'Sullivan. Extended parent-offspring relationships in the Greenland white-fronted goose.

39. Warren, S. M., A. D. Fox, A. Walsh, and P. O'Sullivan. Age of first pairing and breeding amongst Greenland white-fronted geese.

40. Marshall, A., and J. Black. The effect of rearing experience on subsequent behavioural traits in Hawaiian geese (*Branta sandvicensis*): implications for the recovery programme.

41. Petersen, M. Intraspecific nest parasitism among emperor geese.

42. Lindberg, M. S., J. S. Sedinger, R. F. Rockwell, D. V. Derksen, and K. S. Bollinger. Natal and breeding dispersal of black brant.

43. Rockwell, R. F., J. Sedinger, D. Derksen, and M. Lindberg. Dispersal, gene flow, and population genetic structure of Pacific black brant.

44. Rockwell, R. F., D. Lank, and F. Cooke. On the heritability of fitness components in lesser snow geese.

45. Ratner, S., R. Rockwell, and E. Cooch. A skeletal view of structural size of lesser snow geese.

46. Kuznetsov, S. B. The electrophoretical analysis of proteins and enzymes of *Anser* and *Branta* geese.

47. Avise, J. C., R. T. Alisauskas, W. S. Nelson, C. D. Ankney. Matriarchal population genetic structure in an avian species with female natal philopatry.

48. Bromley, R. G., and B. Croft. Summer plumage of greater white-fronted geese in relation to age.

49. Thomas, N. J. A summary of necropsy findings in wintering Aleutian Canada geese, 1976-1991.

50. Lafon, A. Snow goose feeding ecology in Chihuahua, Mexico.

5:30 - 6:30 **Dinner** - Main Dining Room

8:00 - 9:00 **Additional Workshop Session: Body Measurements of Geese.**

Cooch, E. G., and A. X. Dzubin. Techniques for morphological measurements.

Saturday, January 11

7:00 - 7:45 **Breakfast** - Main Dining Room

8:30 - 10:00 **Paper Session V: Disturbance - Geese as Victims?**
Chair - Dirk V. Derksen, U. S. Fish and Wildlife Service

8:30 Anderson, B. A., S. M. Murphy, and M. T. Jorgenson. Seasonal patterns of habitat use by geese in the Prudhoe Bay oilfields, Alaska, 1985-1989.

8:45 Burgess, R. M., and A. A. Stickney. Reaction of brood-rearing snow geese to oil-development related and natural disturbances in the Endicott development area, Alaska, 1985-1990.

9:00 Murphy, S. M., and B. A. Anderson. The effects of the Lisburne oil development project on geese nesting in Prudhoe Bay, Alaska, 1985-1989.

9:15 Burgess, R. M. The relative influence of oil development related disturbance and environmental factors on activity budgets of brood-rearing snow geese at Howe Island, Alaska.

9:30 McWilliams, S. R., J. P. Dunn, and D. G. Raveling. Eagle predation on cackling Canada (*Branta canadensis minima*) and Ross' geese (A. rossii) geese wintering in California with comments on the reaction and susceptibility of Great Basin Canada geese (*B. c. moffitti*) to eagle predation.

9:45 Ely, C. R., and C. A. Babcock. The great white peril: tundra swans as predators of arctic geese.

10:00 - 10:30 **Break**

10:30 - 12:00 **Paper Session VI: Survival Rates of Geese and Their Markers**
Chair - Robert Trost, U. S. Fish and Wildlife Service

10:30 Bell, M. C., M. Owen, and J. M. Black. Evaluation of the use of Jolly-Seber models in the estimation of annual survival rates of barnacle geese *Branta leucopsis* wintering on the Solway Firth.

10:45 Sheaffer, S. E., and R. L. Jarvis. The status of dusky Canada geese: an examination of past and present trends in survival and population size.

11:00 Schmutz, J. Estimates of seasonal survival in emperor geese.

11:15 Fox, A. D., M. C. Bell, and A. Walsh. Changes in patterns of mortality amongst Greenland white-fronted geese under protective legislation in Ireland.

11:30 Yparraguirre, D. R., P. F. Springer, and S. G. Torres. Annual and semi-annual survival rates of Aleutian Canada geese.

11:45 Johnson, S. R. and G. F. Searing. Neck collar loss rate in adult male and female lesser snow geese.

12:00 - 1:00 **Sack Lunch** - Auditorium Foyer

1:00 - 3:00 **Paper Session VII: Population Structure - Past and Present I**
Chair - Robert G. Bromley, Northwest Territories

1:30 Ritchie, R. J., P. W. Banyas, J. G. King, A. A. Stickney, and S. Hamilton. Distribution and abundance of arctic geese in Alaska's North Slope oilfields.

1:45 Orthmeyer, D. L., J. Y. Takekawa, and C. R. Ely. Morphological differences in greater white-fronted geese populations from the Pacific Flyway.

2:00 Merendino, M. T., C. D. Ankney, D. D. Dennis, and J. L. Leafloor. A morphometric study of giant (*Branta canadensis maxima*) and interior Canada geese (*B. c. interior*) of the southern James Bay population (SJBP) in Ontario.

2:15 Dzubin, A. X. Increases of blue geese in western Canada and Saskatchewan over the past decade: an update.

2:30 Drewien, R. C., W. M. Brown, and J. P. Taylor. Some population parameters of light geese wintering in the Rio Grande Valley, New Mexico and in Chihuahua, Mexico.

2:45 Quinn, T. W. The genetic legacy of mother goose.

3:00 Kurechi, M., Y. Sabano, and S. Uemura. Population status of white-fronted goose *Anser albifrons* wintering in Japan.

3:15 - 3:30 **Break**

3:30 - 5:30 **Paper Session VIII: Population Structure - Past and Present II**
Chair - Graham Cooch, New Mexico State University

3:30 Robertson, D. G., A. F. Jennings, and R. D. Slack. Movements and fidelity of snow geese wintering in Texas.

3:45 Taylor, J. P., and R. E. Kirby. Wintering light goose population response to management practices in the middle Rio Grande Valley, N.M., 1987-1991.

4:00 Trost, R., et al. Indirect population estimates for cackling Canada geese based on neckband observations.

4:15 Butler, W. I., Jr., R. A. Stehn, and W. D. Eldridge. Aerial surveys of geese nesting on the Yukon-Kuskokwim Delta, Alaska.

4:30 Campbell, B. H. Recent changes in production and population trends of the dusky Canada goose.

4:45 Bromley, R. G., and B. Croft. Breeding population estimates inversely correlated to nest success in greater white-fronted and Canada geese.

5:00 Baranyuk, V. V. Wrangel Island lesser snow geese population status, numbers, and structure and problems of protection.

5:15 Boyd, H. Changing goose numbers: what's wrong with the NAWMP?

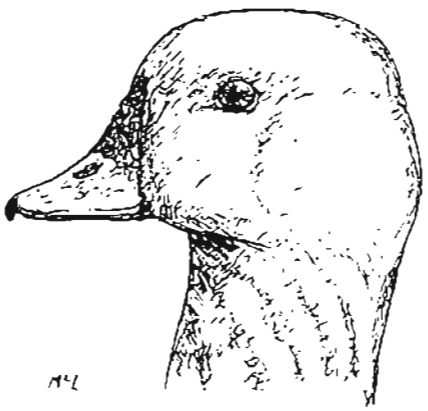
7:00 - 11:00 **Banquet and Farewell Ceremonies** - Marine World Africa USA
Banquet Speaker: Hugh Boyd, Canadian Wildlife Service - "The Golden Years"

Buses will be provided to and from Marine World Africa USA. Please meet at the main parking lot at 6:30 p.m..

Sunday, January 12

6:00 - 6:45 **Continental Breakfast**

7:00 - 7:00 **San Francisco Bay Delta Field Trip** - San Francisco Bay is one of the largest estuaries in the world. The confluence of the Sacramento-San Joaquin Rivers forms one of the most important waterfowl areas in the Pacific Flyway. This field trip through the Delta will include information about the history of the Delta islands and observations of impressive waterfowl concentrations.



VENDORS

Commercial vendors will be open in the Ward Room of the Main Dining Facility and available for walk-through on January 9-11 from 8:00 a.m. to 6:00 p.m. The following vendors will be participating:

Mr. Corey Grey
Coda Enterprises
1038 Norwood
Mesa, AZ 85203

Mr. Chris Ralston
Terra-Mar Res Information Services
1937 Landings Drive
Mountain View, CA 94043-0839

Mr. Frank Croft
Erdas Inc.
4000 Blue Oaks Drive Suite 200
Gilroy, CA 95020

Ms. Linda Burrough
EOSAT
4300 Forbes Blvd
Latham, MD 20706-9954

Ms. Barbara Kermeen
AVM Instrument Co.
2368 Research Drive
Livermore, CA 94550

Mr. Richard Reichle
Advanced Telemetry Systems
470 1st Ave. N.
Isanti, MN 55040

Mr. Osamu Ikuta
Nippon Telegraph and Telephone
New Technology and Business Dept.
Affiliated Business and Department Hdqtrs.
Tokyo, Japan

BOOKSTORE

The North American Arctic Goose Conference Bookstore will be open on January 9 and January 11 from 8:00 a.m. to 6:00 p.m. in the Admiral Rizza Auditorium.

North American Arctic Goose Conference Bookstore
San Francisco Bay National Wildlife Refuge
P.O. Box 524
Newark, CA
510/792-0222

ABSTRACTS

Contributed Papers

Abstracts are arranged alphabetically by first author

Note: The enclosed abstracts were reformatted but otherwise printed as provided by authors, except for minor editing for style and syntax. Information contained herein should not be cited without first obtaining author approval.

DETERMINATION OF SNOW GOOSE DIETS AND DISTRIBUTION DURING WINTER USING STABLE ISOTOPE ANALYSIS

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KEITH A. HOBSON, Department of Biology, University of Saskatchewan, Saskatoon, SK, Canada S7N 0W0

We measured stable-isotope ratios of carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$), in lipid-extracted breast muscle of 30 lesser snow geese (*Chen caerulescens caerulescens*) collected in winter from 3 distinct habitat types: coastal marsh in Louisiana, rice agriculture in Texas and corn agriculture in Iowa. We also measured concentrations of the same stable isotopes in 5 winter foods important to geese: tubers and rhizomes from coastal marsh habitat, monocot and dicot green vegetation and non-agricultural seeds from rice prairie habitat and corn from agricultural habitat. With the exception of *Spartina* rhizomes from marsh habitat and forbs from rice prairie, foods were segregated isotopically. This provided potential for isotopic segregation of geese wintering in the 3 habitat types. Stable-isotope ratios of goose muscle tissue correctly classified 64%, 86% and 75% of geese collected from corn, marsh and rice habitats, respectively; however, if only geese from rice and marsh habitats were considered, 86% of rice geese were correctly classified as were 100% of marsh geese. Outliers were presumably birds that had moved between habitat types or individuals which had not consumed "average" diets from within habitats. The application of this technique for assigning geese to geographic areas or habitats is discussed.

SEASONAL PATTERNS OF HABITAT USE BY GEESE IN THE PRUDHOE BAY OILFIELDS, ALASKA, 1985-1989

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M. TORRE JORGENSON, Alaska Biological Research, Inc., P.O. Box 84338, Fairbanks, AK 99708

We monitored the seasonal habitat use of 4 species of geese (Canada geese, greater White-fronted geese, brant, and snow geese) in Prudhoe Bay from May to September, 1985-1989. This study was designed to assess the effects of additional oilfield development (Lisburne Development Project) on geese already using the area. We conducted road surveys and mapped the locations of all geese during the pre-nesting, nesting, brood-rearing, and fall-staging seasons. We also mapped habitats within the 63 km^2 study area and calculated available area for each habitat. Pre-nesting geese occurred in mixed-species flocks primarily near roads in habitats that are snow-free due to the "dust-shadow" created by frequent truck traffic. As the snow receded, geese moved away from roads or to areas where traffic is less frequent. By early June, most geese have selected nest sites. Nesting Canada geese preferred islands in small lakes and ponds, whereas greater white-fronted geese nested on the tundra away from ponds. Brant nested colonially in lakes with islands. Snow geese nested almost exclusively on Howe Island, 10 km east of Prudhoe Bay. Brood-rearing Canada and greater white-fronted geese congregated in small flocks on moist and wet tundra adjacent to large lakes that were used for predator avoidance. Brant and snow geese preferred coastal habitats for brood-rearing, particularly halophytic wet meadows (i.e., Arctic salt marshes). Both Canada and greater white-fronted geese also used moist and wet meadows during fall-staging and select areas that remain green later into fall, including habitats near terrain disturbances (i.e., roads and pads) that prolong plant phenology. Brant and snow geese rarely stage in the oilfield. Oilfield activities affect use of habitats directly through habitat loss and temporary changes in availability (e.g., impoundments) and indirectly through disturbance.

ESTIMATING BRANT POPULATIONS WITH AIRBORNE VIDEO

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WILLIAM ANDERSON, Center for Mapping, Ohio State University, 1216 Kinnear Road, Columbus, OH 43212

JAMES S. SEDINGER, Institute of Arctic Biology and Department of Biology and Wildlife, University of Alaska, Fairbanks, AK 99775-0180

LYMAN L. McDONALD, Western EcoSystems Technology, Inc., 2676 East Otero Place, Suite 11, Littleton, CO 80122

We used a video camcorder mounted in a Cessna 206 aircraft to sample brant densities in nesting colonies in western Alaska. Pacific black brant congregate in May-June on the coast of the Yukon-Kuskokwim Delta in several dense nesting colonies. These high concentrations of brant in well defined areas make sampling with aerial transects feasible. Our goals were to reduce disturbance as well as improve the precision of estimates from currently employed on-the-ground samples in nesting areas. A vertically-oriented camcorder was used to record 12-m wide strip transects systematically spaced across nesting areas. Video scenes were recorded at an altitude of 150 m and ground speed of 150 km/hour with the camera set at 80-mm focal length, 1/1000-second shutter speed, and focus on infinity. Location of flight paths (latitude-longitude), time, date, and transect numbers were recorded with a portable computer interfaced with the aircraft's LORAN navigation device. Date, time, and audio notes were recorded on the video tape to facilitate analysis of the images. Independent counts of brant on nests and unoccupied nests by two observers from freeze-frame images on a high resolution (400 lines) video monitor were used to make density estimates. Proportion of known nests identified by each observer were used to compute observability correction factors. Comparisons of nests counted by both observers also were used to estimate nesting density. Video images corroborated previous observations that aircraft flying overhead at $\geq$150 m do not cause nesting brant to flush. Although images must be manually interpreted on the screen, estimates of time required to process images (about 15-20 hours for 30-40 minutes of video tape) indicated that this procedure makes annual estimates of colony size feasible with minimal disturbance and greatly reduced costs compared to other alternatives.

MATRIARCHAL POPULATION GENETIC STRUCTURE IN AN AVIAN SPECIES WITH FEMALE NATAL PHILOPATRY.

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WILLIAM S. NELSON, Department of Genetics, University of Georgia, Athens, GA, 30602

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We employed mitochondrial (mt) DNA markers to examine the matrilineal component of population genetic structure in the snow goose Chen caerulescens, a species that has been described as "...the best documented example of male biased natal and breeding dispersal..." in an avian species (Greenwood 1980). From banding returns, it is known that females typically nest at their natal or prior nest site, whereas males pair with females on mixed wintering grounds and mediate considerable nuclear gene flow between geographically separate breeding colonies. Despite site philopatry documented for females, mtDNA markers show no clear distinctions between nesting populations across the species' range from Wrangel Island, USSR to Baffin Island in the eastern Canadian Arctic. Two major mtDNA clades (as well as rare haplotypes) are distributed widely and provide one of the few available examples of "phylogeographic category II" (Avise et al. 1987), in which phylogenetic discontinuity in a gene tree exists without obvious geographic localization within a species' range. The major mtDNA clades may have differentiated in Pleistocene refugia, and colonized current nesting sites through recent range expansion via pulsed or continual low-level dispersal by females. The contrasts between results of banding returns and mtDNA distributions in the snow goose raise general issues regarding population structure: direct contemporary observations on dispersal and gene flow can in some cases convey a misleading impression of phylogeographic population structure, because they fail to access the evolutionary component of population connectedness; conversely, geographic distributions of genetic markers can provide a misleading impression of contemporary dispersal and gene flow because they retain a record of evolutionary events and past demographic parameters that may differ from those of the present. An understanding of population structure requires integration of both evolutionary (genetic) and contemporary (direct observational) perspectives.

ACTIVITY BUDGETS OF CACKLING CANADA GEESE DURING FALL STAGING ON THE ALASKA PENINSULA

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ROBERT E. GILL, JR. U.S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center, 1011 E. Tudor Road, Anchorage, AK 99503

Cackling Canada geese were studied on fall staging areas at Cinder Lagoon and Ugashik Bay on the Alaska Peninsula between 1985 and 1988. Each fall we recorded continuous samples of diurnal behaviors for marked geese of known age and sex. The proportion of time spent in various behaviors differed significantly with respect to age, sex, family status, time of day, and phenology of the staging period. Adult and hatching-year geese differed significantly in feeding 74% and 79% of the day, respectively. The proportion of time spent alert was significantly higher for adults compared to hatching-year geese (11% vs. 5%), males compared to females (11% vs. 7.5%), and for families and pairs compared to single geese (11% vs. 6%). As migration neared, geese increased the amount of time feeding from 69% to 79%, with complimentary decreases in the proportion of the day spent resting and alert. These differences appear to be linked to higher nutrient and energy requirements necessary for first migration and in overall developmental growth.

WRANGEL ISLAND LESSER SNOW GEESE POPULATION STATUS, NUMBERS, AND STRUCTURE AND PROBLEMS OF PROTECTION

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The Wrangel Island lesser snow goose (*Anser caerulescens caerulescens*) population (WSG) comprises more than 98% of Asian snow geese in one large colony in the Tundra River Valley, where more than 90% of the breeding population nests. Nesting away from the main colony occurs near snowy owl nests and varies from a few to hundreds of nests in a colony. In general, fluctuations in the size of WSG correlates with success of nesting in the main colony. In 1970, WSG amounted to 150,000 birds. After 4 years of unsuccessful nesting, the number of geese decreased to 57,000. In the second half of 1970s, the population increased to 100,000 and maintained this level until the end of 1980s when it fell to 60,000 after 3 years of unsuccessful nesting. In relation to wintering areas, the WSG can be divided into 2 sub-populations: northern (Washington-BC) and southern (California). The ratio of birds in the northern sub-population to the number in the southern sub-population was 33:65 in 1980 but is 52:48 now. The geese of these 2 sub-populations differ phenotypically and genetically. As a result of using different habitats, geese of these 2 sub-populations differ in appearance: geese of the northern sub-population use salt marshes in winter and return to Wrangel Island with intensive red faces. In spring the geese of the southern sub-population have white, yellow, or bright-orange faces. The geese of these 2 sub-populations have different reproductive success in some years (different brood size) in the main colony. In relation to total number of successful nests, the percent of successful nests of the northern sub-populations varied from 51-75%. Out of main colony, the ratio of nesting birds of the northern sub-population to the southern one is 30:70. The WSG is now in a critical state and needs effective measures of protection. The southern sub-population is a matter of greatest concern: the size of the northern sub-population is close to that of 1970, but the size of the southern sub-population is now 4 times less than in 1970.

EVALUATION OF THE USE OF JOLLY-SEBER MODELS IN THE ESTIMATION OF ANNUAL SURVIVAL RATES OF BARNACLE GEESE WINTERING ON THE SOLWAY FIRTH

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J. M. BLACK, The Wildfowl and Wetlands Trust, Slimbridge, Gloucestershire, United Kingdom GL2 7BT

It is known that the population of Svalbard-breeding barnacle geese (*Branta leucopsis*) which winters on the Solway Firth in northern Britain is virtually closed. The population has been extensively studied since 1970, and a more comprehensive body of information on production, reproductive success and survival has been gathered than for any other Western Palaearctic goose population. The annual resighting rate of leg-ringed birds is in excess of 95%, so that annual survival rates amongst ringed birds may be calculated with a high degree of precision, simply by assuming that any bird not seen in two successive seasons was dead. The opportunity has been taken of evaluating the use of Jolly-Seber type models in investigating patterns of mortality in Arctic-breeding goose populations. Time and age-dependent survival and resighting rates are estimated from resightings of ringed birds using the program SURGE, and compared with their 'known' values. The effects of sample size and of different sampling strategies are considered. SURGE has already been used in the estimation of annual rates of survival of Greenland white-fronted geese *Anser albifrons flavirostris* wintering in SE Ireland.

FORAGING DYNAMICS IN GOOSE FLOCKS: THE COST OF LIVING ON THE EDGE

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MYRFYN OWEN, The Wildfowl & Wetlands Trust, Slimbridge, Gloucestershire, United Kingdom GL2 7BT

The effects of flock position on foraging performance of individual barnacle geese *Branta leucopsis* were determined by comparing foraging behavior, vegetation quality and diet of geese located at the edge and centre of feeding flocks. Birds on the edge of flocks feed in a hurried fashion compared to centre positions (shorter bouts of foraging) probably because of the increased amount of vigilant behavior and aggressive encounters. In energetic terms, however, the costs of grazing and vigilance balance out, so that it is as 'expensive' to feed in either flock position. Geese appear to obtain more food when in edge positions because they peck faster and obtain more food per peck as a result of the higher biomass of grass. A series of calculations which includes measures of energy expenditure, gross intake and energetic quality of food show that the net energetic payoff of birds in edge positions was substantially higher than that of those in the centre. We speculate on the relative merits of taking positions in the flock edge for single geese, pairs and families. The finding that dominant families most often inhabit edge positions and avoid the centre, and the fact that families attack neighbors more often than do any other geese, suggests that they actively attempt to monopolize the best food resource available to flock members which is usually on the edges of the flock.

KHANKA LAKE WETLANDS AND THEIR USE BY GEESE POPULATIONS

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Y. N. GLUSCHENKO, Pacific Institute of Geography, Far East Branch, USSR Academy of Sciences, Vladivostok, Russian Commonwealth 690032

Khanka Lake is a vast and shallow wetland situated in the western part of Pimorsky krai and northeastern part of Chinese Heilongsian province (44°32' - 45°14'N, 132°00' - 132°52'E). The total area of wetlands of international importance is 310,000 ha but 50,000 ha of these wetlands have been developed. Original elements of the wetland landscape are "plavni". These are dense hydrophilic plants (*Cyperacea, Calamagrostis, Phragmites, Zizania*) with tightly tangled rhizomes and peat float on the surface of shallow-water sites. According to the value of the wetland for migrating geese, wetlands and rice fields are distinguished. The total area of rice fields was 65,800 ha by 1985. These are main goose feeding sites. Eight goose species are recorded using the Khanka Lake and 3 of them are vagrant (*Branta bernicla, Chen caerulescens, Eulabria indica*). *Anser anser* and *Anser cygnoides* are known to breed in the area. The breeding population of *Anser anser* is 30 pairs, but recent low water levels on Khanka Lake have resulted in decreasing numbers. The molting of *A. anser* takes place in the same habitats. The total number does not exceed 300 molting individuals. The molting period is from mid-June until late July. In summer, A. anger makes regular flights to rice fields. In the past 30 years, only 1 brood of *A. cygnoides* has been recorded (in 1976). Migration of *A. albifrons* and *A. fabalis* is characterized by a well-defined flight, a long staging period, and formation of considerable flocks in the south and southwest parts of Prikhankayakaya lowland. Mass migration begins in the third week of March and lasts until late April. Roosting sites are on ice flows and in gullies, and after the ice melts, they gather in open water and marsh areas. During the day, geese regularly fly to rice fields to feed. There were up to 130,000 geese simultaneously recorded in good years (1978, 1981, 1990) and 30,000 in other years on Khanka Lake. The majority of flocks is composed of *A. albifrons* and this account for 70-90%. The largest flocks of geese were counted in the mid-1970s. This was the result of the expansion of the rice field area and large seed losses during harvest. The roost sites of the goose population are now in the territory of Khanka Nature Reserve, which was established in 1990. Managers are now considering prohibiting hunting in the feeding habitats.

EVIDENCE FOR HIGHER MORTALITY OF SUCCESSFULLY NESTING SNOW GEESE FOLLOWING SEVERE WEATHER DURING BROOD-REARING ON WRANGEL ISLAND

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An unusually long period of poor weather, beginning a week after peak hatch, stretched throughout the brood rearing period of the lesser snow geese (*Anser caerulescens caerulescens*) on Wrangel Island, USSR, in 1989. At least 5000 adults and nearly all of the 63,000 goslings died from the combined effect of the weather and predation by Arctic foxes in a low lemming year. We compared the survival rates of unpaired adult geese, and paired birds which had hatched or failed to hatch young prior to this severe episode of selection, by tabulating sightings of neck-banded birds at migratory stopover and wintering areas. Unsuccessful nesting birds had the highest resighting rates, while successful nesters and unpaired birds, especially females, were underrepresented. The differences were more pronounced for females known to have spent the previous winter in California rather than in Washington and British Columbia; but paired, unsuccessful nesting females had similar resighting rates in both locations. The larger difference in resighting rates in California suggests that differences in mortality related to pair and hatching status persisted on migration. Under these unusual conditions, the most successful nesting adults apparently suffered unusually greater mortality.

INTERACTION BETWEEN WRANGEL ISLAND SNOW GEESE AND THEIR WINTER HABITAT ON THE FRASER (B.C.) AND SKAGIT (WASH.) DELTAS

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Lesser snow geese from Wrangel Island, USSR, winter on the Fraser (B.C.) and Skagit (Wash.) Deltas. I am documenting the seasonal and annual changes in abundance and distribution of these geese and patterns of interaction between them and their habitat. Air photo counts have revealed that the Fraser/Skagit population is essentially a closed one from mid-November onwards. Since the mid-1970s, the peak number and the number of goose-days on the Fraser Delta have increased by 3 to 4 times. Use of the Fraser Delta can be split into fall/early-winter versus spring staging periods. Goose distribution changes considerably between those periods due to differences in hunting pressure and foraging requirements. In fall and early-winter, the highest concentrations of geese are found on marshes and fields that are protected from hunting. In spring, however, the geese concentrate on marshes near the river mouths where newly emerging stems of sedge (*Carex lyngbyei*) are abundant. The entire Fraser flock moves to the Skagit in mid-winter, possibly in response to a 40% decline in the abundance of their major fall/early-winter food item, bulrush (*Scirpus americanus*) rhizomes. Non-destructive and destructive sampling efforts inside and outside exclosures have revealed definite spatial and temporal patterns in goose use of the bulrush zone. Also, an equilibrium between the growth and consumption of rhizomes appears to have been established, at least during recent years.

CHANGING GOOSE NUMBERS: WHAT'S WRONG WITH THE NAWMP?

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There are many more geese in North America now than there were in 1955, though the growth of most populations slowed during the 1980s. The general increase in goose numbers has been accompanied by shifts in midwinter distribution: more geese are now found in the middle-tier and northern states ("short-stopping"). Scenarios of climate changes in response to the effects of increasing concentrations of "greenhouse gases" suggest that winters in the interior of North America will become warmer, and probably wetter, with less marked changes near the Pacific and Atlantic coasts. Were those changes to occur, they might be expected to assist the changes in goose distribution seen in recent decades. Yet in most of the nine major climatic regions of the USA winter temperatures fell from the 1950s to the 1970s and, though rising in the 1980s, are not yet markedly above the long-term means for 1895-1983. Moreover, except for brant in Washington, the numbers of geese wintering in northern and middle-tier states have not been directly related to temperatures in winter, or in the preceding fall. An unpublished study of waterfowl wintering in the Atlantic flyway in the 1960s and 1970s suggested that the winter distribution of Canada geese was affected more by local precipitation in the previous summer, through its effects on crop yields, than by current conditions. More extensive studies along those lines are needed before the roles of climate in the USA in determining the distribution and survival of wintering geese can be well understood. Scenarios of future climatic change do not suggest that geese will encounter insurmountable problems in adapting to altered conditions, unless changes in farming practices greatly reduce current supplies of unharvested cereals and grass.

DOES THE GRAZING OPTIMALITY MODEL HAVE ANY RELEVANCE FOR WINTERING BARNACLE GEESE?

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McNaughton (1983,1984) has suggested that for some herbivores, some optimal grazing pressure may exist at which forage availability is maximized. In this grazing optimality model, there is a non-linear relationship between grazing pressure and vegetation growth with growth maximized at some intermediate grazing pressure. There is also an implicit assumption that some optimal return time exists for the herbivore which maintains this pressure. We investigated whether this model has relevance in explaining the foraging patterns of wintering barnacle geese (*Branta leucopsis*) on red fescue (*Festuca rubra*) dominated swards on the salt marshes of Schiermonnikoog, The Netherlands. From April to May 1989, experiments in which captive barnacle geese grazed *Festuca*-dominated swards at different grazing pressures showed that at intermediate pressures, biomass production was significantly greater than for control (ungrazed) and more intensively grazed sites. From February to April 1989, we investigated whether *Festuca*-dominated swards on the salt-marsh with different grazing histories, imposed by exclosing swards from wintering geese on different dates, varied in rates of forage production. We also monitored goose grazing patterns to determine whether swards were grazed in some predictable way, related to grazing pressure and rates of forage regrowth. While forage production varied with grazing history, the major factor influencing vegetation growth was a severe high tide in March 1989, which caused massive vegetation die-back. Geese subsequently abandoned these grazing sites. These results indicate that while (1) vegetation can respond to variation in grazing pressure in a non-linear way, and (2) while some optimal grazing pressure and therefore some optimal return time may theoretically exist, for wintering barnacle geese on Schiermonnikoog, random disturbances are likely to be more important in influencing forage growth than goose grazing pressure.

BREEDING POPULATION ESTIMATES INVERSELY CORRELATED TO NEST SUCCESS IN GREATER WHITE-FRONTED AND CANADA GEESE

ROBERT G. BROMLEY, Department of Renewable Resources, Government of the Northwest Territories, Yellowknife, NT, Canada XIA 2L9

BRUNO CROFT, Department of Renewable Resources, Government of the Northwest Territories, Yellowknife, NT, Canada XIA 2L9

We surveyed breeding populations of greater white-fronted geese (WFG) (*Anser albifrons frontalis*) and Canada geese (CG) (*Branta canadensis hutchinsii*) on 80 km^2 in the central Canadian Arctic from 1986 through 1991. Standard helicopter surveys (50 m above ground, 90 kmph, 400 m transects with 2 observers and 1 navigator) covering 20% of the area were conducted within the first 8 days of incubation each year. Birds were recorded as singles, paired or flocked. Nest success, usually Mayfield, was determined for both species each year. Population estimates varied annually from 240 to 1030 for WFG and from 340 to 1219 for CG. Nest success varied from 0.034 to 0.940 and from 0.050 to 0.900 for WFG and CG respectively. Annual nest success was inversely correlated with population estimates for both WFG ($r=-0.946$) and CG ($r=-0.887$). Precision of population estimates for WFG varied widely (range of $cv=0.089$ to 0.427), but was less variable for CG (range of $cv=0.119$ to 0.226). The proportion of birds flocked was fairly consistent for WFG (0.43 to 0.60), and negatively correlated with the population estimate ($r=-0.571$). The proportion of CG in flocks varied more widely (0 to 0.41) and was positively correlated with the population estimate ($r=0.717$). Sightability of each species was likely different, and contributed to these different results. Our study indicates that, even with fairly intensive coverage (eg. 20%), breeding population estimates may be inaccurate and vary widely and significantly from year to year. Based on ground work, we believe these indicated population changes occurred in a manner largely unrelated to actual or likely population fluctuations. Due to influential factors such as early reproductive failure, population estimates may be rendered meaningless. However, if survey results can be demonstrated to be consistently correlated to other population parameters, such as reproductive success, they may still be worth pursuing.

SUMMER PLUMAGE OF GREATER WHITE-FRONTED GEESE IN RELATION TO AGE

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During late July and early August from 1987 to 1991, we banded greater white-fronted goose (*Anser albifrons frontalis*) goslings in the central Canadian Arctic. We photographed the black ventral markings on a sample of recaptures of known age (yearlings, actually 13 months = 15 male, 11 female; 2-year olds = 8 male, 17 female; 3-year olds = 3 male, 6 female; and 4-year olds = 1 male, 2 females). This sample included 7 individual birds recaptured during 2 consecutive years. Based on scoring of photographs by 10 objective (inexperienced) observers, males had more black ventral feathering than females for all age groups (1, 2 and 3+). When given the sex of the bird in the photograph, and the average score of black ventral feathering for each age and sex class, observers were most accurate at assigning yearlings to the correct age class, but considerably less so for 2-year olds and older. Even yearlings were incorrectly aged about 20% of the time. Incorrect aging of 2-year olds was largely due to over-estimation of age, while the 3+ class was consistently under-estimated. Bill nails and toe nails were examined for dark pigmentation on a sample of the yearlings. Few retained the dark coloration on the bill nail characteristic of juvenile birds, while 65% had some dark pigmentation remaining in the toe nails, of which lateral streaking was the most frequent form. This was also observed in adults of unknown age, although it was restricted to only one side of the nail. When used in combination, these characteristics may help in more accurate identification of yearlings on the Arctic breeding grounds. Reliable identification of yearlings is desirable for behavioral, age composition and spring hunt studies.

NEST CENSUSES AND NEST DISTRIBUTION IN THE SNOW GOOSE COLONY ON HOWE ISLAND, ALASKA, 1984-1990

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Censuses of avian nests on Howe and Duck Islands on the Sagavanirktok River Delta have been conducted annually since 1984. Beginning in 1985, two census methods were used; a post-hatch ground search for nests and (for snow geese) aerial photography during incubation. Evaluation of ground, aerial, and combined census techniques on Howe Island suggests that counts of snow goose nests by aerial photography alone provided a quick and reasonably accurate estimate of numbers. Ground census of nests after hatching provided a more precise estimate of snow goose nest numbers, and was the only method available for other species (e.g., brant, common and king eiders, Baird's sandpipers). Limitations of the ground census were more apparent in years during which large numbers of nests failed. In all years, the best estimates of nest numbers (for snow geese) were provided by combining the 2 methods. Aerial photographs allowed mapping of avian nests at a resolution of several meters. Nest maps and available information on snow goose nests on the Sagavanirktok River Delta indicate that several changes in distribution have occurred since the early 1970s. Nest distribution appears to be controlled by nest-site availability (as determined by snow cover in late May/early June), fidelity of individual geese to specific locations, and natural and development related disturbance. These results indicate that restriction of development activities in the vicinity of the colony during incubation (primarily the restriction of air traffic) were justified and largely effective, and that similar caution should be exercised during any future development activities in the region to avoid undue impact on snow geese.

REACTIONS OF BROOD-REARING SNOW GEESE TO OIL-DEVELOPMENT RELATED AND NATURAL DISTURBANCES IN THE ENDICOTT DEVELOPMENT AREA, ALASKA, 1985-1990

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Disturbance monitoring and behavioral observations were conducted during the brood-rearing period of snow geese, 1985-1990, in the Sagavanirktok River Delta, Alaska, as part of a scientific program to monitor the environmental effects of the Endicott Development Project, an oil and gas recovery project situated offshore of the Sagavanirktok River Delta. The behavioral reactions of brood-rearing snow geese were recorded whenever natural or development-related disturbances were observed. To compare disturbances, an index of severity was calculated for each reaction observed. Severity was based on the level of behavior exhibited (from alert to flying away), the duration of reaction, and the distance moved. The most severe disturbances during brood-rearing were those that caused snow geese to flee: banding drives, tundra swans, raptors, foxes, humans on foot, low altitude fixed-wing aircraft, boats, and slowing or stopping vehicles within 50 m. The primary responses of brood-rearing snow geese to aircraft were alert postures and movement (usually walking) to water. Road traffic was by far the most frequently observed disturbance. The primary response of brood-rearing snow geese to most types of road traffic was an alert posture. However, more severe reactions were caused by maintenance vehicles (especially mobile cranes) and vehicles that slowed or stopped; these disturbances elicited longer duration reactions and movement in more geese than other disturbances. It was difficult to evaluate reactions to stationary structures, like the elevated road and pipeline, but reactions to the pipe were obvious during attempted pipeline crossings. Although the road/pipe corridor was not an absolute barrier to movement of geese, reactions and distribution in the vicinity of the corridor suggest that it is a temporary impediment.

THE RELATIVE INFLUENCE OF OIL-DEVELOPMENT RELATED DISTURBANCE AND ENVIRONMENTAL FACTORS ON ACTIVITY BUDGETS OF BROOD-READING SNOW GEESE AT HOWE ISLAND, ALASKA

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Activity budgets of brood-rearing male and female snow geese in the Sagavanirktok River Delta, Alaska, were obtained by instantaneous scan sampling of focal individuals, 1988-1990. Observations were made in two brood-rearing areas, one near the access road for the Endicott Development Project (an offshore oil and gas production project in the Beaufort Sea), and another in an undeveloped area approximately 1.8-3.6 km west of the road. The hypotheses that traffic levels on the Endicott Road had no effect on activity budgets of brood-rearing male and female snow geese was rejected (ANOVA). In both sexes, alerts and walking increased and resting decreased with increasing traffic. Year/proximity (a categorical variable) to road had the strongest influence on activity budgets of the independent variables tested but, for most activities, the variation attributable to year/proximity was independent of disturbance, being generated by large differences in weather among years and an apparent difference in habitat quality between the two main areas. Proximity to road did reflect disturbance-related effects when geese were located between the elevated gravel road and the elevated pipeline; both alert postures and walking increased substantially in that area. Days from peak hatching strongly influenced all activities of brood-rearing geese, but the lack of an interaction with traffic indicated little or no habituation to road traffic during a season. Temperature and time of day also influenced activity budgets. Although the low traffic levels observed in 1988-1990 appeared unlikely to have profound impact on energy balance, the response to traffic indicates a potential for severe energetic impacts under prolonged high traffic conditions. This suggestion is corroborated by observed levels of use of areas adjacent to the road since 1985, which are strongly correlated with the decrease in traffic from the construction to the production phase of the Endicott Project.

THE RELATIVE INFLUENCE OF OIL-DEVELOPMENT RELATED DISTURBANCE AND ENVIRONMENTAL FACTORS ON ACTIVITY BUDGETS OF NESTING SNOW GEESE AT HOWE ISLAND, ALASKA

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Activity budgets of nesting male and female snow geese on Howe Island, Alaska, were obtained by instantaneous scan sampling of focal individuals in the years 1986-1989. The independent variables, day of incubation, temperature, hour of day, year, eventual nest fate, and ambient noise were examined. In males, noise level and nest fate were the independent variables with greatest influence. High noise caused depressed levels of feeding, increased levels of resting, and increased frequency of alert postures. In females, temperature and year were the most influential independent variables; noise was less influential but still a significant factor. A slight decrease in resting and a corresponding increase in comfort movements were observed at higher noise levels. Noise effects were more pronounced at warm temperatures and responses also varied among years, suggesting that different sources of noise (road traffic noise versus flaring events) affected females differently. To evaluate the potential direct effect of noise on nesting success, we computed linear contingency models of incubation constancy of females. Temperature, year, and nest fate all influenced incubation constancy, but noise had no significant effect. It is clear that nesting snow geese perceived and reacted to changes in ambient noise during incubation. Although the magnitude of response was minor for most activities, the impact of noise on activities of nesting males and females clearly represents an increase in energy expenditure. However, because of the small magnitude of the effect, the reaction to noise appeared likely to lead to significant reduction of energy reserves of females only in the most severe seasons.

AN AERIAL SURVEY-GIS FOR DEVELOPING WATERFOWL DISTRIBUTION AND DENSITY MAPS

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We conducted aerial surveys of geese over the coastal zone of the Yukon-Kuskokwim Delta from 1985-1991. We systematically located linear transects along lines of latitude starting at the coast and extending 6.4 to 64.0 km inland. We flew the transects in a single-engine high-wing aircraft at 145-160 kph and 30-45 m altitude. A LORAN-C was used to locate and navigate transects accurately. The pilot and right seat observer voiced the start and end of each transect and segment, and all singles, pairs, and flocks of geese observed in a 200 m strip on each side of the aircraft on continuously running tape players. Tapes were played back and data were entered into laptop computers by keystrokes programmed to species codes. We entered the transect start, segment transitions, each observation, and the transect end in synchrony with the actual observations recorded during the survey. The computer calculated distance along each transect to the point of each observation through the use of the internal clock. We determined the accuracy of this method of capturing location data by comparing map measured distances to 109 known points with computer calculated distances. The mean deviation was 367 m $\pm$322 SD (range 0 - 1800 m). We converted linear distances to map coordinates for input into PC ARC/INFO software allowing display of specific point locations for each species. The number of observations per unit length along transects was calculated and displayed as density blocks. Density data along transects was converted to x,y,z coordinates for use with PC TIN (three dimensional software) to create contour plots of waterfowl distribution. The aerial survey-GIS system developed here has been used to determine detailed patterns of breeding distribution, evaluate waterfowl values on private versus federally owned lands, and design stratum boundaries for population surveys. It has the potential for developing waterfowl habitat classification systems by relating waterfowl density maps to habitat variables determined by remote sensing procedures.

AERIAL SURVEYS OF GEESE NESTING ON THE YUKON-KUSKOKWIM DELTA, ALASKA

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Dramatic population declines of cackling Canada (*Branta canadensis minima*), emperor (*Anser canagica*), and greater white-fronted (*Anser albifrons frontalis*) geese nesting in the coastal fringe of the Yukon-Kuskokwim Delta (YKD) occurred in the early 1980s. We developed and conducted an aerial survey for these species within 12,800 km^2 of coastal tundra on the YKD from 1985-1991. Our objectives were to monitor the annual size and accurately map the distribution of breeding populations. The survey was based on stratified systematic random placement of linear transects oriented along lines of latitude. We divided the coastal zone into 16 physiographic strata based on visual interpretation of 1/250,000 scale LANDSAT images. We made design decisions based on 1985-1987 survey data on distribution and abundance of cackling Canada geese. We calculated stratified estimates of mean density and total population, based on observed singles plus pairs and total geese for each species. Aerial observations were positively correlated with estimates of numbers of nests. Annual populations of cackling Canada geese were indexed with 6-7% coefficient of variation. Annual emperor and white-fronted goose populations were indexed with 8-12% coefficients of variation. Aerial survey indices for emperor geese remain below 1985 levels. Aerial survey indices for cackling Canada and white-fronted geese have doubled since lows in 1986. The methods to monitor future changes in breeding populations are established and this kind of data should be integrated into the management of these important species.

RECENT CHANGES IN PRODUCTION AND POPULATION TRENDS OF THE DUSKY CANADA GOOSE

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Between 1979 and 1989 the dusky Canada goose (*Branta canadensis occidentalis*) population declined from 25,500 to 11,700. This decline was attributed primarily to poor production on the nesting grounds where nest success averaged 21.5 $\pm$ 17.6% ($\bar{x} \pm SE$) between 1979 and 1989. Production was exceptionally poor between 1985 and 1989 when nest success averaging only 13.1 $\pm$ 7.5% and an average of 10.9 $\pm$ 6.9% of the fall population was young geese. Nest predation was the cause of poor production with brown bears and coyotes being responsible for from 54.1% to 83.7% of the nest destruction during the period. A simple model of the age structure of the dusky goose population in 1989 estimated that, due to the decade of poor production, over 75% of the birds exceeded 6 years of age. Nest predation by mammalian predators has declined the past 2 years. Nest success has averaged 47.8%, and young production has exceeded 20% both years. Under current harvest restrictions, the 1991-92 winter population could easily exceed 17,000 geese for the first time in a decade. While it is too soon to determine if changes in production are ephemeral, habitat conditions on the nesting grounds suggest they may not be. Beaver (Castor canadensis) activity has increased immensely. Much of the low laying habitat is now inundated and many alder/willow thickets have been cut or flooded out. While this limits nesting to more open, elevated areas that are more exposed to avian predators, large mammalian predators may be avoiding the area.

REPRODUCTIVE ENERGETICS OF FEMALE GREATER SNOW GEESE ON BYLOT ISLAND (N.W.T.), CANADA

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Ryder (1970) proposed that Arctic nesting geese fast during the breeding period and that clutch size is dependent upon nutrient reserves accumulated on the staging areas. Greater snow geese (*Chen caerulescens atlantica*) migrate 3000 km from staging areas along the St-Lawrence Estuary to their nesting areas in the Canadian Arctic. Half of the fat stored in spring is used to cover the cost of migration. Females do not start egg-laying until two weeks after their arrival on Bylot Island but feed intensively during that period. Our aim was to establish the relative importance of exogenous and endogenous sources of energy for female greater snow geese from arrival to early incubation. We collected 46 females in 1989 and 1990 and measured total somatic and reproductive fat and protein. Rapid follicular growth has not yet started when females arrived on the nesting ground. Although more than 60% of the fat invested in reproductive tissues occurred between arrival and laying, female somatic fat reserves were maintained at a constant level (13% of body mass). This was followed by a significant decrease in somatic fat from laying to early incubation. Although up to 150g of protein was invested in reproductive tissues, we observed no significant change in somatic protein reserve from arrival to early incubation (18% of body mass). Neither clutch size nor total fat and protein investment in reproduction were related to structural size. We conclude that feeding was efficient and contributed significantly to the formation of the clutch and maintenance cost of laying females.

MATE CHOICE IN BARNACLE GEESE: AN EXPERIMENTAL DESIGN

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Wild Svalbard barnacle geese *Branta leucopsis* appear to preferentially choose their first mates from mutual molting flocks on the Arctic tundra. Since first time pair formation mainly occurs on the wintering grounds, where geese from many breeding/molting areas mix, the assortative mating is likely to be due to active mate choice. Two alternative mechanisms were tested in this study: 1) geese recognize and choose molting flock associates, or 2) geese choose traits common to their own molting area. We tested these hypotheses in two experimental designs with 78 young geese. Design 1 included two male and two female groups from eggs from one population. They were reared next to only one group of the opposite sex, thus becoming familiar with some birds and not with others. Design 2 included two male and two female groups from eggs from two geographically separate populations and were reared without becoming familiar with birds from the other population. Pairing patterns were observed when the geese (at age two years) were allowed to mingle within each design. We discovered that the geese in design 1 (the familiar birds) formed pairbonds sooner and assortatively chose "known" birds for mates. The geese in design 2 chose mates from the same and the different populations at random. Other potential choice criteria (e.g. body size, social rank, vigilance behavior, plumage etc.) were also investigated. Females in the best body condition paired sooner and may be preferred as mates. Dominance rank did not appear to play a major role in the mate choice process.

IS THERE A RELATIONSHIP BETWEEN BODY SIZE AND FECUNDITY IN LESSER SNOW GEESE?

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We examined the relationship between structural size and measures of reproductive effort (fecundity) known to be influenced by variation in pre-laying levels of endogenous nutrient reserves (clutch size and laying date) in the lesser snow goose (*Chen caerulescens caerulescens*) breeding in the Canadian subarctic. Clutch size, laying date and structural size all varied significantly with age in our data. Thus, we examined the relationship between structural size and fecundity within age-class. There was no detectable relationship of either clutch size or laying date with structural size within an age class overall, although the relationship was significant in a few years. We suggest that while there may be a significant relationship between structural size and components of pre-laying nutrient reserves, there is little support for a direct relationship between variation in structural size and variation in either clutch size or laying date in this species. The lack of a detectable relationship overall between structural size and either factor may in part reflect differences in the relative covariation of structural size with both total amounts of nutrient reserves and the absolute proportions of these totals used for metabolic maintenance.

LOCAL VARIATION IN GROWTH RATES OF LESSER SNOW GOOSE GOSLINGS

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Growth of lesser snow goose goslings (*Chen caerulescens caerulescens*) hatched at a colony in the Canadian subarctic differed significantly between two spatially distinct feeding areas. Goslings which dispersed away from the traditional feeding area were significantly heavier (84 *g* - 7.3%), had longer culmens (1.2 *mm* - 3.1%) and marginally longer tarsi (1.7 *mm* - 2.2%) than goslings which remained in the traditional feeding area. These differences were apparent in 5 of 5 years, although a significant proportion of this consistency may be due to annual adult fidelity to specific feeding areas. There was no evidence that the larger size of goslings at dispersed locations was due to either a tendency for larger adults to disperse to those sites, or mortality selection against smaller goslings in the dispersed sample. The most likely cause for the larger size of dispersed goslings is enhanced foraging opportunities on food plants which are both more abundant and of higher quality than those presently encountered by goslings in the traditional feeding areas.

THE SNOW GEESE OF LA PEROUSE BAY; THE FOURTH DECADE

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The long term aim of the LPB study has been a detailed investigation of all stages of the life cycle of the population, with a view to understanding the environmental and genetic factors contributing to success of Snow Geese. This involves analysis of both fecundity and survival components of fitness. Whereas variation in fecundity has been well examined in many organisms including several species of geese, variation in survival is much more difficult to study. Only with large data sets and a long period of study can one examine the causes of variation in survival. Francis (1990) has recently carried out a comprehensive analysis of survival data from LPB and other populations of snow geese which I summarize in this presentation. Adult survival has increased in our population during the course of our study. At the same time recovery rates and harvest rates have declined. We suggest that the decline in harvest rates has caused the increase in adult mortality. By contrast, for geese banded just prior to fledging, mortality during their first year of life has increased with time, despite decreased harvest rates. Most of this mortality appears to occur soon after fledging, since in years of high immature mortality, recovery rates are lower than average. We attribute the variation in immature mortality to variability of condition of the fledglings which can in turn be related to the availability of forage during the fledging period. Annual immature survival rates can be calculated from band recovery data or from data from recruitment into the breeding colony. These estimates are remarkably similar, giving us confidence that they reflect true annual variations in survival. There is little evidence for sexual differences in survival rates although results are difficult to interpret due to different dispersal patterns in the two sexes. We compared survival and recovery rates at 2 Arctic nesting colonies (LPB and Cape Henrietta Maria) and found that despite differences in recovery rates there were no differences in survival rates. Yearlings and first time breeders appear to have lower survival than adults, although there was no evidence of changes in survival rates of experienced breeders at least up to the age of 15 years. We have no evidence that breeding status affects survival, beyond the age effects per se.

THE FALL MIGRATION OF PACIFIC FLYWAY BRANT IN RELATION TO CLIMATIC CONDITIONS

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Fall migrations of brant (*Branta bernicla*) from Izembek Lagoon, Alaska, to wintering areas in Baja California, Mexico were studied for 30 years from 1959 to 1988. Surface and upper air weather patterns were analyzed for departure, approximate mid-route and arrival locations. Radar was used to determine the average departure direction and altitude of 30 migrating flocks within 130 km of Izembek Lagoon. Based on radar observations, upper air wind directions at the 850 millibar level were used to estimate the most favorable migration route to wintering areas in Mexico. Estimated migration routes averaged 5301 km via direct route distance of 4408 km. Estimated time in route averaged 54.3 hours and average ground speed was 99 kph on probable routes over the 30 year period. During 1974, 1983, and 1984, observers in Alaska and Mexico documented Brant departures and arrivals, estimating times en route to be 60, 60, and 95 hours, respectively. The configuration of the departure weather system, and the direction and velocity of winds, are probably important factors causing variability in observed flight duration. The rapid fall migration of Pacific populations of brant is energetically costly with males and females, respectively, losing an estimated 33 % and 31 % of their total body weights. Physiological demands of migration from Izembek Lagoon to Mexico may exceed the amounts of body reserves accumulated during the fall staging period.

ENERGY BALANCE IN ARCTIC GEESE: BALANCE IN RELATION TO THE GREEN WAVE HYPOTHESIS

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Abstract not available.

SOME POPULATION PARAMETERS OF LIGHT GEESE WINTERING IN THE RIO GRANDE VALLEY, NEW MEXICO AND IN CHIHUAHUA, MEXICO

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Wintering flocks of snow (*Chen caerulescens*) and Ross' geese (*C. rossii*) of the Western Central Flyway Light Goose Population were monitored annually in the Rio Grande Valley, New Mexico, mainly at Bosque del Apache NWR (Bosque) from 1978-1990 and at 5-7 sites in Chihuahua, Mexico from 1984-1990. Estimates of numbers, species composition, proportion of blue phase snow geese, and adult:immature ratios were gathered by location; snow/Ross' goose hybrid occurrence was assessed at Bosque. Light geese >1,000 first wintered at Bosque in 1962 and by 1980-1990 the annual peak valley population averaged 40,660 (SD=10,920). Snow geese averaged 22.2% (SD=10.3) immatures and 1.9% (SD=0.30) blue phase. Fourteen Ross' geese appeared in 1964 and increased to 9,000 or 16.4% of the winter flock by 1990. Ross' geese averaged 18.9% (SD=7.9) immatures. Occurrence of snow/Ross' hybrids was 0.20% (n=19,879). Light goose flocks in Chihuahua averaged 67,746 (SD=24,096) annually and were distributed as follows: Laguna de Babicora (36%), Ascension (32%), A. Gonzales Reservoir (9.5%), Laguna de Mexicanos (9.1%), N. Casas Grandes (6.8%), Laguna Bustillos (3.9%), and Laguna Las Encinillas (2.7%). Ross' geese averaged 9.5% (SD=3.2) in winter flocks but varied by location from 0.79% (SD=0.71) at Encinillas to 15.6% (SD=9.4) at N. Casas Grandes. In 1990, we estimated 7,150 Ross' geese at 7 sites in Chihuahua. Snow and Ross' geese averaged 20.9% (SD=9.7) and 15.4% (SD=8.0) immatures, respectively. In snow geese, blue phase averaged 0.59% (SD=0.07) but were more abundant ($P<0.01$) at 2 northern sites (0.79%) than 5 areas farther south (0.31%). Ross' and blue phase snow geese were more abundant in New Mexico ($P<0.01$) than in Chihuahua except at N. Casas Grandes where Ross' geese were more common. These findings show a difference in latitudinal winter distribution of Ross' and blue phase snow geese, indicating a higher proportion of Central Arctic light geese winter in New Mexico and a higher proportion of Western Arctic snow geese winter in Chihuahua.

COMPARISONS OF APPARENT METABOLIZABILITIES AND NUTRIENT UPTAKE FOR CACKLING CANADA GEESE FED GRASS OR ALFALFA

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We conducted digestibility trials on 6 adult male cackling Canada geese (*Branta canadensis minima*) captured during spring migration 1991 in Big Valley, California, which is a traditional spring staging area for cackling geese. During the ten day acclimation period and six day digestibility trials three geese were fed fresh-cut grass (*Poa* spp.) and 3 birds were fed fresh-cut alfalfa (*Medicago* spp.). Neutral detergent fiber (NDF) analysis revealed that the grass we fed to the geese averaged 32.5% NDF and the alfalfa averaged 23.5% NDF. We chose to conduct digestibility trials on grass and alfalfa because those forages constitute the primary spring diets of cackling geese in Big Valley. Apparent dry matter digestibility averaged 56% for grass-fed and 57% for alfalfa-fed geese. Total dry matter intake per bird averaged 1208 grams for grass-fed and 1953 grams for alfalfa-fed geese. Apparent metabolizability of nitrogen averaged 52% for grass-fed and 54% for alfalfa-fed geese. NDF apparent metabolizability varied over time for both diets. Average NDF apparent metabolizability values ranged from 37% - 52% for grass-fed and 49% - 56% for alfalfa-fed geese from day 1 to day 6 respectively. Body mass increased for all geese throughout the trials. In addition to digestibility trials we conducted nutrient uptake experiments on the same 6 geese using the everted sleeve technique to measure glucose and amino acid uptake. Furthermore, we determined that total gut length and the lengths of the duodenum, jejunum, ileum, proximal ceca, distal ceca, and colon segments were not significantly different between diets, even though the NDF values for grass were higher than alfalfa. However, glucose uptake (nM/min mg) in the ileum was significantly higher in grass fed geese. Our results from the digestibility trials and nutrient uptake experiments suggest that geese fed fresh-cut alfalfa are better at metabolizing NDF and are capable of eating more forage than grass-fed geese, but grass-fed geese are able to compensate for a lower intake rate by having a higher uptake rate of glucose.

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INCREASES OF BLUE GEESE IN WESTERN CANADA AND SASKATCHEWAN OVER THE PAST DECADE: AN UPDATE

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Recent increases in the proportion of blue morphs of the dimorphic lesser snow goose (*Chen caerulescens*) were tracked using results of; (a) the Canada Species Composition Survey (HQS) for 1968-1990, (b) field appraisal counts, 1961-1990, and (c) to a lesser extent, Parts and Harvest Surveys in the western United States. I plotted tail-fan receipts by degree blocks over 5 year intervals from 1968-1990. Autumn mixing, increasing numbers and population shifting described earlier have accelerated. Significant westward emigration of colored morphs has continued with higher infusions documented for southwestern Manitoba, east-central and west-central Saskatchewan and east-central and northern Alberta. Blues remain uncommon in British Columbia. Previously proposed models (1979) showing multiple colony origins for white morphs staging in western Saskatchewan and primary affiliation of blue morphs with Central Arctic colonies have been corroborated by neckbanding observations. In western Saskatchewan the proportion of adult blue to adult white morphs, from field counts, has increased from 1:11,000 in 1960, to 1:500 in 1978 and further to 1:100 in 1990. Parallel observations have been reported in those stocks migrating east of the Cordillera and wintering in New Mexico and the northern highlands of Mexico. Examination of social characteristics of adult blue morphs, either as pure B x B or B x W pairs, showed consistently low numbers of young-of-the-year, suggesting many westward dispersing adults may be molt migrants, perhaps subadults or failed breeders. Blue offspring associated with homozygous recessive white morph pairs were extremely rare. Pure Blue Ross' adults, and Blue x Ross' hybrids, remain uncommon, both at approximately 1:20,000 to 1:30,000 Ross. Both present detection problems. Reflecting colony affiliations there was an eastward, longitudinal gradient of blue morphs through Saskatchewan roughly from 1:100 at 100° W (Alberta/Saskatchewan border) to 1:10 at 108° W and 1:4 from 104° W to 101° W (Saskatchewan/Manitoba border). Past projections of accelerated expansions of colored morphs westward have been dampened since 1978 by widespread droughts on the southwestern Canadian prairies, fragmenting migration habitats, plus asymmetrical migrations eastward of the blue morph from expanding Central Arctic stocks. I recommend that rigorous biogeographical studies of blue morph distribution continent-wide be conducted on migration and wintering grounds, as an adjunct to expanded field productivity appraisals. Systematically gathered benchmark data would aid in evaluating the causes of long-term changes in distribution and how they relate to global warming, colony affiliation, population connectedness, dispersal abilities and fitness consequences.

GOOSE SURVEYS OF THE CHUKOTKA PENINSULA, USSR: POTENTIAL AND PROBLEMS

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A cooperative effort between the USFWS and Soviet biologists to conduct aerial goose surveys of the Anadyr lowlands of the Chukotka Peninsula was undertaken during 11-26 July, 1991. The primary objective of the survey was to obtain an overview of breeding habitat, and size and location of breeding and molting concentrations of black brant (*branta bernicla nigricans*) emperor geese (*Chen canagica*), and greater white-fronted geese (*Anser albifrons frontalis*) for development of a breeding pair survey. A second objective was to band young geese and/or molting adults. Approximately 1,800 white-fronted geese, 1,800 emperor geese, and 400 brant were counted, without correction for visibility, in an aerial survey of less than 30% of primary breeding habitat. Sufficient knowledge of habitat, numbers of geese, logistical concerns, and navigational aides was gained to plan a breeding pair survey and band several hundred geese of each species. Long term planning and funding will probably continue to be complicated by the rapidly changing political and economic situations in the Soviet Union. Soviet aircraft were not suited for the survey work and availability of aircraft was unreliable. Our principal recommendation was to pursue permission to use United States' aircraft, pilots, and equipment for future work in the region.

THE GREAT WHITE PERIL: TUNDRA SWANS AS PREDATORS OF ARCTIC GEESE

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We examined factors contributing to the mortality of greater white-fronted geese (*Anser albifrons*), cackling Canada geese (*Branta canadensis minima*), and emperor geese (*Anser canagicus*) during the brood rearing period on the Yukon-Kuskokwim (Y-K) Delta, Alaska, 1985 - 1991. The most commonly observed cause of death was trampling by territorial tundra swans (*Cygnus columbianus*). Aggressive swans killed up to 10% of the greater white-fronted goose goslings on our study area in some years. The Y-K Delta is the most important breeding area in North America for tundra swans, and greater white-fronted, cackling Canada, and emperor geese. Geese and tundra swans occur sympatrically throughout their breeding range, and utilize similar habitats during nesting and brood rearing. Home ranges of geese and swans on our study area overlapped considerably during brood rearing. There is thus a high likelihood of aggressive interaction. In some years, swan-induced mortality may significantly limit recruitment of geese from the Y-K Delta.

FACTORS AFFECTING GOSLING SURVIVAL OF BLACK BRANT

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We examined factors related to survival of juvenile black brant (*Branta bernicla nigricans*) goslings on the Yukon-Kuskokwim Delta, Alaska during the summers of 1987-89. We webtagged 2778 goslings at hatch over the 3 years of the study and examined the relative recapture rates of these individuals in late summer, in relation to year, egg number in the laying sequence, hatch date, egg volume, initial brood size, and nesting density. Univariate analysis showed that survival differed among years, early hatching goslings were more likely to be recaptured, and goslings from larger eggs were also more likely to be recaptured. For a multivariate comparison, these 3 variables were included in a stepwise logistic regression and all 3, hatch date, year, and egg volume, contributed significantly to the probability of recapture.

CHANGES IN PATTERNS OF MORTALITY AMONGST GREENLAND WHITE-FRONTED GEESE UNDER PROTECTIVE LEGISLATION IN IRELAND

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We estimated annual survival amongst Greenland white-fronted geese *Anser albifrons flavirostris* wintering at their most important wintering site at Wexford, south-east Ireland. We used population census data and productivity measures to derive indirect adult survival rates before and after the population was protected. Mortality was significantly higher prior to protection and during 2 years when the shooting moratorium was lifted at Wexford after the implementation of protective legislation. Between 1982 and March 1990, 706 geese have been fitted with neck-collars and we have used band recovery models to estimate annual survival and recovery rates and test hypotheses concerning the source of variation in these rates. Finally, we derived maximum likelihood estimates of obtained survival and resighting probabilities for collared birds based on about 15,000 resightings of individuals. This study suggests that, at current population levels, mortality from hunting is additive in this species. We review data from other goose populations in Europe and North America which suggests hunting mortality is additive rather than compensatory.

MIGRATING WHITE-FRONTED GEESE IN THE KLAMATH BASIN: APPLICATION OF A COMPUTER SIMULATION MODEL

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A computer simulation model, REFMOD, was applied to white-fronted geese (*Anser albifrons*) in the Klamath Basin, northern California, to investigate the importance of food availability and hunting disturbance to migrating and wintering populations. The model validly described distances moved by geese from their Tule Lake Refuge roosting site (core) to feeding sites within the surrounding Klamath Basin arena, and simulated observed behavior, including time spent feeding and habitat use. Based on 25 stochastic simulations with input parameters set at control levels, white-fronted goose population dynamics were validly simulated over the fall and early-winter season ($P>0.8$). When food was removed from within the Tule Lake Refuge boundaries, simulated geese had to fly farther ($P<0.0001$) to find food, hastening emigration and resulting in a decline ($P<0.05$) in use of the Klamath Basin by geese. Although barley is normally abundant within the basin and is extensively used by geese, simulated elimination of barley within the arena did not cause a reduction in goose numbers ($P>0.05$). The elimination did cause an increase in the distance traveled to feed ($P<0.05$), but the availability of other foods within the basin (e.g. potatoes) was evidently sufficient to support the population. The elimination of hunting within the Klamath Basin and the related decrease in disturbance of feeding birds had little effect ($P>0.05$) in reducing the distance traveled to feed or in increasing goose numbers over the season. A 10-fold increase in disturbance hastened emigration and reduced population levels ($P<0.0001$) over the season by about 30%, and a 100-fold increase in disturbance reduced population levels ($P<0.0001$) by 85%. When goose immigration was increased to simulate an average peak population of 500,000 geese, population levels remained high throughout the fall, indicating the Klamath Basin's capability to sustain a population much larger than currently exists, and suggesting food availability and disturbance levels in the Klamath Basin are not responsible for observed population declines over the last 2 decades.

FORAGE QUALITY AND GOSLING NUTRITION IN THE LESSER SNOW GOOSE

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Over the last decade, the breeding population of lesser snow geese (*Chen caerulescens caerulescens*) at La Pérouse Bay, near Churchill, Manitoba, increasingly has been forced to graze non-preferred vegetation in summer. In spring, before above-ground growth of vegetation has begun, the birds forage destructively for roots and rhizomes in the salt marsh, reducing the availability of salt marsh graminoids, the preferred summer forage. The birds in the bay area in summer now feed extensively on less preferred fresh-water sedges and inland grasses. Concurrent with this shift in summer foraging behavior, there has been a gradual decline in gosling size and weight at fledging. Results from plant-nutrient analyses and feeding trials with captive goslings suggest that the shift in diet may be a cause of this decline. Goslings can gain more weight on preferred forages than non-preferred forages in 6-hour feeding trials. Preferred forage species appear to be easily grazed and are of higher nutritional quality and digestibility than non-preferred species. Calcium, sodium and nitrogen contents of plant tissues are found to be correlated with food quality. Food quality is particularly important for young goslings (<15 days), which have high growth rates and inefficient digestion. In contrast, older goslings (30-40 days) are more able to cope with lower quality forage. The experimental results provide an explanation for the observed intensive feeding by families of snow geese on salt marsh flats during the period immediately following hatch, and indicate the value of this type of forage in accounting for the breeding success of this population. This loss of coastal habitat at La Pérouse Bay and elsewhere has implications for the breeding success of these snow goose populations and the existence of northern coastal plant communities.

ACTIVITY BUDGETS OF LESSER SNOW GEESE PRIOR TO INCUBATION

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It is commonly believed that Arctic-breeding geese have very little opportunity to feed on their breeding grounds before the start of incubation and that throughout egg-laying and incubation females rely entirely on the nutrient-reserves they acquire on the wintering grounds and spring staging areas. The importance of winter and spring feeding has therefore been emphasized. This study investigates the question of whether early feeding on the breeding grounds can make a contribution to the condition of the geese before incubation. Activity budgets of lesser snow geese were recorded between their arrival on the breeding grounds and the onset of incubation. Both individual sampling and scan sampling methods were used. Female geese spent 75% of the time before laying and between the laying of subsequent eggs feeding. Males were feeding about 40% of the time and alert another 40% of the time. The geese fed either on below-ground organs of grasses or grazed the very short vegetation that emerged from under the snow. The amount of time spent feeding and the difference between the sexes suggest that females can top up their nutrient reserves before incubation while the males spend a lot of time guarding their mates against predators and/or conspecifics. The significance of the topping-up in relation to the total reserves of the females and to the costs of egg production will be discussed. As the geese stay in the immediate vicinity of their nests during the laying period, the availability of food around the nest site is considered to be an important clue for breeding site selection.

DIET, FOOD QUALITY AND FOOD INTAKE OF PRE-LAYING AND LAYING GREATER SNOW GEESE

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Several species of Arctic-nesting geese feed little during the laying period and rely almost entirely on nutrient reserves to meet the high energetic and nutrient cost of laying. However, in contrast to this pattern, we showed previously that the greater snow goose (*Chen caerulescens atlantica*) fed heavily during the pre-laying and laying periods. Here I document the diet, food quality and food intake of geese during the nesting period in late May and early June at the Bylot Island colony. Diet and food intake was assessed by examining the oesophagus content and weighing the gut content of shot geese, respectively, whereas food quality was evaluated by proximal analyses of food plants. Roots and rhizomes accounted for 40% of the diet and included *Oxytropys maydelliana*, *Polygonum viviparum*, grasses and sedges. Aboveground plants eaten by geese included young leaves of grass, *Eriophorum* sp. and *Salix*, and stems of *Carex aquatilis*. Grass, *Eriophorum*, *Salix*, and *Oxytropys* were high in protein content (>19 %) whereas grass, *Eriophorum*, and *Carex* (stems) were low in acid detergent fiber (<25 %). In females, the weight of the gut content was identical to that of geese collected along the St. Lawrence Estuary in spring, a period of rapid fat accumulation. In males, the weight of the gut content was significantly lower compared to geese from the St. Lawrence. These results support data on change in nutrient reserves and suggest that food intake by female greater snow geese during the laying period is very high.

THE PRESENT STATUS OF BEAN GEESE PRESENT ON KAMCHATKA PENINSULA: CURRENT RESEARCH AND CONSERVATION PROBLEMS

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There are 3 populations of Bean geese of 2 subspecies on the Kamchatka Peninsula. Most *Anser fabalis serrirostris* nesting on the northwest portion of the peninsula migrate to wintering areas in China and probably in the Korean peninsula. *Anser fabalis serrirostris*, which nests in southwest Kamchatka, and thousands of *Anser fabalis middendorffii* molting in the central part of west coast of Kamchatka, migrate to Japan for wintering. Breeding populations of *Anser fabalis middendorffii* have not been located. Numbers of bean geese on the peninsula have declined dramatically in the past 30 years. Today there are 25,000 breeding and molting bean geese in West Kamchatka as a result of conservation measures undertaken from 1972-1983. Status of this species is most successful in Kamchatka when compared with other Northeast Asian regions. However, during the past 4 to 5 years, effectiveness of conservation measures has decreased. Illegal hunting and disturbance within protection areas might be contributing to the decline. About 15,000 bean geese concentrate in 3 molting areas in West Kamchatka. A banding and neck-collar program, in cooperation with Japan, was conducted in 1984-1991. During 8 years, 978 geese were marked, including 769 birds with neck-collars. We have received several returns from Kamchatka and along the migration routes, but several thousand in wintering areas in Japan. Neck-collar research will be continued for completing information about goose migration routes and to find areas of breeding *Anser fabalis middendorffii*. Suggestions for protection of bean goose habitats will be based on this investigation. Also, we propose to use *Anser fabalis serrirostris* which nests in southwestern Kamchatka and migrates along the Kurile Islands to Japan as foster parents for Aleutian Canada goslings.

USE OF A NEW STAGING AREA BY GREATER SNOW GEESE IN QUÉBEC

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The recent population increase of greater snow geese (*Chen caerulescens atlanticus*) has been associated with an expansion of their spring staging area in Québec. More than 120,000 snow geese are now observed near lake St. Pierre located 200 km upstream from the traditional areas along the St.Lawrence Estuary. This new staging area is characterized by floodplains and agricultural lands dominated by corn fields. The objectives of our study were to establish activity budgets, habitat use and food habits of snow geese in this new area. Geese roosted in flooded lowlands near the lake and flew up to 40 km in the morning to feed in corn stubble, ploughed corn fields and grasslands. During the day, some geese returned to the floodplains where they spent their time resting and swimming. Examination of oesophagi and microhistological analysis of feces showed that geese fed on wasted corn and on a variety of grass species (*Phleum pratense, Agropyron* spp. and *Bromus* spp.) but rarely on legumes (*Trifolium* spp., *Medicago* spp.). Use of the lake St.Pierre area by geese might improve their condition before leaving for the Arctic. We also suggest that promoting spring use of this area where crop damage is not a problem may lessen losses of hay encountered downstream along the St.Lawrence Estuary where geese feed heavily in grasslands.

ARCTIC GOOSE JOINT VENTURE

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Unknown breeding distributions of many Arctic nesting geese, uncertain status of populations, alteration of ranges and population-mixing are among the issues that require immediate attention for effective population management. Given the international scope of Arctic geese, partnerships are required to study Arctic goose populations. An Arctic Goose Joint Venture (AGJV) was formed by recommendation of the North American Waterfowl Management Plan of 1986. The goal of the AGJV is to foster greater research and monitoring of Arctic geese so that improved population management may proceed. The AGJV will identify important information needs and priorities, identify funding requirements, review proposals and communicate results. The AGJV is designed to complement existing Arctic goose research and management programs. The management structure includes a Management Board and Technical Committee with members from Canadian and U.S. government and nongovernment agencies, and a Coordination Office. Thirty projects have received endorsement to date.

POPULATION DIFFERENCES IN THE NESTING BEHAVIOR OF LESSER SNOW GEESE

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Abstract not available.

EFFECTS OF ISOSTATIC UPLIFT AND GRAZING BY LESSER SNOW GEESE ON THE DYNAMICS OF SALT MARSH COMMUNITIES

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We examined changes in floristic composition, above-ground biomass, and replacement rates (R) of vegetation of salt marsh communities in response to isostatic uplift and grazing by lesser snow geese at La Perouse Bay, Manitoba. Changes were examined in relation to the discrete community concept which predicts that communities are connected in a discontinuous or non-linear sequence. We tested 3 predictions of this model using direct experimental manipulation of swards and long-term monitoring of floristic and biomass data: (1) At La Perouse Bay the grazed community in the lower marsh is composed of *Puccinellia phryganodes* and *Carex subspathacea*. This assemblage of species is also present in the upper marsh, but only as a consequence of intense grazing by geese. When these swards are released from grazing there is a rapid increase in R followed by a slight increase in above-ground biomass. (2) When *Puccinellia-Carex* swards are protected from grazing over a longer period (> 3 years), changes in floristic composition of vegetation occur. There is also a substantial increase in above-ground biomass and a decrease in R, leading to the establishment of a new community, where the vegetation is dominated by *Calamagrostis deschampsiodes*, *Festuca rubra* and dicotyledonous plants. (3) If grazers are reintroduced into the *Calamagrostis-Festuca* community the species composition and above-ground biomass do not revert to that characteristic of the *Puccinellia-Carex* community. Our experimental evidence is consistent with the predictions of the discrete community concept. We discuss the applicability of these results to the management of coastal lesser snow goose breeding colonies.

MOVEMENTS AND HABITAT USE OF WINTERING GREATER SNOW GEESE ON THE DELMARVA PENINSULA

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During the late 1960s, the wintering population of greater snow geese (*Chen caerulescens atlantica*) at Bombay Hook National Wildlife Refuge (BHNWR) in Delaware was approximately 1,500 birds, but in the mid-1980s peak populations at the refuge reached 75,000. This large concentration of birds combined with their voracious foraging habits caused destruction of parts of the refuge tidal saltmarsh. During the winter of 1990-1991, we studied the local movements, feeding patterns, and roost-site use of 33 radio marked adult female greater snow geese captured at BHNWR. During October-November (early season), marked birds did not move large distances from roosting to feeding sites ($x=5.4$ km) or between roosting sites ($x=3.9$ km). Habitats most often utilized for roosting during early season were freshwater impoundments (26%), farm ponds (29%), and the tidal saltmarsh (42%), and harvested corn fields were the most heavily visited type of feeding habitat (49%). Total distance moved by a goose in one day averaged 15.5 km. Large areas of denuded tidal saltmarsh became apparent in November and early December coinciding with observations of night movements by marked birds into the tidal saltmarsh. Mean distances travelled per day increased ($P<0.05$) in December and January (mid season; $x=21.0$ km) with some feeding flights up to 37 km from the roosting area. During January, there was minimal use of BHNWR, when many marked birds were found roosting in freshwater impoundments (37%) at Prime Hook National Wildlife Refuge in Delaware (52 km south of BHNWR) and on several farm ponds in Kent Co., Maryland (50 km west of BHNWR). Distances travelled between roosting sites ($x=22.9$ km) and from roosting to feeding sites ($x=11.4$ km) were considerably larger ($P<0.05$) than in early season, and harvested corn was still the most heavily utilized habitat type (37%). In February and March (late season) marked birds began to return to BHNWR, and habitats most used for feeding were harvested corn (32%) and small grains (27%). Distances moved from roosting to feeding areas declined ($P<0.05$) in late season ($x=4.3$ km). Mean distances between roost sites ($x=10.8$ km) and total distance moved in a day ($x=13.5$ km) also decreased ($P<0.05$). Virtually no use of the tidal saltmarsh occurred in late season, and freshwater impoundments were the most often used roosting habitat (75%).

HABITAT USE BY BROOD-REARING GREATER SNOW GEESE

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Greater snow goose (*Chen caerulescens atlantica*) numbers have risen dramatically during the past several decades. Still, little is known about their use of summer brood-rearing habitat. Bylot Island, N.W.T. has been identified as the most important nesting area for this race (16,000 pairs or 16% of the population in 1988). We studied habitat use from mid July to mid August, 1990 in a 60 km^2 glacial valley characterized by Arctic tundra polygon habitat. Valley lowlands consisted of a diversity of habitats from small lakes and concentrations of ponds to large expanses of wet meadow and drier areas traversed by occasional streams. The valley was bounded by mountains and rolling hills of drier tundra. Daily surveys of brood-rearing geese were conducted from elevated observation points starting 2 days after peak hatch and continuing until 5 days before the first gosling was observed flying. An average of 221 families were present daily in the 13.6 km^2 segment of the valley under observation. Individual habitat use patterns were also studied by following 20 radio-marked females. Based on survey data, habitats with abundant ponds and small lakes were preferred throughout the rearing period. In these habitats, grazing was restricted to narrow bands of vegetation around ponds and a few larger flat areas adjacent to lakes. Extensive wet meadows, farther from water, were avoided at first but became preferred as the season progressed. Variability in individual habitat use patterns of radio-marked birds was high.

FORAGE SITE SELECTION BY LESSER SNOW GEESE IN AN ARCTIC TUNDRA ECOSYSTEM

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We examined forage site selection of wild and captive lesser snow geese (*Chen caerulescens caerulescens*) as they fed on the subterranean stembase of cottongrass (*Eriophorum angustifolium*) during fall staging on the coastal plain of the Arctic National Wildlife Refuge in northeastern Alaska. Soil moisture and plant species composition were analyzed at 120 feeding sites of captive snow geese in 1989 and 61 feeding sites of wild geese in 1990. Logistic regression analysis was used to discern differences between sites where feeding occurred vs. sites where feeding activity was not observed. Snow geese were more likely to feed on *E. angustifolium* in sites where there was $\geq$ 1 cm of standing water, and where the cover of shrubs, *Carex* spp., and *E. vaginatum* were low. Feeding sites were primarily located in water tracks, thermokarst pits, and in polygon troughs in areas of patterned ground. The sites where snow geese were likely to feed on *E. angustifolium* were highly interspersed with areas of less suitable habitat. Preliminary studies suggest that *E. angustifolium* requires > 2 years to regrow following removal by geese. Snow geese that stage on the Arctic National Wildlife Refuge likely require a large coastal staging area due to a high degree of spatial and temporal variability in the availability of forage resources.

GRAZING AND PLANT GROWTH

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The processes that maintain the availability of high quality forage so that goslings of Arctic geese are able to achieve rapid growth rates between hatch and fledging are poorly known. Different species of geese use different tactics to obtain forage. One used by some populations of lesser snow geese (*Chen c. caerulescens*) involves a positive feedback between the geese and the vegetation, whereby the geese increase resource availability that sustains growth in a nitrogen-limited system. The characteristics of the system are as follows: a) selective grazing and minimum damage to meristems, b) forage species capable of continuous growth, c) increased turnover of nitrogen, d) a gregarious bird population, e) a period at the end of summer free of grazing to allow the vegetation to recover. These requirements are rarely met in natural ecosystems. Recently, the breakdown of this positive feedback system has occurred in some coastal sites in the Arctic, as a consequence of spring grubbing of vegetation by large numbers of snow geese resulting in the destruction of salt marsh swards. Survivorship, and fecundity of snow goose populations have been adversely affected. The birds are very much "prisoners of their food supply". The management ramifications associated with the deterioration of Arctic salt marshes are considerable in relation to the breeding success of lesser snow geese in particular and Arctic waterfowl and shorebirds in general.

NECK COLLAR LOSS RATE IN ADULT MALE AND FEMALE LESSER SNOW GEESE

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Over 1500 molting adult and subadult lesser snow geese (*Chen c. caerulescens*) were neck collared (blue with 4-character alpha-numeric codes; e.g. TK68) in late July 1980-89 in brood-rearing areas of the Sagavanirktok River Delta, Alaska. Neck collar loss rate was computed for 380 collars on females and 267 collars on males that returned to brood-rearing areas in the study area in late July 1981-1990. Collar loss rate was heavily influenced by the sex of the geese, and by the amount and type of adhesive applied to the collars.

SOME UNEXPECTED RESULTS OF THE INTERNATIONAL SNOW AND ROSS' GOOSE PROJECT

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Wildlife agencies, non-government groups and volunteers from Canada, USA, Mexico and USSR are cooperating in an extensive study to determine current distribution patterns and related information for lesser snow and Ross' geese. Totals of 6,358 snow and 1,468 Ross' geese have been marked with coded plastic neckbands on their breeding grounds of the western and central Canadian Arctic, Wrangel Island and Alaska from 1987 to 1990. Cooperators are monitoring the geese throughout their migration and wintering range. Most of the neckbands were read each year and individual codes were recorded an average of 3 to 5 times per year. To date, complete neckband records have been accumulated for 29,100 snow geese and 5,000 Ross' geese. Distribution and movement patterns disclosed are in some cases quite different from previously held views. Substantial numbers of snow geese move between California and the western Central Flyway. Wrangel Island snow geese wintering in California migrate through the Canadian prairies in spring, but mainly down the Pacific in autumn. Results in calculating population sizes and survival rates from mark-resight data are presented. Begun before the Arctic Goose Joint Venture was started, this project on "white" geese was incorporated into the Venture in 1990. However, with the concentration of the Venture on "dark" geese, using much of the same observer network, the total number of snows and Ross' recorded in 1990-91 declined significantly from the previous two years of observations. Nevertheless, and despite the early skepticism of some professionals, the International Snow and Ross' Goose Project is yielding a great deal of new information.

DISTRIBUTION AND ECOLOGICAL ASPECTS OF THE GREATER WHITE-FRONTED GOOSE IN THE RUSSIAN FAR EAST

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The greater white-fronted goose (*Anser albifrons frontalis*) breeds in the Anadyr and Magadan regions of the Far East, USSR. In the Anadyr region, greatest concentrations of nesting greater white-fronted geese occur near the central portion of the Anadyr River, where it is the predominant nesting goose species. In the southern part of the region, it nests sporadically near the coasts of the Bering and Okhotsk Seas. A separate breeding population is found in the Magadan region, south west of Magadan. There appears to be little variation in breeding phenology between the 2 populations. In spring, the first geese arrive between 1 and 11 May, with the majority arriving between 5 and 22 May. The nesting period occurs from 20 May to the beginning of June. Clutch size in the Anadyr region averages 5.2 eggs (range = 3-7). Females spend 98-99% of the 24-day incubation period on the nest, maintaining a constant temperature required for egg development. Hatch occurs during the last week of June to the beginning of July. Broods then congregate into flocks of 30 to 70 individuals. Young geese are fledged during the middle of August, during which time adults complete their molt. The majority of the geese leave the area in the middle of September. From 1975 to 1990, numbers of greater white-fronted geese in the Anadyr region have decreased more than 10 times. This decrease is undoubtedly due to hunting and other anthropogenic influences along migration routes and wintering areas in southeastern Asia, particularly in China. While greater white-fronted geese are considered to be a species breeding in more northerly latitudes, the Anadyr and Magadan populations have maintained the general reproductive strategy characteristic of species in a relatively mild climate. This points to preservation of distinct behavioral patterns in southern populations of the greater white-fronted geese which are possibly relics of a more widespread ancient population in this region.

POPULATION STATUS OF WHITE-FRONTED GEESE WINTERING IN JAPAN

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We report the population status of white-fronted geese, which is the predominant species among the wintering geese in Japan. Fifty years ago the number of the wintering geese in Japan Islands was known to exceed 70,000. The wintering number, however, drastically decreased to several thousand in the 1960s. The essential cause of the decline is attributed to the increase in hunting pressure and the rapid industrialization of Japan after World War II. In 1971, the Japanese Association for Wild Geese Protection was organized in order to study the ecology of wintering geese and to conserve habitats for waterfowl. The hunting of wild geese has been prohibited in Japan since 1971 due to the encouragement of our association. The number of wintering white-fronted geese (*Anser albifrons*) increased henceforth, and amounted to 20,000 birds in the last winter, 1990-1991. The recent increase in the population of wintering geese may be attributed to the hunting ban. This is ascertained by an observed decrease in the ratio of juveniles, which resulted from the prolonged lifespan of the goose. The increase in the populations of wintering geese in Japan is exceptional for east Asia. The populations of geese are severely decreasing in the wintering areas in China and Korea, mainly due to strong hunting pressure. It may be possible that the increase in goose populations wintering in Japan is attributed to the influx of geese from adjacent countries.

THE ELECTOPHORETICAL ANALYSIS OF PROTEINS AND ENZYMES OF *ANSER* AND *BRANTA* GEESE

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Analysis of proteins and enzymes of 8 *Anser* species: *A. anseri*, *A. caerulescens*, *A. fabalis*, *A. indicus*, *A. cygnoides*, *A. canagicus*, *A. albifrons*, *A. erythropus*, and 2 *Branta* species: *B. canadensis*, *B. bernicla nigricans* was made by means of electrophoresis in polyacrilamide and starch gels. The samples of *Anser* and *Branta* species were taken from ornithological collections of different zoos and from wild populations of Wrangel Island snow goose and black brant. Ten polymorphus proteins: Prealbumins 1,2,3,4, Albumin, Haptoblobin, Postalbumin-3, Transferrin, and Posttransferrin-2 of plasma pattern were distinguished and described. The polymorphism of plasma esterases and 10 erythrocite enzymes: Esterase D, Isocitrate Degidrogenase, Superoxide Dismutase, Maltate Degidrogenase, Maltate Oxidoreductase, Glucose Phosphate Isomease, Peptidase B, Glutation Reductase, Adenosine Desaminase, and Carbonic Anhidrase was described. The possibility of using these results for elucidation of relationships in *Anser* and *Branta* on intergeneric, interspecific and intraspecific levels and for description of genetic differentiation of wild goose populations is discussed.

OVERVIEW AND STATUS OF THE ARCTIC GOOSE JOINT VENTURE

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Although monitoring and research activities have been conducted to varying degrees on all North American goose populations, there has never been a coordinated effort to develop a cohesive plan for monitoring and research activities on Arctic nesting geese. In 1986 the North American Waterfowl Management Plan identified this need and recommended the formation of an Arctic Goose Joint Venture (AGJV). The goal of the AGJV is to facilitate research and monitoring of Arctic goose populations so that improved population management may proceed. The international cross-flyway approach of the AGJV is represented by a MANAGEMENT BOARD with senior Canadian and U. S. government representatives, and non-government groups; a TECHNICAL COMMITTEE with similar representation; and a COORDINATION OFFICE to facilitate the work of the AGJV. The AGJV currently addresses research and monitoring needs and priorities for 16 populations of Arctic nesting geese. In 1991 the AGJV produced a revised prospectus, proposal guidelines and evaluation criteria, endorsed 30 proposals of which 19 received partial support, and produced a draft strategic plan. Proposals for 1992 are currently under review.

SNOW GOOSE FEEDING ECOLOGY IN CHIHUAHUA, MEXICO

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Abstract not available.

HABITAT AND FOOD SELECTION BY EMPEROR GOOSE GOSLINGS

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The habitat and diet of emperor goose (*Anser canagicus*) goslings were studied on the Yukon-Kuskokwim Delta, Alaska in 1985 and 1986. Diet was studied in relation to the availability and nutrient content of potential food plants to determine to what extent emperor goose goslings selected food plants to maximize nutrient intake. Emperor goose broods moved from inland nest sites to coastal salt marsh within 1 week of hatching. This movement resulted in abandonment of areas which contained *Triglochin palustris*, a food that was selected in a feeding trial. Wild goslings selected vegetated mudflats in coastal salt marsh, spending 80-82% of their feeding time there, although mudflats covered only 5% of the study area. The relative densities of the 2 mudflat plant species available on a feeding trial plot, *Puccinellia phryganodes* and *Carex subspathacea*, changed over the 2 years of the study, with *P. phryganodes* increasing from 65% in 1985 to 84% in 1986. Captive goslings selected *C. subspathacea* more often than *P. phryganodes* in 1985, but ate primarily *P. phryganodes* in 1986. *T. palustris* was significantly higher in total nitrogen and water content and lower in cell wall content than other available species, but productivity and nutrient value of the two mudflat species may increase with grazing. Emperor geese may leave areas where *T. palustris* is available to avoid predation or competition. By feeding repeatedly on coastal mudflats they are likely to find recently fertilized, nitrogen-rich plant food in a habitat providing refuge from predators.

MOVEMENT AND HABITAT USE BY GREATER WHITE-FRONTED GEESE WINTERING IN MEXICO

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We studied the Pacific Flyway subpopulation of greater white-fronted geese (*Anser albifrons frontalis*) that nest on the Bristol Bay Lowlands (BBL) of southwestern Alaska, migrate down the Pacific Coast and winter in Mexico. We radio-marked 13 adult molting geese in 1989 and 71 in 1990 at 2 sites on the BBL, and 39 BBL geese at Klamath Basin in northern California during migration. In September 1990, 123 of these radios were active. We used aerial and ground surveillance to relocate geese during spring and fall migration in Washington, Oregon, California and Nevada, and during the winter in Mexico. The mean date for BBL geese arriving at Klamath Basin staging areas was 31 August; their mean departure date was 9 September (N=54). Fifty-five geese were relocated in Mexico with mean arrival time of 12 September (N=49). Eight geese were found in wetlands on the west coast near Culiacan, Sinaloa, but the majority (47) were discovered at Laguna de Babicora, Chihuahua in the Interior Highlands. This high altitude (2135 m) basin has been categorized as 1 of the 27 most important wetlands in Mexico. Our habitat surveys indicated that the primary agricultural crops grown in the Babicora area included corn, oats, potatoes, and beans. After arrival at Babicora, geese fed in wetland and grassland areas although oat fields were harvested and available for use beginning in September. The geese began to feed in corn and oat fields in late November when the weather was colder. The major feeding areas were near the towns of Nicolas Bravo, La Lobera, Pena Blanca and Madera. The geese departed from Mexico on 20 January ($\pm$ 5 days, n=47). They were first located in California in the San Joaquin Valley and their mean arrival date was 2 February. Almost all geese migrating through California stopped in the Sacramento-San Joaquin River Delta or in the Klamath Basin prior to returning to Alaska in early May.

NATAL BREEDING DISPERSAL OF BLACK BRANT

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Dispersal is a fundamental determinant of the structure and dynamics of waterfowl populations. Philopatry of females to natal and breeding areas has been well documented, especially for populations of geese. However, previous assessments of philopatry have relied exclusively on single study sites. Consequently, estimates of philopatry and survival are confounded. Between 1986 and 1991 we observed black brant (*Branta bernicla nigricans*) breeding at several colonies in Alaska and western Canada to obtain estimates of philopatry and dispersal rates for brant originally marked as goslings at the Tutakoke River colony. Our results indicate that relative rates of natal dispersal are approximately 8 times higher for males than females. Preliminary findings also indicate that male natal dispersal is not random among breeding populations of black brant. Males are more likely to return to their natal colony to breed than expected by chance.

HATCH DATE, FOOD QUALITY AND GROWTH OF JUVENILE GREATER SNOW GEESE

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Recent studies have demonstrated that late-hatched goslings have slower growth rates than early-hatched goslings (Cooch et al. 1991; Sedinger and Flint 1991) and have attributed the slower growth rate to declining nutrient concentrations in Arctic plants consumed by geese during the breeding season (Sedinger and Raveling 1986). We experimentally tested the effect of hatch date and food quality on the growth of goslings of the greater snow goose (*Chen caerulescens atlantica*) at the Bylot Island colony (73°N), Northwest Territories. We raised 19 early and 19 late-hatched goslings in semi-captivity, allowing one half of each group of goslings to range freely throughout the day, while the other half ranged freely 12 hours per day and were provided with a high quality food, duck chow, for the remaining hours. We monitored five body measurements from 0 - 40 days of age. Late-hatched goslings raised without supplementary food experienced the highest mortality and the slowest growth rates compared with all other goslings. Access to duck chow allowed late-hatched goslings to attain the same growth rates as early-hatched goslings. Among early-hatched goslings, those with supplementary food were significantly larger than early-hatched goslings raised on vegetation alone. We suggest that late-hatched goslings faced inferior feeding conditions than early-hatched goslings which resulted in slower growth rates and later fledging, which may have a significant effect on gosling survival.

THE ROLE OF ARCTIC FOX PREDATION IN THE NESTING SUCCESS OF ARCTIC GEESE

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Abstract not available.

MIGRATION PATTERNS OF LESSER SNOW GEESE NESTING ON WRANGEL ISLAND, USSR

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Neck collars were placed on lesser snow geese (*Anser caerulescens caerulescens*) on Wrangel Island, USSR in 1988 (902) and 1989 (460). In the winter of 1988-89, 701 codes were reported in North America, 563 being seen more than once. In 1989-90, 460 of the 1988 bands and 210 of the 1989 bands were seen. In 1990-91, 80 bands from year 1 and 60 from year 2 were reported. The largest number of sightings and codes has been obtained from the northern wintering area (Fraser River, BC/Skagit River, WA) (659 codes, 3,618 sightings), followed by sightings in California (473 codes, 2,754 sightings). Codes seen in one location and during one season (fall, winter, spring) were compared with those seen in subsequent seasons in the same location, or in the same or subsequent seasons in other locations. Of the 581 unique codes seen as direct returns in the northern wintering area, 20.6% were also seen in California, in the same or subsequent seasons. Most codes were seen in fall in the northern wintering area, while most codes were seen in winter in California. Fewer codes were seen in spring on the prairies or in Alaska than were seen at other times in the wintering areas. Collars seen in the northern wintering area and also in California were resighted on the prairies in spring (40.8%) or less frequently in Alaska (5.0 %). Collars seen directly only on the northern wintering area (198 codes) were seldom reported from the prairies in spring (3), but more frequently from Alaska (49). The migration pattern appears mainly to involve a southward movement along the west coast of North America to the northern or California wintering areas. Spring migration involves a reverse migration for the northern wintering birds, while California wintering birds appear to favor the prairie route in spring.

BROOD-REARING HABITATS IN GREATER SNOW GEESE: A COMPARATIVE STUDY BASED ON THE ANIMAL PERCEPTION OF ITS ENVIRONMENT

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We studied the rearing habitats of the greater snow goose (*Chen caerulescens atlantica*) on Bylot Island, NWT, in the summer 1990. The main objective was to compare the nutritive value of two wet meadow habitats grazed by broods using 3 different approaches. First, we analyzed quantitatively and qualitatively plant phenology in both habitats. Second, we compared gosling feeding effort between habitats using behavioral data. Third, we used physiological data to compare the protein intake estimated by combining data on food selection, apparent nitrogen metabolizability and rate of food intake. The last two approaches used human-imprinted goslings. The 2 habitats are made up of *Eriophorum* sp., *Dupontia fisheri* and *Carex* aquatilis but differ in their relative specific abundance and total biomass. Nitrogen and fiber content differed among plant species but, overall, was similar between habitats. Gosling feeding effort was higher in habitats with low plant biomass. Goslings fed selectively only where *Eriophorum*, a plant high in nitrogen and low in fiber, was abundant. Apparent metabolizability and total nitrogen intake were also generally higher in habitats where *Eriophorum* was abundant compared to those where *Carex* was abundant. In the habitat with low nitrogen intake, goslings did not compensate by increasing their food intake which suggests that they were already processing food at their maximum capacity. Based on the behavioral and physiological analyses, we conclude that quality of the 2 habitats was quite different for goslings. Quality of wet Arctic meadows as goose rearing habitat may not be as uniform as previously thought.

THE EFFECT OF REARING EXPERIENCE ON SUBSEQUENT BEHAVIOURAL TRAITS IN HAWAIIAN GEESE BRANTA SANDVICENSIS: IMPLICATIONS FOR THE RECOVERY PROGRAMME

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The risk of the Nene (*Branta sandvicensis*) becoming extinct has been minimised by the release of over 2,000 captive-reared geese, but the population (now at 500) is yet to achieve a self-sustaining status. The majority of birds released have been reared in gosling only groups, thus missing out on the opportunity to learn social and feeding skills from adults. In this paper we test the hypothesis that rearing experience affects the subsequent behavioural traits of Nene goslings. We raised 42 goslings under 4 conditions: a gosling group not exposed to adults, a gosling group exposed to adults from 16 days onward, 3 groups in view of 'foster' adults for 14 days, and 4 groups reared continuously by parents. All birds were eventually released into an 8 ha pen where a flock of adult Nene roamed. The method by which Nene goslings were raised had a significant effect on dominance, flock integration, and vigilance. Parent-reared birds were dominant to and more vigilant than goslings raised without parents or goslings reared in sight of adults. Parent-reared birds also integrated into the adult flock sooner than other goslings. Growth rate and final body size was not affected by rearing regime (with or without parents or foster parents). In the future, managers should provide goslings with as much 'parental' experience as possible in order to equip them with appropriate skills to cope once released in the wild.

EAGLE PREDATION ON CACKLING CANADA AND ROSS' GEESE WINTERING IN CALIFORNIA, WITH COMMENTS ON THE REACTION AND SUSCEPTABILITY OF GREAT BASIN CANADA GEESE TO EAGLE PREDATION

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We documented eagle predation rates on cackling Canada geese (*Branta canadensis minima*), Great Basin Canada (*B. c. moffitti*), and Ross" geese (*Anser rossi*) in Big Valley, California, during March and April, 1989 and 1990. We then compared predation rates on cackling geese with those from other wintering locations in California from observations collected between Oct.-April in 1985-1988. Eagles were seen successfully killing a cackling goose on average every 7.5 days and 17.5 days in the Klamath Basin and Big Valley, respectively. Only two eagle kills were observed in 220 days of observation in the Sacramento and San Joaquin Valleys. In any given year, golden eagles accounted for at least 84% and usually 100% of the successful attacks observed. Bald eagles flushed flocks regularly throughout California, but only in the Klamath Basin were bald eagles responsible for any of the successful attacks observed (16% from 1985-1988). In Big Valley, Great Basin Canada geese were attacked by eagles only once in over 125 days of observation, and did not respond to eagles by flushing as did cackling and Ross' geese. In both 1989 and 1990, eagle disturbance of cackling and Ross' goose flocks in Big Valley averaged > 2.1 flushes per day during early March and declined to < 0.70 flushes per day during April. In 1989 and 1990, most flushes of geese in Big Valley occurred during midday (62% and 43%, respectively), but the distribution of eagle attacks and kills during a day varied between years. Eagle attacks occurred either while geese were feeding in pasture (46% in 1989, 36% in 1990) or alfalfa (8% in 1989, 21% in 1990), or while geese were roosting during mid-day (38% in 1989, 36% in 1990). In Big Valley, cackling geese were attacked and killed by eagles twice as often as Ross' geese. Ross' geese are less vulnerable to eagle predation in Big Valley in part because they rarely fed in pasture fields where many eagle attacks occurred, and in part because they are there for a shorter time. During spring and summer 1991, we will obtain morphometric characteristics (culmen, tarsus, skull) from breeding giant Canada geese in southern Ontario and interior Canada geese from James Bay, Ontario. Discriminate function analyses of morphometric measurements will be used to separate the two subspecies. During the 1991 hunting season (September - December), we will obtain morphological measurements, sex, and age from geese shot by hunters in southern Ontario. Additionally, date and kill location will also be recorded. Our objectives are: 1) to determine which morphological variables best distinguish adult giant Canada geese from adult SJBP geese in Ontario, and 2) to use measurements of those variables from hunter-killed geese to determine harvest composition of Canada geese in southern Ontario. Date and location of kill will provide information on migrational patterns of SJBP geese through southern Ontario. Also, a determination of the morphological differences between giant Canada geese and SJBP geese will enable James Bay goose banders, in future, to accurately distinguish molt-migrant giant Canada geese from SJBP geese.

A MORPHOMETRIC STUDY OF GIANT AND INTERIOR CANADA GEESE OF THE SOUTHERN JAMES BAY POPULATION (SJBP) IN ONTARIO

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The dramatic increase in giant Canada goose (*Branta canadensis maxima*) populations has resulted in bag limit increases and longer hunting seasons in many areas, including southern Ontario. In Ontario, the staging areas and migration corridors of giant Canada geese and interior Canada geese (*B. canadensis interior*) of the Southern James Bay Population (SJBP geese) overlap. Therefore, regulations implemented to increase the harvest of giant Canada geese could potentially lead to an increased harvest of SJBP geese. This summer we are initiating a study that will examine morphological differences between giant and interior Canada geese and that will use morphological measurements to determine subspecific composition of the southern Ontario Canada goose harvest. During spring and summer 1991, we will obtain morphometric characteristics (culmen, tarsus, skull) from breeding giant Canada geese in southern Ontario and interior Canada geese from James Bay, Ontario. Discriminate function analyses of morphometric measurements will be used to separate the 2 subspecies. During the 1991 hunting season (September - December), we will obtain morphological measurements, sex, and age from geese shot by hunters in southern Ontario. Additionally, date and kill location will also be recorded. Our objectives are: 1) to determine which morphological variables best distinguish adult giant Canada geese from adult SJBP geese in Ontario, and 2) to use measurements of those variables from hunter-killed geese to determine harvest composition of Canada geese in southern Ontario. Also, a determination of the morphological differences between giant Canada geese and SJBP geese will enable James Bay goose banders, in future, to accurately distinguish molt-migrant giant Canada geese from SJBP geese.

INFLUENCE OF LESSER SNOW GOOSE HERBIVORY ON MID-TEXAS COASTAL MARSH DYNAMICS

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Recent accelerated transformation of emergent salt marsh to mudflats on the San Bernard National Wildlife Refuge, Texas and subsequent partial revegetation of areas heavily utilized by wintering lesser snow geese was quantified at 2 spatial/temporal scales. Historical mudflat/vegetation dynamics for a 1600 ha salt marsh area was evaluated from aerial photography utilizing GIS. Less than 3% of the area was unvegetated in 1939 with 17% unvegetated in 1990. Rate of mudflat development increased after 1965 (1970s & 80's documented heavy snow goose use) and reached a maximum extent in 1987 followed by a 5% decline from 1987 - 1990 (reduced snow goose numbers). Mudflat areas were dynamic; some areas revegetated, others expanded or converted to deeper mudflats with semipermanent open water. *Distichlis spicata* dominated areas recently denuded by geese contain remnant vegetation islands (2-4 m^2). The boundaries of 100 islands marked following goose use in 1988 expanded without further snow gose use from 1988 - 1990. Rate of expansion was initially slow (1977/88; dry, heavy algal mat) for *D. spicata* and *Spartina alterniflora* dominated islands, but accelerated in 1989-1990 (wet, algal mat reduced). Intense repeated snow goose use and environmental factors (low water, high salinity) which delay recovery appear to result in mudflat expansion.

SCIRPUS OLNEYI RECOVERY FOLLOWING UTILIZATION BY WINTERING LESSER SNOW GEESE ON A MID-TEXAS COASTAL MARSH

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Scirpus olneyi response to various levels of wintering snow goose utilization and environmental conditions was evaluated from 1988-1990. Following heavy utilization (75-100% vegetation uprooted with roots and rhizomes removed) in 1988, regrowth of *S. olneyi* resulted from survival and regrowth of uprooted crown material. Seedling establishment was absent. Average spring rainfall (low salinity and declining water levels) facilitated reattachment and rhizomatous spread of *S. olneyi*. In October 1988, *S. olneyi* mean foliar cover in heavily utilized areas was 47%. Mean foliar cover of lightly utilized areas (less than 25% of vegetation uprooted) was 75%. Repeated snow goose use in 1989 followed by below normal rainfall (high salinity, low water levels) resulted in lack of regeneration of uprooted *S. olneyi*. Regrowth was restricted to areas where rooted material and severed rhizomes remained. In 1990, snow goose use was light and continued recovery of areas variously utilized in previous years resulted in a mosaic of vegetation height and various size gaps in the *S. olneyi* canopy. Intensity and frequency of snow goose use interacting with subsequent environmental conditions influenced the pattern of recovery of foliar cover, height and above ground production of *S. olneyi* vegetation.

THE EFFECTS OF THE LISBURNE OIL DEVELOPMENT PROJECT ON GEESE NESTING IN PRUDHOE BAY, ALASKA, 1985-1989

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Construction of the Lisburne Oilfield within the Prudhoe Bay complex generated concern over the effects of additional development on the Canada goose, greater white-fronted goose, and brant populations that nest in the oilfields. This study evaluated whether the distribution, abundance, or nesting success of geese were affected during the construction (1985-1986) and post-construction (1987-1989) phases of the Lisburne Development Project. We monitored natural (e.g., predators) and development-related (e.g., traffic) factors affecting the productivity and status of breeding populations in a 63 km^2 study area surrounding Prudhoe Bay. The relative influences of spring weather conditions, predators, and disturbance from oilfield activities on nesting success varied among species. Nesting efforts of Canada geese and brant, which nested in aquatic habitats, were influenced primarily by nest site availability, as mediated by weather, and predation by foxes and gulls. greater white-fronted geese, which nested in terrestrial habitats, were influenced less by weather and were more adept at defending their nests against predators. Greater white-fronted geese frequently used nest sites in the "dust shadows" of roads, which became snow-free earlier than areas away from the road system. Nest distribution was affected by the network of roads and pads (direct habitat loss) and on a species-specific basis by oilfield activity (indirect habitat loss). Routine oilfield activities (e.g., road traffic and drill-site operations) generally did not affect nesting success. Unusual activities requiring pedestrian traffic off the road system or site-specific use of heavy equipment did cause nest failures, however. Scheduling of construction activities to avoid prime nesting areas during May - July is recommended.

OBSERVATIONS OF LEG-BANDED AND NECK-COLLARED WESTERN MID-CONTINENT WHITE-FRONTED GEESE FROM ALASKA

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As a part of a cooperative marking program between the U. S. Fish and Wildlife Service, the Canadian Wildlife Service, and numerous territorial and state resource agencies, biologists and volunteers captured, leg-banded, and neck-collared mid-continent greater white-fronted geese (*Anser albifrons frontalis*) at numerous locations in Alaska and Canada in 1990 and 1991. One of several objectives of this program is to document differences in breeding, molting, migration, and wintering areas of possible subpopulations of western mid-continent greater white-fronted geese captured in interior and northern Alaska. Sightings of geese collared and banded in 1990 were made by observers in migration areas and on U .S. wintering areas and by biologists capturing geese on molting and breeding areas in July, 1991. Potential differences in timing and use of staging and wintering areas by geese captured at different locations were examined. Foreign retraps, returns, and recoveries of geese were examined to document extent of return by geese to areas of prior use in Alaska.

MORPHOLOGICAL DIFFERENCES IN GREATER WHITE-FRONTED GEESE POPULATIONS FROM THE PACIFIC FLYWAY

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We used discriminant analysis to compare morphological measurements of greater white-fronted goose populations in the Pacific Flyway. These populations included the Pacific (*Anser albifrons albifrons*) and tule (*A. a. gambelli*) subspecies and a recently identified population from the Bristol Bay Lowlands of Alaska. The Pacific population (225,000 geese) breeds on the Yukon-Kuskokwim River Delta in western Alaska and winters in the Central Valley of California. The tule goose (8,000) nests in Trading and Redoubt Bays in Cook Inlet, southcentral Alaska. The Bristol Bay population (>10,000) breeds in the Bristol Bay Lowlands of the Alaska Peninsula. This population of geese winters on the west coast of Mexico and in the interior highlands of northern Mexico near Laguana Babicora, Chihuahua. We found significant size differences between the adult geese of these populations across 6 morphometric variables (ANOVA, $P \leq 0.05$). There were significant differences in weight, culmen length, culmen height, total tarsus, diagonal tarsus, and mid-toe measurements among these populations. The geese from Bristol Bay were intermediate in size between the Pacific and tule white-fronted geese. The results suggest that there are more distinct subspecies or populations of greater white-fronted geese than are currently recognized.

THE SVALBARD BARNACLE GOOSE - LESSONS FROM A NON-CONSUMPTIVE STUDY

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This 20-year intensive study of a small, closed goose population has concentrated on understanding population processes on a population and an individual level. The study has relied on accurate estimates of total population size, annual recruitment and mortality, and on detailed observation of marked birds. This paper concentrates on aspects of population biology which rely on following the fate of individuals and the whole group over extended periods, and on questions that can only be answered on a long-term basis. At the population level, these include: a) changes in the age structure of the population over time, and in relation to population size, b) annual variations in the achievement of breeding condition in relation to variability c) the possible impact of the birds on their food and other resources as numbers change. At the individual level: a) variations in individual breeding performance and lifetime reproductive success in relation to density and breeding conditions b) comparative impact of body reserves and pair quality on individual breeding success. We review and compare this approach with short term, intensive studies and suggest that both are needed to understand population processes in geese and the contribution of individuals to population viability.

INTRASPECIFIC NEST PARASITISM AMONG EMPEROR GEESE

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The frequency and occurrence, and costs and benefits of intraspecific nest parasitism was determined for emperor geese (*Anser canagica*) nesting near Kokechik Bay, Alaska. Many (62.2%) nests contained parasitic eggs and 14.9% of goslings produced were from parasitic eggs. Parasitized nests contained 2.15 $\pm$ 0.11 parasitic eggs laid by 1.51 $\pm$ 0.06 females. Nesting success was similar between nests with (93.3% of 195) and without (89.7% of 107) parasitic eggs. A significantly greater proportion of host eggs hatched in nests without parasitic eggs (93.2% of 413 eggs in 105 nests) than with parasitic eggs (88.7% of 716 eggs in 193 nests); 49.2% of 362 parasitic eggs in 182 successful nests hatched. Most (93.1% of 417) eggs laid parasitically were incubated by host females. The relatively high rate of nest parasitism may reflect a high proportion of females unpaired and newly re-paired in spring and unable to establish or maintain nesting territories. The cost to the host as measured by host egg mortality was low. Benefits to the host from raising large broods may include increased dominance status or decreased predation of host young. By nesting parasitically emperor geese are "making the best of a bad situation".

ON THE RECENT STATE OF THE SWAN-GOOSE POPULATION IN RUSSIA

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A population decrease was found in the early 20th century, but until the mid-20th century this species was widespread and quite common in the eastern breeding area. Until the 1970s the breeding range was divided into a few parts; the Torey Lakes with many pairs, the Ulma River with 10-20 pairs, Khanka Lake with dozens of pairs and northern Sakhalin with 10-20 pairs. The largest population existed on Udyl Lake in the Khabarovsk region (about 150-200 pairs). Geese evidently nested along the stream valleys and broods gathered in creches were found among wide sedge-mound marshes in river mouths (mainly in the Bichi River Delta). The home range covered the same area of 4-5 km^2. A seasonal reserve was established on Udyl lake in 1978 and turned into a republic reserve in 1986. Still, the number of swan-geese decreased to 30-40 pairs in the mid-80s because of poor preservation. In 1984, 5-6 pairs of swan-geese were found nesting in the same conditions as on Udyl Lake. Hunters informed us that similarly small populations inhabit other places in the Lower Amur region. On Sakhalin Island, swan-geese were not observed in 1990-91. A few pairs may be nesting on Torey Lakes and Khanka Lake. As a result, we now know the nesting places of not more than 100 pairs: the total number of swan-geese in the USSR is near 500. The reason for this catastrophic decrease in numbers is that these swan-geese inhabit places easily accessible to people during the hatching period and the adult birds do not fear man - we often came within 50 meters of them. Hunting in the wintering grounds in China may have played a role too.

INDIVIDUAL VARIATION IN FEEDING BEHAVIOR AND BODY RESERVES IN SPRING STAGING GEESE

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In Arctic-breeding geese, the amount of body reserves accumulated in spring is an important factor determining the breeding success in the subsequent summer. Brent geese *Branta bernicla* and barnacle geese *B. leucopsis* were studied (in The Netherlands and Norway, respectively) to explore to what extent the variation in body reserves could be related to differences in feeding behavior between individuals. Both goose species studied use semi-natural vegetation in spring, which they graze in small flocks. The availability of food on the staging areas is dynamic in space and time, depending on the growth rate of the food plants and on the intensity of grazing by geese. The tracks of foraging, individually recognizable geese were registered, and film records allowed a detailed analysis of the feeding behavior and the interactions with other individuals. One aspect of the performance of the geese that appeared to affect the food intake rate, and hence the accumulation of body reserves, was the pattern in the choice of feeding sites: the extremes were (a) pairs that showed high site-fidelity revisiting frequently the same spots in the area during the staging period; (b) pairs that showed an erratic distribution pattern. Which of the 2 groups obtained most food varied in the course of spring; high growth rates of the food plants were in favor of the former group. The occurrence of the large individual differences in feeding strategies is discussed in perspective of variable food conditions within the annual cycle.

THE GENETIC LEGACY OF MOTHER GOOSE

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The polymerase chain reaction (PCR) was used to gather DNA sequence information from individual lesser snow geese sampled across their breeding range. In snow geese, there is strong female philopatry which results in little intercolonial movement of females, contrary to the pattern observed in males. By choosing a rapidly evolving maternally inherited DNA molecule (mitochondrial DNA) I have attempted to trace the female lineage through time and across the species range. To optimize resolution of genetic differences, the fastest changing portion of that molecule, region I of the control region was sequenced. The results were surprising. At present, lesser snow geese are considered to be divided into 2 populations, an eastern and a western one. The most prominent genetic feature found was 2 distinct DNA 'types', but rather than one type being found in the east and one type in the west, both types were distributed among all colonies. It is likely that this is a vestige of 2 major goose refugia during past glaciation events, with subsequent mixing of those populations. Superimposed on that pattern, a minor amount of divergence between the modern east and west populations was detected. The techniques used in this study are quite new, and by designing DNA primers which match conserved sequences in and around the fast evolving (control) region, it becomes possible to efficiently sequence the same portion of DNA from a wide variety of other taxa within and beyond waterfowl. Such approaches will be valuable for studies of population history and hence for conservation genetics.

A SKELETAL VIEW OF STRUCTURAL SIZE OF LESSER SNOW GEESE

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The structural size of a lesser snow goose can be viewed as a naked frame on which protein and fat reserves can be amassed. Several recent papers addressing the relation of body size, condition and reproductive success have used field-measured morphometrics as indicators of structural size. In some cases, univariate relations were found and in others they were not. In this study, we assess the structural size of snow geese using numerous measures of entire skeletons. Some of these are traditional ornithological measures while others are more directly relatable to feeding constraints and stress loadings for flight. We examine the relationships among these measures and use them to generate multivariate estimators of structural size. We pay particular attention to the relative contribution of single measures to such overall estimates and their relation to field-measured morphometrics.

INCUBATION BEHAVIOR AND BODY WEIGHTS OF FEMALE GREATER SNOW GEESE

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Nest attentiveness of incubating female greater snow geese (*Anser caerulescens atlanticus)* was monitored on Bylot Island during 1991. Females incubated for 93% of the 24 h daylight period. Incubation bouts lasted on average 3.5 h and mean recess time was 15 min. During recesses, females remained close to the nest and devoted most of their time to feeding which was characterized by a rapid pecking rate. Females captured during the last few days of incubation showed relatively high body weights. This suggests that by feeding intensively during relatively frequent and lengthy recesses, female greater snow geese can maintain higher levels of body reserves through incubation than most other goose species.

USE OF EELGRASS MEADOWS BY BRANT ON THE NORTHEAST COAST OF JAMES BAY: A PROGRESS REPORT

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Since the mid-1980s, intensive studies have been conducted on the distribution, ecology, and production of eelgrass (*Zostera marina*) along the northeast coast of James Bay. These studies show that coastline to be one of the major concentrations of eelgrass in North America. Large numbers of Atlantic brant (*Branta bernicla hrota*) stage in the area during spring and fall migration, feeding heavily on eelgrass; investigations on this relationship were begun in 1990 by examining habitat use by brant, diet, feeding strategies and nutrient reserve status. Preliminary results show that brant feed intensively and exclusively on eelgrass, and attain high body weights. These and other results summarized in the poster suggest that the eelgrass meadows of northeastern James Bay represent a critical source of nutrient reserves for migrating brant in both spring and fall.

DISTRIBUTION AND ABUNDANCE OF ARCTIC GEESE IN ALASKA'S NORTH SLOPE OILFIELDS

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Four species of geese nest, rear young, and stage in the oilfields on Alaska's North Slope: brant (*Branta bernicla*), greater white-fronted goose (*Anser albifrons*), Canada goose (*Branta canadensis*), and snow goose (*Chen caerulescens*). This paper summarizes information on numbers and distribution of these species gathered during a variety of fixed-wing aerial surveys conducted between the Canning and Colville Rivers, 1988-1991. Oilfields, including Prudhoe Bay, Kuparuk, and Endicott, as well as proposed oil lease areas in the region were surveyed. Brant were the most common breeding goose species. Brant numbers ranged from approximately 1000 adults during nesting to approximately 3000 during brood-rearing, with goslings making up 40% of the latter. Nest numbers ranged from 150-500, with most nests located in two major river deltas. However, small inland colonies (<20 nests) were productive elements of this population. Major brood-rearing areas were confined to the coast. White-fronted geese were the most abundant species, although molting was the primary use, especially west of Prudhoe Bay; summer numbers exceeded 5000 in the region. Snow goose nesting was almost entirely confined to Howe Island in the Sagavanirktok River Delta. July numbers exceeded 1600 birds in 1990 and brood-rearing birds used the area between Prudhoe Bay and the Kavik River delta. Canada goose nests were distributed widely, but were most common east of the Kuparuk River. Mid-summer numbers probably did not exceed 1500 birds. Additional information on the distribution of these species, in the context of Alaska's North Slope is provided.

MOVEMENTS AND FIDELITY OF SNOW GEESE WINTERING IN TEXAS

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Lesser snow geese wintering in Texas utilize a belt of the upper Texas coast which includes coastal marsh and inland rice agriculture regions. To gain a better understanding of how snow geese use this wintering area, we examined movements and fidelity of snow geese through observation of marked birds and analysis of band recoveries. Snow geese were color-marked on 2 coastal wildlife refuges in 1987-88, and neckbanded and radio-tagged on 1 coastal refuge in 1988-89 and 1989-90. Movements of marked birds were monitored from December through March from 1987 through 1990 to examine movements and fidelity within one winter season. Band return data from 4 coastal banding sites (3 in Texas, 1 in Louisiana) were compiled and analyzed using Chi-square goodness-of-fit tests to examine fidelity to wintering areas between winter seasons. Marked snow geese exhibited highly variable movements. Color-marked birds were observed throughout the upper Texas coast and in Louisiana. Neckbanded and radio-tagged geese exhibited a wide range of movement patterns, from short, localized movements to long range movements throughout the upper Texas coast. Marked birds were observed using both coastal marsh and inland agricultural areas. Snow geese banded at one of the 4 banding sites and recovered in years subsequent to banding were found to exhibit fidelity to the banding site. Chi-square analysis of each banding site showed that snow geese were more likely to be recovered near their banding site than one of the other banding sites. Marked snow geese observed from 1987 through 1990 did not exhibit within season fidelity to wintering areas. However, band recoveries indicate that snow geese do exhibit between season site fidelity. Snow geese wintering in Texas may exhibit traditional fidelity to an area annually, but exhibit variable movements throughout the upper Texas coast based on resource availability within 1 season.

DO OLDER BIRDS ALSO DO LESS WELL?

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We examined the effect of age on reproductive performance of female lesser snow geese at the La Perouse Bay colony near Churchill, Manitoba. We evaluated each of the fitness components contributing to reproductive success, as well as an overall composite spanning the entire period from egg laying through fledging. Younger birds perform less well for several of the fitness components but not for all. Not surprisingly, the composite reproductive success increases from ages 2 through 7. While the performance for some fitness components did not decline for birds aged 7 through 15, it became sufficiently poor for enough components that the composite estimate declines after age 7. Thus, overall reproductive success in this sample of lesser snow geese forms an inverted U with both younger and older birds doing less well. While the poorer performances at both ends of the age distribution may relate in part to developmental or physiological constraints, we feel that behavioral processes may also be involved. Younger birds may need several years to acquire the skills related to feeding and nesting that allow them to maximize their reproductive output. For our sample of older birds, philopatry to traditional nesting and brood-rearing sites at La Perouse Bay may reduce their performance since many of those geographic sites have become degraded.

DISPERSAL, GENE FLOW AND POPULATION GENETIC STRUCTURE OF PACIFIC BLACK BRANT

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The movement of individuals among breeding populations of a subdivided species can have profound effects on growth dynamics of individual populations. Moreover, when those dispersers incorporate their genes into local populations, they can alter the genetic potential and population genetic structure of the entire assemblage. Theoretical work has demonstrated that dispersal and overall population genetic structure can be important determinants in both the short- and long-term health of managed species. Most work in this area has focused either on simple monitoring of dispersal or the inference of genetic structure from allozyme of DNA-based polymorphism data. Our work involves using demographic data and models to generate estimates of population genetic structure of pacific black brant. These estimates are then directly tested with tools of molecular genetics. In this way, we avoid some of the circularity and traps that beset more inferential approaches. In this presentation we outline our basic models and present some of our boundary predictions of genetic differentiation among the populations. We also provide some initial assessments of dispersal and gene flow in pacific black brant.

ON THE HERITABILITY OF FITNESS COMPONENTS IN LESSER SNOW GEESE

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The heritability of a trait indicates the relative propensity with which the trait will be transmitted to the next generation. It also provides an upper limit for the rate of evolutionary change in the trait, given that it has some impact on an individual's fitness. This latter constraint is removed when the trait is itself a component of fitness contributing directly, for example, to reproductive success. In this study, we evaluate the heritabilites and genetic covariances among the set of fitness components that define reproductive success of lesser snow geese nesting at La Perouse Bay, near Churchill, Manitoba. We discuss the implications of the estimates with respect to evolutionary change in the population. We also consider the relation of the genetic architecture defined for the components to proximate morphological and physiological mechanisms underlying fitness in this species.

ESTIMATES OF SEASONAL SURVIVAL IN EMPEROR GEESE

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Juvenile and adult emperor geese were neck-collared during late July - early August 1988-1990 and resighted at spring and fall migratory staging grounds during 1988-91. Survival was estimated for 3 different seasons: 1) banding to first fall (Postbreeding), 2) fall to spring (Over-winter), and 3) spring to fall (Over-summer). Postbreeding survival of juveniles was 25% lower than that of adults. Juveniles exhibited a weak relationship between mass at banding and subsequent survival to first fall. Over-winter and over-summer survival of juveniles was 20-25% and 78%, respectively. Over-winter and over-summer survival of adults was 60-100% and 92%, respectively. Average monthly rates of survival within seasons were also calculated. These rates of over-winter survival are the lowest known for geese. Additional seasonal estimates will soon be available. Assumptions of the survival model were considered, and a simple, deterministic population model constructed to examine how survival estimates interacted with other life history parameters.

OBSERVATIONS OF NECKBANDED WHITE GEESE AT FREEZEOUT LAKE, MONTANA

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From the spring of 1989 through the spring of 1991, observations of neckband codes on banded white geese migrating through North Central Montana have been recorded. The records have been contributed to the International Goose Neckbanding Project. They have been obtained on a volunteer basis. The volunteer observations have yielded 1,259 records, 679 of which are complete and unique; 109 codes have been recorded in more than 1 season. The effort demonstrates that a volunteer who is properly located geographically, equipped, and motivated can provide a significant contribution to a wildlife banding program.

THE STATUS OF DUSKY CANADA GEESE: AN EXAMINATION OF PAST AND PRESENT TRENDS IN SURVIVAL AND POPULATION SIZE

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Dusky Canada geese (*Branta canadensis occidentalis*) comprise one of the smallest populations of Canada geese that presently sustains a harvestable surplus for sport hunting. This subspecies breeds on the Copper River Delta, Alaska and winters in the Willamette Valley of northwestern Oregon and the Lower Columbia River Basin of southwestern Washington. Although estimates of population size ranged from 20,000 to 25,000 during the 1970s, the population declined to an estimated 12,000 geese during the 1980's. Concern about their status prompted restrictions in harvest regulations implemented in 1983 and continued to date. Production studies on the Copper River Delta have provided the best database on annual recruitment into this population. However, reliable estimates of survival and population size are lacking. Annual postseason counts, conducted on the winter range since 1952, provide only an index to population size and not actual estimates. Leg band recovery data from preseason banding on the breeding grounds has never been satisfactorily analyzed, and current harvest restrictions limit the information from band recoveries during the 1980s. Recently developed statistical techniques to analyze leg band recovery data, and mark-reobservation studies involving geese banded with engraved plastic neck bands during 1984-1991, have greatly improved the precision of survival rate and population size estimates. Past and present trends using these new techniques will be discussed along with guidelines for future management strategies of dusky Canada geese.

WHERE HAVE ALL THE SNOW GEESE GONE?

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Ross' geese, *Anser rossii*, and lesser snow geese, *Anser caerulescens caerulescens*, have been the most abundant geese wintering in the Central Valley (CV) of California in the past three decades. During this period, the total number of white geese inventoried has remained relatively stable. However, the proportion of Ross' geese in CV white goose flocks has increased dramatically. These wintering population trends have occurred during a period of documented growth of Western Canadian Arctic (WCA) and Central Canadian Arctic (CCA) snow and Ross' goose breeding colonies. Possible explanations for the decrease in snow geese and increase in Ross' geese surveyed on CV winter grounds include: a decline in the Wrangel Island (USSR) snow goose population wintering in the CV; disproportionate harvest and disease mortality between snow geese and Ross' geese; an increase in the proportion of WCA snow geese wintering in the western Central Flyway; and winter period transflyway migrations of snow geese from the CV to New Mexico. All these factors may be influencing wintering white goose populations. Therefore, future research should include: comprehensive population inventories; detailed analysis of white goose harvest, disease records, and neck-band data from the Pacific and Central Flyways; investigations of the relationship between local abundance and geographic range among white goose populations; investigations of behavioral relationships between lesser snow and Ross' geese at feeding and roosting sites during the wintering period. Information obtained from such research is needed to gain a better understanding of wintering white goose population dynamics.

BROOD DISPERSAL IN ROSS' AND LESSER SNOW GEESE: DOES THE BROOD REARING DISTANCE INFLUENCE GOSLING GROWTH AND SURVIVAL?

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Environmental degradation has been implicated as the cause of a reduction in body size and, possibly, a decline in recruitment of lesser snow geese hatched at the growing La Perouse Bay colony. In the central Canadian Arctic, the population of Ross' and lesser snow geese nesting at Karrak Lake has also grown rapidly, increasing from 8,500 to over 100,000 nesting pairs since 1966. Habitat degradation has been observed around this colony, but the influence of the apparently poor foraging conditions on gosling growth and survival is unknown. Since brood density likely decreases with increasing distance from the colony, dispersing broods should experience a higher per capita food availability the farther they radiate from the colony. Consequently, gosling growth and survival rates should also increase with rearing distance. We used radio telemetry to test the hypothesis that gosling growth and survival is distance-dependent. We followed 11 Ross' and 4 lesser snow goose females and their goslings during the brood rearing period. Dispersal from the colony occurred rapidly and within 18 days broods had established home ranges 8-59 km north of the colony. After 30 days, we recaptured 7 Ross' and 4 lesser snow geese females, then counted, weighed, and measured their surviving goslings. Within each species, gosling survival was not distance-dependent. Ross' Goose broods, however, settled farther from the colony and experienced a higher gosling survival rate than did Lesser snow goose broods (42.6 $\pm$ 14.1 km vs 13.6 $\pm$ 3.9 km and 42.9% vs 33.3% respectively). These results suggest that between species, goslings raised close to the colony suffer higher mortality than goslings raised farther away. We are currently analyzing morphometric data from wild and captive-reared goslings for distance-dependent effects.

USING PRESCRIBED BURNING TO MANAGE HABITAT FOR SPRING MIGRATING ARCTIC NESTING GEESE

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We investigated whether fall burning creates areas attractive to cackling Canada (*Branta canadensis minima*) and Pacific white-fronted geese (*Anser albifrons frontalis*) during spring migration (15 February - 3 May, 1991) in Fall River Valley, California. Cackling goose use was limited to mid-day (1000-1500 hr) roosting on flooded portions of 4 replicate burned and unburned plots (1.9-2.7 ha each). White-fronted geese foraged on upland portions of the burned and unburned plots primarily during the evening (1600 hr-sunset), and, like cackling geese, roosted during mid-day on flooded portions of the burned and unburned plots. The total number of white-fronted geese per scan and the number of white-fronted geese feeding per scan were significantly higher in burned compared to unburned areas for 8 of the 9 evenings in which feeding was observed. Absolute percent plant cover recorded within one week of the first day of goose use (7 April, burned, $\bar{x}$=21.3, SD=1.4; unburned, $\bar{x}$=2.9, SD=1.2) and within one week of the last day of the goose use (5 May, burned $\bar{x}$=32.4, SD=7.4; unburned $\bar{x}$=10.0, SD=6.2) in the treatment areas was significantly greater in burned compared to unburned areas ($F_{1,6}$=218.0, P=.0001, and $F_{1,6}$=17.8, P=.0056, respectively). Thus, the white-fronted goose preferential feeding in burned plots can be partially explained as a response to increased food availability. However, white-fronted geese foraged primarily in only 1 of the 4 burned blocks. In this one burned plot, the relative percent cover of canary grass (*Phalaris arundinaceae*) and quackgrass (*Agropyron repens*) was 79.8% on 7 April and 70.6% on 5 May in the frequently used burned plot and 35.6% and 15.7% on average, respectively, in the other 3 burned areas. Foxtail barley (*Hordeum jubatum*), saltgrass (*Distichlis spicata*), and spike rush (*Eleocharis palustris*) accounted for most of the remaining plant species available to the geese. Whether canary grass and quackgrass are preferred by white-fronted geese is not clear because preference is complicated by differences in plant phenology. Cackling geese did not forage in the burned plots apparently because of inadequate availability of their preferred plants.

FIELD BIOLOGISTS' NEED FOR GOOSE NECK-BAND INFORMATION

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Biologists have placed neck bands on geese for decades to study aspects of population biology, migration, energetics, habitat selection, and social behavior. Neck-band protocol is assigned cooperatively by the Canadian Wildlife Service and the U. S. Fish and Wildlife Service, but actual data have been maintained by individual researchers. The cost has been prohibitive for developing a centralized database for all neck-band information, including resightings. I propose a method for distributing more limited information among researchers and management personnel in the Central and Pacific Flyways. The data base would provide information only on where, when, and by whom geese were neck-banded. Ready access to this information would allow biologists and refuge managers to keep official observers on their areas better informed, fostering more effective resighting of neck bands. They could also respond quickly to requests for neck-band information from the public. I recommend that commercially available database software for IBM-compatible personal computers be utilized. Species of primary interest are Canada goose (*Branta canadensis*), lesser snow goose (*Chen caerulescens caerulescens*), greater white-fronted goose (*Anser albifrons frontalis*), and Ross' goose (*C. rossii*).

THE FORAGING ACTIVITIES OF LESSER SNOW GEESE AND THE DEGRADATION OF ARCTIC SALT MARSHES

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During the last decade, populations of lesser snow geese (*Chen c. caerulescens*) have increased substantially in the eastern Canadian Arctic and elsewhere. In spring, before the onset of above-ground plant growth, the birds grub the roots and rhizomes of Arctic salt-marsh graminoids. This foraging activity has led to the destruction of salt-marsh swards and the loss of summer grazing pasture used by both adults and goslings. The remaining swards are intensively grazed between hatch and when goslings fledge. These changes in use have had a number of "knock-on" effects which have led to a further deterioration in the state of swards at different sites. They include the following: a) removal of the insulating layer of ground vegetation, plant litter, and peat, b) high surface temperatures and the development of dry, hypersaline sediments where vegetation has been removed, c) development of an algal mat in spring which dries out in summer to form a tough blister-like skin, d) poor ability of the salt-marsh graminoids to reestablish in dried-out algal mats and hypersaline soils, f) the opening-up of the remaining intact swards because of the intense grazing and the onset of the above conditions leading to poor growth and lack of preferred summer forage. Such changes are in progress at a number of coastal sites in the Canadian Arctic and are having a profound effect on the size and structure of at least the La Pérouse Bay population which has been studied in detail.

ADAPTATIONS OF THE EUROASIAN GEESE AND SWANS TO ARCTIC CONDITIONS

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This presentation summarizes long-term ecological studies of Arctic nesting Anseriformes, specifically tundra swan, bean goose, greater white-fronted goose, lesser snow goose, barnacle goose, and black brant in the Soviet Union. I identify the main factors affecting breeding success of geese and swans and analyze the ways the birds have adapted to Arctic nesting conditions. The main factors affecting the breeding success of Arctic nesting swans and geese include the conciseness of the Arctic "summer", the changeability of Arctic spring weather conditions, abundance and condition of predators, and abundance and condition of lemmings, an alternate prey species. While the first mentioned factor determines the presence of swans and geese in a given area, combinations of other factors generally affect their ability to successfully breed. The main adaptations that help the birds to successfully breed in the Arctic include abbreviation of all breeding stages compared to southern populations of the same species, smaller body size correlated with shortened development periods for eggs and young, and a changeable breeding strategy. The latter factor determines transitions from virtual population replenishment in especially favorable years to population "rest" during especially unfavorable years. Arctic species also tend toward nesting and the selection of breeding sites with mountainous or hilly landscapes. The result of these adaptations could result in Arctic geese living longer on average than populations breeding farther south. Depending on the specific features of the breeding grounds, a population's ecology and morphology, including body size, are particularly important to the combinations of adaptations mentioned here.

DOCUMENTING THE FALL MIGRATION ROUTE OF WRANGEL ISLAND LESSER SNOW GEESE WITH A MINIATURE SATELLITE TRANSMITTER

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Lesser snow geese (*Anser caerulescens caerulescens*) nested in several areas of the Siberian coast during the early 1900s, but the population declined more than 70% between 1960 and 1990 resulting in their current status as a protected species on the Russian 'red-list.' Less than 60,000 breeding snow geese now remain in a single colony on Wrangel Island. The Wrangel Island snow goose (WISG) colony consists of 2 subpopulations which winter in 2 different areas: a northern population on the Fraser and Skagit River Deltas of British Columbia and Washington, and a southern population in the Central Valley of California. Although Russian biologists have studied the WISG breeding colony for more than 20 years, little is known about their activities during the 6-months of fall and spring migration. In 1990, I worked with Nippon Telegraph and Telephone Corporation (NTT) to develop a small satellite radio for studying WISG migration. NTT developed a 54 g radio with a 120-day lifespan, resulting in an 83 g package including a durable harness or collar attachment. In July, 1991, I captured molting geese on Wrangel Island with a team of Russian and Canadian biologists and placed 30 NTT satellite radios on adult male geese. These satellite-marked geese were relocated each day during fall migration. Preliminary results indicated that most radio-marked WISG used large wetland areas during fall migration. These wetland areas included Cape Blossom on southwestern Wrangel Island, Cape Billings on the Arctic coast, Kolyuchin Bay in the Chukotsk Peninsula, St. Lawrence Island in the Bering Sea, and the north Yukon Delta in Alaska. NTT plans to reduce the size of the current satellite radio by 50%, creating a tool which can be used to improve our understanding of migration routes, staging and breeding areas of several smaller migratory species, especially those inhabiting remote Arctic areas.

MASS AND CONDITION OF MOLTING PACIFIC BLACK BRANT ON THE ARCTIC COASTAL PLAIN, ALASKA

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Mass and condition of molting adult and subadult Pacific black brant (*Branta bernicla nigricans*) were studied near Teshekpuk Lake, Alaska, during 1987-89. Carcass mass and fat showed significant declines from arrival through late molt in all age and sex groups. Carcass mass was at minimum during mid-molt for subadult males, but continued to decrease through late molt for adults and subadult females. Carcass protein significantly declined in adults and subadult females but not subadult males. Between arrival on the molting area and start of molt, breast muscle mass and protein significantly decreased while leg muscle mass and protein significantly increased, indicating that mass and condition changes occur prior to the drop and subsequent growth of remiges.

WINTERING LIGHT GOOSE POPULATION RESPONSE TO MANAGEMENT PRACTICES IN THE MIDDLE RIO GRANDE VALLEY, N.M., 1987-1991

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Populations of snow (*Chen caerulescens*) and Ross' geese (*Chen rossi*) in the Middle Rio Grande Valley (MRGV), New Mexico tripled from 1976 to 1986, reaching a peak of 62,400 birds ($r=.79$, 10df, $P<0.001$). Reasons for increases were related to undisturbed environments and expanding Arctic breeding populations. Increasing flocks resulted in food shortages, crop depredations, disease and competition with cranes for available resources. Between 1980 and 1986, average December, January and February (DJF) populations were correlated with early season peaks ($r=.97$, 5df, $P<0.001$) forming predictive capabilities for actual wintering populations. In 1987, objective levels were set at 24,000-28,000 during DJF equivalent to an early season peak of about 40,000 geese. Sixty-five percent of the population would also be maintained in the north MRGV. Crop manipulations and flock disturbance would be used to move birds in excess of objective levels out of the MRGV. Monitoring over four succeeding years compiled data on total populations and flock distributions supported by an assessment of neckbanded individuals within the MRGV on a weekly basis. Similar surveys were conducted in Chihuahua, Mexico in January after movements occurred. Peak populations of 39,400 in 1987-88 and 42,400 in 1988-89 corresponded to predicted average populations within the objective framework but were surpassed by 11% in 1987-88 and 17% in 1988-89. During these years, cropland acreage was available and manipulated in excess of objective needs. Delayed crop manipulations initially reduced populations 30% in 1987-88 and 11% in 1988-89 but birds returned responding to abundant manipulated crops in unhunted, predator-free environments uncharacteristic of seasonal population trends. Sixty-three percent of wintering geese were maintained in the north MRGV consistent with objectives. Average populations above objective levels were predicted from peaks of 47,800 in 1989-90 and 55,275 in 1990-91. Delayed crop manipulations combined with flock disturbance on a north MRGV refuging area phased out of the MRGV refuging system reduced populations 33% in 1989-90 and 39% in 1990-91. Lower numbers were maintained through crop manipulations directed at supporting only remaining birds resulting in averages within +1% in 1989-90 and +8% in 1990-91 of target levels. Although lower populations (34%) were maintained on north MRGV refuges, greater hunting opportunity existed on private lands. The distribution of neckbanded geese generally mirrored the distribution of all birds in the MRGV in all years. Observations of neckbanded birds in Mexico seen in the MRGV were also recorded. 6200 total observations were logged ranging from 900 in 1990-91 to over 2000 in 1989-90. One hundred ninety different complete neckband codes were identified in the MRGV.

A SUMMARY OF NECROPSY FINDINGS IN WINTERING ALEUTIAN CANADA GEESE, 1976-1991

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During the past 15 years, 101 Aleutian Canada Geese (*Branta canadensis leucopareia*) found dead in migration or wintering areas in California were examined at the National Wildlife Health Research Center. Most (90%) of these were recent mortalities, collected in the last 5 years. The most frequent (61%) diagnosis was avian cholera. All avian cholera cases occurred in the upper San Joaquin Valley. Gunshot wounds caused the death of 14% if the Aleutian geese examined. Lead poisoning was documented for the first time in this subspecies in 1987 and was diagnosed in 11% of the birds submitted. Other conditions identified include blunt traumatic injuries, emaciation of unknown cause, drowning, parasitism and salmonellosis.

INDIRECT POPULATION ESTIMATES FOR CACKLING CANADA GEESE BASED ON NECKBAND OBSERVATIONS

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A total of 5,127 Cackling Canada geese have been neckbanded between 1982 and 1990. A total of 19,169 observations of these marked geese were made in Washington, Oregon, and California during the Fall, Winter, and Spring for the three year period 1988-1991. Observations were used in a mark-resight analysis to estimate population sizes for this population of geese. These estimates were compared to estimates derived from operational surveys routinely conducted by State and Federal personnel. Comparisons of total population estimates derived by mark-resight and the operational surveys were in general agreement. This supports the use of the existing survey procedures as reasonable estimates of population change over time for Cackling Canada geese. However, area specific estimates of numbers of Cackling Canada geese within particular time periods of a given year were less supportive of the operational survey estimates. Possible reasons for these observed differences are discussed and recommendations for improvements in these techniques are made.

AGE OF FIRST PAIRING AND BREEDING AMONGST GREENLAND WHITE-FRONTED GEESE

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Juvenile Greenland white-fronted geese *Anser albifrons flavirostris* were marked with neck-bands from 1983 to 1990; observations of juveniles enabled the determination of age of first pairing for 65 birds and age of first successful breeding (defined as returning to wintering grounds with at least 1 young) of 27 geese. Nine percent of geese were paired in their second year, but none bred successfully. Birds paired most commonly in their third year and most often bred successfully for the first time in their fourth year. Mean brood size was 3.5 amongst geese breeding successfully in their third year, but this increased to 4.0 in birds breeding successfully in subsequent years. These data suggest that this population does not show signs of deferred maturity which could explain the low proportion of successfully breeding pairs in the population.

EXTENDED PARENT-OFFSPRING RELATIONSHIPS IN THE GREENLAND WHITE-FRONTED GOOSE

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An unusually high degree of parent-offspring cohesion was found in individually collared Greenland white-fronted geese (*Anser albifrons flavirostris*). Juveniles in their first winter were associated with 1 or both parents on 94% of occasions. In the second winter, 70% of marked birds remained with 1 or more parent, in the third winter 48% and 29% in their fourth winter. By the fifth winter, 27% still associated with 1 parent (although none was seen with both parents). No sexual differences were found in the number of birds remaining with their parents in the second, fourth or fifth year of life, although more females than males remained with their parents in their third winter. There was no evidence to suggest that older offspring were deterred from remaining with their parents when their parents bred successfully again.

THE YUKON-KUSKOKWIM DELTA GOOSE MANAGEMENT PLAN

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The Yukon-Kuskokwim Delta (Delta) of Alaska is the primary breeding area of 4 species of Arctic nesting geese: cackling Canada geese, emperor geese, Pacific brant, and Pacific white-fronted geese. Alaska natives in the Delta region have traditionally taken large numbers of these birds in the spring for subsistence. Other hunters in the Pacific Flyway harvest the same goose populations in fall staging and wintering areas. When these goose populations approached all time lows in the early 1980s, a cooperative management plan was developed and called the Yukon-Kuskokwim Delta Goose Management Plan (Plan). Partners in the Plan include the U.S. Fish and Wildlife Service, the Association of Village Council Presidents (AVCP), AVCP's Waterfowl Conservation Committee, the Alaska Department of Fish and Game, and the California Department of Fish and Game. Since the Plan was implemented in 1984, it has been successful in achieving reduced harvest and increased populations of the 4 species of Arctic nesting geese. Most notable are the increases in cackling Canada geese (up from a low of 25,800 in 1984 to 110,200 in 1990) and Pacific white-fronted geese (from 91,700 in 1982 to 240,800 in 1990). Through good communications between cooperators; established population objectives and management guidelines; an intensive education program; population biology research; and monitoring, verification, and enforcement of the plan, the process has proven an effective mechanism for managing goose populations and a good forum for discussing a variety of waterfowl issues of common interest.

MODELING SNOW GOOSE HABITAT FOR IMPACT ASSESSMENT

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A model of Snow Goose (*Chen caerulescens caerulescens*) brood-rearing habitat in the Sagavanirktok River Delta near the Prudhoe Bay oil field in Arctic Alaska was developed using a Compact Airborne Spectrographic Imager (CASI) and field observations of brood distributions. High resolution images (2.5 m x 2.5 m pixel size) were classified to vegetation types and ground-truthed. Multi-year maps of brood distributions were used to determine levels and patterns of use of vegetation types, measure brood proximity to escape habitat, and characterize levels of fidelity of known individuals to specific brood rearing locations. The relative importance to geese of each vegetation type and of specific vegetation polygons was estimated using goose habitat literature and a variety of indices, including probability of use, and proximity to escape habitat. A sensitivity analysis was undertaken to provide a measure of confidence in the model's ability to predict habitat value. The model will be used to quantify the impacts of a gravel road on snow goose brood-rearing habitat. Preliminary results suggest that brood locations can be accurately plotted using road-based observations, that geese select stands of *Puccinellia phryganodes* and *Carex subspathacea* in a manner consistent with observations in other Arctic locations, and that vegetation types important to geese occur in small stands that can be mapped accurately only with high resolution imaging systems such as CASI.

FIDELITY TO FEEDING AREA: COSTS OR BENEFITS IN BROOD-REARING LESSER SNOW GEESE?

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In stable environments fidelity to traditional feeding areas is considered to be adaptive: increased experience and knowledge about local resources and potential dangers, e.g. predation, enhance survival and reproductive success. At the La Perouse Bay lesser snow goose colony there has been a marked increase in breeding population size since the early 1970s and, since the mid-1980s, this has been associated with a measurable decrease in food availability on the traditional brood-rearing areas. Under these conditions fidelity to feeding area might, instead, be disadvantageous, and there is recent evidence of movement of some birds to new brood-rearing areas up to 50 km away from the nesting grounds. I present data from radio-collared and banded adult geese and web-tagged goslings on the temporal and spatial pattern of foraging movements during brood-rearing. Inter- and intra-annual changes in brood loss and age structure of birds which continued to utilise traditional brood-rearing areas are described for 1979-1991. I use these data to test the hypothesis that older, more experienced birds remain faithful to traditional brood-rearing areas but consequently, under conditions of declining availability, suffer a cost in terms of a decrease in reproductive success.

PLANT GROWTH AND THE AVAILABILITY OF NITROGEN IN A GRAZED ARCTIC SALT MARSH

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Salt marshes, which are nutrient sinks, contain an abundance of all nutrients except nitrogen. The demand for forage by a breeding population of lesser snow geese (*Chen caerulescens caerulescens*) is high in an Arctic salt marsh at La Pérouse Bay which is nitrogen limited - yet goslings can show a weight gain of 1500g in 7 weeks. It is known that the summer grazing activities of the geese result in increased net above-ground primary production of salt marsh graminoids, their preferred forage, as a result of an increase in available soil nitrogen. A tentative nitrogen budget for this marsh indicates that the overall effects of grazing lead to a rapid turnover of nitrogen in the system where the rate is equal to, or exceeds that of temperate ecosystems. Early in the growing season most of the available soil nitrogen for plant growth is NH_4-nitrogen. The drying out and the partial oxidation of sediments in summer results in the accumulation of NO_3-N in the soil, rather than NH_4-N. Some of the nitrate is denitrified and lost from the system. The large input of faecal droppings and the rapid net mineralization of organic nitrogen, either in the droppings themselves or in the sediments beneath, sustain the flow of NH_4-N for plant growth. There is evidence that under the increased salinity associated with the drying out of sediments in summer, some forage species are unable to use NO_3 ions as a nitrogen source. The continual input of faecal droppings and the associated supply of ammonium ions may be essential to maintain growth of forage plants, even though soil nitrogen is available as NO_3-N. These transformations increase nitrogen turnover in the system but nitrogen-fixation by cyanobacteria replaces much of the nitrogen assimilated by geese.

CURRENT HABITAT ACQUISITION PROGRAMS IN THE NORTHERN SAN JOAQUIN VALLEY, CALIFORNIA

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The northern San Joaquin Valley of California provides vitally important wintering habitat for Arctic-nesting geese. Over 90% of the Aleutian Canada geese (*Branta canadensis leucopareia*) population are present there each winter from late November to March. Lesser snow geese (*Anser caerulescens*) from Wrangel Island and the Western Canadian Arctic begin arriving in the Grasslands area in late November and depart by February and March. Ross' geese (*Anser rossii*) and cackling Canada geese (*B. c. minima*) primarily use the area in late winter and are present mid-January through April. Collar observations indicate that some geese shift southward from the Sacramento Valley to the Grasslands as late as February and March. The U.S. Fish and Wildlife Service (FWS) is actively pursuing a variety of programs to protect this valuable habitat through fee acquisition, perpetual conservation easements, and technical assistance to private landowners. The San Joaquin River National Wildlife Refuge (NWR) was established in 1988 to provide wintering habitat for Aleutian Canada geese. Although only 315 hectares (ha.) have been acquired to date, active negotiations are underway with the landowners to expand it into a 4,050 ha. refuge. The Grasslands Wildlife Management Area was established in 1978 as a major FWS conservation easement project within Merced County. The 46,302 ha. project area consists of private lands on which the FWS is purchasing perpetual conservation easements to maintain and enhance existing habitat values. As of September 1991, 16,986 ha. of hunting clubs and ranches have been enrolled in easements out of goal of 31,672. Additional goose habitat in the east grasslands is being purchased in fee title through a 162 ha. addition to Merced NWR, and the proposed acquisition of the 1,007 ha. Sunrise Ranch as a National Wildlife Refuge. A third program which will benefit wintering geese in the San Joaquin Basin Action Plan/Kesterson Mitigation Plan. Under this plan, 4,702 ha. out of a goal of 9,510 ha. have been purchased by the FWS and California Department of Fish and Game and are being restored or enhanced as wetlands and uplands. Lands acquired through completion of these various programs, when added to existing Federal and State properties, will result in a total of 55,784 ha. of wetland and upland habitat being protected for geese and other waterfowl in the northern San Joaquin Valley.

ANNUAL AND SEMI-ANNUAL SURVIVAL RATES OF ALEUTIAN CANADA GEESE

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We analyzed the resightings of 813 Aleutian Canada geese (*Branta canadensis leucopareia*) that were marked during the spring between 1976 and 1988 near Crescent City, California with individually coded color plastic leg bands. The average annual survival rate for adult males was .76 (SE = .02) and for adult females was .70 (SE = .02). The average annual juvenile male survival rate was .69 (SE = .03) and for juvenile females was .60 (SE = .05). These estimated annual survival rates for an essentially nonhunted goose population appear to be low compared to hunted populations. Adult survival rates (adjusted for interval length) were estimated for the breeding and migration period and compared with estimated rates for the winter.