9th NORTH AMERICAN ARCTIC GOOSE CONFERENCE AND WORKSHOP

JANUARY 7-11, 1998
VICTORIA, BRITISH COLUMBIA

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Victoria, British Columbia, Canada

Welcome to the 9th North American Arctic Goose Conference & Workshop! In the preamble to the 8th meeting held in 1995 in Albuquerque, New Mexico, the incredible growth of interest in goose biology was duly noted. The number of people coming to Victoria to participate in this the 9th meeting shows no sign of this trend changing. Separate from the interest in geese because they are a harvested species, most researchers in the field have discovered that geese are extremely good study organisms for a whole host of questions, some well removed from the practical concerns of harvest and management. Geese typically breed in large numbers, are large and visible, have generally high site fidelity, and exist in relatively simple ecosystems. These attributes have undoubtedly contributed to the diverse array of papers being presented in Victoria - from proximate-level studies of the effects of variation in egg size to more theoretical explorations of life history evolution and advanced demography.

And yet, it is ironic, but perhaps not surprising, that this meeting has several very real concerns as underlying themes. At the Albuquerque meeting, a preliminary workshop was held to address the question "can we have too many geese?". In part precipitated by this early discussion, the intervening years have witnessed considerable discussion of the general issues of the practical management of goose species, from both the traditional perspective of conservation, and from the relatively new paradigm of possible problems caused by overabundance.

In fact, the energy and intensity brought to the debate owes much to how far we've come in our understanding of basic goose biology - motivated by simple scientific curiosity. We know enough about geese to raise the level of our discussions concerning conservation and management beyond virtually any other system. Our considerable successes in understanding geese owes very much to the successful merger of basic science with more applied pursuits. If the North American Arctic Goose Conference fosters interaction between the theoretical and the applied, then it is arguable that the papers being presented at this incarnation of the meeting provide good evidence that this intent has been achieved.

NAAG'98 Plenary Speakers

Ray Alisauskas - *The Prairie-Arctic Connection: Spring Nutrition in Geese.*

Gilles Gauthier - *The Role of Food and Timing of Nesting in Greater Snow Goose Reproduction.*

Barwolt Ebbinge - *The Role of Predators in Regulating Goose Numbers.*

Jim Sedinger - *Life-histories of Arctic Geese: Synergism between Applied and Evolutionary Biology.*

Hugh Boyd - *Future Research on Goose Behaviour: Hazards, Needs and Opportunities.*

Welcome to Victoria!

NAAG'98

Conference Staff

CHAIRPERSONS

Ken Abraham
Ontario Ministry of Natural Resources

Sean Boyd
Canadian Wildlife Service Pacific & Yukon Region

Scientific Program

Ken Abraham (Chair)

- Robert Rockwell (*American Museum of Natural History*)
- Dave Ankney (*University of Western Ontario*)
- Bob Jefferies (*University of Toronto*)
- Ray Alisauskas (*Canadian Wildlife Service*).
- Evan Cooch (*Simon Fraser University*)

Local Organizers

Sean Boyd (Chair)

- Web Pages (*Evan Cooch*)
- Program Design & Printing (*Emily Gonzales & Pam Whitehead*)
- Field Trip (*Saul Schneider, Kathleen Moore & Don Kraege*)
- Registration & Reception (*Shelagh Bucknell & Wilma Boyd*)
- Brant & Snow Goose Prints (*Glen Rabena & Sherrie Russell Meline*)
- Banquet (*Bob McLandress & Robert Rockwell*)
- Snow Goose Film (*Bruce Batt*)
- Mexican Affairs (*John Taylor & Sonja Najera*)
- Russian Affairs (*John Takekawa*)

Sponsors

No meeting of this size could ever come about without the ongoing and generous support of many individuals, agencies and corporations. Major sponsorship for the 9th North American Arctic Goose Conference & Workshop has been provided by:

- Arctic Goose Joint Venture (NAWMP)
- California Waterfowl Association
- Canadian Wildlife Service, Pacific & Yukon Region
- Canadian Wildlife Service, Prairie & Northern Region
- Ducks Unlimited Canada
- Ducks Unlimited Inc.
- Pacific Coast Joint Venture (NAWMP)
- Pacific Flyway Council
- Turner Foundation
- Tuscany Research Institute
- US Fish & Wildlife Service
- US National Parks Service
- Washington State Department of Fish & Wildlife

Workshops

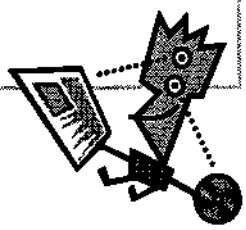
- Monitoring Plant Responses to Goose Foraging

  Bob Jefferies - *University of Toronto*

- Population Dynamics

  Evan Cooch - *Simon Fraser University*

  Robert Rockwell - *American Museum of Natural History*



General Information

Welcome to the 9th North American Arctic Goose Conference & Workshop. The conference staff are here to help you. If you have any questions regarding any aspect of the conference, please don't hesitate to ask one of the staff. The Victoria Conference Centre staff and the staff of the Empress Hotel are also available to assist you.

Registration

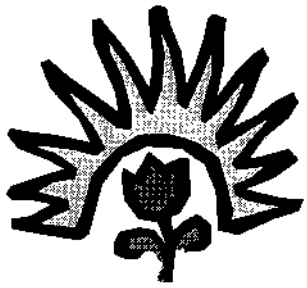
Registration will be held in The Victoria Conference Centre Plaza, 7 January from 4 PM to 8 PM, 8 January from 8 AM to 7 PM, and 9 January from 7 AM to 10 AM. An information table will be staffed at all times.

Papers & Workshops

All paper sessions will be held in the Lecture Theatre in the Conference Centre. The 2 workshops will be held on Thursday evening, in Oak Bay Rooms 1 & 2. The DU documentary film will be shown in the Lecture Theatre Thursday evening.

Poster Session

The formal poster session is scheduled for the evening of 9 January (Friday), 8:00-10:00 PM. It will be held in the Saanich Room. We would ask that poster presenters put up their posters as early as possible, to allow other delegates to view them at their convenience. Posters will be taken down on Saturday, January 10.



Name Tags & Tickets

Your name tag is your pass for admittance to all activities at the conference, and must be worn at all times. Your name tag is also good for free admittance to the Royal British Columbia Museum. Separate tickets will be issued to those registered for the banquet and the field trip. Beverage tickets (beer and wine) can be used at the reception, poster session, and banquet.

E.mail & FAX services

Adjacent to the theatre are 2 telephone booths where delegates can hook-up their laptops and, with a swipe of a charge card, access their e.mail. FAX services can be arranged through either the Conference Centre or the Empress Hotel.

Banquet

The NAAG'98 Closing Banquet will be held at 6:30 PM on Saturday, 10 January, in the Crystal Ballroom of the Empress Hotel. We thank Gray Monk Estate Winery & Vancouver Island Brewery for donating some of the banquet "refreshments".

Field Trip

This is a day-long trip on Sunday, 11 January, to the Fraser River and Skagit River deltas. Warm clothes are needed. Delegates are responsible for passports and visas required for entry into the US and back into Canada. Buses depart at 05:45 AM sharp (!) from the Empress Hotel.

Meeting Overview

Wed	Thur	Fri	Sat	Sun
7 *General Registration & Opening Reception* *(Conference Centre Plaza)*	8 *Paper Sessions 1 & 2* *(Lecture Theatre)* *Workshops* *(Oak Bay Rooms)*	9 *Paper Sessions 3 & 4* *(Lecture Theatre)* *Poster Session* *(Saanich Room)*	10 *Paper Sessions 5 & 6* *(Lecture Theatre)* *Banquet* *(Crystal Ballroom)*	11 *Field Trip*

Thursday, January 8 - Morning

8:00 - 8:15 **Welcome & Introductions** - North American Arctic Goose Conference co-chairs, **Sean Boyd** (Canadian Wildlife Service) and **Ken Abraham** (Ontario Ministry of Natural Resources)

8:15 - 9:00 **Plenary Paper 1** - Ray Alisauskas (Canadian Wildlife Service and University of Saskatoon)

"The Prairie-Arctic Connection: Spring Nutrition in Geese"

PAPER SESSION 1 - SPRING MIGRATION, NUTRITIONAL ECOLOGY & ENERGETICS

CHAIR: JIM LEAFLOOR, ONTARIO MINISTRY OF NATURAL RESOURCES

9:00 - 9:15 **Rudi Drent & Mennobart Van Eerden.** An allometric perspective on the feeding ecology of waterfowl.

9:15 - 9:30 **Daan Bos.** Spring staging in Brent Geese: capacity of coastal marshes in relation to salt-marsh management.

9:30 - 9:45 **Rene Van der Wal.** Goose spring feeding conditions and the importance of facilitation.

9:45- 10:00 **Julia Stahl.** The interaction between Brent and Barnacle Geese- facilitation or competition? An experimental approach.

10:00 - 10:15 **Refreshment Break**

10:15 - 10:30 **Joel Schmutz & Keith Hobson.** Variation in stable isotopes among geese nesting on the Yukon-Kuskokwim Delta: implications for foraging and reproductive ecology.

10:30 - 10:45 **Mark Gloutney, Ray Alisauskas, Alan Afton & Stuart Slattery.** Foraging time and dietary intake by breeding Ross' and Lesser Snow Geese.

10:45 - 11:00 **Bruno Croft & Ray Alisauskas.** Nutrient reserves of small Canada Geese nesting in the central Canadian Arctic.

11:00 - 11:15 **Ray Bon & Ray Alisauskas.** Spring nutritional ecology of migrating and breeding Ross' Geese.

11:15 - 11:30 **Robert Bromley & Suzanne Carrière.** Testing hypotheses on seasonal declines in clutch size using arctic-nesting geese and latitudinal asynchronies in the timing of spring.

11:30 - 11:45 **Michael Eichholz & James Sedinger.** Individual quality and regulation of incubation behavior in Black Brant.

11:45 - 12:00 **Jeff Danielson & Ray Alisauskas.** Effects of landscape on nest site selection and nest success in Ross' and Lesser Snow Geese.

12:00- 12:15 **Craig Ely, Ada Fowler & Christopher Babcock.** Factors influencing individual variation in reproductive investment in Cackling Canada Geese.

12:15 - 13:30 **Lunch Break**

Thursday, January 8 - Afternoon

13:30 - 14:15 **Plenary Paper 2** - Gilles Gauthier (Universite Laval, Quebec)

"The Role of Food and Timing of Nesting in Greater Snow Goose Reproduction"

PAPER SESSION 2 - NESTING AND BROOD REARING ECOLOGY

CHAIR: ALLISON ARNOLD, US FISH & WILDLIFE SERVICE

14:15 - 14:30 **Catherine Poussart, Gilles Gauthier & Jacques Larochelle.** Incubation behavior of Greater Snow Geese in relation to weather conditions.

14:30 - 14:45 **Lea Craig & Ray Alisauskas.** Variation in egg temperatures in Ross' and Lesser Snow Geese.

14:45 - 15:00 **Konstantine Litvin & Elena Gurtovaya.** The differences in nesting ecology of Tundra Bean Goose and White-fronted Goose in north-eastern coast of Barents Sea.

15:00 - 15:15 **Refreshment Break**

15:15 - 15:30 **Michael Hill, C. Davison Ankney & James Leafloor.** The influence of egg volume, hatch date, brood rearing area, age, year, and sex on growth of pre-fledging Canada Goose goslings on Akimiski Island, Northwest Territories.

15:30 - 15:45 **Shannon Badzinski, C. Davison Ankney, James Leafloor & Ken Abraham.** Comparative growth and development of external morphology, digestive organs and skeletal muscles of Canada and Lesser Snow Goose goslings on Akimiski Island, Northwest Territories.

15:45 - 16:00 **Steve Timmermans, C. Davison Ankney & Ken Abraham.** Egg size, growth and survival of Lesser Snow Goose goslings.

16:00 - 16:15 **Stuart Slattery & Ray Alisauskas.** Do gastric helminths reduce survival of immature Ross' Geese?

16:15 - 16:30 **Scott McWilliams, James Leafloor & William Karasov.** Response of goslings to reduced habitat quality: A physiological perspective.

16:30 - 16:45 **Emily Gonzales & Evan Cooch.** Looking for greener pastures? - A different view of habitat switching during brood rearing.

16:45 - 17:00 **Christopher Babcock & Roger Ruess.** Goose grazing controls over sedge growth form and quality.

17:00 - 17:15 **Laura Cowen & Evan Cooch.** Modeling plant-herbivore interactions of the Lesser Snow Goose.

17:15 - 17:30 **Helene Masse, Line Rochefort & Gilles Gauthier.** Estimating carrying capacity of wetland habitats used by breeding Greater Snow Geese on Bylot Island (NWT, Canada).

17:30 - 19:30 **Dinner Break**

19:30 - 21:30 ***Workshop A: Population Dynamics*** *- Convenors: Evan Cooch and Robert Rockwell*

19:30 - 21:30 ***Workshop B: Monitoring Plant Responses to Goose Foraging*** *- Convenor: Robert Jefferies*

20:00 or 21:30 **FILM SCREENING: *"SNOW WARNING"*.** INTRODUCED BY BRUCE BATT

Ducks Unlimited invites conference attendees to preview 2 separate showings (50 minutes) of a soon-to-be released documentary film addressing the issue of over-abundant mid-continent Lesser Snow Geese. The film covers the birds' biology, behaviour and habitat interrelationships throughout the annual cycle. Special emphasis is placed on the habitat degradation problems on the sub-arctic coastal salt marshes of the Hudson Bay and James Bay lowlands.

Friday, January 9 - Morning

7:55 - 8:00 **Morning Announcements**

8:00 - 8:45 **Plenary Paper 3** - Barwolt Ebbinge (Institute for Forestry and Nature Research, Dept of Aquatic Ecology, Wageningen, The Netherlands)

"The Role of Predators in Regulating Goose Numbers"

PAPER SESSION 3 - PREDATION, PRODUCTIVITY & NESTING ECOLOGY

CHAIR: MARK LINDBERG, DUCKS UNLIMITED INC.

8:45 - 9:00 **Bob Bromley & Suzanne Carrière.** Variation in annual nest success of geese in relation to spring phenology and predators.

9:00 - 9:15 **Gustaf Samelius & Ray Alisauskas.** Deterring Arctic fox predation: The role of parental nest attendance by Lesser Snow Geese.

9:15 - 9:30 **Jason Bantle & Ray Alisauskas.** Comparative nest defense by Ross' and Lesser Snow Geese against Arctic fox.

9:30 - 9:45 **Deborah Wilson & Robert Bromley.** Indirect effects of fluctuations in lemming density on the nesting success of White-fronted and Canada Geese.

9:45 - 10:00 **Joël Bêty, Gilles Gauthier & Jean-François Giroux.** Factors affecting nesting success in Greater Snow Geese: The interplay between nest density, lemming abundance and association with Snowy Owls.

10:00 - 10:15 **Refreshment Break**

10:15 - 10:30 **Barry Grand, Robert Anthony and T. Fondell.** Productivity of Dusky Canada Geese in the Copper River Delta, Alaska

10:30 - 10:45 **John Hughes & Austin Reed.** Productivity of Atlantic Population Canada Geese: A progress report.

10:45 - 11:00 **E. E. Syroechkovski, Jr.** Population dynamics of Black Brant in Siberia.

11:00 - 11:15 **Austin Reed & Michial O'Briain.** Eastern high Arctic Brant: Strategies of a high arctic breeder and trans-oceanic migrant.

11:15 - 11:30 **Ingunn Tombre, Kjell Einar Erikstad, Jeff Black & Maarten Loonen.** Reproductive effort in relation to the time of season: An experimental study of Barnacle Geese in Svalbard.

11:30 - 11:45 **Barbara Ganter & Barwolt Ebbinge.** Age and breeding success in Dark-bellied Brent Geese.

11:45 - 13:00 **Lunch Break**

Friday, January 9 - Poster Session (Evening)

13:00 - 13:45 **Plenary Paper 4** - James Sedinger (University of Alaska, Fairbanks)

"Life Histories of Arctic Geese: Synergism between Applied and Evolutionary Biology"

Paper Session 4 - Life History Strategies, Population Biology and Demographics

Chair: Kathy Dickson, Canadian Wildlife Service

13:45 - 14:00 **Evan Cooch.** Back to the future: Age of first breeding and environmental change - methods and results.

14:00 - 14:15 **William Kendall, Mark Lindberg & James E. Hines.** On the use of capture-recapture and band recovery data to simultaneously estimate permanent and temporary emigration.

14:15 - 14:30 **Marcus Rowcliffe & Richard Pettifor.** From individuals to populations: Towards a behaviour-based model of goose population dynamics.

14:30 - 14:45 **David Ward, Joel Schmutz, James Sedinger, Karen Bollinger, Philip Martin & Betty Anderson.** Survival and pre-fledging body mass in juvenile Black Brant.

14:45 - 15:00 **Stéphane Menu, Gilles Gauthier & Austin Reed.** Survival of young Greater Snow Geese during the fall migration.

15:00 - 15:15 **Evan Cooch, Solange Brault & Robert Rockwell.** Post-mortem of a population collapse: The relative importance of life-history stages.

15:15 - 15:30 **Refreshment Break**

15:30 - 15:45 **John Takekawa, Dennis Orthmeyer, Michael Samuel & Vasily Baranyuk.** Over-winter survival of Lesser Snow Goose populations in California: Can we explain this exception to over-abundance?

15:45 - 16:00 **Michael Samuel, John Takekawa, Vasily Baranyuk, Dennis Orthmeyer & Evan Cooch.** Effects of avian cholera on survival of Lesser Snow Geese in the Pacific Flyway.

16:00 - 16:15 **James Hines, Myra Wiebe & Richard Kerbes.** Survival rates and population size of mid-continent Greater White-Fronted Geese estimated from collar sightings.

16:15 - 16:30 **Arthur Smith, Donald Rusch, John Cary & Michael Samuel.** Bias in survival estimates from continuous samples of neckbanded geese.

16:30 - 18:30 **Managing Over-abundant Snow Geese: A Discussion Forum**
Moderated by Dirk V. Derksen, USGS - Alaska Biological Science Centre

18:30 - 20:00 **Dinner Break**

20:00 - 22:00 **Poster Session**

Friday, January 9 - Poster Session (Evening)

1. **Robert Rockwell, Paul Matulonis & Barbara Pezzanite.** Abnormal embryos of Lesser Snow Geese.

2. **Walter Skinner.** Summer season interactions between Lesser Snow Geese, climate and vegetation at La Pérouse Bay, Manitoba

3. **Diana Pollak, Robert Rockwell, Ken Abraham, Peter Kotanen & Robert Jefferies.** Declines in bird species using La Pérouse Bay.

4. **Brian Milakovic & Robert Jefferies.** Changes in aquatic and terrestrial invertebrate populations as a result of the destruction of vegetation triggered by the foraging activities of geese.

5. **Curtis Vacek, Robert Rockwell & Ken Abraham.** Effects of an increasing Lesser Snow Goose population on shorebird populations and foraging ecology at La Pérouse Bay, Manitoba.

6. **Tanya Handa & Robert Jefferies.** Re-vegetation trials in degraded coastal marshes of the Hudson Bay lowlands.

7. **Esther Chang & Robert Jefferies.** Seed bank dynamics in degraded and undamaged coastal habitats of the Hudson Bay lowlands.

8. **Robert Jefferies & Deborah Tam.** Long-term loss of inter-tidal vegetation and a decline in remaining above-ground biomass: the result of foraging activities of geese.

9. **Robert Jefferies & Ken Abraham.** Agricultural nutrient subsidies and the increasing mid-continent population of Lesser Snow Geese.

10. **Andrew Jano.** Habitat loss assessment by multi-temporal analysis of LANDSAT data.

11. **Ken Abraham, Robert Jefferies, Andrew Jano & James Leafloor.** Preliminary assessment of goose foraging conditions on Akimiski Island, Northwest Territories.

12. **Ken Abraham, Ken Ross, Don Fillman & Robert Rockwell.** Recent surveys of Snow Goose colonies in southern Hudson Bay.

13. **Michael Hill, C. Davison Ankney & James Leafloor.** The influence of pre-fledging condition on band recovery of Canada Goose goslings from Akimiski Island, Northwest Territories.

14. **Shannon Badzinski, C. Davison Ankney, James Leafloor & Ken Abraham.** Egg characteristics, body reserves, and tissue maturity of neonate Canada and Lesser Snow Geese of Akimiski Island, Northwest Territories.

15. **Steve Babler, Donald Youkey & John Crouse.** Artificial nest islands for Dusky Canada Geese on the Copper River Delta, Alaska.

16. **Jason Bantle & Ray Alisauskas.** Spatial and temporal patterns in Arctic Fox diets at a large goose colony.

17. **Mark Gloutney, Ray Alisauskas & Keith Hobson.** Use of supplemental food by breeding Ross' and Lesser Snow Geese: Anorexia and body composition dynamics

18. **Vasily V. Baranyuk.** The "PERESTROJKA" of the Wrangel Island Snow Goose colony is completed.

19. **Nikolay Poyarkov.** Swan-Goose: Natural history and system of conservation in Russia.

20. **Marjorie Bousfield.** Relative timing of reproductive interactions in the Lesser Snow Goose.

21. **Evgeny V. Syroechkovsky.** The territorial structure of the Tundra Bean Goose nesting population in Vaigach Island (Russia).

22. **Timothy Bowman, Robert Stehn & Kim Scribner.** Glaucous Gull predation of goslings on the Yukon-Kuskokwim Delta, Alaska

23. **Vegard Bunes, Ingunn Tombre & Kjell Einar Erikstad.** Body reserves and incubation behaviour in Barnacle Geese

24. **Evan Cooch, Robert Rockwell & Alex Dzubin.** How old are you? - using the 9th primary as an indicator of gosling age.

Friday, January 9 - Poster Session (Evening)

25. **Evan Cooch, Barwolt Ebbinge & Sean Boyd.** There and back: Intraseasonal movement patterns of Snow Geese in the Fraser-Skagit.

26. **Evan Cooch, Jean-Dominique Lebreton & Fred Cooke.** Some explorations of a matrix model of constant harvesting - implications for Snow Goose control.

27. **Brian Person, Christopher Babcock & Roger Ruess.** Forage variation in brood rearing areas used by Pacific Black Brant Geese on the Yukon-Kuskokwim Delta, Alaska.

28. **Brian Person & Roger Ruess.** Interconversion of sedge ecotypes mediated by grazing: Implications for ecosystem carrying capacity.

29. **Amy Zacheis, Jerry Hupp & Roger Ruess.** Effects of migratory geese on plant communities and nitrogen- cycling processes within a coastal salt-marsh ecosystem.

30. **Jerry Hupp, Amy Zacheis, Michael Anthony, Donna Robertson, Kelly Chapin & Karen Bollinger.** Use of GPS flight tracking and aerial videography to assess changes in Snow Goose distribution and snow cover in south-central Alaska.

31. **Mike Eichholz & James Sedinger.** Migration patterns and survival of Canada Geese staging in interior Alaska

32. **William Anker, Eric Rexstad & James Sedinger.** Development of a simulation model for flyway management of Pacific Black Brant.

33. **Lorna Ellestad, Jack Payne & Mike Davison.** "Barley for Birds" - A cooperative water quality, sustainable agriculture and wildlife habitat enhancement program.

34. **Ada Fowler & Craig Ely.** Timing of wing molt and primary growth rates of Cackling Canada Geese on the Yukon-Kusksokwim Delta, Alaska.

35. **Karen Bollinger, Craig Ely, Tom Rothe & John Sarvis.** Nesting ecology of Tule Greater White-fronted Geese.

36. **Rodney King & Karen Bollinger.** Use and distribution of three species of molting geese in the Teshekpuk Lake area of Alaska's Arctic coastal plain.

37. **Jean-François Giroux, François Blouin, Jean Fern, Gilles Gauthier & Jean Doucet.** The fall migration of Greater Snow Geese tracked by satellite.

38. **Frederic Demers, Jean-François Giroux & Gilles Gauthier.** How faithful to their mate are radio-marked Greater Snow Geese?

39. **Arnaud Bechet, Jean-François Giroux & Gilles Gauthier.** Opportunism versus tradition in habitat use by staging Greater Snow Geese.

40. **Mark Herzog, James Sedinger & Marcie Chambers.** Effects of habitat and simulated density on gosling growth and behavior in Pacific Black Brant.

41. **Larry Carpenter, James Pokiak, James E. Hines & Myra Wiebe.** Co-management of waterfowl in the Inuvialuit settlement region of the western Canadian Arctic.

42. **Myra Wiebe & James Hines.** Annual fidelity of Brant, Greater White-Fronted geese, and Canada Geese to moulting areas in the western Canadian arctic

43. **Dennis Orthmeyer, John Takekawa, Craig Ely, John Mensik, Martin St. Louis, Tom Rothe & Dan Yparraguirre.** Comparing population size estimators for the vulnerable Tule Greater White-Fronted Goose subspecies from counts, collar observations and radio locations.

44. **Eric Reed, Evan Cooch, Fred Cooke & Ian Goudie.** Studying the wintering and migration patterns of Black Brant using mark-resight models.

45. **Robert Ritchie & Robert Suydam.** Identification of Brant colonies and monitoring of their use and productivity in northern Alaska, Fish Creek to Kasegaluk Lagoon.

46. **James Sedinger, Nathan Chelgren, Mark Lindberg & Mark Herzog.** Permanent emigration and Markovian age-specific breeding proportions for Black Brant from the Tutakoke River Colony.

47. **Donald Rusch, John Wood, Dale Caswell & Ken Gamble.** Population and harvest trends of Canada Geese in the Mississippi Flyway.

48. **Joel Schmutz, Bryan Manly & Christian Dau.** Gosling survival and population dynamics of Emperor Geese: Effects of Glaucous Gulls and weather.

49. **Gustaf Samelius & Ray Alisauskas.** Productivity of Lesser Snow Geese on Banks Island 1995-1997.

50. **Stuart Slattery, Ray Alisauskas, Andrew Didiuk, Malcolm Conly & Dana Kellett** Potential environmental impacts of rapid growth in populations of Ross' and Snow Geese nesting at Karrak Lake, Northwest Territories.

51. **Stuart Slattery, Ray Alisauskas, Dana Kellett & Ferguson Moore.** Estimating ratios of Ross' and Lesser Snow Geese on nesting colonies.

52. **Michael Spindler, Jenny Lowe, Jean Fujikawa & Robert Stehn.** Local and regional trends of White-fronted Geese based on aerial and float surveys in western interior Alaska.

53. **Robert Stehn, Timothy Bowman & Michael Wege.** Monitoring nesting populations and annual production of geese on the Yukon-Kuskokwim Delta, Alaska.

54. **Ingunn Tombre, Jeff Black & Maarten Loonen.** Critical components in the dynamics of a Barnacle Goose colony: a sensitivity analysis.

55. **Barbara Ganter & Hugh Boyd.** The summer that never was: A circumpolar perspective on the 1992 breeding season.

56. **Jens Kristiansen, Christian Glahder, David Stroud, Tony Fox & Barbara Ganter.** Recent changes in Canada Goose and White-Fronted Goose numbers in west Greenland.

57. **Maarten Loonen.** Do the number of siblings and date of birth cause measurable difference in fitness in Barnacle Geese?

58. **David Ward, Craig Ely & Karen Bollinger.** Heart rates of free-living Greater White-fronted Geese: implications for studies of behavioral ecology and energetics.

59. **Sachiko Uemura, Yukata Sabano, Masayuki Kurechi, Alexandar Andreev, John Takekawa, Richard Kerbes & Vasily Baranyuk.** Lesser Snow Goose breeding and moulting in Kolyma Lowland.

60. **Barbara Pierson, Kim Scribner, John Pearce, Sandra Talbot & Dirk Dersksen.** Molecular status of Aleutian Canada Geese from Buldir Island and Semidi Islands, Alaska.

61. **Allan Baker, James Leafloor & C. Davison Ankney.** Mitochondrial DNA structure of Canada Geese in eastern Canada.

Saturday, January 10 - Morning

8:00 - 8:15 **Morning Announcements**

8:15 - 9:00 **Plenary Paper 5** - Hugh Boyd (Canadian Wildlife Service, National Wildlife Research Centre, Ottawa)

"Future Research on Goose Behaviour: Hazards, Needs and Opportunities"

PAPER SESSION 5 - BEHAVIOUR, POPULATION STRUCTURE AND DELINEATION

CHAIR: BARBARA GANTER, INSTITUTE FOR FORESTRY AND NATURE RESEARCH, THE NETHERLANDS

9:00 - 9:15 **Peter Schmidt & Todd Arnold.** Disturbance factors affecting Black Brant at Humboldt Bay, California.

9:15 - 9:30 **Terry Armstrong.** Consequences of winter philopatry and pair formation in Lesser Snow Geese.

9:30 - 9:45 **Marjorie Bousfield.** A comparison of brood cohesion in Snow and Canada Goose goslings.

9:45 - 10:00 **Richard Malecki, Susan Sheaffer & Bruce Batt.** Temporal and geographic distribution of Atlantic Population Canada Geese from satellite telemetry.

10:00 - 10:15 **Eric Reed, Evan Cooch, Fred Cooke & Ian Goudie.** Fidelity of Black Brant wintering and spring staging in the Strait of Georgia, British Columbia.

10:15 - 10:30 **Refreshment Break**

10:30 - 10:45 **Mark Lindberg, James Sedinger, Gerald Shields, Robert Rockwell & Dirk Derksen.** Gene flow in the Black Brant metapopulation: Contemporary and genetic evidence.

10:45 - 11:00 **James Leafloor, C. Davison Ankney, Donald Rusch & Ken Abraham.** Environmental effects on body size of Canada Geese.

11:00 - 11:15 **Kim Scribner, John Pearce, Barbara Pierson, Sandra Talbot & Dirk Derksen.** Molecular status of the Dusky Canada Goose: Genetic assessment of a relocation effort.

11:15 - 11:30 **John Pearce, Barbara Pierson, Sandra Talbot, Dirk Derksen & Kim Scribner.** Genetic characterization of Pacific Flyway Canada Geese: Assessment of subspecific classifications and composition of admixed wintering flocks.

11:30 - 11:45 **Dan Nieman & Sam Barry.** Population delineation and wintering ground distribution of mid-continent Greater White-fronted Geese.

11:45 - 12:00 **Robert Trost & Martin Drut.** Recent changes in the wintering distribution of Cackling Canada Geese.

12:00 - 12:15 **Scott Walter & Donald Rusch.** Localized decline in production of Eastern Prairie Population Canada Geese.

12:15 - 13:30 **Lunch Break**

PAPER SESSION 6 - POPULATION DISTRIBUTION, MONITORING AND MANAGEMENT

CHAIR: RICHARD KERBES, CANADIAN WILDLIFE SERVICE

13:30 - 13:45 **Rod Drewien & D. Benning.** Distribution and abundance of geese wintering in the interior highlands of Mexico, 1948-1997.

13:45 - 14:00 **Sam Barry & Dan Nieman.** Migration and wintering distribution of small Canada Geese from the Canadian Arctic.

14:00 - 14:15 **Simon Lane & Yoshihiko Miyabayashi.** Status and distribution of Pacific Brent Goose wintering in Japan.

14:15 - 14:30 **Donald Rusch, Robert Williamson, Ken Gamble & Dale Caswell.** Declining age ratios in Canada Geese: Fact or Artifact?

14:30 - 14:45 **Jon Bergquist & Brenda Hill.** Canada Goose harvest control in Wisconsin.

14:45 - 15:00 **Richard Kerbes & Andrew Didiuk.** Inventory of Lesser Snow Geese nesting in the eastern Canadian Arctic in 1997: How many in the Horde?

15:00 - 15:15 **Refreshment Break**

15:15 - 15:30 **Dale Caswell, Andrew Didiuk, Ron Bazin & Steve Wendt.** A multi-species, multi-purpose program to monitor trends of eastern Arctic geese of the Northwest Territories.

15:30 - 15:45 **Larry Strong & Robert Trost.** Improvements in monitoring Arctic habitat and forecasting goose production using satellite imagery.

15:45 - 16:00 **Andrew Didiuk & Dale Caswell.** Habitat monitoring of West Hudson Bay, Northwest Territories

16:00 - 16:15 **Andrew Didiuk, Ron Bazin, Keith Warner & Dale Caswell.** Goose productivity and brood distribution along the West Hudson Bay coast, Northwest Territories

16:15 - 16:30 **Yukata Sabano, Sachiko Uemura, Masayuki Kurechi, Alexandar Andreev, Alexandar Kondratyev, Evgeny V. Syroechikovsky, Konstantine Litvin, Vasily Baranyuk, John Takekawa, Dennis Orthmeyer & Fred Cooke.** Restoration of Lesser Snow Geese to east Asia: An international conservation project, II

16:30 - 16:45 **Jean-François Giroux, Gilles Gauthier, Jean Bédard & Marcel Laperle.** Can Greater Snow Geese be kept away from vulnerable hayfields?

16:45 - 17:00 **Robert Adamcik.** The role of National Wildlife Refuges in managing the Central Flyway Lesser Snow Goose population.

18:30 **BANQUET**

ABSTRACTS

CONTRIBUTED PAPERS

Abstracts are arranged alphabetically by first author (with the exception of Plenary Abstracts, which are listed in order of presentation). The abstracts were reformatted but otherwise printed as provided by the authors, except for minor editing for style and syntax. Information contained herein should NOT be cited without first obtaining author approval.

Plenary Paper 1 – Thursday 8:15

THE PRAIRIE-ARCTIC CONNECTION: SPRING NUTRITION IN GEESE

Ray T. Alisauskas

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Spring energy and nutrient dynamics of geese constitute an important event in their annual cycles. Arctic geese (Lesser Snow Geese, Ross' Geese, small Canada Geese and White-fronted Geese) travelling through the Canadian Prairies, experience significant increases in body mass. Most annual variation in body mass is the result of annual variation in fat reserves both upon arrival on spring staging areas and before their departure. In Mid-continent Lesser Snow Geese, production of young (1983-84, 1988-93) was positively related to fat reserves ($P = 0.001$) accumulated in the Dakotas and Manitoba the previous spring. Protein reserves on the Prairies were not related to productivity ($P = 0.160$), but mineral reserves were negatively correlated ($P=0.022$) with age ratios. I suspect that this negative correlation is merely a correlated response whereby a tradeoff exists between storage of mineral reserves vs. fat reserves. Diets in nesting Ross' and Lesser Snow Geese from Canada's central arctic indicate significant use of eggshell, but body composition analysis of Ross' Geese also suggests significant use of mineral reserves for supplying eggshell material. Eggshells recycled from previous years' nests appear to be an important mineral source for eggshell. Constraints on nutrient reserves include food intake, body size, age, and even parasite burden. Such burdens, particularly nematodes, may be more prevalent with increased population sizes and greater probability of transfer among geese. Parasite burdens may be an emerging density-dependent mechanism whereby long-term declines in productivity of geese has been motivated by the interplay between nematode infection, fat reserves and annual fitness.

The prairie-arctic nutritional connection undoubtedly is further confounded by events on subarctic nesting areas where geese may persist for 3-4 weeks. Little is known about what arctic geese eat, or even where they go after leaving the Prairies. Further investigations of the nutritional cycle of geese should expand onto subarctic or arctic staging areas. Satellite telemetry would be a valuable first step in such an endeavor and would provide a properly weighted assessment of the temporal and geographical spring distribution of geese before reaching nesting areas.

Plenary Paper 2 – Thursday 13:30

THE ROLE OF FOOD AND TIMING OF NESTING IN GREATER SNOW GOOSE REPRODUCTION

Gilles Gauthier

Département de biologie and Centre d'études nordiques, Université Laval, Ste-Foy, Québec, Canada

Arctic-nesting geese live in highly seasonal environments where summers are short and environmental conditions can vary greatly among and within years. In such environments, the timing of breeding is critical to ensure successful reproduction, especially in birds that have a lengthy breeding cycle. Seasonal variations are probably most extreme in Greater Snow Geese, a species that breeds in the High Arctic. I will show how seasonal variations in food resources affect reproduction in this species and may ultimately shape reproductive strategies in geese. A seasonal decline in some measures of reproductive success has been documented in several goose populations. One of the most consistent and universal seasonal pattern is the seasonal decline in clutch size. In Greater Snow Geese, clutch size declines by about 1 egg for every 5 days of delay. Decline in clutch size in this species is not a consequence of a decrease in nutrient reserves over time (nutrient re-allocation hypothesis). An alternative hypothesis to explain this phenomenon is that clutch size is a trade-off between the advantage of breeding early and the advantage of delay. This hypothesis assumes that birds breeding late can improve their body condition through feeding but that the offspring value of birds breeding early is higher. We have already shown that both feeding conditions and body condition improved over time during egg-formation in the Arctic.

Offspring value also varies seasonally in relation to food supply in Greater Snow Geese. Egg survival and nesting success both showed a seasonal decline although the earliest nesting birds had lower success. Gosling survival varied according to laying date and tended to show a slight seasonal decline. Even at moderate brood density, gosling growth declined seasonally but its magnitude varied considerably among years. Variations in gosling growth were closely linked to intra and inter-annual variations in food supply. Late-hatched goslings had poor growth for several reasons. First, food quality declined during the summer. Second, in our system moderate goose grazing did not enhance plant production; hence plant regrowth did not compensate for the amount removed by early-hatched goslings. Even though plant regrowth was of higher quality, food intake by goslings on grazed swards was lower than on ungrazed ones. When combining the various components of reproductive success, the probability of survival of individual offspring until fledging was greatest for females initiating laying 2 days before the peak of egg laying, and declined thereafter. This seasonal decline in offspring value can explain the seasonal decline in clutch size, except for the earliest nesting birds, and suggests that clutch size may be the outcome of a trade-off with laying date. Future refinement of the model should include post-fledging survival because early-hatched goslings, who fledge earlier in the summer and at a greater mass, also have higher survival during the fall than late-hatched ones.

These results provide further evidence that environmental and density dependent factors have a strong influence on goose reproduction, even at moderate density. They also show that successful breeding by geese in the High Arctic results from a complex interaction between climatic factors, food supply and timing of breeding. Future changes in any of these factors such as increased food depletion due to expanding goose populations or change in the climatic regime due to global warming will likely have a major influence on goose reproduction.

Plenary Paper 3 – Friday 8:00

THE ROLE OF PREDATORS IN REGULATING GOOSE NUMBERS

Barwolt S. Ebbinge

DLO-Institute for Forestry & Nature Research, Department of Aquatic Ecology, Wageningen, The Netherlands

Actual predation is rarely observed in the field, and therefore the role of predators is often severely underestimated. Not only by predation but also by the anti-predator behaviour that prey-species have developed under the continuous selection pressure of predators, prey-species are limited in their distribution. How finely tuned this anti-predation behaviour can be, is shown by the way in which Dark-bellied Brent Geese play off one predator against the other. Snowy Owls keep arctic foxes at bay, when lemmings are abundant, and Brent Geese then nest in association with nesting Snowy Owls. However, when lemmings are scarce Snowy Owls even take incubating Brent Geese on the nest. Likewise Brent Geese prefer to nest within Herring Gull colonies despite the high toll these gulls take by preying on newly hatched goslings. On the other hand Herring Gulls are probably used as indicators by Brent Geese to show which places will be fox-free islands after the ice break-up. Moreover the gulls provide additional protection against Snowy Owls and against other gulls.

Predator activity and predator abundance in the arctic is very much dependent on lemming cycles. After a lemming peak year on the Taymyr peninsula in northern Russia foxes are more abundant on Spitsbergen. Because there are no lemmings on Spitsbergen, this must mean that foxes from the Russian mainland must have crossed the ice in winter. It is not unlikely that lemming cycles in the Russian arctic can even affect predator numbers in the North American arctic, and this could explain the positive correlation in breeding success of Snow Geese and Dark-bellied Brent Geese.

The impact of predators on goose numbers is likely to become more obvious now that so many goose populations have increased in numbers, and the nesting habitat which is safe from predators is becoming filled to capacity. Density-dependent effects may become evident as more geese are now forced to nest in places that are easier to reach for predators.

Plenary Paper 4 – Friday 13:00

LIFE-HISTORIES OF ARCTIC GEESE: SYNERGISM BETWEEN APPLIED AND EVOLUTIONARY BIOLOGY

James S. Sedinger

Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, Alaska, USA

Life-history traits are fundamental to our understanding of biological populations because they determine fitness. Life-history traits, especially survival and fecundity, are principal drivers of population dynamics and are, therefore, also of primary interest to managers. Over the past decade goose researchers have established a fundamental role of environmental influences in determination of life-histories. Studies of several goose populations have shown, unequivocally, that environment, primarily nutrient availability, is a principal control of growth and adult body size. These studies, conducted principally by scientists pursuing basic questions, have demonstrated density-dependent effects on growth and related life-history parameters; these studies are altering the paradigm underlying management of goose populations. To date, field studies have demonstrated a predominant role of environment in phenotypic variation in growth rate, body size, timing of breeding, clutch size and survival. There is also a suggestion that age of first breeding is strongly influenced by early environment. Absence of controlled experiments makes it difficult, however, to determine the relative contributions of genetic and environmental effects to life-history traits. Understanding environmental regulation of life-history traits is important because such variation will influence response of goose populations to management actions. It is clear that genetic variation also influences life-history traits, e.g., species and subspecies of geese differ in most life-history traits. Examination of correlated suites of fundamental traits that evolve together and vary among populations is likely to yield important insights into constraints on evolution of life-histories. For example, demonstration that snow geese hatch in a less mature state than Ross' geese suggests constraints on the possible combination of egg size, development time and adult body size in white geese.

I believe that closer examination of the genetic basis for fundamental physiological traits such as basal metabolism or protein metabolism, which translate environmental conditions into life-history traits, will yield important insights into life-history variation. Evolved variation in life-history traits and ecology should inform management plans for goose populations because this variation will influence response of populations to harvest, habitat change and potentially global climate change. Many of the important advances in our understanding of goose life-histories have resulted from long-term studies of marked individuals. Role of management agencies in support of these long-term efforts has been mixed. Although we can do better, managers and scientists concerned with Arctic nesting geese represent one of the best examples of synergism between applied and basic science. Furthermore, there are tremendous advantages to working with harvested species for answering basic evolutionary questions. Nevertheless, I contend we have failed to take full advantage of the potential to use both applied and basic approaches to improving our understanding and management of Arctic geese. I urge a closer working relationship between applied and basic scientists and mangers in planning future research on Arctic geese.

Plenary Paper 5 – Saturday 8:15

FUTURE RESEARCH ON GOOSE BEHAVIOUR: HAZARDS, NEEDS AND OPPORTUNITIES

Hugh Boyd

National Wildlife Research Centre, Canadian Wildlife Service, Environment Canada, Ottawa, Ontario, Canada

Research is likely to continue to be driven by fashions, funds and devices, as well as by curiosity. Original ideas that are also fruitful will presumably remain rare. Piling in behind a leader will probably continue to be the safest way to proceed, once a school of thought has become acceptable by the committees which allot funds. While governments continue to reduce their research establishments and direct expenditures, academics will continue to have most influence in awarding grants, so that theory will remain more respectable than practice, with the additional advantages that it is cheaper, less messy and carries fewer political risks. The development of computing will encourage increasingly elaborate modeling and statistical techniques. In the field, further development of satellite-based imagery and miniature tracking devices (if they remain affordable) and advances in video and sound recording will make it possible to revisit many topics hitherto inaccessible to precise recording and measurement. The ability to make detailed studies of goose behaviour without using your own eyes has many attractions, but devices can only record what they have been programmed to deal with. The need for human observers, to notice and interpret the unexpected will remain essential. Decision-making, by individuals and within groups of geese, raises many unresolved questions. Satisfying answers would be of practical as well as theoretical importance. Examples to be discussed include: ' how do individuals select what parts of what plants to eat at different times of year?' and ' how can we identify and explain mistakes made by geese?'

PRELIMINARY ASSESSMENT OF GOOSE FORAGING CONDITIONS ON AKIMISKI ISLAND, NORTHWEST TERRITORIES

ABRAHAM, KENNETH F. & JANO, ANDREW P. Ministry of Natural Resources, Peterborough, Ontario, CANADA

JEFFERIES, ROBERT L. Department of Botany, University of Toronto, Toronto, Ontario, CANADA

LEAFLOOR, JAMES O. Ministry of Natural Resources, Cochrane, Ontario, CANADA

Akimiski Island, NWT is a nesting and migration area for Canada geese, Lesser Snow Geese, Ross' geese and a migration area for Atlantic Brant. The north shore is particularly important for the Southern James Bay Population Canada geese and a small colony of Lesser Snow Geese. Comparison of satellite images over 25 years shows significant decline in vegetation cover along this shore. We used ground investigative techniques, including biomass sampling, exclosures and transects to determine indices of productivity, grazing intensity and species composition in coastal inter-tidal marshes dominated by *Puccinellia phryganodes*, *Carex subspathacea*, and supra-tidal marshes dominated by *Festuca rubra* and *Carex aquatilis*. Above ground biomass values in intact *Puccinellia-Carex subspathacea* swards ranged from 8-36 g/m^2 at the beginning of the growing season (late incubation and hatch for geese), 17-49 g/m^2 in early July (2 weeks post-hatch) and 26-62 g/m^2 near the end of the growing season (7 weeks post hatch, near end of brood-rearing for geese). In exclosures, above ground biomass values were 2-3 times as high as grazed samples from the same swards after 7 weeks of protection (63-147 g/m^2). Near the end of the second growing season after protection from grazing, values of live material reached 275 g/m^2. There was no difference in biomass estimated between the shared snow and Canada nesting/rearing area and the area used Canada geese alone. Percentage of the inter-tidal ground with intact swards and percentage of bare ground resulting from subterranean 'grubbing' is being analyzed to compare areas occupied by both snow geese and Canada geese with areas occupied by Canada geese alone. Observations also indicate high evaporation rates and a general absence of freshwater in the brood rearing zone compared to intact *Carex aquatilis* vegetation in freshwater fens.

POSTER - FRIDAY - 20:00

RECENT SURVEYS OF SNOW GOOSE COLONIES IN SOUTHERN HUDSON BAY

ABRAHAM, K.F. Ministry of Natural Resources, Peterborough, Ontario, CANADA

ROSS, R.K. & FILLMAN, DON. Canadian Wildlife Service, Nepean, Ontario, CANADA

ROCKWELL, R.F. American Museum of Natural History, New York, New York, USA

Results are presented for quantitative surveys undertaken in 1996 and 1997 of five well-established Lesser Snow Goose colonies south of 60° N (Knife-Seal Rivers and La Pérouse Bay, Manitoba, Pen Islands, Shell Brook, and Cape Henrietta Maria, Ontario). Substantial increases in breeding pair numbers over those of previous surveys were documented in all cases. Notes on the status and approximate size of four other smaller nesting concentrations were also made. The surveys employed a new helicopter-based method using narrow (100 m) strip transects positioned through satellite (GPS) navigation. Three observers counted all the actual nests within the transect, the boundaries of which were established by test flights over measured markers. The GPS was used to determine start and end points of the transects and to divide them into standard units to facilitate distributional analysis. Flight speed was determined by the density of the nests encountered. Advantages of the method include relatively low cost, the ability to be quickly deployed (in most weather conditions) to take advantage of aircraft availability, and the immediacy of survey results. The method is still being refined and comparisons will be made with results from the standard aerial photographic technique of Kerbes (1975).

POSTER - FRIDAY - 20:00

THE ROLE OF NATIONAL WILDLIFE REFUGES IN MANAGING THE CENTRAL FLYWAY LESSER SNOW GOOSE POPULATION

ADAMCIK, ROBERT S. Division of Refuges, U.S. Fish and Wildlife Service, Arlington, Virginia, USA

The U.S. Fish and Wildlife Service is responding to the overabundance of the Mid-Continent Snow Goose population with the White Goose Management Initiative (WGMI). This initiative is a joint effort by the Division of Refuges and the Office of Migratory Bird Management. National Wildlife Refuges, which currently provide food, refugia, and roosting sites along the flyway will play an appropriate role in this initiative. Wildlife management techniques on National Wildlife Refuges can be used to impact Lesser Snow Goose movements and probably numbers within the Central Flyway. Changes can be made to public uses (hunting, photography and observation), habitat manipulation (water and moist soil management) and farming for food production to impact local populations on and around refuges. Unfortunately, such changes to existing habitat management schemes will affect numerous other species utilizing the affected resources, and increased hunting activity may impact non-hunting visitation. Conflicts also arise with existing refuge management plans, some of which may only be changed through a formal public comment and approval process. These concerns highlight the issues which will need to be addressed as the Service moves forward with the WGMI.

ORAL - SATURDAY - 16:45

DEVELOPMENT OF A SIMULATION MODEL FOR FLYWAY MANAGEMENT OF PACIFIC BLACK BRANT

ANKER, WILLIAM E., REXSTAD, ERIC A. & SEDINGER, JAMES S. Institute of Arctic Biology and Department of Biology and Wildlife, University of Alaska Fairbanks, Fairbanks, Alaska, USA

Significant declines in the populations of Pacific Black Brant (*Branta bernicla nigricans*) over the past 30 years have led to concern regarding appropriate management strategies. Midwinter populations showed steady declines from the early 1960s through the mid-1970s, particularly in the continental United States. Colonies on the Yukon-Kuskokwim Delta in south-western Alaska exhibited declines in the number of nesting birds of more than 60% in the 1980s. A computer model was developed to explore the population dynamics of this species and to aid wildlife professionals in crafting future management plans. The model divides the population into five age classes within separate breeding colonies. These colonies are tracked throughout the life cycle using a matrix based approach. Sensitivity analyses were performed to validate the model's behaviour and to examine the interrelationships between biological parameters. Results clearly demonstrated that survival of young birds plays a crucial role in determining Brant population dynamics. Analysis of competing management strategies is currently underway. A management decision index has been developed to rank the effectiveness of competing strategies. The model allows users to control the relative importance of the criteria used to determine these rankings.

POSTER - FRIDAY - 20:00

CONSEQUENCES OF WINTER PHILOPATRY AND PAIR FORMATION IN LESSER SNOW GEESE

ARMSTRONG, TERRY. Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA

Observations of neck-banded snow geese from the western Arctic have revealed that both sexes are highly philopatric to wintering areas, in contrast to female-biased philopatry to nesting areas. Lesser snow geese also form pairs during the winter, therefore interbreeding lesser snow goose populations occur in winter rather than on nesting areas in summer. Most wintering populations subsequently fragment as geese migrate to separate nesting areas, and many nesting areas have geese from different wintering populations. Due to these features of snow goose ecology, the operational definition of lesser snow goose populations should be based on winter distribution rather than nesting colonies. While nesting colonies are convenient study units, they may not be appropriate units for population management purposes.

ORAL - SATURDAY - 9:15

GOOSE GRAZING CONTROLS OVER SEDGE GROWTH FORM AND QUALITY

BABCOCK, CHRISTOPHER A. & RUESS, ROGER W. Department of Biology and Wildlife , University of Alaska, Fairbanks, Alaska, USA

On the coastal Yukon-Kuskokwim delta of Alaska, Pacific black Brant preferentially graze on swards of the sedge *Carex subspathacea*. These high quality grazing lawns are typically surrounded by extensive taller and lower quality meadows of the sedge *Carex ramenskii*. Field observations suggested that the two species were actually conspecific ecotypes induced by grazing or lack thereof. Clipped meadows were used and maintained as grazing lawns by geese, while long exclosed swards became meadow-like and when made re-available to geese were not grazed. Lower salinity meadows required more clipping events before converting to sward-like growth form. We conducted a growth chamber experiment to test for the inter-convertability of the two ecotypes under 3 levels of simulated grazing and 3 levels of salinity. Beginning with small sods of the two ecotypes, we found that high frequencies of simulated grazing and high levels of salinity converted the *C. ramenskii* form to that of *C. subspathacea*, and maintained *C. subspathacea* in its original form. Conversely, under no grazing and low salinity, the *C. subspathacea* form grew up to resemble the *C. ramenskii* form, while *C. ramenskii* maintained its original form. There were also complimentary changes across the response surfaces in forage quality (% nitrogen), above- and below-ground biomass, and above-ground production. Goose numbers breeding on our study area declined 85% from 1981 to 1986 and have now recovered to previous levels. Growth rates and body size of goslings have declined across the period of population recovery. The reduction in goose numbers may have allowed high quality grazing lawns o convert to lower quality meadows, effectively resetting the carrying capacity of the ecosystem. Although the potential conversion of meadows to high quality swards has been demonstrated, the naturally occurring process may be slow relative to current rates of Brant population increase.

ORAL - THURSDAY - 16:45

ARTIFICIAL NEST ISLANDS FOR DUSKY CANADA GEESE ON THE COPPER RIVER DELTA, ALASKA

BABLER, STEVE, YOUKEY, DON & CROUSE, JOHN A. U.S. Forest Service, Cordova Ranger District, Cordova, Alaska, USA

From 1983 to 1992, 861 artificial nest islands of 6 designs were installed on the west Copper River Delta in south coastal Alaska to decrease nest predation. Use by nesting dusky Canada geese (*Branta canadensis occidentalis*) was monitored annually from 1984-1994. A total of 397 nests were found on 239 islands during this period. Island use averaged 16% annually and nest success averaged 59% annually. During this period, nest success on natural sites averaged 22%. Islands greater than 2-m2 in size, located 20-60 m from shore, with freeboard greater than 15 cm, and with shrub cover greater than 30%, were used more frequently. Costs for materials, transportation, and labour to install, monitor, and maintain islands from 1983-1994 ranged from $523/sandbag island to $1316/fibreglass-floater islands. Estimated cost per gosling produced ranged from $223/fibreglass-floater islands to $3200/rebar-platform islands.

POSTER - FRIDAY - 20:00

EGG CHARACTERISTICS, BODY RESERVES, AND TISSUE MATURITY OF NEONATE CANADA AND LESSER SNOW GEESE OF AKIMISKI ISLAND, NORTHWEST TERRITORIES

BADZINSKI, SHANNON, S. & ANKNEY, C. DAVISON. Department of Zoology, University of Western Ontario, London, Ontario, CANADA

LEAFLOOR, JAMES, O. Ontario Ministry of Natural Resources, Cochrane, Ontario, CANADA

ABRAHAM, KENNETH, F. Ontario Ministry of Natural Resources, Peterborough, Ontario, CANADA

We investigated interspecific differences in egg composition, body reserves, degree of development, and tissue maturity of neonate Canada and Lesser Snow Geese on Akimiski Island, NWT. Southern James Bay Population (SJBP) Canada and Lesser Snow Geese are syntopic on Akimiski Island, but have historically evolved under different ecological conditions. SJBP Canada geese are dispersed nesters and evolved in sub-arctic environments with relatively long growing seasons. Conversely, Snow Geese evolved in high arctic environments with short growing seasons and they nest in colonies, which increases competition for rapidly declining food resources. Therefore, we tested the hypothesis that these two species would differ at hatch with respect to body reserves, degree of development and functional maturity of tissues, organs, and external body parts. We predicted that neonate Snow Geese would have relatively more body reserves and be more developed (nearer adult size) and functionally mature at hatch because they are adapted to high arctic environments and to competition for food in and around nesting colonies. Overall, Snow neonates were more developed and had more mature tissue at hatch. Structurally, Snows required less incremental growth to attain adult size, despite their absolutely smaller size at hatch. Both species had similar relative amounts of body protein at hatch. However, contrary to our prediction, Canada neonates had relatively higher lipid stores. Digestive organ length and mass, relative to body size, were similar between species. However, Snow neonates had relatively larger and heavier gizzards and longer ceca. Snow Geese had more functionally mature breast, leg, and gizzard muscles. Hatching in a more developed state, with more mature tissues, may allow enhanced thermogenic, travel, and food processing capabilities at an earlier age.

POSTER - FRIDAY - 20:00

COMPARATIVE GROWTH AND DEVELOPMENT OF EXTERNAL MORPHOLOGY, DIGESTIVE ORGANS, AND SKELETAL MUSCLES OF CANADA AND LESSER SNOW GOSLINGS OF AKIMISKI ISLAND, NORTHWEST TERRITORIES

BADZINSKI, SHANNON, S. & ANKNEY, C. DAVISON. Department of Zoology, University of Western Ontario, London, Ontario, CANADA

LEAFLOOR, JAMES, O. Ontario Ministry of Natural Resources, Cochrane, Ontario, CANADA

ABRAHAM, KENNETH, F. Ontario Ministry of Natural Resources, Peterborough, Ontario, CANADA

Growth and development of arctic geese under natural conditions has received little attention owing to difficulties of recapturing marked goslings. Akimiski Island offers a unique opportunity to investigate aspects of prefledging growth between free ranging goslings of two species. The landform and high densities of nesting pairs allows for large numbers of goslings to be web tagged and subsequently recovered during banding drives. Southern James Bay Population (SJBP) Canada Geese and Lesser Snow Geese are syntopic on Akimiski Island and thus experience similar meteorological conditions, day length, growing season, and forage conditions. Further, both species evolved under differing selection regimes, and comparing them under somewhat "controlled" conditions may elucidate the role of environmental conditions on ultimate control of rates and patterns growth and development. Ricklefs (1979) hypothesized growth rate of birds was inversely related to the functional maturity of their tissues at hatch. Arctic gees hatch with large proportions of functionally mature tissues but grow extremely fast for their size. Other investigators have stated that arctic geese do not conform to Ricklefs hypothesis and environmental conditions ultimately influence the rate and pattern of growth and development. Therefore, we compared growth and development, from hatch to a mean common age and over a range of similar ages, of external morphology, digestive organs, skeletal muscles, and feather characteristics between syntopic SJBP Canada and Lesser Snow Goslings on Akimiski Island, NWT, with special reference to Ricklefs tissue allocation hypothesis.

ORAL - THURSDAY - 15:30

MITOCHONDRIAL DNA STRUCTURE OF CANADA GEESE IN EASTERN CANADA

BAKER, ALLAN J. Centre for Biodiversity & Conservation Biology, Royal Ontario Museum, Toronto, Ontario, CANADA

LEAFLOOR, JAMES O. Ministry of Natural Resources, Cochrane, Ontario, CANADA

ANKNEY, C. DAVISON. Department of Zoology, University of Western Ontario, London, Ontario, CANADA

Using a set of 21 restriction enzymes to cut mitochondrial DNA (mtDNA) into fragments, we examined the genetic structure among and within populations of mostly large-bodied Canada Geese (*B. c. interior/canadensis/maxima*) in Eastern Canada. Two populations of small-bodied Canadas that nest on Baffin and Southampton Islands were easily distinguishable from the large-bodied populations. Analysis of samples from breeding areas around Hudson Bay and James Bay revealed that Akimiski Island birds were unique in their mitochondrial profile, and thus constituted a separate genetic stock. Birds from the Ungava Peninsula have slightly divergent genotypes referable to *B. c. canadensis*. All of the other populations examined belonged to the subspecies, *B. c. interior* and could not be readily distinguished by their composite mitochondrial genotypes.

POSTER - FRIDAY - 20:00

SPATIAL AND TEMPORAL PATTERNS IN ARCTIC FOX DIETS AT A LARGE GOOSE COLONY

BANTLE, JASON L. Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA

ALISAUSKAS, RAY T. Canadian Wildlife Service, Prairie and Northern Research Centre, Saskatoon, Saskatchewan , CANADA

We studied diets of arctic fox (*Alopex lagopus*) associated with a large nesting colony of lesser snow and Ross' geese in the central Canadian Arctic. From 15 May to 5 August, 1994, and 18 May to 7 August, 1995, we examined arctic fox diets using frequency of occurrence of prey remains in faeces. Most scats (n=792) were collected from den sites. Scats from foxes with dens inside the goose colony contained egg shell fragments more frequently than foxes that depended more on small mammals outside the colony. Foxes were opportunistic in their feeding habits as prey use was linked to the nesting cycle of geese, coinciding to periods of egg, goose, and gosling abundance. However, spring diets, i.e., before geese arrive, reflected the importance of caching geese and eggs from the previous summer by arctic fox at Karrak Lake, NWT. We suggest that large increases in nesting populations of lesser snow and Ross' geese may have beneficial implications for arctic fox populations over a large scale.

POSTER - FRIDAY - 20:00

COMPARATIVE NEST DEFENSE BY ROSS' AND LESSER SNOW GEESE AGAINST ARCTIC FOX

BANTLE, JASON L. Department of Biology, University of Saskatchewan, Saskatoon, SK, S7N 0W0, CANADA.

ALISAUSKAS, RAY T. Canadian Wildlife Service, Prairie and Northern Research Centre, Saskatoon, Saskatchewan, CANADA

We compared attacks by Ross' (Chen rossii) and lesser snow geese (Chen caerulescens) on arctic fox (Alopex lagopus) during egg-laying and incubation at Karrak Lake, NWT in 1994-95. Twenty-five observation bouts of interactions between arctic fox and geese were recorded for a total of 998 minutes, ranging from 4-100 minutes. Attack rates by lesser snow geese on arctic fox were greater than by Ross' geese during both egg-laying and incubation. In both species, number of nests depredated decreased from egg-laying (7/h) to incubation (2/h). However, Ross' geese increased their attack rate from egg-laying to incubation greater than lesser snow geese. Number of nests depredated of each goose species was directly related to respective species composition of surrounding goose nests; this relationship was stronger during egg-laying than during incubation. Ross' geese nesting in association with lesser snow geese had fewer nests depredated by arctic fox during egg-laying, but this trend was not evident during incubation. As expected, arctic fox caching of eggs was greater during egg-laying (5.9 eggs/h) as compared to incubation (2.7 eggs/h). Fox preferentially cached and depredated Ross' goose eggs in 1994, but in 1995 there was no difference in the frequency of Ross' and lesser snow goose eggs cached or depredated. These findings suggest that smaller species of geese may increase nesting success by nesting in association with larger species.

ORAL - FRIDAY - 9:15

THE "PERESTROJKA" OF WRANGEL ISLAND SNOW GEESE COLONY IS COMPLETED

BARANYUK, VASILY V. Wrangel Island Governmental Reserve, Russia. Lomonosovskiy Prospekt 35-40, Moscow, RUSSIA

At the moment the Tundra River Snow Geese colony in Wrangel Island (Russia) differs very much from that one of 1970s. The characteristic features of its present conditions are the more compact area and higher average nest density (up to 50 nests/ha). The colony took such a form for the first time in 1989 in the year of lemming depression and high Arctic Fox abundance. After that year the colony did not fall outside the limits of the "new" area and in these favourable nesting conditions for geese, the average nest density increased. In our opinion we were the witnesses of the merging of two subpopulations (with different wintering areas) within one colony and at the moment this process is completed.

POSTER - FRIDAY - 20:00

MIGRATION AND WINTERING DISTRIBUTION OF SMALL CANADA GEESE FROM THE CANADIAN ARCTIC

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The Short Grass Prairie and Tall Grass Prairie populations of small Canada geese nest from the western Canadian arctic east to Baffin Island, and are managed as distinct populations by the Central and Mississippi flyways. In recent years apparent mixing on the migration and wintering grounds suggested that the management of these geese as two distinct populations be re-assessed. Thus, these geese became the focus of a major international neckbanding program from 1990 - 1996, designed to test if it is appropriate to manage the Short Grass Prairie and Tall Grass Prairie populations separately. Government agencies, aboriginal groups, non-government and volunteer personnel cooperated in marking adult and young geese with uniquely coded plastic neckbands across the breeding range of both populations. Neckbanded birds were re-observed range-wide throughout the annual cycle. Analyses of neckband observations, by contouring total observations by week, yielded detailed fall migration and wintering ground distributions. The temporal and distributional patterns of these observations indicate that management of these geese as two distinct populations is appropriate. Small Canada geese from the western and central arctic west of the Boothia Peninsula are distributed differently on the migration and wintering grounds than geese from the west coast of Hudson Bay and from more easterly locations including Southampton and Baffin Islands. Detailed information on the distribution of the Tall Grass Prairie Population, and recent changes in the winter distribution of the Short Grass Prairie Population are also discussed. This information is essential to the current process of revising the flyway management plans for Short Grass Prairie and Tall Grass Prairie populations of Canada geese.

ORAL - SATURDAY - 13:45

OPPORTUNISM VERSUS TRADITION IN HABITAT USE BY STAGING GREATER SNOW GEESE

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Tradition offers the advantages of coming back to well-known places and the familiarity with resources distribution, roosts and presence of predators. Opportunism, on the other hand, may offer benefits through the use of new niches which may improve foraging efficiency. Every spring, the entire population of Greater Snow Geese (*Chen caerulescens atlantica*) stops over in the Saint-Lawrence valley in Quebec during their annual migration between their wintering areas in the mid-Atlantic coast of the United States and their Canadian high arctic breeding grounds. In the past Greater Snow Geese used bulrush (*Scirpus americanus*) tidal marshes. However in the past two decades they have colonized Spartina salt marshes, and more recently grasslands and stubble corn fields. During spring staging, geese now concentrate in 'cornfield area' in south-western Quebec, 'mixed area' in the upper estuary and 'without-cornfield area' in the lower estuary. The spring staging period is of critical importance because body condition of the birds may affect their subsequent breeding performance in the Arctic. We examine the costs and benefits associated with traditionalism and opportunism at two levels: staging area and habitat selection. Our aim is to identify the mechanisms involved in the new distribution of the geese by monitoring individual movement patterns between the different areas throughout the staging period. We followed 38 radio-tagged Greater Snow Geese during Spring 1997 from the day they arrived in Quebec (March 30) until the day they left for the Arctic (May 26). Precise daily location was known in 94% of cases. Multivariate analyses showed that our tagged birds can be classified as waste corn consumers, mixed consumers (cornfield/grassland) and grassland consumers which may represent different subflocks within the population.Seven of the 38 birds were recaptured and fitted with a new radio in summer 1997 along within with 73 new birds to be followed during spring 1998 and 1999.

POSTER - FRIDAY - 20:00

CANADA GOOSE HARVEST CONTROL IN WISCONSIN

BERGQUIST, JON R. & HILL, BRENDA F. Wisconsin Department of Natural Resources, Madison, Wisconsin, USA

Wisconsin, like 5 other states in the Mississippi Flyway has a maximum allowable harvest set for Canada geese. In this paper, we will discuss past and present techniques employed in Wisconsin to ensure that the kill does not exceed the allowable harvest. Methods to control harvest include separating zoning the state into 3 major zones; restricting hunters to hunt in only one zone; requiring all Canada goose hunters to obtain a Canada goose hunting permit prior to hunting; requiring birds to be tagged in two of the zones and controlling the harvest by the number of kill tags issued; and monitoring the harvest in the third zone and closing the season early if the allowable harvest is achieved before the normal end of the season.

ORAL - SATURDAY - 14:30

FACTORS AFFECTING NESTING SUCCESS IN GREATER SNOW GEESE: THE INTERPLAY BETWEEN NEST DENSITY, LEMMING ABUNDANCE AND ASSOCIATION WITH SNOWY OWLS

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GIROUX, JEAN-FRANÇOIS. Département des sciences biologiques, Université du Québec à Montréal, Montréal, Québec, CANADA

In arctic ecosystems, low predation rate on bird nests in years of high lemming abundance has been attributed to prey switching by predators. However, an alternative hypothesis is their nesting association with raptors who are more abundant in peak lemming years. Here, we present observational and experimental results on the role of these factors in affecting the nesting success of Greater Snow Geese (*Chen caerulescens Atlantic*). The study was conducted in two areas separated by 30 km on Beloit Island: the Base-camp (BC) and the Secondary camp (SC.). Lemming abundance was estimated with snap-traps at BC (1994 to 1997) and at SC. (1997), and from winter nest surveys at SC (1993) and at BC (1996). Goose nests (n > 300 each year) and Snowy Owls (*Nyctea scandiaca*) nests were monitored in both areas from 1993 to 1997. Goose nesting success varied considerably among years and site (from 89% in 1993 at BC to 4.5% in 1995). Arctic foxes (*Alopex lagopus*) were responsible of 53% of attacks observed on goose nests (n = 137) compared to 47% for avian predators. Peak lemming abundance occurred in 1993 and 1996. Owl nests were found only in those years: twelve pairs in 93 at BC and nine in 96 (7 at BC and 2 at SC). There was a strong positive relationship between goose nesting success and lemming abundance at BC ($r^2 = 0.90$, $P < 0.05$) but not at SC ($r^2 = 0.25$, $P > 0.05$). Goose nests were more abundant in the SC area (>1000 nests each year) than in the BC area where goose colonies were relatively small (from ~10 to 300 nests). In 1993 and 1996, goose nests were clustered around owl nests at BC. In 1996, 92% of goose nests found were < 600m from an owl nest at BC (n = 114), compared to only 42% at SC (n = 257). Unlike other years, goose nesting success was also higher at BC than at SC (78% vs 59%, $P < 0.05$). In 1996, 20 artificial goose nests made of 3 chicken eggs placed in a bowl of goose down were distributed between 5 and 150m from a snowy owl nest. Twenty other nests were placed in a control area 2 km away from the owl nest. No eggs were lost around the owl nest during a 17-day exposition period while 93% of the eggs in the control area were depredated after only one day. These observations support the hypothesis that the relationship between lemming abundance and goose nesting success is in part a consequence of their nesting association with owls in peak lemming years. More experiments were conducted in 1997 and are planned for 1998 to better understand the numerical and functional responses of predators to lemming abundance and their impact on goose nest predation.

ORAL - FRIDAY - 9:45

NESTING ECOLOGY OF TULE GREATER WHITE-FRONTED GEESE

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ROTHE, TOM. Alaska Department of Fish and Game, Anchorage, Alaska, USA

SARVIS, JOHN. U.S. Fish and Wildlife Service, Region 7, Anchorage, Alaska, USA

We studied the nesting ecology of Tule Greater White-fronted Geese at a newly located nesting area in the Susitna River Valley of south-central Alaska from 1994-1997. Little research has been conducted on boreal forest nesting geese and the only previous information on nesting Tule Geese is from Redoubt Bay, located approximately 120 km south-west of the mouth of the Susitna River on the west side of Cook Inlet. We located 31 nests by tracking radio-marked geese that had been captured and marked prior to spring migration. The entire known breeding range was systematically searched for radioed birds; and thus, determination of nesting habitat was unbiased relative to study area location/boundaries. Nest initiation occurred in mid-May, which is similar to dates reported for Tule Geese found nesting at Redoubt Bay in the late 70's and early 80's. Clutch size averaged 4.23 eggs/nest. Nesting success was poor during all years of the study, likely due to the high density of fur-bearers and bald eagles in the study area. The habitat of the upper Susitna River Valley is generally described as a black spruce and birch boreal forest interspersed with wetlands, as compared to that of Redoubt Bay, which is more characteristic of a high flood plain coastal wetland. Sites selected by geese for nesting were generally in association with these interspersed wetlands.

POSTER - FRIDAY - 20:00

SPRING NUTRITIONAL ECOLOGY OF MIGRATING AND BREEDING ROSS' GEESE

BON, RAY L. Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA

ALISAUSKAS, RAY T. Canadian Wildlife Service, Saskatoon, Saskatchewan & Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA

Reproductive potential in Ross' Goose (*Chen rossii*) is greatly affected by amount of nutrients a female possesses before laying because little food is available on nesting areas. Thus females must store and transport nutrient reserves required for clutch formation and incubation. Ability of females to acquire and store nutrients was thought to determine clutch size (Ryder 1970a). Therefore, we studied nutrient dynamics of Ross' Geese during spring migration through the western prairies, and during nesting. Geese were collected in western Saskatchewan and at the nesting colony at Karrak Lake. For each goose, structural measurements were recorded. The carcass was dissected, somatic tissues were separated from reproductive tissues, and these tissues, or subsamples, were analyzed for protein, fat, and mineral to determine total somatic and reproductive nutrients. Relationships between reproductive and somatic nutrients were determined by ANCOVA separately for each nutrient type. Staging areas in prairie Saskatchewan were an important source of lipids in both males and females. Boreal, subarctic and arctic habitats used after departure from western Saskatchewan were important sources of protein and mineral and a minor source of lipid in females. Males, conversely, lost lipid during migration but maintained protein. In 1993, females started laying with more mineral and less fat than females in 1994. There were no differences between years in amount of protein. Protein and mineral were correlated to structural size, but lipid was not. Structurally larger females laid more eggs. Larger clutches were laid by females with more protein and mineral. Our results suggest that protein and mineral, but not lipid, were limiting nutrients in determination of clutch size. By following Sedinger et al. (1997) recommendation of controlling for clutch size in analyses of this kind, we arrived at very different conclusions than had we not controlled for clutch size. This has important implications for the interpretation of results from other studies of nutrient reserve use by arctic-nesting geese.

SPRING STAGING IN BRENT GEESE: CAPACITY OF COASTAL MARSHES IN RELATION TO SALT-MARSH MANAGEMENT

BOS, DAAN. Department of Plant Ecology, University of Groningen, THE NETHERLANDS

Brent geese in Western Europe gather in the Wadden Sea in spring, prior to migration to their breeding grounds. During this period, they have to gain body mass in order to increase chances of successful reproduction (Ebbinge and Spaans, 1995, J. of Avian Biology 26: 105-113). In this period, salt marshes are key feeding areas, but geese also utilize improved grassland and agricultural land, giving rise to conflicts with farmers. The management of salt marshes, by livestock-grazing, fertilization or drainage, determines to a large extent the type of vegetation that will occur. Heavy grazing and drainage results in a short homogeneous turf (Aerts et al., 1996, Z. Oekologie u. Naturschutz 5: 65-75.), which is attractive for Brent geese. By extensive grazing a vegetation mosaic is created. Natural succession, however, results in a disappearance of the preferred food species (Van de Koppel et al., 1996, Ecology, 77: 736-745.). At present, a trend is observed to abandon salt marshes; farmers loose interest and changes in nature management option towards excluding livestock. This might eventually increase the problems with the farming community. In a recent field study, habitat use of Brent geese on the Island of Schiermonnikoog was determined and related to parameters of food availability. A comparison is made between grazed and ungrazed marshes. Also, the effect of fertilization on carrying capacity for geese is studied by adding nutrients to small experimental plots of grazed salt-marsh. Results from this experiment are contrasted to long term data on vegetation and goose grazing pressure of the same meadow, which had been fertilized until 5 years ago. The study is part of a larger project which aims at understanding the effects of management of salt marshes on the occurrence of vegetation types and the function of these areas as feeding grounds for Brent Geese. The intention is to predict compensation schemes for farmers under different management scenarios, by integrating these findings with existing vegetation maps at the level of the International Wadden Sea.

A COMPARISON OF BROOD COHESION IN SNOW AND CANADA GOSLINGS

BOUSFIELD, MARJORIE A. Wolfe Island, Ontario, CANADA

In tests of interactions of parentless goslings raised in separate broods, snow geese showed brood cohesion, as determined by more aggressive behaviour exhibited towards members of other broods than towards one's brood mates, within two days of hatching. Canada goslings, on the other hand, continued to "creche" throughout the week-long testing period and even weeks later. This difference in basic social behaviour early in life seems to reflect the difference in social structure of the two species as adults, particularly during the reproductive period. Early recognition of one's own family is essential in a colonial nesting species in order to maintain effective parental care and to prevent total chaos. In the more dispersed Canada goose, this mechanism apparently has not developed to the same extent. Separation of young families tends to be spatial rather than behavioural.

ORAL - SATURDAY - 9:30

RELATIVE TIMING OF REPRODUCTIVE INTERACTIONS IN THE LESSER SNOW GOOSE

BOUSFIELD, MARJORIE A. Wolfe Island, Ontario, CANADA

In a captive situation in which all individuals were marked, their recent reproductive histories and pre-reproductive hierarchies known, area available for nesting manipulated, nests checked frequently and observations made regularly, the reproductive behaviour of snow geese was monitored. Males engaged in copulations with their mates into and up to the end of egg-laying and in forced copulations before (and after) their own mates began incubating. This behaviour was the same whether or not the female was laying eggs in her own nest or in the nests of others. Experienced males continued to force copulations after copulations with their own mates ceased. Females that did not lay that season copulated with their mates but were rarely involved in forced copulations. Injuries to males forcing copulations and to females parasitizing nests were not comparable. Time taken by a parasite to lay was related to her readiness to lay, i.e., her normal interval between eggs. This was particularly obvious in females whose first eggs were laid parasitically, but who completed their clutches in nests of their own once more nesting space became available.

POSTER - FRIDAY - 20:00

GLAUCOUS GULL PREDATION OF GOSLINGS ON THE YUKON-KUSKOKWIM DELTA, ALASKA

BOWMAN, TIMOTHY D. , ROBERT A. STEHN, U.S. Fish & Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA

SCRIBNER, KIM T. Biological Resources Division, U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska, USA

Glaucous gulls (Larus hyperboreus) frequently prey on goslings and ducklings. To quantify the impact of gull predation to annual waterfowl production on the Yukon-Kuskokwim Delta, we estimated the number of depredated young waterfowl, and for emperor geese (Chen canagicus), we compared this to the number fledged. We conducted aerial surveys to estimate the distribution and population sizes of gulls, geese, and goslings. Population indices from early June surveys 1985-1996 for Glaucous gulls showed the average annual rate of increase at 1.06, more than doubling in the last 12 years. In our selected study area of 2,148 km2, we estimated 12,500 glaucous gulls in early July 1994 with higher density near the coast and lower density inland. We estimated about 15,000 emperor goslings surviving in early August. We collected 434 gulls from late June to early August 1994 to examine diet and estimate the number of goslings taken by gulls. We used DNA analysis to identify the species of waterfowl tissue remaining in gull stomachs. Gosling species included emperor geese, white-fronted geese (Anser albifrons frontalis), and cackling Canada geese (Branta canadensis minima). No gull stomachs contained black brant (Branta bernicla nigricans) or spectacled eider (Somateria fischeri) ducklings. Inland gulls collected >1.6 km from the coast accounted for 70% of the predation on emperor and cackling Canada, and 96% of the white-fronted goslings. We calculated total goslings taken by gulls from the observed incidence of prey in gull stomachs contents, the rate of digestion, and numbers of gulls observed on aerial surveys in strata delineated by relative densities of predator and prey and by distance from the coast. We estimated 21,000-52,000 (minimum-maximum) emperor, 34,000-84,000 cackling Canada, and 16,000-38,000 white-fronted goslings were eaten by gulls during the brood rearing period in our study area in 1994. Localized removal of inland gulls could be a practical way to temporarily accelerate population recovery and meet management plan objectives for emperor geese.

POSTER - FRIDAY - 20:00

VARIATION IN ANNUAL NEST SUCCESS OF GEESE IN RELATION TO SPRING PHENOLOGY AND PREDATORS

BROMLEY, ROBERT G. & CARRIÈRE, SUZANNE. Department of Resources, Wildlife and Economic Development, Government of the Northwest Territories, Yellowknife, Northwest Territories, CANADA

Relative to other Anatidae, less attention has been directed towards understanding factors affecting nest success of arctic geese. We studied factors associated with nest success of White-fronted (*Anser albifrons frontalis*) and Canada (*Branta canadensis hutchinsii*) geese over 8-11 year periods and two study areas (Walker Bay-WB; Albert Edward Bay-AB) to determine annual variation in annual nest success by species, study area and year, and within years (early nesting period - lay to incubation day 7; late nesting period - day 8 to hatch). We asked how nest success varies with respect to annual phenology (slope of decline during snow-melt, date of 50% snow-melt, water depth) and predator indices (fx [*Alopex lagopus*] kits, fox sightings, gulls [*Larus spp.*], jaegers [*Stercorarius spp.*], lemmings [*Dicrostonyx sp.* and *Lemmus sp.*]). Finally, using relationships detected for one species and study area, we determined the reliability of predicting nest success of another species on the same study area, and of the same species on another study area. Nest success varied widely among years, though less so at AB than at WB. Nest success was linearly correlated with water depth, and curvilinearly related to the slope of snow-melt at WB for both species. Nest success was not correlated with the date of 50% snow-melt for either species or study area. We detected no simple relationship between nest success and lemming indices. Of direct predator indices, only fox sightings were correlated (negatively) with nest success of both species at WB. Within the early nesting period, we again found a curvilinear relationship between nest success of both species and the slope of snow-melt at WB, and for CG only within the late nesting period at WB. Nest success was correlated with fox sightings for both species at WB during early nesting, but no relationships occurred during late nesting. No relationships were detected at AB with indices of either phenology or predation. We found greater differences in success between study areas than between species within years and study areas, indicating a strong study area effect. Thus, a model based on relationships of Canada Goose nest success with slope of snow-melt at WB did poorly at predicting nest success of Canada Goose at AB (4 of 8 years were outside the 95% CI); the model did better at predicting success of White-fronted Geese at WB (2 of 9 years were outside of the 95% CI). As stressed by Schmutz 1997, variation in reproductive parameters such as nest success may strongly influence population dynamics when other parameters (e.g. adult survival) are relatively less variable.

ORAL - FRIDAY - 8:45

TESTING HYPOTHESES ON SEASONAL DECLINES IN CLUTCH SIZE USING ARCTIC-NESTING GEESE AND LATITUDINAL ASYNCHRONIES IN THE TIMING OF SPRING

BROMLEY, ROBERT, G. & SUZANNE CARRIÈRE. Department of Resources, Wildlife and Economic Development, Government of the Northwest Territories, Yellowknife, Northwest Territories, CANADA

Seasonal declines in clutch size are a well-known phenomenon in birds. Long-term studies, however, indicate that the rates of decline greatly vary among years for some species. Two non-exclusive hypotheses have been proposed to explain why seasonal clutch-size declines occur, which may be extended to explain their annual variation. According to the "condition"-constraint hypothesis, a decline would occur in years when late breeders could not invest energy in producing extra eggs. According to the "time"-constraint hypothesis, a decline would occur in years when late breeders could not invest time in producing extra eggs. Both "condition" and "time" constraints can simultaneously affect individual reproductive strategies and their relative importance may differ among bird species. We suggest that both hypotheses may be tested simultaneously using the annual variations of the rate of seasonal declines of clutch size in migratory birds, and the annual latitudinal asynchronies in the timing of spring. We used data from 8+ year studies on the reproduction of White-fronted (*Anser albifrons frontalis*) and Canada geese (*Branta canadensis hutchinsii*), nesting on two study areas in the central Canadian Arctic. First, we determined to what extent the rates of decline varied among years for each goose species and study area. Second, we used the annual variations in the timing of spring on southern migratory stopovers (index: date of +5 °C; AB and SK locations) and on the arctic nesting areas (date of 50% snow-melt) as a natural experiment "manipulating" the condition and time constraints. We predicted that a slower rate of decline would occur in years when both southern and arctic spring phenologies were early. Conversely, we predicted that a slower rate of decline would occur in years when the southern phenology was early relative to the Arctic. Test results were examined graphically. We detected greater annual variation in the rates of seasonal clutch-size decline in Canada Geese (Victoria Island, 1987-1994; Kent Peninsula, 1987-1997) than in White-fronted Geese (Kent Peninsula, 1987-97). Relatively slower rates of decline were associated with later Arctic springs for Canada Geese and with earlier southern springs for White-fronted Geese. We found that, in Canada Geese, a release of the time constraint would result in slower rates, whereas, in White-fronted Geese, a release of both condition and time constraints would be necessary to significantly lower rates of clutch-size decline. These findings fit well with our current understanding of the pre-nesting feeding ecology and incubation behaviour of the two species. Assessing the relative importance of time and condition constraints in other species for other areas may help increase our understanding of the factors that determine annual productivity in geese.

ORAL - THURSDAY - 11:15

BODY RESERVES AND INCUBATION BEHAVIOUR IN BARNACLE GEESE

BUNES, VEGARD, TOMBRE, INGUNN & ERIKSTAD, KJELL EINAR. Norwegian Institute for Nature Research, Tromsø, NORWAY

Arctic nesting barnacle geese *Branta leucopsis* heavily rely on their body reserves when arriving the breeding grounds. The body condition of the female is crucial for reproductive success. A good body condition enables the females to incubate more continuously, which might reduce egg predation and shorten the length of incubation. We studied a colony of barnacle geese in Kongsfjorden, Svalbard (78°5°6°N, 12°15°E), in June and July 1997. Eighteen females were weighed on the nest using a nest balance 5 days after they had started incubation. Four 24 hour observations were done during the incubation period; one the day after weighing, one in the middle of the incubation period, and two towards the end of the incubation period. Total time off the nest was measured to the nearest minute, and we assumed that the female was feeding most of the time during a recess. The results show a significant negative relationship between the initial body mass and the total time off the nest, and the correlation increased as the incubation progressed. The results demonstrate the importance of body mass for incubation, since females with more body reserves were more nest attentive than females with less reserves.

POSTER - FRIDAY - 20:00

CO-MANAGEMENT OF WATERFOWL IN THE INUVIALUIT SETTLEMENT REGION OF THE WESTERN CANADIAN ARCTIC

CARPENTER, LARRY & POKIAK, JAMES. Inuvialuit Game Council, Inuvik, Northwest Territories, CANADA

HINES, JAMES E. & WIEBE, MYRA O. Canadian Wildlife Service, Yellowknife, Northwest Territories, CANADA

"A basic goal of the Inuvialuit Land Rights Settlement is to protect and preserve the Arctic wildlife, environment and biological productivity through the application of conservation principles and practices" (The Western Arctic Claim 1984).

The Inuvialuit and other indigenous people of the Northwest Territories have a long history of dependence on waterfowl. They realize that waterfowl conservation depends on the long-term protection of good quality habitat at breeding, migration, and wintering areas, as well as careful harvest management. The signing of the Inuvialuit Final Agreement (IFA) in 1984 guaranteed the Inuvialuit greater control and involvement in the management of their homeland. It also represented a giant step towards enlightened management and conservation of waterfowl in the region. With the implementation of the IFA, co-management committees consisting of equal numbers of Inuvialuit and government members were established to advise on all wildlife management issues, thereby ensuring that regional perspectives were considered in waterfowl management. Funding from the Final Agreement has supported a variety of baseline research that facilitates waterfowl management both within and outside the Inuvialuit Settlement Region (ISR). Projects supported by Inuvialuit funding include the collection of harvest data from ISR hunters; large-scale aerial surveys of the distribution and abundance of White-fronted Geese, Canada Geese, Pacific Brant, and other waterfowl; air photo surveys of Snow Goose colonies; extensive banding and marking programs for White-fronted Geese, Canada Geese, Snow Geese, and Pacific Brant; and intensive studies of factors influencing the productivity of Snow Goose and Pacific Brant populations. The commitment of the Inuvialuit to waterfowl management was highlighted in 1996 when the Inuvialuit Game Council received the prestigious International Canvasback Award in recognition of its substantial, long-term contribution to the maintenance and implementation of the North American Waterfowl Management Plan.

POSTER - FRIDAY - 20:00

A MULTI-SPECIES, MULTI-PURPOSE PROGRAM TO MONITOR TRENDS OF EASTERN ARCTIC GEESE OF THE NORTHWEST TERRITORIES.

CASWELL, DALE & BAZIN, RON . Canadian Wildlife Service, Winnipeg, Manitoba, CANADA

DIDIUK, ANDREW. Canadian Wildlife Service, Saskatoon, Saskatchewan, CANADA

WENDT, STEVE. Canadian Wildlife Service, Place Vincent Massey, Hull Quebec, CANADA

The Canadian Wildlife Service has been monitoring trends in size of lesser snow goose populations on west and south Hudson Bay, Southampton Island , west Baffin Island, through the use of aerial photography of nesting colonies at intervals since 1973. More recently the Canadian Wildlife Service has developed and conducted summer aerial surveys on west Baffin Island, west Hudson Bay and Southampton Island in the Northwest Territories. These stratified helicopter surveys, conducted in conjunction with an August banding program, have generated estimates of both the breeding and non-breeding components of Canada geese, Lesser Snow geese and in some areas Ross geese and Atlantic Brant as well as brood numbers and juvenile/adult ratios. Dramatic increases in populations of lesser snow goose numbers on Southampton Island and West Baffin Island have been noted to be each in excess of 1 million . This is a 3-5 fold increase in breeders when compared to estimates from the 1979 aerial photography of nesting geese. Canada goose breeding population estimates in excess of 100,000 have also been noted on West Baffin Island. These summer aerial surveys provide a cost-effective alternate means to monitor populations, develop productivity indices, and provide a sample of banded/collared birds for harvest recovery and survival information of the geese breeding in these remote regions. The Canadian Wildlife Service proposes the continuation of these summer aerial surveys as part of a comprehensive, coordinated program in the eastern arctic to monitor population size, harvest distribution, adult survival and habitat changes as a key component of an arctic ecosystem initiative.

ORAL - SATURDAY - 15:15

SEED BANK DYNAMICS IN DEGRADED AND UNDAMAGED COASTAL HABITATS OF THE HUDSON BAY LOWLANDS

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During the past two decades, the mid-continent population of the lesser snow goose (*Anser caerulescens caerulescens*) has been increasing at an exponential rate. Spring grubbing and heavy grazing by high numbers of geese trigger a positive feed back cycle that leads to increased evapotranspiration from exposed sediment and hypersalinity causing further loss of vegetation. Large tracts of coastal salt marsh have been converted into mudflats largely devoid of vegetation. The objectives of this study were 1) to determine the size and composition of the seed bank in undamaged and degraded soils, 2) to deduce the relationship between the existing species present in the vegetation and the seed bank and 3) to assess the potential for revegetation in the case that grazing pressure can be stabilized. Soil cores were collected from both intact and degraded sites and their seed content was determined after the soil was washed and the seeds collected on sieves. Preliminary results have indicated large differences in the seed bank composition of intact and degraded sites. The seed banks of degraded areas were dominated by weedy species, in particular the halophyte, *Salicornia borealis*. In contrast, there was greater diversity of seeds and closer representation of species typical of salt-marsh vegetation in undamaged sites. However, seedlings of some of the dominant dicotyledonous species of intact swards (*Potentilla egedii, Plantago maritima, Stellaria humifusa*) failed to emerge from the seed bank, possibly because heavy grazing of inflorescences by geese limited seed input into the soil. In order to measure seed input, seed traps were also set at both intact and degraded sites. These results are currently being analyzed.

POSTER - FRIDAY - 20:00

POST-MORTEM OF A POPULATION COLLAPSE: THE RELATIVE IMPORTANCE OF LIFE-HISTORY STAGES

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ROCKWELL, ROBERT F. Ornithology Department, American Museum of Natural History, New York, New York, USA

BRAULT, SOLANGE. Biology Department, University of Massachusetts, Boston, Massachusetts, USA

Determining the relative importance of life-history events for population growth is a significant goal of population dynamics research. Perturbation analyses, which explore the magnitude of changes in the vital rates on population growth, provide a formal approach to this problem. One analytical method using perturbation is spectral decomposition analysis of life-table responses (LTRE Analysis - sensu Caswell 1989). Using this approach, population growth rate is measured as a deviation from a reference control value using methods analogous to linear ANOVA. We apply this approach retrospectively to data from the snow goose colony at La Pérouse Bay. The number of geese in the La Pérouse Bay and Cape Churchill region has increased from 2500 pairs in 1969 to more than 40,000 pairs today. Much of this growth is reflected in geographical expansion. Indeed, the numbers of geese using the original core area of La Pérouse Bay have declined, primarily due to habitat destruction related to a trophic cascade precipitated by over-consumption by increasing numbers of geese. The long-term changes in the conditions at the original core area of the colony constitute a natural experiment - a systematic reduction in forage abundance and quality over time. By partitioning the data into a series of consecutive 3-year blocks, we can treat each block as a different level of an overall food reduction treatment effect, using the first block (when conditions were optimal) as the reference control.

We show that although systematic changes in realized fecundity (clutch size and first-year survival) are driving a decline in population growth rate within the core area of the colony, the relative effect of adult survival on that growth rate has actually increased. Coincident with the onset of the trophic cascade, increasing numbers of adults began rearing broods, nesting or both at ever-greater distances from the core area, in habitat that is currently less degraded and where realized fecundity and first-year survival are at levels once found in the core area. Since adult survival is the same over the entire region, the growth rate of the dispersing population is greater than 1 and the geographically expanding regional colony continues to increase numerically. We discuss the details of these results and show that they are in agreement with basic predictions from life-history theory.

ORAL - FRIDAY - 15:00

HOW OLD ARE YOU? - USING THE 9TH PRIMARY AS AN INDICATOR OF GOSLING AGE

COOCH, EVAN G. Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia, CANADA

ROCKWELL, ROBERT F. Department of Ornithology, American Museum of Natural History, New York, New York, USA

DZUBIN, ALEX. Saskatoon, Saskatchewan, CANADA

Gosling growth rate is significant - perhaps the fastest among precocial birds. It is also highly plastic, varying significantly in response to even small variations in quantity and quality of nutrients. As such, it is important to be able to assess gosling age precisely to differentiate between sources of variation in size due to age, and due to other sources. In some studies, where goslings are individually web-tagged at hatch, gosling age can be assigned with a precision of 1 day (where age (days) = encounter date - tagging date). However, individually tagging goslings at hatch can be both time-consuming and expensive, and the encounter rate of tagged goslings can be very low in large populations or populations where there is significant spatial dispersal after hatch. In such cases, some researchers have made use of the 9th primary as a surrogate for "true age". In this study, we examine the utility of using the 9th primary as a measure of gosling age, using the large dataset of known-age snow goose goslings from La Pérouse Bay. We show that 9th primary is the best univariate index of gosling age among typically measured morphometric characters, and in fact is also generally better than multivariate indices. However, while seeming to suggest that 9th primary length may be our best solution to the problem of ageing goslings without web-tags, there are significant biases which can (and do) occur under normal use of this metric. We discuss the magnitude of these biases, and show that in some cases, they may be sufficient to obscure potentially interesting differences in gosling growth rates.

POSTER - FRIDAY - 20:00

BACK TO THE FUTURE: AGE OF FIRST BREEDING AND ENVIRONMENTAL CHANGE - METHODS AND RESULTS

COOCH, EVAN G. Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia, CANADA

'At what age to start breeding?' is a question fundamental to analysis of life history evolution. While there has been considerable effort focused on the theoretical aspects of age of first breeding, comparatively little work has been done on the problems of estimation of recruitment rates in wild populations. Most studies to date have relied on ad hoc methods which rely on one or more assumptions which may be generally untenable. Recently, it has been suggested that mark-recapture analysis can provide a robust statistically formal approach for analysis of age of recruitment, by using 'reverse capture-histories' to estimate the probability of entering the population over a given interval. This approach was applied to data from the arctic-breeding lesser snow goose, using data from a long-term study at La Pérouse Bay. I tested the hypothesis that recruitment rate in this species was influenced by structural size, which is know to be significantly influenced by early growth conditions. Since arctic-nesting geese rely heavily on endogenous nutrient reserves for reproduction, structurally smaller birds may be less able to recruit at a young age than larger birds. However, despite significant long-term changes in body size, and significant annual variation in recruitment rate, we found no evidence of correspondence between the two at La Pérouse Bay. However, it should be noted that it is important to differentiate between 'age of first breeding' and 'breeding propensity'. The former is an irreversible state-transition, while the latter is a probabilistic event conditional on the former having occurred. While there is no strong evidence that body size influences the age at which snow geese start to breed, this does not preclude size-dependent variation in subsequent breeding propensity.

ORAL - FRIDAY - 13:45

THERE AND BACK: INTRASEASONAL MOVEMENT PATTERNS OF SNOW GEESE IN THE FRASER-SKAGIT

COOCH, EVAN G. Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia, CANADA

EBBINGE, BARWOLT S. DLO-Institute for Forestry & Nature Research, Department of Aquatic Ecology, Wageningen, THE NETHERLANDS

BOYD, SEAN. Pacific Wildlife Research Centre, Canadian Wildlife Service, Delta, British Columbia, CANADA

Snow geese in the Western Flyway winter predominantly in the Fraser-Skagit region, and the Sacramento Valley in California. We examined the seasonal movement patterns of snow geese wintering in the Fraser-Skagit population using multi-state mark-recapture models applied to annual observations of neck-collared geese. To eliminate the confounding problems of collar loss, we conditioned our analyses on birds known to have been in alive in subsequent years. Extreme early season movements (October 5-15) consisted primarily of a large efflux of birds through the Fraser-Skagit to the Sacramento Valley. Remaining winter 'resident' birds were dichotomized between those which settled immediately on the Skagit River estuary, and those which settled immediately in the Fraser River estuary. Following initial settlement events, there was a increasing probability of movement of birds from the Fraser site to the Skagit site, with a comparatively smaller probability of movement in the opposite direction - birds which initially settled on the Skagit site tended to remain there, whereas birds which settled on the Fraser site showed a seasonally increasing tendency to move to the Skagit site. By mid-January, generally prior to the start of the spring harvest in BC, virtually all of the birds were in the Skagit sites. However, we suggest that this timing is coincidental, and not causal - the progressive departure of birds from Fraser to Skagit suggests it is not a threshold behavioural response to hunting seasons. Instead, we suggest that the movement patterns may reflect differences in historical use between the two sites. Such plasticity in what is often assumed to be a fixed behaviour (philopatry) are important from both theoretical and management perspectives.

SOME EXPLORATIONS OF A MATRIX MODEL OF CONSTANT HARVESTING - IMPLICATIONS FOR SNOW GOOSE CONTROL

COOCH, EVAN G. Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia, CANADA

LEBRETON, JEAN-DOMINIQUE. CEFE-CNRS, Montpelier, France.

COOKE, FRED. Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia, CANADA

Analysis of the effects of harvest on the dynamics of a population has been the subject of intense research for many years. However, much of this research has addressed situations where either (a) harvest rates were proportional to population abundance, and (b) all individuals in the population were treated as being of equal value. While proportional harvest may be a reasonable assumption for many species, it is probably not so for geese, where a good argument can be made for assuming a constant harvest. Constant harvest differs in many respects from a proportional harvest scheme - most notably in that the timing of a constant harvest leads to significantly different effects on population dynamics, whereas a proportional harvest is not affected by timing. Further, as first noted by MacArthur in the early 60's, sustainable harvest strategies must acknowledge that it is insufficient to focus solely on the number of individuals harvested - we must also consider the relative "worth" of individuals in the harvested sample. In age- or stage-structured populations, relative contributions to population growth are scaled by the reproductive value of a given class. We present the results of some preliminary explorations of a constant harvest model, using a matrix modelling approach. We show that the conditions for sustainable growth (or reduction) of an age-structured population subjected to a given constant harvest depend upon the (a) relative magnitudes of the starting population vector and (b) the current geometric growth, both weighted by the reproductive values of each age-class in the harvest vector. We discuss our findings in terms of strategies for reduction of expanding snow goose populations.

POSTER - FRIDAY - 20:00

MODELLING HERBIVORE - PLANT INTERACTIONS OF THE LESSER SNOW GOOSE: SOME INITIAL RESULTS

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Edelstein-Keshet (1989) outlined a general approach for studying the dynamics of plant-herbivore interactions. We applied the basic elements of this approach to assess how these dynamics might be affected if low to moderate levels of herbivory is beneficial to vegetative plant growth. Such a positive impact on plants has been shown clearly for the lesser snow goose (*Anser c. caerulescens* L.). We considered two forms of simple Lotka-Volterra models for predator-prey interactions, expressed in terms of a herbivore-plant system. We found that the dynamics ranged from stable limit cycles to globally-stable systems, depending primarily on the way in which the frequency-dependent effects of herbivores on plants were modelled. When the positive effects of herbivores on the vegetation is dependent on the amount of vegetation, locally-stable limit cycles are formed. In contrast, when the positive effects of herbivores on the vegetation is independent of the amount of vegetation, globally stable equilibrium are generally observed. While this suggests that a stable equilibrium between geese and plants might exist, the necessary conditions (foraging only within a defended area rather than grazing in a spatially random fashion) are unlikely to be met for snow geese, which do not exhibit territorial grazing behaviours during brood-rearing.

ORAL - THURSDAY - 17:00

VARIATION IN EGG TEMPERATURES IN ROSS' AND LESSER SNOW GEESE

CRAIG, LEA M. Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA

ALISAUSKAS, RAY T. Canadian Wildlife Service, Saskatoon, Saskatchewan & Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA

Variability in egg temperature may greatly influence incubation period. The structure of a bird's nest that insulates eggs can thus influence egg micro-climate while the incubating female is on or off the nest. Nest insulation of arctic-nesting geese has been shown to significantly affect cooling rates of eggs, with nests containing more down demonstrating a significantly slower rate. In addition, nest insulation may partially explain differences in incubation constancies between species, with more insulated nests built by species with lower constancies. Nest morphology, insulation and egg temperature fluctuations were studied in Ross' (*Chen rossii*) and Lesser Snow Geese (*Chen caerulescens*) at Karrak Lake, NWT in 1996 and 1997. A previous comparative study of nest morphology and insulation at Karrak Lake reported that Ross' Geese build proportionally larger and presumably more insulated nests which more closely fit clutch size. Species differences in nest morphology and insulation, and their affects on egg temperature fluctuations will be reported. In addition, the effect of temperature fluctuations on incubation length will be reported.

ORAL - THURSDAY - 14:30

NUTRIENT RESERVES OF SMALL CANADA GEESE NESTING IN THE CENTRAL CANADIAN ARCTIC

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ALISAUSKAS, RAY T. Canadian Wildlife Service, Saskatoon, Saskatchewan & Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA

Although arctic-nesting geese rely on nutrient reserves for reproduction, different species show variation in the extent to which nutrient reserves are supplemented with concurrent food intake. Small Canada Geese (*Brant canadensis hutchinsii-parvipes*) nest in the Central Canadian Arctic are at the northern limit of their breeding range, and thus may face greater nutritional stress during reproduction than other races of Canada Geese. We examined spatial and temporal variation in nutrient reserves of small Canada Geese to determine important sites for storage of nutrient reserves. From 19 April to 7 June, 1994, and 13 April to 16 June, 1995, n = 75 and n = 92 small Canada Geese were collected in respective years from agricultural areas in Prairie Saskatchewan, boreal forest wetlands on the North Arm of Great Slave Lake, and tundra staging and breeding areas on Victoria Island and Kent Peninsula. Although geese arrived in Prairie Saskatchewan with considerable reserves (indexed by abdominal fat) in one year, this area was very important for continued storage of fat reserves. Geese from the North Arm had fat reserves similar to levels at departure from Prairie Canada, although a significant difference between years appeared related to annual differences in the rate of storage on the Prairies. In both years, fat reserves declined from Great Slave Lake to pre-nesting staging areas on tundra where comparatively low levels were maintained until initiation of egg laying. Thereafter, egg production resulted in diminished fat reserves. Protein reserves (indexed by breast muscle mass) increased somewhat from the prairies until staging in the North Arm, but declined thereafter presumably as a result of egg synthesis. These preliminary results suggest that fat storage in Prairie Canada is critical for subsequent reproduction. Once these birds depart boreal wetlands, they enter negative energy balance. Nevertheless, fat stored before and after arrival on the Prairies provides small Canada Geese with an energy supply to reach breeding areas, and with nutrients to synthesize eggs.

EFFECTS OF LANDSCAPE ON NEST SITE SELECTION AND NEST SUCCESS IN ROSS' AND LESSER SNOW GEESE

DANIELSON, JEFF R. Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA

ALISAUSKAS, RAY T. Canadian Wildlife Service, Saskatoon, Saskatchewan & Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA

Arctic-nesting geese rely heavily on nutrient reserves for reproduction. Any excess use of these reserves before egg-laying can lead to a decrease in nest success, or in extreme cases, total nest failure. Two factors that might contribute to excess use of reserves in arctic-nesting geese are microclimate and snow melt. Nest sites of small birds are often associated with favourable microclimatic conditions. Also, timing and pattern of snow melt between years can affect nest success of arctic-nesting geese. The influence of landscape then becomes important because it can affect microclimate directly and influence spring snow melt. A study to determine if landscape influences nest site selection and nest success in Lesser Snow Geese (*Chen caerulescens caerulescens*) and Ross' Geese (*Chen rossii*) was conducted in 1997 at Karrak Lake goose colony, NWT. A study area of variable terrain was selected and over 2,000 nests were found. Topography of the study area and location of all nests were determined using conventional rod and stadia survey methods. A habitat map and a digital elevation model of the area were created and snow melt was monitored until completion. Nest initiation date, species, nest measurements and success were determined for each nest. Goose nesting phenology and nest success will be compared between species and evaluated against variability in landscape using GIS.

HOW FAITHFUL TO THEIR MATE ARE RADIO-MARKED GREATER SNOW GEESE?

DEMERS, FRÉDÉRIC & GIROUX, JEAN-FRANÇOIS. Département des sciences biologiques, Université du Québec à Montréal, Montréal, Québec, CANADA

GAUTHIER, GILLES. Département de biologie and Centre d'études nordiques, Université Laval, Ste-Foy, Québec, CANADA

It is generally agreed that all species of Anserini are faithful to their mate and are paired for life. Preliminary results based on 60 female Greater Snow Geese captured on the breeding grounds in individual families and marked with radio-collars indicated that only 53% remained with their original mate during the first year. Repeated observations of these birds revealed that 26% were alone and 21% were paired with a new male. The objective of our study is to further document the status change of the marked birds and to explain why any changes occur. Is it because Greater Snow Geese are intrinsically less faithful to their mate than other species? Are these changes caused by modification of the behaviour associated with the radio collar, mass capture on the breeding grounds or by other factors such as disturbances caused by repeated scaring of the birds on farmlands or hunting activities? Or is it simply related to the death of the mate? In addition to the 60 birds marked in 1996, 71 other females were captured in family groups in August 1997 on Bylot Island and fitted with a radio fixed on a neck collar (55 g) while their mate received an individually-coded neck collar (22 g). These birds will be tracked during their fall and spring staging along the St. Lawrence River, as well as on the breeding grounds next summer. Every time a bird is sighted, its mating status is determined and focal observations are conducted during 30-min bouts to establish activity budget. Females with standard neck collars and control unmarked birds are also observed to establish comparative time budgets. Any disturbance affecting the flocks in which the marked birds are found is also noted.

POSTER - FRIDAY - 20:00

HABITAT MONITORING OF WEST HUDSON BAY, NORTHWEST TERRITORIES

DIDIUK, ANDREW. Canadian Wildlife Service, Saskatoon, Saskatchewan, CANADA

CASWELL , DALE. Canadian Wildlife Service, Winnipeg, Manitoba, CANADA

The Canadian Wildlife Service has been assessing coastal wetland habitat along the west coast of Hudson Bay since 1985 based on ground investigations and habitat mapping using LANDSAT TM satellite imagery. The entire coastal plain from the Manitoba/ NWT border to Dawson inlet, approximately 2000 square kilometres, has been subject to habitat change. An original inland vegetation community of low shrub tundra, a mosaic of dwarf shrubs and wet fen vegetation, has been altered to vast expanses of exposed sedge peat where fen vegetation is no longer present. Expansive moss carpets have developed in areas of impaired drainage. The degree to which sedge and grass turfs along the immediate coastline have been damaged or destroyed is not known. The role of snow goose foraging, in conjunction with the potential effects of other factors which may be altering moisture regimes in the area, will be discussed. In 1997 an cooperative habitat monitoring program with the Arviat Hunters and Trappers Association was initiated to complement ongoing investigations at more southerly nesting areas. Future habitat mapping, assessment and monitoring programs by the Canadian Wildlife Service, involving ground and satellite-based investigations, across the eastern arctic are proposed.

ORAL - SATURDAY - 15:45

GOOSE PRODUCTIVITY AND BROOD DISTRIBUTION ALONG THE WEST HUDSON BAY COAST, NORTHWEST TERRITORIES

DIDIUK, ANDREW. Canadian Wildlife Service, Saskatoon, Saskatchewan, CANADA

RON BAZIN, WARNER, KEITH & CASWELL, DALE. Canadian Wildlife Service, Winnipeg, Manitoba, CANADA

The Canadian Wildlife Service has been assessing brood distribution and productivity of lesser snow geese and Tall Grass Prairie Canada geese along the west coast of Hudson Bay, NWT since 1987. Helicopter surveys along east-west transects, and along the immediate coastline, are conducted in late July to estimate numbers and determine the spatial distribution of broods. Snow goose broods continue to disperse inland to sedge fens but up to 40% of broods remain within 1 km of the coastline. Specific portions of the coastline have large numbers of Canada goose broods. Since 1994 the number of white geese has increased north of the Tha-ane River which may represent the rapid increase in Ross' goose nesting in this area.

ORAL - SATURDAY - 16:00

AN ALLOMETRIC PERSPECTIVE ON THE FEEDING ECOLOGY OF WATERFOWL

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VAN EERDEN, MENNOBART. Wetlands Unit, RIZA, Lelystad, THE NETHERLANDS

Data on food intake rates and metabolizable energies of various food sources are scattered through the literature, and together with trials conducted by our team through the years when plotted against body mass reveal clear patterns. The quantification of the increasing fastidiousness with regard to food quality as body mass declines can provide insights on the constraints operating on dietary choice (for example the minimal body mass that can be supported by a diet of leafy material alone). The data base also allows quantification of the impact that food choice has on time budgets, and in particular the time savings entailed by utilizing seeds in preference to leafy material. These results help to explain why agricultural food sources are utilized preferentially by many goose species today. The critical question is whether these new foods provide the nutritional balance required, for example when geese acquire body reserves prior to migration and breeding. We will provide an interpretation of recent results indicating that this is not always the case (fat/protein balance). Scarcity of preferred foods may combine with short-term profitability of alternative sources to constitute a nutritional trap reducing changes of successful breeding.

ORAL - THURSDAY - 9:00

DISTRIBUTION AND ABUNDANCE OF GEESE WINTERING IN THE INTERIOR HIGHLANDS OF MEXICO, 1948-1997

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BENNING, D.S. Office of Migratory Bird Management, U.S. Fish and Wildlife Service, Denver, Colorado, USA

This paper summarizes winter goose aerial count conducted by the USFWS during the past 50 years in the Interior Highlands region of Mexico. This vast region covers >1,000 km from the US border southward below Mexico City and between the Eastern and Western Sierra Madre Mountains where most arctic geese (except Brant) winter in Mexico. Aerial surveys have been conducted during 30 Januarys between 1948 and 1997. This region includes >50 large water areas in 12 Mexican states. The White-fronted goose has the widest distribution. Lesser Snow and Ross' geese are most abundant in the Northern Highlands and Canada geese are scarce throughout the region. Habitat losses and alterations due to drainage , water diversions, and increasing human populations are adversely impacting some of the most important winter areas; other major wintering areas have already been lost or greatly reduced in value.

INDIVIDUAL QUALITY AND REGULATION OF INCUBATION BEHAVIOUR IN BLACK BRANT

EICHHOLZ, MICHAEL W., & SEDINGER, JAMES S. Institute of Arctic Biology, Department of Biology and Wildlife, University of Alaska, Fairbanks, Alaska, USA

We assessed the influences of climatic, environmental, and biological factors on nest attentiveness of female Black Brant (*Branta bernicla nigricans*). Within females, nest attentiveness varied significantly with time of day, precipitation, ambient temperature, incubation day, and incubation day^2. Among females, nest attentiveness was lower in 1992 (= 82%) than 1993 (= 87%) and increased with clutch volume and mass. Our results show that climatic, environmental, and biological conditions influence incubation behaviour in Black Brant. A significant positive relationship between nest attentiveness and mass controlling for variation in body size and clutch volume, suggests a trade-off between investment in the clutch and nest attentiveness, if nutrient reserves limit clutch size. Also, a positive relationship between nest attentiveness and clutch volume suggests substantial variation of investment in reproduction, associated with individual quality.

MIGRATION PATTERNS AND SURVIVAL OF CANADA GEESE STAGING IN INTERIOR ALASKA

EICHHOLZ, MICHAEL W., & SEDINGER, JAMES S. Institute of Arctic Biology, Department of Biology and Wildlife, University of Alaska, Fairbanks, Alaska, USA

We present preliminary results of a study determining the relationship between nutrient reserves and over-winter survival of Canada geese (*Branta canadensis parvipes* and *B. c. taverneri*) staging in interior Alaska. We also present data on locations of band returns and sightings of migrating and wintering Canada geese banded in interior Alaska. Mass controlled for variation in body size was used as an estimate of nutrient reserves. We found that a model including an estimate of nutrient reserves had a significantly better fit using AIC and chi-square goodness of fit tests, suggesting a positive relationship between nutrient reserves and apparent over-winter survival. Additionally, preliminary analysis of apparent over-winter survival suggests lower survival rates of these geese, than over-winter survival of most goose species. We also found Canada geese staging in interior Alaska migrate through central British Columbia and winter mostly in central Washington and Oregon East of the Cascade Mountains, while a smaller portion winter along the coast of Washington and Oregon.

POSTER - FRIDAY - 20:00

"BARLEY FOR BIRDS" - A COOPERATIVE WATER QUALITY, SUSTAINABLE AGRICULTURE AND WILDLIFE HABITAT ENHANCEMENT PROGRAM

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DAVISON, MIKE. Washington Department of Fish and Wildlife, Mount Vernon, Washington, USA

"Barley for Birds" is a multi-agency Sustainable Agriculture, Water Quality and Wildlife Habitat Enhancement Program. It was designed as a three year pilot program with funding provided by Ducks Unlimited, U.S. Fish and Wildlife, and Washington State Fish and Wildlife on a year to year basis through March 1996. The project commenced in 1993 when 12 local farmers planted 500 acres of Poco barley in 16 different fields following the harvest of an early summer crop. "Poco" barley is a patented 60-day, short-stature barley cultivar that functions like a regular cover crop with the added benefit of maturing by November 1st, thus providing valuable food for over-wintering waterfowl. Cover crops have a high potential for improving water quality by removing nitrates from the soil and reducing erosion. In this study the fields were analyzed for nitrate concentrations at time of planting and after the maximum amount of biomass had been produced and the uptake of nitrogen by the cover crop was complete. The fields were further analyzed for biomass and yield, soil type, soil tilth, organic matter, water infiltration and weed suppression. Waterfowl usage was tracked for species, number of birds , length of stay, timing of use, and direction of flight into and out of the fields to assess the program's value to wildlife. The first year, 500 acres of Poco barley produced 450 tons of grain for an average of 0.9 ton/acre and sustained thousands of waterfowl throughout the winter. More than 30,000 ducks, geese and swans gathered in a single field. This gave the Washington State Department of Fish and Wildlife an opportunity to evaluate the age ratio of the Skagit swan population with 98% in the field. The barley fields provided the birds with food from the middle of October until the 1st of March. Planting barley fields throughout the Skagit delta helped redistribute birds between several Northern Puget Sound estuaries. This cover crop also provided improved water quality by uptake of approximately 30 tons of nitrate nitrogen and improved soil quality by replacing organic matter. Barley for Birds is now in its fifth year with 1000 acres of barely and winter wheat.

POSTER - FRIDAY - 20:00

FACTORS INFLUENCING INDIVIDUAL VARIATION IN REPRODUCTIVE INVESTMENT IN CACKLING CANADA GEESE

ELY, CRAIG R., FOWLER, ADA C. & BABCOCK, CHRISTOPHER A. Alaska Biological Science Centre, U. S. Geological Survey, Anchorage, Alaska, USA

We present data on reproductive investment of female cackling Canada geese (*Branta canadensis minima*) to test several hypotheses concerning factors influencing clutch size and egg size relationships in waterfowl. Clutch size varied significantly among years. Additive genetic variance, as determined from repeatability estimates, explained most (> 60%) of the variation in egg size, but little (< 20%) of the variation in clutch size. Clutch size and egg size were both positively correlated with female age. We hypothesized that evidence of an investment trade-off between egg size and clutch size would be manifest in a platykurtic distribution of total clutch volumes for a given clutch size. Although there was substantial overlap in clutch investment relative to the number of eggs laid, the distributions of clutch volumes within a given clutch size were normally distributed. Cackling geese invest a relatively large amount of energy in eggs (total clutch volume) compared to other northern-nesting geese. We examine the relationship between female body size and clutch investment, and discuss the importance of foraging during the prenesting and nesting period on reproductive investment.

ORAL - THURSDAY - 12:00

TIMING OF WING MOULT AND PRIMARY GROWTH RATES OF CACKLING CANADA GEESE ON THE YUKON-KUSKOKWIM DELTA, ALASKA

FOWLER, ADA C. & CRAIG R. ELY. National Biological Survey, Alaska Science Centre, Anchorage, Alaska, USA

We studied the timing of moult and ninth primary growth rates in adult Cackling Canada geese (*Branta canadensis minima*) with goslings between 1990 and 1997 on the Yukon-Kuskokwim Delta in western Alaska. Timing of moult in adults varied annually but there was no difference between brood rearing areas. There was no correlation in timing of moult between members of a pair nor was there any propensity for one sex to moult before the other. On average both members began moult about the same number of days after hatch. Timing of moult by adults maybe be influenced by the benefits of retention of flight capability for gosling protection. By staggering moult, adults reduce the overall time period that both members of the pair are flightless. Additionally, condition of adults may influence the ability to re-grow primaries after hatch. Other investigations of arctic-nesting geese and swans have suggested that sex-related differences in the timing of wing moult maybe constrained by length of season, clutch/brood size, and brood defence. Further studies should emphasize questions of annual differences in timing of moult and the effects of other factors, such as forage quality and age, on timing of moult.

POSTER - FRIDAY - 20:00

AGE AND BREEDING SUCCESS IN DARK-BELLIED BRENT GEESE

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Age-specific breeding propensity and age-specific breeding success are important parameters in the life history of a bird species. In some species of Arctic-nesting geese, both breeding propensity and breeding success have been shown to increase during the first years after sexual maturity (typically at ages 2 through 4); the costs of first time breeding may be higher for younger birds than for birds that defer breeding, as was demonstrated in Snow Geese. Reduced breeding success at very high ages, which may be due to breakage of pair bonds, environmental degradation or true senescence, has been shown in Snow Geese and Barnacle Geese. We investigated age-related breeding success in Dark-bellied Brent Geese which breed on the Taymyr Peninsula in northern Siberia. Due to the scarcity of data on known-age marked individuals on the breeding grounds, we have no information on age-specific breeding propensity; only breeding success, as measured by observing marked individuals and their offspring on the wintering grounds, could be evaluated in relation to age. Most birds first breed successfully when they are 3 years old; however, this is largely due to the fact that successful breeding years for the population as a whole are related to peaks in the lemming cycle on Taymyr, which almost always occur 3 years apart. Thus, most birds hatch in good breeding/lemming peak years and encounter the next good breeding/lemming peak year, and thus the first good chance to breed successfully themselves when they are 3 years old. However, the small group of Brent Geese which happen to be 2 years old in a lemming peak year seem to breed just as successfully as older birds do. Thus, there is no evidence for delayed maturity or age specific breeding propensity in Dark-bellied Brent Geese 2 years or older. In the unpredictable high-arctic environment of this goose population where favourable breeding seasons are relatively infrequent, selection pressure to breed already at age 2, if the season permits it, may be particularly high. We could not detect reduced breeding success in old individuals (> 10 years) as compared to younger birds. However, data for this analysis were sparse, and effects may have remained undetected.

ORAL - FRIDAY - 11:30

THE SUMMER THAT NEVER WAS: A CIRCUMPOLAR PERSPECTIVE ON THE 1992 BREEDING SEASON

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BOYD, HUGH. Canadian Wildlife Service, Ottawa, Ontario, CANADA

In 1992, many biologists doing field work in the Arctic experienced a very bad summer: snow melt was late, birds arrived and started to breed later (if they started at all), temperatures stayed low throughout the season, and breeding success in many species of waterfowl and shorebirds was very low. The persistent cold also changed the distribution of some species. It became clear only in retrospect that this experience was shared by many field worker at a large number of study sites throughout the Arctic that summer. While bad weather and resulting breeding failures on a local or regional scale are a common phenomenon in the Arctic, a bad year affecting (almost) the entire Arctic is quite unusual. With a view to potential global climate change, I am attempting to make use of this unusual summer to explore the different ways in which unusually adverse weather conditions can negatively affect breeding success in arctic waterbirds. I have asked biologists who were in the field in the summer of 1992 how their data on various breeding parameters compared to other years. I will present an overview of results relating to spring phenology, timing of breeding, predation, various measures of breeding success, and other parameters.

POSTER - FRIDAY - 20:00

THE FALL MIGRATION OF GREATER SNOW GEESE TRACKED BY SATELLITE

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Greater Snow Geese breed in the Canadian High Arctic and winter along the Atlantic coast of the United States, a distance of about 4000 km. Approximately 5-6 weeks elapse between the departure of the birds from their breeding grounds and the first known staging area along the St. Lawrence River in Québec. The objective of our study was to determine the location and the frequency of stops as well as the route used by snow geese during their fall migration. In August 1995, 11 males were fitted with a Telonics ST-10 PTT fixed on a neck collar (99 g); a vertical antenna extended downwards. The geese captured on Bylot Island weighed 2650-3200 g and the transmitter represented 2.9-4.1% of body mass. All transmitters operated on a 90±6 sec repetition period and a duty cycle of 16 h off and 8 h on. Five birds travelled from the Arctic to the St. Lawrence River (2800 km), among which, four successfully completed their migration to the wintering grounds (1000 km further south). For two other birds, movements stopped in northern Quebec after 1400 and 1560 km, respectively. They may have died or lost their PTT because the radios continued to transmit. The four remaining birds did not leave Bylot Island and the radios were recovered the following summer. These birds may have died from direct or indirect effects of the transmitter, either from exhaustion or predation. To characterize the migration pattern, we used locations with LC (0, that is with an accuracy of approximately 10 km. We first computed the distance moved between successive days and categorized each day either with migratory movements (>20 km) or with local movements ((20 km; staging). A migration bout was established as a series of consecutive days with migratory movements. The migration pattern consisted of 8-10 (8.8±0.4) bouts lasting 1-5 (2.1±0.1) days with intervening staging periods lasting 1-7 (2.8±0.1) days. After the initial departure from Bylot Island, the geese started and ended their migration with two long flights (> 1000 km) with 5-7 shorter ones(20-300 km) in between. From Bylot Island, the geese flew straight south, crossed Baffin Island and then followed the north-east shore of Foxe Basin to the Ungava Peninsula where they staged several days at a few inland sites. Upon reaching the tree-line, they flew within a corridor between 72° and 74°W of longitude to the St. Lawrence River. The flight to the Atlantic coast was made overland through the New England states.

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CAN GREATER SNOW GEESE BE KEPT AWAY FROM VULNERABLE HAYFIELDS?

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The main problem related to the demographic expansion of Greater Snow Geese so far is their impact on farmlands. Grazing by geese on hayfields during the spring staging period along the St. Lawrence River can result in production loss up to 25% for numerous farmers. As part of an integrated management plan started in 1997, set-aside lands (± 500 ha) located on private farmlands were established near roosting sites in the Montmagny area to concentrate the birds. Concomitant scaring of the geese from vulnerable hayfields located in the surrounding areas was also initiated. The objective of our study was to evaluate the use of these set-aside lands by geese and to compare the efficiency of two scaring devices. The first device, recently designed by a Quebec firm, was a 2-m high, wind inflated, bright yellow effigy of a hunter with arms moving under a light breeze. The other device was a propane canon (M-8 Multibang) that can fired 1-3 thunderclap explosions at regular intervals (4-6 min). At four sites, four treatments and one control were established in five 36-ha plots: the first treatment involved one canon, the second, five effigies, the third, a canon plus four effigies and in the fourth treatment, farmers were free to scare the birds as they wanted. No scaring was conducted in the control plot. All the plots and the set-aside lands were surveyed 2-3 times/day throughout the spring migration. Only 51% of the area in the set-aside land were covered by hayfields, the rest having been plowed the previous fall since the implementation of the management plan did not start until late winter. Nevertheless, four of the five set-aside sites were used by geese with 15-45 birds/ha/survey on average. Monetary compensations (100%) will be paid to farmers for the loss of yield in the set-aside lands. Overall, 3723 goose-hours were recorded in the control plots without any disturbance compared to 719 in the plots with scaring by farmers, 515 for the plots with effigies, 143 for the plots with effigies and a canon and 61 for he plots with only a canon. Although no scaring devices was totally effective in keeping the geese away from vulnerable hayfields, the reduced use may be below the threshold required to obtain measurable losses.

ORAL - SATURDAY - 16:30

FORAGING TIME AND DIETARY INTAKE BY BREEDING ROSS' AND LESSER SNOW GEESE.

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We compared foraging times of female Ross' (*Chen rossii*) and Lesser Snow Geese (*Chen caerulescens caerulescens*) breeding at Karrak Lake, NT, Canada and examined variation due to time of day and reproductive stage. We subsequently collected female geese that had foraged for known duration and we estimated mass of foods consumed during foraging bouts. Female Ross' Geese spent more time foraging (mean1SE=29.311.4; P = 0.0016), on average, than did female Lesser Snow Geese (23.111.4). Foraging time by female geese was greatest during prelaying (38.312.2) and declined significantly (P < 0.05) during laying (32.111.8) and incubation (8.211.2). Foraging time varied significantly (P = 0.0001) through the day, peaking during afternoons (12:00-16:00 h). Ross' Geese also spent a greater proportion of time feeding (83.012.8) during incubation recesses than did Lesser Snow Geese (60.913.6). Consumption of organic matter during foraging bouts was minimal; estimated consumption averaged 12.314.6 and 10.114.2 g (mean1SE) dry mass/day before incubation and 7.512.8 and 10.013.4g dry mass/day during incubation for Ross' and Lesser Snow Geese, respectively. Diets consisted primarily of Moss, Chickweed (*Stellaria spp.*) and Sedges (*Carex spp.*). Before incubation, eggshell consumption was estimated as 0.410.3 and 4.513.3g dry mass/day for Ross' and Lesser Snow Geese, respectively; neither species consumed eggshell during incubation. We conclude that use of eggshell from nests of previous years is likely an important source of dietary calcium to meet mineral demands of eggshell formation at Karrak Lake. Our findings of wide disparities between foraging time and food intake indicate that results from studies that do not directly measure intake rates should be questioned. Finally, we propose four hypotheses accounting for foraging effort that evidently yields little nutritional or energetic benefit to geese nesting at Karrak Lake.

ORAL - THURSDAY - 10:30

USE OF SUPPLEMENTAL FOOD BY BREEDING ROSS' AND LESSER SNOW GEESE: ANOREXIA AND BODY COMPOSITION DYNAMICS

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Recent research suggested that food eaten during laying and incubation played a greater role in supplying energy and nutrients to arctic-nesting geese than previously believed. We conducted food supplementation experiments with Ross' (*Chen rossii*) and Lesser Snow (*C. caerulescens caerulescens*) Geese to evaluate: 1) if supplemental food was consumed by laying and incubating geese, 2) how food consumption influenced mass dynamics of somatic tissues of breeding geese and 3) whether energetic constraints would cause smaller Ross' Geese to consume more food relative to their body size than larger Snow Geese. Quantity of supplemental food eaten by both species during laying and incubation was highly variable among individuals, with geese generally preferring corn to wheat and rice. Consumption of supplemental food during laying resulted in differences in overall body composition between control and treatment female geese, with treatment females completing laying at a greater mass and with more abdominal fat than controls. There were no differences in overall body composition between control and food-supplemented geese (both sexes and species) at the end of incubation, but treatment geese were heavier and had heavier hearts than controls. This suggests that treatment females did not rely to the same extent on metabolic adaptations associated with anorexia to meet energetic costs of incubation as did controls. Stable-nitrogen isotope analyses revealed patterns of protein maintenance during incubation consistent with metabolic adaptations to prolonged fasting. Finally, our prediction that energetic constraints would cause smaller Ross' Geese to consume more food relative to their body size than larger Snow Geese was not supported.

POSTER - FRIDAY - 20:00

LOOKING FOR GREENER PASTURES? - A DIFFERENT VIEW OF HABITAT SWITCHING DURING BROOD REARING

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Many animals exhibit ontogenetic shifts in food and habitat use as they increase in size. In geese, recent experimental evidence suggests that such shifts commonly observed during brood-rearing may be adaptations to both (a) differential nutrient requirements with increasing gosling size, and (b) changing capacity to process different food plants (both in the mechanical and physiological sense). However, it is an accepted paradigm of behavioural ecology that under conditions where state and time constraints to growth can be established, such shifts may also reflect an adaptive trade-off between growth and predation (or mortality) risk among habitat patches. In switching habitats, animals are often exposed to different growth rates and different predation pressures during different portions of their growth. Stochastic dynamic programming is a modelling approach very well suited to deriving optimality functions under time and state constraints (which are often not tractable both standard approaches), characteristic of life-history strategies in arctic nesting birds in general. We present the results of simulation analysis of a series of simple stochastic models, examining the optimal decision rules governing patch selection under differing growth and predation risk scenarios, using recent observations of long-term changes in patch selection among snow geese at La Pérouse Bay as a general reference. Traditionally, goslings were reared on the salt-marsh adjacent to the nesting area at La Pérouse Bay. In early years of the study, the entire brood-rearing period was spent on the LPB salt-marsh. As the salt-marsh has degraded through time, birds began to move from the traditional salt-marsh to novel areas exhibiting a variety of different food plant assemblages. Using dynamic programming, we show that variation in timing of intraseasonal patch transitions as observed at La Pérouse Bay is well-predicted by competing concerns of optimizing growth within a time constraint, and minimizing predation risks. We suggest that hypotheses concerning variation in patch selection while rely solely physiological constraints may be incomplete - expectations from simple competing risks models are in many respects equivalent, and may be a significant factor in intraseasonal patch selection dynamics. Interseasonal patterns over the long-term are probably more complex, requiring a frequency-dependent dynamic game approach. Our intent is not to rule out previously suggested explanations for patch selection, but rather to bring other potentially important factors into consideration.

PRODUCTIVITY OF DUSKY CANADA GEESE IN THE COPPER RIVER DELTA, ALASKA

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Understanding the factors limiting productivity of dusky Canada geese (*Branta canadensis occidentalis*) is of increasing importance as the population declines to near critical levels and managers exhaust options for harvest regulation. In 1997, we began a multiyear investigation to examine nest success, and gosling survival, to identify the relative importance of predators, and to document the incidence of renesting by dusky geese on their primary breeding area in the Copper River Delta, Alaska. Previous studies suggested that nest success and gosling survival in the CRD were very low and that canids (*Canis spp.*) and grizzly bears (*Ursus horribilis*) were important nest predators. Our preliminary results suggest that nest success is higher than expected and that gosling survival is very low. We also suggest that bald eagles (*Haliaeetus leucocephalus*) are important predators of adults, nests, and goslings. Furthermore, extensive renesting may inflate visibility correction factors used to estimate the size of the breeding population. We present a preliminary analysis of nest success and gosling survival based on data from 416 nests, 34 radio-marked adult females, and 63 radio-marked goslings monitored in 1997.

REVEGETATION TRIALS IN DEGRADED COASTAL MARSHES OF THE HUDSON BAY LOWLANDS

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Intense foraging (grubbing and grazing) by an exponentially increasing population of lesser snow geese (*Anser caerulescens caerulescens*) has led to the degradation of coastal habitats in the Hudson Bay lowlands. Fresh-water sedge meadows, dominated by *Carex aquatilis*, have become moss carpets as a consequence of shoot-pulling. Salt-marsh swards, dominated by the preferred forage of the geese, *Puccinellia phryganodes* and *Carex subspathacea*, have been transformed into hypersaline mudflats, largely devoid of vegetation. Revegetation of the mudflats is restricted to short-lived, weedy species characteristic of disturbed habitats and the successional clock continues to be reset every year. In an attempt to understand the potential for revegetation of these degraded areas, we are (1) conducting assisted revegetation trials whereby native graminoids are planted into mudflats or moss carpets, exclosed from geese, and treated with mulch and/or fertilizer, and (2) documenting the natural sequence of vegetation change following sward destruction in existing short and long-term exclosures. Results from the assisted revegetation trials, conducted over two growing seasons, indicate that the three native graminoids are capable of successfully establishing in the absence of foraging by geese. In the fresh-water areas, *C. aquatilis* tillers have established in the moss carpets and produced new vegetative shoots. In the salt-marsh, plugs of *P. phryganodes* and *C. subspathacea* have established and, in some cases, coalesced into a continuous mat of vegetation. The strongest treatment response on plant growth was the initial application of a peat-mulch treatment. Experiments indicate that, depending on the stage of the snow-free season, two properties of the mulch act to enhance growth: (1) its insulation properties and low albedo alter soil temperatures in a favourable way for establishment and (2) it retains soil moisture in a habitat where lack of water is evident during the growing season. Now that a vascular template has been established in these exclosures, subsequent changes in the plant assemblages will be recorded over time.

EFFECTS OF HABITAT AND SIMULATED DENSITY ON GOSLING GROWTH AND BEHAVIOUR IN PACIFIC BLACK BRANT

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Several species of arctic geese show declines in gosling growth rates associated with increased densities. First year survival is highly correlated with gosling growth. Thus, observed declines in gosling size at banding on the Yukon-Kuskokwim (Y-K) Delta can be considered a precursor to a subsequent decline in black Brant recruitment on the Y-K Delta. We conducted an experiment to study the effect of 3 simulated gosling density levels on growth and behaviour in two different habitat types used by broods from the Tutakoke River Black Brant (*Branta bernicla nigricans*) Colony, Y-K Delta. Simulated density levels were created by allowing goslings to graze a specific plot every 6, 9, or 12 days. We placed captured goslings in one of six treatment groups (3 grazing frequencies X 2 habitats). Goslings remained in a specific treatment group throughout the experiment. We placed goslings in the appropriate plot and allowed them to graze for 8 hours, every 3 days. At all other times goslings remained in pens on ad libitm food. We found gosling growth to be dependent on habitat type, grazing frequency, sex and forage availability. Proportion of time spent feeding also was correlated with grazing intensity, as well as age of gosling and time during a specific 8 hour trial. These data suggest the importance of further examining the link between brood rearing habitat, density of broods and the resultant gosling growth and survival rates.

THE INFLUENCE OF PRE-FLEDGING CONDITION ON BAND RECOVERY OF CANADA GOOSE GOSLINGS FROM AKIMISKI ISLAND, NORTHWEST TERRITORIES

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LEAFLOOR, JAMES O. Ontario Ministry of Natural Resources, Cochrane, Ontario, CANADA

Direct band recoveries for Canada Goose (*Branta canadensis interior*) goslings from the portion of the Southern James Bay Population breeding on Akimiski Island have declined markedly since 1987, and it is suspected that degradation of brood rearing areas is causing low survival. Goslings on Akimiski may be dying on the brood rearing areas from malnutrition or those able to leave are probably in poor condition and more vulnerable to hunters. Consequently, we examined the influence of pre-fledging condition (body mass corrected for capture date and structural size) on band recovery from 3,023 goslings (1529 males, 1494 females) that were banded during late July and early August of 1994 - 1996. Although the number of recoveries was low (70), mean condition of goslings that were recovered was higher than mean condition of non-recovered goslings in all year by sex comparisons. Separate binary regression analyses for each year by sex category showed a positive relationship in every case between condition and recovery probability . When years and sexes were combined, there was a highly significant ($P = 0.003$) positive relationship between condition and recovery probability indicating that only the goslings in good condition were being harvested by hunters. We also separately regressed condition on latitude of band recovery and date shot (Julian day) for goslings banded and recovered in the same year for each year by sex category but found no significant relationship ($P > 0.05$) in any of the models. Poor condition goslings would probably show up in hunter recoveries during early migration. But, on Akimiski Island, we suspect that poor condition goslings are not fledging in time to leave the island before the onset of fall migration and thus goslings have no opportunity to be recovered. Our results strongly suggest that goslings in poor condition are not being recovered because of poor growth during brood rearing. Thus, until there is an improvement in habitat conditions on brood rearing areas, direct recovery rates will likely continue to be low for Canada Goose goslings from Akimiski Island.

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THE INFLUENCE OF EGG VOLUME, HATCH DATE, BROOD REARING AREA, AGE, YEAR, AND SEX ON GROWTH OF PRE-FLEDGING CANADA GOOSE GOSLINGS ON AKIMISKI ISLAND, NORTHWEST TERRITORIES

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Since 1990, the portion of the Southern James Bay Population of Canada Geese (*Branta canadensis interior*) which nests on Akimiski Island has decreased from 16,360 to approximately 8,000 breeding pairs, a reduction of almost 50% (Leafloor et al. 1996). There is evidence to suggest that poor growth of goslings on the island, possibly due to degradation of brood rearing habitats by Canada Geese and Lesser Snow Geese (*Chen caerulescens caerulescens*), is contributing to poor recruitment. Two Canada Goose brood rearing areas were compared, as one area was located within the confines of an increasing Snow Goose Colony where both Canada Goose and Snow Goose broods fed in the same area, and the other brood rearing area was used by Canada Goose broods only. Analysis of body mass showed significant differences between the sexes as males were heavier than females, and goslings recaptured outside the Snow Goose area were 348.3 g heavier than goslings caught within the Snow Goose Area. Body mass decreased as hatch date advanced in 1994 and 1995, but in 1996 later hatched goslings attained heavier pre-fledging body mass than did early hatched goslings. As hatch date advanced goslings from large eggs increased in body mass while goslings from small eggs decreased in body mass. When body size was considered, males were larger than females and goslings attained the largest size in 1996. As hatch date increased, pre-fledging body size declined rapidly in the Snow Goose area but body size was constant in areas outside the Snow Goose area. Males of a given size were lighter than females, and goslings recaptured in areas outside the Snow Goose area were heavier than goslings caught within the Snow Goose area. Furthermore, corrected body mass of goslings hatching from small eggs rapidly declined with later hatch dates, whereas pre-fledging body mass of goslings hatching from large eggs remained relatively constant as hatch date advanced. Growth of ninth primary length, when corrected for body size, showed that male ninth primary was shorter than that of females, and differences among years indicated that goslings in 1994 had much shorter ninth primary lengths than did goslings from either 1995 or 1996. Ninth primary growth was also more rapid in the areas outside the Snow Goose area as compared to within the Snow Goose area. These results indicate that habitat degradation, particularly in the Snow Goose area, is greatly affecting the growth of Canada Goose goslings on Akimiski Island. Poor growth during pre-fledging is likely affecting the recruitment of individuals into the population.

ORAL - THURSDAY - 15:15

SURVIVAL RATES AND POPULATION SIZE OF MID-CONTINENT GREATER WHITE-FRONTED GEESE ESTIMATED FROM COLLAR SIGHTINGS

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The large harvest relative to the known population size and general uncertainties about the status of Mid-continent White-fronted Geese have led to a major neck-collaring and resighting program. The 40,000+ observations of >20,000 marked geese made from 1990 to 1997 potentially can provide good estimates of survival and population size as well as detailed information on fall - winter distribution of the geese required for the management of this population. Analyses of collar resightings using Jolly-Seber and related methods suggest a west to east cline in survival rates with geese from Alaska and the Canadian Western Arctic having lower survival rates than their counterparts from the Canadian Central Arctic. Annual survival estimates for Western Arctic and Alaska samples averaged about 70% and were similar to rates which caused some other populations of arctic-nesting geese to decline. Survival rates seemed to be influenced by the wintering ground affinities of the geese as well as their breeding area. This finding probably reflected regional variation in hunting pressure. Overall harvest rates (estimated from band recoveries) averaged <11% and did not appear to be unusually high. The estimated population size from the mark-resight data ranged from 868 thousand to 1.4 million and averaged 1.1 million over the six-year period. The mark-resight population estimates are about five times larger than those obtained from late winter aerial surveys which averaged about 200,000 in the late 1980s and early 1990s, and nearly twice as large as recent aerial counts of fall-staging white-fronts. Although the mark-resight estimates of population size seem to disagree with some of the aerial counts, they are consistent with recent harvest statistics. Based on our findings, as well as a review of historic and recent information on the breeding distribution of mid-continent whitefronts, we hypothesize that most of the recent growth of this population has occurred in the Central Arctic with the western segment of the population remaining relatively stable during the past decade.

PRODUCTIVITY OF ATLANTIC POPULATION CANADA GEESE: A PROGRESS REPORT

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Much attention has been focused on the status of Atlantic Population (AP) Canada geese since the sudden decline of their numbers in the late 1980's and early 1990's. In 1996, a multi-year research program was initiated to obtain information about this population, to identify factors which may have played a role in its decline and to propose measures to help bring about its rapid recovery. One aspect of the research consists of acquiring basic data on the productivity of the population. A pilot study in 1996 revealed that AP geese nest at sufficiently high densities, at least in parts of their range, to allow measurement of productivity from intensive ground studies. In May 1997 we began a full-season productivity study at a 35 km^2 site in the heart of the breeding range near Povungnituk, along the north-east coast of Hudson Bay. Additional data were collected at 7 secondary sites in a 200 km long north-south band along Hudson Bay, and at 2 sites in the eastern portion of the breeding range near Ungava Bay. Preliminary results show that 1997 production was very good. At the principal study area, mean clutch size (±se) was 5.0±0.1 eggs/nest and nest success was 82%. resulting in the production of 3.7 goslings per initiated nest (n=129 nests found during laying) or 4.2 goslings per successful nest (n=237). Nest density in the main study area was 8.4 nests/km^2. At secondary sites, mean clutch size was also high (4.4-5.0 eggs/nest) and mean (apparent) nest success was 74%. Helicopter brood surveys along transects perpendicular to the Hudson Bay coast showed a mean brood size (at about 4 weeks age) of 3.5±0.1 goslings (n=137) and a mean brood density over a large part of the northern Hudson Bay nesting grounds of 0.7 broods/km^2 (n=10). Mean brood size was similar farther east near Ungava Bay (3.6±0.3, n=94). Of 852 goslings marked in the nest with web tags, 216 were recaptured during banding drives in late July-early August; these data will be analyzed to study the movements, growth and survival of goslings. Snow cover was light in the winter of 1996-97 and mammalian predation may have been unusually low during the 1997 breeding season because of a reported die-off of arctic foxes during the previous winter. Only after several years of study will we be able to determine whether the excellent productivity of 1997 was characteristic of the population or an exceptional situation.

USE OF GPS FLIGHT TRACKING AND AERIAL VIDEOGRAPHY TO ASSESS CHANGES IN SNOW GOOSE DISTRIBUTION AND SNOW COVER IN SOUTH-CENTRAL ALASKA

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We assessed changes in lesser snow goose (*Chen caerulescens caerulescens*) distribution relative to snow cover on a migration stopover area in south-central Alaska, 1993-94. We flew aerial surveys at 1-4 day intervals during a 16-17 day study period in late April and early May. Snow goose distribution across approximately 170 km of coastline was assessed using Global Positioning System (GPS) flight tracking software. Snow cover in coastal wetlands was analyzed from video imagery obtained along a single flight line flown during each survey. We used ARC/INFO to divide the coastline into 128 2-km2 polygons and assessed percent snow cover and presence or absence of snow geese in each polygon for each survey. We observed 102 snow goose flocks during 7 surveys in 1993 and 191 flocks during 6 surveys in 1994. In both years, median flock distribution changed by approximately 75 km between the first and last surveys. Video imagery from 1994 has been analyzed although analysis of 1993 imagery is ongoing. Snow cover diminished along a north-south gradient during the study period in 1994 and influenced goose distribution on each survey ($P < 0.02$). Geese were most likely to use areas with 10-49% snow cover and least likely to occur in areas with no snow or >90% snow cover. Snow geese abandoned used areas shortly after snow melt and moved into areas where snow was still present. We examined phenology of forage plants following snow melt in 1995-97. Concentrations of acid detergent fibre generally increased and soluble carbohydrates diminished after snow melt. We cannot conclude that observed changes in goose distribution were a response to changes in forage quality. However, by exploiting habitats shortly after snow melt, snow geese were foraging on plants at a time when nutritional quality was likely high.

POSTER - FRIDAY - 20:00

HABITAT LOSS ASSESSMENT BY MULTI-TEMPORAL ANALYSIS OF LANDSAT DATA

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Since 1972, the LANDSAT series of satellites have been providing frequent, low-resolution, multi-spectral digital imagery of the surface of the Earth. Comparison of suitable images from the resulting long-term historic record has the potential to detect and quantify changes occurring in the land cover. This approach is especially valuable in the study of remote and inaccessible areas. As part of a larger study on the effect of dramatically increased lesser snow goose populations on the coastal ecosystems of the Hudson Bay region, remote sensing techniques - analysis of multi-temporal satellite imagery - were used to determine changes in the coastal vegetation between 1973 and 1996 at three snow goose breeding sites, La Pérouse Bay, Manitoba, the Seal River and Knife River delta, Manitoba and the North shore of Akimiski Island, North-West Territories. For each study site three cloud-free summer LANDSAT images, recorded about ten years apart were acquired in digital format. Calendar dates of the images of each set were selected as close as possible to each other. The three images were registered to a common geographic base, the UTM grid. Derived images enhancing vegetation density and vegetation change were produced with arithmetic and logical operations on the co-registered images. Difference Vegetation Index (DVI) or Normalized Vegetation Index (NDVI) images were generated from each image. These images are calculated as the difference between the near-infrared and the red values (DVI) or as the ratio of the difference and sum of the near-infrared and the red values (NDVI). In both DVI and NDVI images digital values are directly correlated to the amount of green vegetation. Low values correspond to little or no vegetation. Pair-wise differences between the DVI or NDVI images of different dates demonstrate the change in vegetation indices between the respective dates. Subtracting the earlier image from the matching later image yields new images, where low values correspond to a decline of the vegetation index, indicating loss of vegetation. These secondary images may also be normalized by dividing them by the sum of the two images. Long-term field observations of the extent, location and sequence of vegetation loss due to overgrazing by geese show close agreement with the results of the LANDSAT data analysis. Although no quantitative statement can be made with regard to the vegetation loss, the real extent of the vegetation decline between successive dates can be estimated by classifying the pair-wise difference images into vegetation loss and no change classes. Depending on the availability of archived imagery this approach could be used on all known snow goose breeding and staging sites in order to estimate habitat loss in the Hudson Bay region.

POSTER - FRIDAY - 20:00

AGRICULTURAL NUTIENT SUBSIDIES AND THE INCREASING MID-CONTINENT POPULATION OF LESSER SNOW GEESE

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In both Western Europe and North American, many populations of Arctic Breeding Geese (but not all populations) continue to increase. The reasons for the increase are complex and varied, and reflect changing conditions on both the breeding and wintering grounds. One species that has shown overall increase in North America is the lesser snow goose (Anser caeruslescens caerulescens). The Mid-Continent population of this species continues to increase at between 5% and 8% per annum. Although there are a number of factors that have contributed to this increase, we believe that the energy-nutrient subsidy derived from agricultural products is the major factor sustaining the high growth rate. This has r5eleased the population from density-dependent control processes on the wintering grounds and along the migration route. The nitrogen content of herbivores is about 8% of their body dry weight, whereas the corresponding value for plants is rarely above 3.5%, except in crop plants. Hence, herbivores must continually search for adequate supplies of nitrogen. Nitrogen fertilizer consumption in the U.S. increased from 0.5 million tons per year in 1949 to more than 11 million tons per year in 1980. In particular, total fertilizer use in the seven north central states around Iowa increased by over 2000 % between 1940 and 1955. Today the states of Wisconsin, Illinois, Iowa, Nebraska, Kansas and Texas account for nearly 50% of agricultural use of nitrogen fertilizer. Much of this is associated with corn, soybean and rice production - three of the four crops utilized by the Mid-Continent population of lesser snow geese. Corresponding changes in distribution of lesser snow geese in the continent have taken place during the same time period, with delayed fall migration, a general westward shift of migration and development of broader wintering range. Details of both agricultural changes and goose distribution changes are presented.

LONG-TERM LOSS OF INTER-TIDAL VEGETATION AND A DECLINE IN REMAINING ABOVE-GROUND BIOMASS: THE RESULT OF FORAGING ACTIVITIES OF GEESE

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LANDSAT imagery of the coastal habitats surrounding La Perouse Bay clearly indicates that there has been a substantial loss of vegetative cover during the last two decades - the result of the foraging activities of increasing numbers of lesser snow geese. In one of these habitats, the inter-tidal salt marsh, the loss of vegetation has been recorded annually since 1986 (or 1985) along 12 transects of total length 803 meters. In excess of 90% of vegetation cover either has been removed during this period, or else is now in an extremely poor state (basal cover < 20%). Loss of vegetation was particularly marked between 1989 and 1990. This coincided with very heavy use of the marsh by geese, as indicated by the index of abundance of goose droppings. Coincident with these changes there has been a decline in standing crop of salt marsh graminoids from in excess of 40 g m2 dry weight to less than 15 g m2 in recent years, where the geese have heavily grazed remaining patches of vegetation. These changes reflect not only the direct destructive foraging activities of the geese but also other deleterious biotic and abiotic processes that are coupled to their foraging activities via a positive feedback. They include the development of dried mats of cyanobacteria on sediment surfaces and hypersalinity of sediments in degraded sites, all of which are detrimental to plant growth. This represents a terrestrial trophic cascade and the desertification of the landscape.

POSTER - FRIDAY - 20:00

ON THE USE OF CAPTURE-RECAPTURE AND BAND RECOVERY DATA TO SIMULTANEOUSLY ESTIMATE PERMANENT AND TEMPORARY EMIGRATION

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HINES, JAMES E. Patuxent Wildlife Research Centre, U. S. Geological Survey, Laurel, Maryland, USA

Dispersal is an important component of the dynamics of arctic goose populations, affecting metapopulation demography, breeding probability, social behaviour, and gene flow. When birds are captured at all sites of interest, this dispersal can be monitored using multistate capture- recapture models (Brownie et al. 1993). When birds are captured at only one site, and hunter- recovered bands are also available, permanent emigration can be estimated using the method of Burnham (1993). When breeding birds are captured using Pollock's robust design, where there are multiple capture or resighting occasions within a short period of time, the methods of Kendall et al. (1997) permit the estimation of the proportion of the entire population that is present at the study site (e.g., breeding). We present a methodology whereby both permanent and temporary emigration probabilities are estimated simultaneously for a single-site study. This temporary emigration can be modelled as a Markovian process. Given the fact that arctic goose studies often entail multiple capture or resighting occasions for breeding geese within a season, we anticipate that this methodology will prove useful for estimating both the probability of dispersing to other breeding colonies, and the probability of moving between breeding and nonbreeding status. An additional benefit is the ability to test hypotheses about variability in these phenomena, including modelling the probabilities of permanent and/or temporary emigration as a function of pertinent predictor variables. Although developed for single-site studies, this methodology can be extended for the case where multiple sites are monitored but some parts of the metapopulation are not.

INVENTORY OF LESSER SNOW GEESE NESTING IN THE EASTERN CANADIAN ARCTIC IN 1997: HOW MANY IN THE HORDE?

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"Too many geese!" is now a popular cry in both the scientific and popular press, especially for the Mid-continent population of Lesser Snow Geese (*Anser caerulescens caerulescens*). Most of that population breeds in colonies in the Eastern Canadian Arctic, on the shores of Hudson Bay and Foxe Basin. In June 1997 we used large-format (23 cm) aerial photography and ground surveys to estimate the size of those colonies. Analyses conducted to date of the photos and related data have given the following estimates of total numbers of adult nesting birds by region: Baffin Island, in the colonies of Bowman Bay, Cape Dominion, Koukdjuak River and Taverner Bay = 1.61 million; Southampton Island, in the colonies of East Bay, Coral Harbour, Boas River and Ell Bay = 0.68 Million; West Hudson Bay, in the colonies of Maguse River, Wolf Creek, McConnell River and South McConnell = 0.16 Million. For the South Hudson Bay Region, our inventory included only the Knife River and La Pérouse Bay colonies, which totalled 0.07 Million nesting birds. K.Abraham and K. Ross, using visual transect counts from a helicopter, estimated that Cape Henrietta Maria and other colonies of South Hudson Bay included 0.5 Million nesting adults in June 1997. Thus the grand total for all colonies of the Eastern Canadian Arctic in 1997 was approximately 3 Million, which was almost triple the number there in 1979. The 1997 inventory gives solid support and justification to the current international concern about the "over-population" of Mid-continent Snow Geese.

USE AND DISTRIBUTION BY THREE SPECIES OF MOULTING GEESE IN THE TESHEKPUK LAKE AREA OF ALASKA'S ARCTIC COASTAL PLAIN

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Aerial surveys for moulting geese in the Teshekpuk Lake area of Alaska's Arctic Coastal Plain were made periodically from 1966 through 1978. A systematic aerial survey of 195+ lakes was established in 1976. This group of lakes has been surveyed annually since 1982. Three species of geese: Black Brant (*Branta bernicla nigricans*), Lesser Canada Goose (*Branta canadensis*), Greater White-fronted Goose (*Anser albifrons*), are the major cohorts of moulting geese in this area. During the 15 years of annual (1982-96) aerial surveys average use was Black Brant 46.4%, Canada Geese 34.4%, Greater White-fronted Geese 18.6%, and Lesser Snow goose 0.6% (not discussed here). Average population was: Black Brant 17,570; Canada Geese 13,000; and Greater White-fronted geese 7,024. Black Brant numbers represent approximately 1/5 of the continental population and have had an average annual increase of approximately 1%, whereas greater white-fronted geese have had annual increases averaging more than 6%. Canada geese have had a slight decrease in average annual population. Distribution has been similar throughout the period for Black Brant and Canada Geese, but has increased substantially for White-fronted Geese. Seventy-five percent of the Black Brant were found using 20% of the lakes and 75% of both white-fronted geese and Canada Geese were found on 16% and 17% of the lakes respectively.

RECENT CHANGES IN CANADA GOOSE AND WHITE-FRONTED GOOSE NUMBERS IN WEST GREENLAND

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Until recently the only common goose species breeding in west Greenland was the Greenland White-fronted Goose *Anser albifrons flavirostris*. However, for many years, small numbers of non-breeding Canada Geese *Branta canadensis* have been reported, especially from the Disko Bay area, although records further south were rare. Recent aerial survey results have shown a spectacular expansion in numbers of summering Canada Geese throughout West Greenland. Surveys of the same transect areas in 1992 and 1995 showed an increase from 514 to 1362 birds, with most dramatic increases towards the south of the range. In Isungua (67°05'N, 50° 30'W) in the southern part of the range, annual ground surveys of White-fronted Geese have revealed increasing Canada Goose numbers since 1988. Between 1988 and 1994, 10-20 birds, mainly non-breeders occurred in the area. Since 1995, more than 100 Canada Geese have been present, including several families. In the same period, White-fronted Goose numbers have decreased, especially the non-breeding element of the moulting population. In many areas traditionally used by breeding and moulting White-fronted Geese (from 1988 to 1994) only flocks of broods and non-breeding Canada Geese were found during the ground surveys of 1996 and 1997. It therefore seems likely that there is some interaction between the two goose species which, in the long term, could affect the Greenland White-fronted Goose population. Although the origin of these Canada Geese is not yet fully known, Canada Geese marked in Isungua in 1992 with neck collars have been reported on migration from Labrador, and in winter from New York, New Jersey and Pennsylvania. We urge that future research should focus on the possible interactions between the Greenland White-fronted Goose and the Canada Goose and that more emphasis should be put into ringing and monitoring programmes of these goose populations.

STATUS AND DISTRIBUTION OF PACIFIC BRENT GOOSE WINTERING IN JAPAN

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Seasonal abundance and distribution of Pacific Brent Geese *Branta bernicla nigricans* wintering in Japan were assessed by examining data collected on a monthly basis by the Japanese Association for Wild Geese Protection over six winters (1989/90 to 1994/95). Peak numbers of up to 4000 Brent Geese occurred at two sites in eastern Hokkaido each October. By January none remained in this area and only 300-500 stayed in Japan at wintering sites in southern Hokkaido and northern Honshu. An examination of data collected during an annual January census by the Environment Agency of Japan suggested that these numbers have changed little over the last 25 years and there is no evidence of a decline. In January and February 1995 we surveyed 717 km of coastline in northern Japan to try and locate the remaining population, but found only another 162 individuals. We speculate that the majority of Brent Geese wintering in north-east Asia migrate from eastern Hokkaido to sites in the Korean peninsula and in China, although during a 7 day survey of the southern coastline of Korea in January 1996 we found only 19 Brent Geese.

ORAL - SATURDAY - 14:00

ENVIRONMENTAL EFFECTS ON BODY SIZE OF CANADA GEESE

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Canada Geese (*Branta canadensis interior*) nesting on Akimiski Island, Northwest Territories and those nesting on the Ontario mainland south-west of James Bay share a common wintering range, and are considered to be part of the same population, but differ significantly in size (e.g., skull length of mainland birds averaged ca. 8% longer than that of Akimiski birds). We collected eggs in each area and raised the goslings in a common environment to determine environmental effects on differences in observed size traits in wild birds. We found no differences in asymptotic size or growth periods for skull, culmen, and tarsus length among birds from different origins ($P > 0.05$). Estimated asymptotes for skull length of captive goslings were larger than those of adults from Akimiski Island, and were similar to those of mainland adults. Captive goslings from Akimiski Island had structural measurements that averaged 8-17% larger than those of wild goslings of the same (known) age caught on Akimiski Island the same year These results suggest a significant environmental component to observed differences in body size between insular and mainland populations in southern James Bay. We suggest that lower per capita food availability explains the smaller size of Canada Geese on Akimiski Island, and that size differences between island and mainland birds have been maintained by high rates of natal philopatry to both areas.

ORAL - SATURDAY - 10:45

GENE FLOW IN THE BLACK BRANT METAPOPULATION: CONTEMPORARY AND GENETIC EVIDENCE

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We studied dispersal among breeding colonies of Black Brant by observing marked individuals (n = 20,147) at 7 colonies (1986-1994) and analyzing mitochondrial DNA (mtDNA) collected from 54 goslings hatched at 3 colonies. Probability of breeding and natal philopatry was female biased. Probability of breeding philopatry was high, exceeding 0.90 in all years. We observed an age related increase in natal philopatry of females, which was related to an increase in breeding probability. For females, probability of natal philopatry was negatively related to breeding density. Studies of breeding propensity and evidence from moulting areas suggest that density-dependent declines in natal philopatry of females are explained by an increased probability of nonbreeding or extreme delays in age of first reproduction rather than an increase in gene flow among colonies. We found no effect of density on natal philopatry of males and only weak evidence that natal philopatry of males increased with age. Probability of natal philopatry for males was similar to that predicted under a model with random pairing among colonies, suggesting extensive inter-colony mixing during the period of pair formation. Preliminary phylogenetic analysis of sequence data for mtDNA control region indicates no geographic structuring. Lack of mtDNA differentiation may indicate recent expansion from a common matriarchal gene pool or extensive gene flow among colonies.

ORAL - SATURDAY - 10:30

THE DIFFERENCES IN NESTING ECOLOGY OF TUNDRA BEAN GOOSE AND WHITE-FRONTED GOOSE IN NORTH-EASTERN COAST OF BARENTS SEA

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The nesting ecology of Tundra Bean Goose (*Anser fabalis rossicus*) and White-fronted Goose (*Anser albifrons*) were studied in Vaigach Island in 1986-1988 and in 1995-1997, in the southern island of Novaya Zemlya in 1994-1996 and in the northern part of Yugorsky Peninsula in 1995-1997. The investigations in 1994-1997 were financed by National Geographic Society. We examined 710 nests of Tundra Bean Geese and 150 nests of White-fronted Geese for the period of our work. The nesting ecology of those two species have both common and different features: both species are single nesting with the tendency to form small aggregations of nests. Those birds mainly prefer the same nesting and feeding habitats. Both of them have the same main enemy- the Arctic Fox that could substantially affect their breeding success in some years. Both species are also affected by unstable spring weather that could substantially delay the nest initiation of birds and lessen the productivity of their populations by lessening both the number of breeding individuals and their clutch and egg sizes. Tundra Bean Goose and White-fronted Goose have a statistically significant tendency to lessen their egg sizes in the direction from south to north within the area of our investigations. Both species are objects of hunting but nevertheless have a tendency of increasing their abundance for the period of our work. The species have however some different features of their ecology: the nesting of White-fronted Geese begins as a rule about 5-7 days later than nesting of Bean Geese. As a result the cold spring weather could affect their nesting in different ways. Also, because of the different time of nest initiation they could be differently affected by the Arctic Foxes. For example, in 1997 the foxes destroyed the geese nests mainly in early spring and the percentage of destruction of the nests of early nesting Bean Geese was about 50% while for the later nesting White-fronted Geese it was close to 13%. Both species as a rule use the same nesting habitats but White-fronted Geese prefer to nest more secretly and in the habitats with high vegetation (Dwarf Willow) and that also lessens the detection of their nests by Arctic Fox. The relative abundance of the two species nesting is different, too. There are not substantial differences in their abundance in the period of spring migration and in the time of nest initiation. However, the number of nests of White-fronted Geese are only from 3 to 20 % of the number of nests of Bean Geese. Only in a relatively small area (Gusinaya Zemlya, southern island of Novaya Zemlya) do the White-fronted Geese make up the majority of nesting geese (the number of nests of Bean Geese there are only about 4% of the number of nests of White-fronted Geese). There is a tendency for a relative increase of nesting White-fronted Geese compared to Bean Geese in the area of our investigation.

ORAL - THURSDAY - 14:45

DO THE NUMBER OF SIBLINGS AND DATE OF BIRTH CAUSE MEASURABLE DIFFERENCES IN FITNESS IN BARNACLE GEESE?

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Gosling growth varies between years and is correlated with the birth date of an individual and the brood size of the family in which the individual was raised. There is a strong correlation between gosling growth and final adult size, gosling growth and survival and adult size and reproductive success. All these correlations suggest a causal link between growth conditions in early life and fitness. Does this causal link really exist? First, I will examine the above correlations and present evidence on the causality by showing the effect of experimental manipulations of the number of siblings and hatch date. Secondly, I will quantify fitness of individuals which varied in the number of siblings and date of birth. The data are collected on the Barnacle Goose population breeding on Spitsbergen and wintering in Scotland. Because this population is well monitored on the wintering grounds, fitness parameters (both mortality and reproductive success) are known for almost all ringed birds.

POSTER - FRIDAY - 20:00

TEMPORAL AND GEOGRAPHIC DISTRIBUTION OF ATLANTIC POPULATION CANADA GEESE FROM SATELLITE TELEMETRY

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The Atlantic Population (AP) was once recognized as the largest wintering concentration of Canada geese in North America. Today, this population is closed to hunting in the U.S. and over much of its range in Canada. Excessive harvest combined with poor reproduction on northern breeding areas reduced breeding pair estimates from 118,000 in 1988 to 29,000 in 1995. Efforts to model the population dynamics of AP geese suggest that 25-35% of annual adult mortality occurs outside the fall/winter sport harvest period. This may be attributed to a combination of natural mortality, subsistence harvest by aboriginal groups in Canada, sport harvest associated with experimental seasons for Resident Population geese, and/or factors as yet unknown. We initiated a study of the spatial and temporal movements of AP geese to improve knowledge of these potential sources of mortality. Forty adult females were trapped primarily on breeding areas in northern Quebec and western Labrador during 1996 and 1997 and fitted with satellite transmitters attached by backpack harness. Each transmitter weighed 30 grams and had 1000 hours of battery life programmed to last for a complete annual cycle of migration. Time plots of migration pathways and movements on the winter and breeding range are mapped using GIS ARCVIEW software and data compiled from France's ARGOS satellite tracking system. All data are adjusted by algorithms designed to minimize location errors. Although the study is ongoing, these data already are allowing us to: 1) identify locations of potential spring and fall subsistence harvest, 2) distinguish winter range affiliations among different parts of the breeding range, 3) monitor winter movements of geese, including fall arrival and spring departure dates, as they relate to special hunting seasons for Resident geese, and 4) delineate western limits of the breeding range for geese that migrate through the North Atlantic maritime region.

ORAL - SATURDAY - 9:45

ESTIMATING THE CARRYING CAPACITY OF WETLAND HABITATS USED BY BREEDING GREATER SNOW GEESE ON BYLOT ISLAND (Northwest Territories, CANADA)

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The abundance of Greater Snow Geese (*Chen caerulescens atlantica*) has increased at an average annual rate of 8% over the past 20 years. As food availability on the arctic breeding habitats may become a limiting factor for geese in the near future, there has been increasing discussions on whether we should attempt to limit the population growth and at which level. The purpose of this project is to assess the carrying capacity of freshwater wetland habitats (main feeding habitats for goslings) for the Greater Snow Goose on the south plain of Bylot Island. Specific objectives are 1) to characterize and map the different types of wetland habitats on the south plain of Bylot Island, 2) estimate plant production and quality (in terms of metabolizable energy and nitrogen for the animal) of these habitats at several sites on the island, 3) assess the intensity of goose grazing in these various habitats and 4) compare all these values with total nutrient requirements of growing goslings. Based on previous studies, five different wetland habitats (wet polygon, lake polygon, polygon channel, stream bank and lake shore) were retained at seven sampling sites chosen following a preliminary mapping of the south plain of Bylot Island. These sites are characterized by a high density of wetlands patches such as tundra polygons and shallow ponds and lakes. Plant production was assessed in grazed and ungrazed (1X1m exclosures) plots. The most productive habitats in terms of above-ground graminoid biomass (*Dupontia fischeri, Eriophorum spp.* and *Carex stans*) were polygon channel (42g/m^2), stream bank (37g/m^2) and lake polygon (31g/m^2), all three characterized by the presence of permanent water nearby. However, the proportion of the landscape covered by suitable forage plants for geese varied considerably among habitats. It was highest in stream bank habitat (91% cover of suitable plants) and lowest in polygon channel (9% cover). The sites located on foreign drift (glacial deposits) with organic accumulation showed the highest plant production (42g/m^2) whereas sites located on littoral depot (marine deposits) had the lowest production (15g/m^2). Intensity of use by geese was estimated by the difference in biomass between paired grazed and ungrazed plots and by goose faeces counts. Grazing intensity was highest in stream banks (44% of biomass removed) and lowest in lake polygons (29% of biomass removed). The proportion of biomass removed by geese varied from 22% for the sites developed on foreign drift to 34% for the sites composed mostly of polygon fens. Detailed mapping of all these habitats on Bylot Island is still underway.

RESPONSE OF GOSLINGS TO REDUCED HABITAT QUALITY: A PHYSIOLOGICAL PERSPECTIVE

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Both goslings and adult geese are highly selective foragers that prefer plant foods containing more protein and less fibre than non-preferred foods. However, when habitat quality on the breeding grounds is poor, goslings especially may be forced to eat non-preferred foods. We raised Canada and Snow goose goslings on grass-based diets that differed in fibre content (30% or 50% NDF) and protein content (10%, 14%, or 18%) but not gross energy (17 kJ/g dry food). This range of diet quality is similar to the range of plant quality goslings may encounter in nature. Snow geese had higher protein requirements than Canada geese as indicated by reduced survival and growth rates of Snow geese on the 10% protein diets. Survival and growth rates of Snow goslings declined with increasing dietary fibre on the lower protein diets whereas survival and growth rates of Canada goslings were generally unaffected by dietary fibre. Thus, Canada goslings can apparently tolerate lower quality diets than Snow goslings. Goslings increased their food intake with increasing dietary fibre. The energetic gains realized by a gosling when it eats more depend, however, on how food intake affects digestive efficiency. Simple models of digestion predict that when food intake increases then digestion flow increases, and retention time decreases. Consequently, increased food intake will result in decreased digestive efficiency if there is no modulation of digestive features. In general, digestive retention time and digestive efficiency did not change with increased dietary fibre and the primary mechanism responsible was an increase in gut size. For migratory geese there are clearly limits to such an increase in gut size and this may represent the primary digestive constraint that determines the lowest quality of food eaten.

SURVIVAL OF YOUNG GREATER SNOW GEESE DURING THE FALL MIGRATION

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Long-distance migrants are often exposed to high mortality risks during their migration. The Greater Snow Goose (*Chen caerulescens atlantica*) migrates twice a year between its breeding grounds in the Canadian High Arctic and its wintering grounds along the mid-Atlantic coast of the USA, a journey of almost 4,000 km. In the Arctic, goslings have a limited time to complete their growth before departure for migration. We determined survival of young during the fall migration and factors affecting it in 3 successive years. Brood size of neck banded females was determined by visual observations at the end of the summer on Bylot Island (NWT), and two months later during the fall stopover along the St. Lawrence estuary (Québec), 3,000 km further south. Survival was estimated on two independent data sets: 1) for families observed both on Bylot Island and on the fall staging areas, survival was estimated by the difference in the size of individual families between the two sites; 2) for birds observed only at one site, survival was estimated by the ratio of average family size in Québec on average family size on Bylot Island. A large inter-annual variation in survival rate of young was found. The two methods yielded the following estimates: 0 and 12% in 1994, 51 and 57% in 1995 and 39 and 38% in 1996, respectively. The large discrepancy between the two methods in 1994 is likely due to the small sample size of birds observed both on Bylot and in southern Québec that year (N = 5). Even though some hunting mortality occurred during the fall period in Québec, this had only a slight effect on survival rate estimates. The lowest survival occurred in the year with the lowest body mass of young at the end of the summer. Although body mass was highest in 1996, survival was lower than in 1995. This could be related to a late fledging date that year (average fledging date in 1996 was about 4 days later than in 1994 or 1995). This suggests that fledging date and body mass at fledging can independently influence gosling survival during the fall migration. We will also examine the effect of weather conditions encountered during migration on survival.

ORAL - FRIDAY - 14:45

CHANGES IN AQUATIC AND TERRESTRIAL INVERTEBRATE POPULATIONS AS A RESULT OF THE DESTRUCTION OF VEGETATION TRIGGERED BY THE FORAGING ACTIVITIES OF GEESE

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Foraging (grubbing and grazing) by lesser snow geese (*Anser caerulescens caerulescens*) has led to the destruction of inter-tidal salt-marsh swards and the death of willow bushes in the supra-tidal marsh at La Pérouse Bay. A decline in the abundance of breeding populations of some bird species (stilt sandpiper, semipalmated sandpiper, northern shoveler, American wigeon) may be linked to low availability of invertebrates in areas devoid or nearly devoid of vegetation. Collections of aquatic invertebrates were made from ponds from degraded and intact areas in the supra-tidal marsh. All ponds dried out by early August, but ponds from degraded areas dried out earlier than those in intact areas. The highest salinities and lowest redox sediment values were found in ponds from damaged areas. The benthic macroinvertebrate assemblages showed shifts in group representation. Snails (Gastropoda) and worms (Oligochaeta) were the dominant benthos in densely vegetated intact ponds. Snails were completely absent from ponds in degraded areas. Midge larvae (Diptera: Chironimidae) preferred more open vegetated ponds, and small copepods (Copepoda) dominated degraded ponds. Both snails and chironomids are major food sources for duck species such as the northern shoveler and American wigeon. Collections of terrestrial invertebrates were made from an intact willow sward, a semi-degraded area composed of live and dead (or dying) willow bushes with patches of bare ground and grazed grassland, and a fully degraded site (all bare ground and dead willows) between June and late August, 1997 in the supra-tidal marsh. At each site, 100 yellow pan traps and 3 malaise traps were used to collect invertebrates. There were differences in both species assemblages and biomass between degraded and intact areas. With respect to the ground fauna, springtails (Collembola) and mites (Acari) dominated degraded areas, while spiders (Araneae) and beetles, particularly ground beetles (Coleoptera: Carabidae) and carrion beetles (Coleoptera: Silphidae), dominated intact swards. This shift in group representation is an important result with respect to food availability because springtails are minute insects that are difficult to capture because they are extremely quick. Many of the mites are likely unpalatable and even parasitic. With respect to the flying fauna, degraded areas were dominated by flies (Diptera) and there were few moths and butterflies (Lepidoptera), caddis flies (Trichoptera), and bees and wasps (Hymenoptera). Overall, we are seeing a decline in invertebrate diversity in degraded supra-tidal marsh areas at La Pérouse Bay, as well as potentially detrimental shifts in the abundance of certain organisms in both aquatic and terrestrial systems. These changes are an indirect consequence of the foraging activities of the lesser snow goose and may be linked to declines in breeding populations of other bird species.

POSTER - FRIDAY - 20:00

POPULATION DELINEATION AND WINTERING GROUND DISTRIBUTION OF MID-CONTINENT GREATER WHITE-FRONTED GEESE

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The mid-continent population of greater white-fronted geese nests from interior Alaska and the North Slope east to at least the Boothia Peninsula, Northwest Territories (NWT). Since the early 1980's, this population has been managed by the Central and Mississippi flyways as eastern and western segments. The western segment was defined as geese nesting from Alaska east to about Kugluktuk (Coppermine), NWT. They were believed to winter primarily in the Central Flyway in Oklahoma, Texas and along the east coast of Mexico. Eastern segment white-fronts included birds nesting from about Kugluktuk east to the Boothia Peninsula, and wintering in the Mississippi Flyway, primarily Louisiana and Arkansas. Preliminary data from banding in the 1980's near the common boundary of the two segments within the central Canadian arctic indicated that delineation of the mid-continent population into two segments was perhaps not appropriate. Thus, this population became the focus of a major international dark goose neckbanding program from 1989 - 1996, designed to test the reliability of the eastern and western segment delineations as a basis for management. With the support of government agencies, aboriginal groups, non-government and volunteer personnel, adult and young geese were marked with uniquely coded neckbands across the breeding range, and these were re-observed range-wide throughout the annual cycle. Analyses of neckband observations, by contouring total observations by week, yielded detailed fall migration and wintering ground distributions. The temporal and distributional patterns of these observations indicate that management of the mid-continent white-fronted goose population as two independent segments is inappropriate. Essentially all mid-continent white-fronts migrate through Alberta and Saskatchewan and down the east and west tiers of the Central and Mississippi flyways, respectively, mixing extensively on major fall staging areas in south-eastern Alberta and south-western Saskatchewan, and in the major wintering areas of Texas, Louisiana and Mexico. Almost complete mixing of birds from all banding areas occurs during winter. White-fronts tend to move from east Texas into Louisiana, particularly later in the season, but seldom from Louisiana to Texas; and from west Texas into Mexico. In Mexico geese winter primarily on the east gulf coast and the interior highlands. They over-lap with Pacific Flyway birds in the interior highlands. Further work will better define the overlap in Mexico and include an assessment of white-front distribution and movements within the Central and Mississippi flyways north of the major wintering areas. This information is essential to the current process of revising the flyway management plans for mid-continent white-fronted geese.

ORAL - SATURDAY - 11:30

COMPARING POPULATION SIZE ESTIMATORS FOR THE VULNERABLE TULE GREATER WHITE-FRONTED GOOSE SUBSPECIES FROM COUNTS, COLLAR OBSERVATIONS, AND RADIO LOCATIONS

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Tule greater white-fronted geese (*Anser albifrons gambeli*) comprise the smallest population of Arctic nesting geese in North America. Total count population indices have ranged from 6,860 in 1992 to 3,034 in 1994 and may be confounded by presence of other subspecies or visibility bias. Our concern about the accuracy of autumn counts led to a coordinated effort to determine the population size with other estimators. From 1995-1997, we captured tule geese in Alaska and California and attached neck collars and radio transmitters. Collar-marked geese (n = 100, 175, & 220) were resighted in September during 3 weekly observation periods of 2 days duration. Radio-marked geese (n=50, 45, & 40) were monitored during the same time periods on different days. The 1995 collar estimate of 5,450 was based on the Peterson estimate as modified to reduce bias using the hyper geometric model of Chapman in Seber. We used NOREMARK to determine the population estimate with radio-marked geese. The radio estimate of 6,286 individuals was higher than the collar estimate. We attempted a similar 3 technique survey in 1996 but due to early migration of other subspecies of white-fronted geese (*A. a. frontalis*) the collar observation and total counts surveys were incomplete. We discuss the accuracy, advantages and disadvantages of the 3 surveys. Production estimates varied between years and location. Summer Lake Wildlife Area in 1995 was 16.7% while Sacramento NWR was 30.0%, and Delevan NWR was 36.4%. Other white-fronted geese breeding in Alaska have increased over the last ten years, while the tule goose population has remained stable.

POSTER - FRIDAY - 20:00

GENETIC CHARACTERIZATION OF PACIFIC FLYWAY CANADA GEESE: ASSESSMENT OF SUBSPECIFIC CLASSIFICATIONS AND COMPOSITION OF ADMIXED WINTERING FLOCKS

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Several subspecies of Pacific flyway Canada geese (*Branta canadensis*) have recently exhibited changes in population status. Certain breeding locales, such as those of the dusky Canada goose (*B. c. occidentalis*), are experiencing declines from habitat loss and increased depredation, while others, like those in urban areas of Anchorage, Alaska, demonstrate increased productivity. Such changes in population trends, as well as the use of agricultural areas by admixed flocks of Canada geese in winter, necessitate sound management strategies on both breeding and wintering areas. Currently, seven subspecies of Canada geese are recognized and management relies heavily upon the unambiguous classification of breeding units and taxonomic status. While morphology and plumage coloration are useful in identifying subspecific characters, such measures may overlap across disparate geographic areas, be sensitive to environmental conditions, and can only be accurately assessed with a captured bird. Therefore, we used a series of nuclear microsatellite DNA markers and sequence data from a portion of the mitochondrial (mt) DNA control region to assess subspecific classification of Canada geese from samples collected on breeding areas in coastal and interior Alaska and Washington State. Some DNA was collected from feathers or egg shells at nest sites when birds were unable to be captured. We found significant geographic variation across the Pacific flyway complex using both nuclear and mtDNA markers. mtDNA sequence data clearly delineate large- and small-bodied subspecies. However, within the large-bodied class (*B. c. occidentalis*, *B. c. fulva*, and *B. c. moffiti*), we observed several mtDNA haplotypes to be shared among geographically disparate breeding areas of the Pacific coast. Nuclear microsatellite data show general concordance to currently recognized taxonomic classifications of all subspecies. Computer simulations using nuclear and mtDNA gene frequencies from each breeding population, permitted highly accurate identification of hypothetical wintering flocks composed of several subspecies. We find molecular markers to be very informative in understanding current subspecies distribution during the nesting season as well as identifying the composition of wintering flocks or even a single bird. Finally, the amplification of DNA from nest materials eliminates the need for capture and disturbance in some cases.

ORAL - SATURDAY - 11:15

FORAGE VARIATION IN BROOD REARING AREAS USED BY PACIFIC BLACK BRANT GEESE ON THE YUKON-KUSKOKWIM DELTA,ALASKA

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RUESS, ROGER W. Institute of Arctic Biology, University of Alaska, Fairbanks, Alaska, USA

Forage quality and abundance have substantial effects on secondary productivity and life history characteristics of geese. Because geese are capable of dispersal to areas where their fitness may be higher, it is important to understand spatial variation in net above-ground primary productivity (NAPP), as well as the availability of forage, its quality, and the responses of vegetation to grazing pressure. We investigated the effects of grazing by black Brant geese on *Carex subspathacea* lawns on the Yukon-Kuskokwim Delta, Alaska. We compared variation in growth and forage quality in both grazed and temporarily exclosed sites to determine responses of *C. subspathacea* to grazing at landscape scales within two nesting colonies that had experienced different population dynamics over recent decades. Landscapes differed in forage quality, grazing patterns, and in the effect grazing had on *C. subspathacea* forage characteristics. We found no effect of grazing on NAPP over a wide range of natural grazing intensities at the landscape scale. No differences in forage quality, NAPP, or response of *C. subspathacea* growth rates to grazing pressures could be detected between colonies. This suggests that goose grazing does not have deleterious effects on *C. subspathacea* in this ecosystem. It has been suggested that gosling growth rates are sensitive to seasonal declines in forage availability and quality. Spatial variation in forage quality and availability per sampled area exceeded seasonal variation in these characteristics and is likely to have dramatic effects on gosling growth and recruitment rates.

POSTER - FRIDAY - 20:00

INTERCONVERSION OF SEDGE ECOTYPES MEDIATED BY GRAZING: IMPLICATIONS FOR ECOSYSTEM CARRYING CAPACITY

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Along the coastal flats of the Yukon-Kuskokwim Delta of Alaska, black Brant geese maintain high quality grazing lawns of *Carex subspathacea*. Over recent decades we have observed increases in grazing pressure on the slightly more elevated *Carex ramenskii* wet meadow concurrent with increases in Brant populations. Grazing by Brant controls the growth form of *C. subspathacea* and *C. ramenskii* and we believe there was a loss of the already limited extent of the *C. subspathacea* community during the mid-1980's when goose populations on the Y-K Delta were much reduced. This likely resulted in a reduction in the extent of high quality forage such that density dependent effects observed in Brant are occurring at population densities lower than historic levels. We initiated the reversion of *C. ramenskii* dominated meadows by mowing and removing litter in nine 225 m^2 plots in an attempt to create higher quality forage that black Brant would (1) select as a forage sward and (2) maintain in a short morphology similar of that of their preferred forage *C. subspathacea*. Grazing intensity, as indexed by faecal counts, was higher on manipulated plots compared with both control and plots that were naturally being reverted to *C. subspathacea* ($P = 0.012$). Geese maintained manipulated swards in a morphology similar to *C. subspathacea* for two growing seasons since initial treatments. Naturally reverting *C. ramenskii* plots had higher faecal counts than control plots although we detected no annual variation in grazing intensity, or standing crop biomass in these naturally reverting plots. The latter is of interest because related experiments demonstrated *C. subspathacea* reverts to the taller morphology within two growing seasons, and when made re-available to geese is not grazed. The discrepancy of inter-conversion rates between the two ecotypes likely explains the density dependent effects being observed in brant at lower population levels than seen in the early 1980's. Our experiment suggests it is possible to manipulate large areas of *C. ramenskii* and expedite an increase in the carrying capacity of this ecosystem.

MOLECULAR STATUS OF ALEUTIAN CANADA GEESE FROM BULDIR ISLAND AND SEMIDI ISLANDS, ALASKA

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Aleutian Canada geese (*Branta canadensis leucopareia*) were nearly extirpated from the majority of their historical range after the introduction of non-native predators. By 1967, only one known breeding population (Buldir Island) of Aleutian Canada geese remained, prompting the U.S. Fish and Wildlife Service to list the species as endangered. In 1991, with an increase in population numbers from approximately 800 birds in the mid-1970's to 7000 birds and the discovery of two additional breeding populations (Chaguluk Island and Kaliktagik Island), the Aleutian Canada goose was reclassified from endangered to threatened. Continued recovery requires careful examination of population inter-relationships and of population levels of genetic diversity as delisting is considered. We used DNA analyses of six microsatellite loci and a 173 base-pair portion of the mitochondrial (mt) DNA control region to assess the degree of reproductive isolation and effects of bottlenecks in population size on Aleutian Canada geese from Buldir and the Semidi Islands (Kaliktagik Island). Genetic characteristics of cackling Canada geese (*B. c. minima*) from the Yukon-Kuskokwim Delta were compared to those of Aleutian Canada geese for perspective. Many microsatellite alleles and mtDNA haplotypes were observed in both *B. c. leucopareia* populations and *B. c. minima*. However, populations differed significantly in allele and haplotype frequency suggesting limited contemporary gene flow. The number of alleles and haplotypes differed among all populations reflecting population differences in magnitude and duration of population bottlenecks in size. No evidence of inbreeding was suggested. Genetic distances indicate Buldir and Semidi population are more-closely related to each other than to mainland *B. c. minima* geese supporting current theory that both the Buldir and Semidi Islands Canada geese are remnant populations of the previously more-continuously distributed island-nesting Aleutian Canada goose.

DECLINES IN BIRD SPECIES USING LA PÉROUSE BAY

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The coastal marsh and adjacent willow habitats in the La Pérouse Bay region of Hudson Bay and elsewhere have been degraded severely by processes related to heavy consumption of grasses and sedges by lesser snow geese. Large areas of once-productive coastal marsh now exist as bare, hypersaline soil, pockmarked with salt-tolerant plants (e.g. *Salicornia borealis*) and remnant stands of dead willows (*Salix spp.*). Inland stands of freshwater vegetation have been replaced by moss carpets or peaty areas mostly devoid of vegetation. More than a hundred species of birds are known to use the coastal habitat of this region for staging, feeding or breeding. An obvious question is: Are any of them suffering from this habitat damage? We evaluated a portion of the extensive bird list data from the long-term study at La Pérouse Bay. To minimize potential biases associated with this type of data, we restricted ourselves to only reliably identifiable species from an annual time period that maximized daily effort and involved overage of similar geographic areas. To ascertain whether declines were local phenomena or simply local expressions of more global phenomena, we included analyses of more global data where available. We present evidence of an overall decline in the population sizes of bird species from a range of habitats in the La Pérouse Bay region. We demonstrate specific decreases for American wigeon, northern shoveler, oldsquaw, red-breasted merganser, dowitchers, Hudsonian godwits, stilt sandpipers and parasitic jaegers. All but the last of these species depend on shallow, freshwater ponds and streams and their adjacent vegetation - habitats that have been particularly degraded at La Pérouse Bay. We have found no compelling evidence that these impacted species are declining at a more global level.

POSTER - FRIDAY - 20:00

INCUBATION BEHAVIOUR OF GREATER SNOW GEESE IN RELATION TO WEATHER CONDITIONS

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For species of birds nesting in a cold environment like the Arctic, the rhythm adopted by the incubating parent is important for optimal embryonic development. During two Nesting seasons, we documented daily and seasonal variations in incubation behaviour of Greater Snow Geese *Anser caerulescens atlantica* and examined the effect of weather conditions on recess frequency and duration. Incubation behaviour was inferred from variations in temperature recorded by artificial eggs added to clutches. Mean nest attentiveness during the incubation period was 91%. Females took 5 or 6 daily recesses which lasted about 23 minutes each. Recesses were more frequent, and of longer duration, in the afternoon than at night. Females were also less attentive to their nest as incubation progressed, a consequence of both an increase in recess frequency and in duration. Nest attentiveness increased abruptly about two days prior to hatching, reaching a high of 96% on the day of hatching. Weather parameters influenced movements away from the nests in 11 of the 12 females monitored. Females took more recesses when wind velocity was low and, to a lesser extent, when air temperature and solar radiation were high, but the response was quite variable among females. Although females seem to adjust their incubation behaviour in order to limit egg cooling, daily variations in risks of predation may also influence incubation rhythm.

ORAL - THURSDAY - 14:15

SWAN-GOOSE NATURAL HISTORY AND SYSTEM OF CONSERVATION IN RUSSIA

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Swan goose (*Cygnopsis cygnoides L*) is a monotypic relict genus and autochthon of the Priamurie. The species is endangered in Russia. Up to the middle of the 20th century, swan geese inhabited territories from the Zaisanskaya depression through the Transbaikalia, and the Amur river basin up to the Northern Sakhalin. In the south, they occurred in the Primorie, Manchuria, Mongolia. The species was characterized as "common" or "abundant" though already then it declined in numbers. Rapid decrease in number began in the 1950s. By the 1970s, the goose range disintegrated; several pairs nested at the Toreyskie Lakes, the Ulma river (the Middle Priamurie), the Northern Sakhalin and Khanka Lake, at least 200 pairs nested in the Nizhneye Priamurie. At present, geese are known to nest at the Toreyskie Lakes (about 50 pairs) and in the Nizhneye Priamurie (less than 100 pairs on the Udyl-Kizinskaya lowland and a few dozens of pairs in the Ulbanskiy Bay). Swan geese are still common to particular places in Mongolia. No data on China is available. The main reasons for decline in numbers of the geese are their extreme trustfulness and curiosity, accessibility of their nesting sites and, in some places, anthropogenic changes in the environment. Intensive hunting at the wintering grounds in China also played its negative role. Nesting sites are represented by the lake and river valleys with cut-off meanders with tall grass along their banks. On the Sakhalin, the geese nest on the dry plains in the upper reaches of the rivers and streams. They arrive in the Priamurie in the early April when the rivers are still covered with ice. The broods of 4-6 goslings keep to the sites with tall sedge tussocks along the banks of the streams, meanders and in the river mouths. The "creches" accompanied by several adults are characteristic for the species. In emergency, the goslings dive or run ashore and hide. The diet is based on the sedge in summer and on the berries in spring. The geese leave the Nizhneye Priamurie in the early September. Information about birds wintering in China is poor. The following steps aimed at protection were taken: the swan goose is listed in the Russian-Japanese Convention for the Protection of Migratory Birds and Red Books of the USSR and Russia. The "Udyl" refuge was established in 1977. In 1994, the lake was enlisted in the Convention on Wetlands of International Importance. Daurskiy zapovednik was founded at the Toreyskie Lakes in 1987. Several needed conservation measures will be discussed.

POSTER - FRIDAY - 20:00

EASTERN HIGH ARCTIC BRANT: STRATEGIES OF A HIGH ARCTIC BREEDER AND TRANS-OCEANIC MIGRANT

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O'BRIAIN, MICHIAL Commission of the European Communities, Directorate General, Environment, Nuclear Safety and Civil Protection. XI B.2, Brussels, BELGIUM

A distinct stock of about 15 000-20 000 pale-bellied Brant breeds in the central and eastern Canadian High Arctic, and migrates via Greenland and Iceland to winter in Ireland. These Eastern High Arctic Brant have not been studied in as great detail as have Atlantic Brant and Black Brant, both of which breed at much lower latitudes. We present information on breeding and moulting of Eastern High Arctic Brant gleaned from several sources over many years. They are characteristically non-colonial, breeding in a widely dispersed fashion. They are subjected to periodic breeding failures resulting from cold springs or Arctic fox predation. The young are raised in areas with an apparent low biomass of graminoid vegetation in comparison with more southerly Brant rearing areas. Despite constraints imposed by cold weather and low plant biomass the population doubled between the late 1970s and late 1980s, possibly aided by the counterbalancing advantage of reduced spring snow depth and a full 24-h of daylight for feeding during nesting and brood rearing. By using small wetlands that thaw early in close proximity to nesting sites, these Brant are able to initiate egg laying relatively early and produce large clutches in most years. Low availability of plant foods may explain the wide dispersal and low densities of these Brant during breeding and moulting.

ORAL - FRIDAY - 11:00

FIDELITY OF BLACK BRANT WINTERING AND SPRING STAGING IN THE STRAIT OF GEORGIA, BRITISH COLUMBIA

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GOUDIE, R. IAN. St-Johns, Newfoundland, CANADA

Fidelity is a behaviour that has important implications for the population genetics and dynamics of many species. In birds, most studies have dealt with breeding ground fidelity, ignoring the fact that waterfowl mainly pair in winter or early spring. We used multiple observation data from a mark-resight study of Black Brant to estimate fidelity to wintering and spring staging areas in the Boundary Bay and Parksville-Qualicum area of British Columbia. Fidelity was low for winter residents but still indicated that Brant were philopatric to this wintering area. The models for the spring period showed the presence of transients in both Boundary Bay and Qualicum. Birds seen for the first time in an area had a lower probability of returning to that area than birds seen in more than one year. Apparent survival probability was higher for Qualicum birds than for Boundary Bay birds. We concluded that prior knowledge of an area was an important determinant of site fidelity, and that low fidelity levels were unlikely to lead to genetic sub-structuring of the population.

ORAL - SATURDAY - 10:00

STUDYING THE WINTERING AND MIGRATION PATTERNS OF BLACK BRANT USING MARK-RESIGHT MODELS

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Migratory patterns are often hard to identify from methods relying on counts of individuals in a given area. As well, the ratio of resident and transient individuals in a population at any given time cannot be estimated without knowledge of the identity of individuals present. We used resighting data to evaluate the timing of migratory movements of a population of Black Brant in Boundary Bay, British Columbia, Canada. Intra-seasonal survival estimates were calculated, using program SURGE, from resightings of tarsus-marked individuals from 11 November to 25 April in 1994-95 and 1995-96. Observations were pooled over 7 day periods, and winter dates (11 November to 8 February) and spring dates (9 February to 25 April) were treated separately. Survival estimates, derived from mark-resight methods, provide point estimates that reflect both mortality and emigration from the study area. Assuming that mortality was constant throughout the winter and spring period, major shifts in survival rates between periods reflected emigration from the study area. The model derived for the 1994-95 winter had constant survival throughout that period, indicative of the presence of a winter resident population in the area. There was significant variation in survival rates in the 1995-96 winter period as well as the presence of encounter structure in the model, suggesting the presence of transient as well as resident birds in the area. Survival estimates for the 1995 spring did not differ from the 1996 spring period, and in both years the birds did not start emigrating from the study area until the period of 28 February to 6 March. Applications of this technique will be discussed.

POSTER - FRIDAY - 20:00

IDENTIFICATION OF BRANT COLONIES AND MONITORING OF THEIR USE AND PRODUCTIVITY IN NORTHERN ALASKA, FISH CREEK TO KASEGALUK LAGOON

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Since 1994, aerial surveys using fixed-wing aircraft have been conducted to locate and monitor colonial goose colonies, especially Brant in the coastal region from Fish Creek, west of the Colville River Delta, to the western end of Kasegaluk Lagoon, in northern Alaska. Survey objectives have been threefold. First, extensive surveys are conducted annually in regions not previously explored to identify new colonies for a registry of Brant colonies in the region. Since 1994, Brant have been identified nesting at more than 110 locations, with numbers of nests ranging from single nests to >50 nests. Second, annual surveys are conducted at selected colonies to monitor their use and status. The Fish Creek Delta and Ikpikpuk to Meade river regions have been found to contain the majority of colonies and brood-rearing areas west of the Colville River Delta. In the latter region, 43 colonies, varying in size and geographic location, are monitored annually. Numbers of nests have ranged from 171-254 in the monitoring are, 1994-1997. Finally, an aerial survey during brood-rearing is conducted in traditionally used coastal areas to evaluate annual productivity of the region's colonies. Brant numbers during brood-rearing have ranged from nearly 2000 to over 4000 birds, including goslings between Fish Creek Delta and the Meade River. Goslings have comprised between 10 and 32% of the July population. Hopefully, with increased interest in oil development and in inventorying subsistence resources in the region, annual monitoring of this important resource will continue.

ABNORMAL EMBRYOS OF LESSER SNOW GEESE

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The relative frequency of developmental abnormalities in birds is expected to increase when populations become inbred or when the embryos are exposed to environmental insults ranging from chemical contaminants to temperature extremes during early incubation. Poor nutritional status of arriving or incubating females can also contribute to such abnormalities either through direct impact on egg quality or through temperature fluctuations occurring during inattentive incubation. One of the major complications in evaluating abnormal embryos found in the is the lack of any reliable baseline data for natural populations. As part of our long term study of Lesser Snow Geese (*Anser caerulescens caerulescens*) at La Pérouse Bay, we have collected eggs abandoned by families who leave the nesting area with their successfully hatched goslings. The majority of these abandoned eggs contain embryos that are 1 to 4 days from hatching and some of these display extreme developmental abnormalities, primarily associated with the head and mandibles. In this presentation, we summarize our data on these abnormalities and we present both photographs and X-rays of several of the abnormal embryos. We hope this will stimulate others to collect similar information that can be combined with ours to begin building baseline data on developmental abnormalities in Arctic breeding geese. This is a contribution from the Hudson Bay Project.

FROM INDIVIDUALS TO POPULATIONS: TOWARDS A BEHAVIOUR-BASED MODEL OF GOOSE POPULATION DYNAMICS

ROWCLIFFE, J. MARCUS & PETTIFOR, RICHARD A. The Wildfowl and Wetlands Trust, Slimbridge, Gloucester, UNITED KINGDOM

Population ecologists are frequently called upon by wildlife managers to tackle the 'what if...?' question. Managers wish to know what will happen to a population if the management is changed in some way, and to address this, ecologists must use all the available information on the factors which determine the dynamics of the population in question. As a tool in this process, simple demographic models are often used to simulate population growth under a range of conditions, and such models can provide important insights into the likely consequences of changing conditions. However, this approach has considerable limitations. The most serious problem is the treatment of predictions outside the observed parameter space in general, and in particular the operation of density dependence. The way in which density dependence operates is central to the outcome of any model, and yet field studies can rarely provide reliable functions spanning an adequate range of densities. An alternative angle is to start from first principles, using the principles of behavioural ecological to generate a density dependent function for the wider population. In this approach, density-mediated reductions in demographic parameters are modelled explicitly as the outcome of competition between individuals. Game theory is used to optimize individual foraging success under any given combination of resource availability and competitor density, and the implications for individual death and productivity rates are deduced using models of the deposition and consumption of energy reserves. Linking models of this kind for each stage in the annual cycle allows the implications of changing population size for overall birth and death rates to be quantified. Because these density dependent functions are based on individual optimization decisions, which are not expected to change under novel conditions, they can be used in predictive models with much greater confidence than those derived from field data. In this presentation, the current state of development of such a model for the Svalbard barnacle goose *Branta leucopsis* will be described.

DECLINING AGE RATIOS IN CANADA GEESE: FACT OR ARTIFACT?

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Age ratios in Canada geese in the Mississippi Flyway were determined from tail fans collected from hunters in 1967-1996. These apparent ratios have declined from 1.34 immatures per adult in 1967-1971 to 0.37 in 1992-1996 ($R^2 = 0.6472$, $p<0.001$). Canada goose numbers in the flyway in the same period have increased from about 900,000 to 2.5 million. Do the declining age ratios indicate a decrease in production or survival of goslings due to a density-dependent response to shortage of food or space? Has competition with increasing numbers of snow geese reduced survival of Canada goose goslings? Or is the age-ratio decline an artifact caused by giant Canada geese which have increased from less than 65,000 to more than 1 million? These questions are explored in an ad hoc approach via a series of comparisons of data from different places, populations and species.

POPULATION AND HARVEST TRENDS OF CANADA GEESE IN THE MISSISSIPPI FLYWAY

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Indices to numbers and estimates of harvests of Canada geese (*Branta canadensis*) historically have been gathered at the species level, but modern management occurs at the population or subpopulation level. Some populations are exploding, others are threatened; some locales have too few geese, others have too many. In the Mississippi Flyway, numbers of geese in each population are estimated when they are isolated, i.e., during the breeding season. Since 1993, population-specific harvests have been derived from estimates of numbers, distribution of band recoveries and harvest rates. Indices of numbers of Canada geese began in 1938, Giant Canada geese were rediscovered in 1965, and winter indices began to be broken out by population beginning in 1969. Population estimates of spring numbers began in 1972 for the Eastern Prairie, 1989 for the Mississippi Valley, 1990 for the Southern James Bay and 1993 for Giant populations, respectively. Large-scale annual banding generally began in the 1960s and 1970s and estimates of harvests from questionnaires and tail fans returned by hunters began in 1962. Goals, objectives and strategies for Canada geese are dependent upon insight and hypotheses derived from historical population data. Annual regulations are importantly influenced by predictions of fall flight from models. Plans and models are improved by access and analysis of long-term population data. We attempt here to construct historical indices to breeding-season numbers and harvests of all populations of Canada geese in the Mississippi Flyway. Spring estimates of goose numbers averaged about 147% of numbers of *B. c. maxima* and *B. c. interior* tallied the previous winter. We believe *B. c. hutchinsii* were generally separated from other subspecies in winter surveys, but also believe the survey was incomplete. We thus multiply winter survey for TGPP (the only significant population of *B. c. hutchinsii* in the Mississippi Flyway) by 1.46 to obtain a spring index for TGPP for 1970-1977. The spring index for Giants from 1970-192 is calculated from populations estimates in 1993-1997 and 1969; assuming constant population growth of 1.11. For each year, the spring index for Giants is subtracted from the total spring index, leaving and index for all *B. c. interior*. *B. c. interior* index is then apportioned to population by the same ratios as reported in the winter index. Spring numbers of 5 populations now total about 400,000 TGPP, 1.09 million (EPP, MVP and SJBP combined) and 1.01 million Giants. Indices and estimates for 1970-1997 suggest population growth rates of 1.042 (TGPP), 1.022 (EPP), 1.020 (MVP), 0.985 (SJBP) and 1.104 (Giants). Indices of spring numbers and band recoveries were used to derive indices of harvests of each population by year and state or province. Compositions of harvest were compared to compositions of populations in specific regions to explore questions of population misclassification or differential harvest. Canada goose harvests in the Mississippi Flyway have grown from 100,000 in 1962 to more than 1 million in 1996. Trends in harvest composition tended to follow trends in populations. There was little evidence of geographic shifts in distribution of individual populations in 1970-1977. Giants, thought to be extinct in 1962, now comprise more than one-half of the total Canada geese harvested in the Mississippi Flyway.

POSTER - FRIDAY - 20:00

RESTORATION OF LESSER SNOW GEESE TO EAST ASIA, AN INTERNATIONAL CONSERVATION PROJECT, II

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The restoration project of lesser snow geese (*Anser caerulescens caerulescens*) to East Asia started in 1993 as an international conservation project between Japan, Russia, USA and Canada, in order to save the breeding population in Wrangel Island and to restore snow goose population which breeds and winters in East Asia. We have reported the result of the project in first three years in 8th NAAG conference, and show, here, the recent progress of the project. In June 1993, 100 eggs were transferred from the snow goose colony on Wrangel Island to Anadyr Lowland in North East Siberia. Of these, 41 eggs were used to replace the eggs of white-fronted geese and placed in 6 of their nests. Moreover, 43 snow goose goslings were hatched in incubators and released with blue tarsus band on a lake, where moulting flocks of white-fronted geese were staging. Both in Japan and Korea, unusual number of snow geese have been observed in every winter after 1993, showing an increase over previous years. The snow goose which wintered in Lake Kamoike, Japan in 1995/1996 and 1996/1997 winters had tarsus band of blue N76, apparently one of the project birds. In January 1995 at Cholwon Basin, Korea, a flock composed of eight snow geese and a white-fronted goose was observed. Since the flock was seemed to be sometimes led by the white-front, the flock possibly is one of the foster family groups, which were composed in 1993 summer in Anadyr Lowland. It was observed that twenty snow geese yearlings, both, with and without tarsus band returned to Anadyr Lowland during the summer of 1994. Moreover, two family groups of snow geese were found at Chilynai, approximately 100 km south of Anadyr in the beginning of August, 1996. Both families had two parents and four goslings in each, and one of the parents had the blue tarsus band. The above results show that snow geese juveniles apparently can learn to migrate and return to their area of birth, in both cases of egg replacement and juvenile release, and that some project birds grow to succeed in breeding, getting a mate among snow geese. So, on the base of these successful results of the experimental transplant introduced in 1993, we will be able to make a practical program to attain the aim of the project.

ORAL - SATURDAY - 16:15

DETERRING ARCTIC FOX PREDATION: THE ROLE OF PARENTAL NEST ATTENDANCE BY LESSER SNOW GEESE

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Although nest attendance in geese is high, some birds may leave for up to three hours per day to feed or drink away from nests. Studies have shown that geese least attentive to nests suffer highest nest loss to predators. However, it is unclear how nest attendance by geese may affect foraging patterns of predators. Only female geese incubate, whereas the male is thought to be important during incubation to detect and deter predators and to defend territories against conspecifics. However, recent studies that have experimentally addressed the importance of male attendance have all found that male removal had no effect on nest success. In 1996 and 1997, we examined if parental nest attendance by lesser snow geese affects (1) foraging patterns of arctic fox and (2) egg loss to arctic fox. Arctic fox were observed foraging among nesting geese at Egg River Colony on Banks Island. We recorded (1) whether nests attacked by fox were attended by the pair, a single goose, or unattended and (2) fate of interactions. This data were compared with attendance pattern of a randomly selected subset of 80 goose pairs in the colony.
We found that arctic fox attacked unattended nests and those with only a female far more than expected by chance. In combination with no resistance associated with unattended eggs and less efficient nest defence by single females compared to paired birds, this resulted in unattended nests and single females suffering higher egg loss to arctic fox.
We suggest that our conclusions about the importance of goose attendance at nests differ from conclusions from removal experiments because of (1) the spatially-dependent nature of egg loss to arctic fox and (2) differences in fox densities at different colonies. Possibly, unattended nests and single females benefit from nesting among large numbers of geese thereby "swamping" predators. However, if encountered by arctic fox, birds with low attendance likely face a higher risk of egg and nest loss.

ORAL - FRIDAY - 9:00

PRODUCTIVITY OF LESSER SNOW GEESE ON BANKS ISLAND 1995-1997

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Lesser snow geese nesting on Banks Island are of great importance to the Inuvialuit. These birds constitute an important part of local diets and are harvested by 5 of the 6 communities in the Inuvialuit Settlement Region. Thus, any significant change in numbers of geese nesting on Banks Island could greatly alter the availability for local harvest. The objectives of this study were to collect baseline information on productivity of snow geese nesting on Banks Island. Specifically, we were interested in the nesting and brood ecology/parameters of these birds. This information will be important for recommendations about appropriate harvest levels. We estimated that about 300,000 and 400,000 snow geese nested on Banks Island in 1995 to 1997 (1997 estimate not yet calculated). Although some variation in number of nesting birds is the result of annual variation in spring arrival, the population is about twice as high currently on Banks Island as in the 1980s. Clutch size ranged between 3.5 to 3.8 eggs per nest in 1995 to 1997. This is lower than recorded in colonies of the central and eastern Canadian Arctic. Nest success showed a relatively large variation between years and was 66 %, 94 %, and 66 % in 1995 to 1997, respectively. Brood survival was good during the first two to three weeks after hatch; broods were reduced only by 8.5 % and 9.2 % in 1995 and 1996 respectively (1997 data not yet analyzed). Weather conditions were favourable during these periods but survival may be lower in years of poor weather. The highest densities of dispersing broods were found in the river valleys closest to the colony. Failed and non-breeding birds moved farther away from the colony than successful pairs and were found in highest densities in the delta of Bernard River about 120 km away. However, most birds were found along creeks and smaller rivers of the vast uplands (however, in lower densities). In summary, there were more birds nesting on Banks Island than has ever been reported before (but see Kerbes estimate of 431,000 nesting birds for 1995). However, population growth on Banks Island does not appear to have been as rapid as at some colonies of the central and eastern Canadian Arctic. This may be the result of somewhat lower average nesting effort and success on Banks Island, which may be associated with geographic variation in spring nutrition of lesser snow geese.

POSTER - FRIDAY - 20:00

EFFECTS OF AVIAN CHOLERA ON SURVIVAL OF LESSER SNOW GEESE IN THE PACIFIC FLYWAY

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Non-hunting mortality is commonly believed to be an important demographic factor in waterfowl. Avian cholera, caused by the bacterium *Pasteurella multocida*, is one of the most important diseases affecting waterfowl in North America, but little is known about the impacts of this disease on survival in birds. We studied the epidemiology and mortality from avian cholera on lesser snow geese (*Chen caerulescens caerulescens*) wintering in the Pacific Flyway. We banded geese on their breeding areas at Wrangel Island, Russia and Banks Island, Canada. During banding we sampled birds to determine current infection from avian cholera and antibody titers for prior exposure. Birds were banded with aluminum legbands and individually coded plastic neckbands or radio transmitters. We experimentally vaccinated half of the neckbanded geese to provide protection from avian cholera for one or more years following banding. Observations of neckbanded geese and telemetry tracking of radioed geese were primarily conducted on the wintering areas in California and Oregon to determine causes of mortality, seasonal movement patterns, and survival rates. We compared the causes of mortality and survival rates of vaccinated and unvaccinated geese to determine the effectiveness of our vaccine in wild waterfowl and to estimate the impact of avian cholera on survival of both snow goose populations. Avian cholera significantly reduced survival of snow geese, but impacts varied annually in relation to the weather and habitat conditions in the Central Valley of California.

DISTURBANCE FACTORS AFFECTING BLACK BRANT AT HUMBOLDT BAY, CALIFORNIA

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We examined time/activity budgets, disturbance factors, behavioural responses to disturbances, and distribution of black Brant (*Branta bernicla nigricans*) during winter and spring of 1996 and 1997 at Humboldt Bay, California. Time/activity budgets were calculated from focal birds within flocks. When disturbances occurred, cause of disturbance, duration, and type of response was recorded. Overall, Brant were disturbed 3.32% of the time. Small boats (27%), large boats (21%), and people (22%), accounted for the majority of the disturbance. In over half (54%) the disturbance cases birds responded by taking flight. Brant spent 45% of the time in locomotion, 36% feeding, 11% preening, 5% resting, and 3% in other activities. Feeding rate was significantly affected by tide height ($P = 0.0001$). A weekly census revealed distribution patterns among the three major areas within Humboldt Bay. Brant counts did not differ between years ($T = 1.7474$, $P = 0.0967$). Humboldt Bay remains an important spring staging area for migrating black Brant, but foraging opportunities may be limited by daily tidal cycles and human-caused disturbance.

VARIATION IN STABLE ISOTOPES AMONG GEESE NESTING ON THE YUKON-KUSKOKWIM DELTA: IMPLICATIONS FOR FORAGING AND REPRODUCTIVE ECOLOGY

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The nutrition and energetics of reproduction in geese has been a topic of much study. However, it has been unclear which nutrients or forages are used to meet which somatic versus reproductive investments. We used the stable isotopic differences among habitats (marine versus intertidal and terrestrial) to explore how much foods from these habitats contributed to reproductive effort. Examining lipid-free yolk in freshly laid eggs, mean 15N/14N and 13C/12C in eggs of Black Brant and Emperor Geese were more marine in signature than those laid by Cackling Canada Geese or Greater White-fronted Geese. Looking within nests of Black Brant, first laid eggs were more marine in isotopic signature than last laid eggs, indicating that terrestrial foods (those obtained on the breeding grounds) were being actively incorporated into egg production. Averaging across six clutches for each species, we estimated that Black Brant incorporated significantly more terrestrial foods into their eggs than did Emperor Geese. The magnitude of these differences were sensitive to what isotopically different foods were believed to be included in their diet (e.g., whether herring roe was regularly consumed in spring). During May and June, 15N/14N and 13C/12C of adult Emperor Geese were more marine in signature than eggs and goslings, reflecting the disproportionate use of terrestrial foods (relative to somatic reserves) for egg production. Temporal variation in stable isotopes throughout the breeding season may allow study of other questions about forging strategies and reproductive strategies, particularly when birds can be sampled multiple times and/or birds are of known age or history.

ORAL - THURSDAY - 10:00

GOSLING SURVIVAL AND POPULATION DYNAMICS OF EMPEROR GEESE: EFFECTS OF GLAUCOUS GULLS AND WEATHER

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Numbers of emperor geese (*Chen canagica*) nesting on the Yukon-Kuskokwim Delta have changed little during the past decade, remaining significantly below historic numbers. Because the primary predator of goslings, glaucous gulls (*Larus hyperboreus*), have increased during the past decade and because little is known of emperor goose brood rearing ecology, we studied survival of goslings during 1993-96. Our objective was to examine whether survival rates were correlated to aspects of glaucous gull predation and/or meteorological variables during and shortly after hatch. We individually marked nesting females, resighted them from observation towers, and counted their goslings. We also recorded rates of disturbance of emperor goose broods by glaucous gulls. Gosling survival to age 35 days varied among years, ranging from 35 to 71%. Numbers of nesting glaucous gulls and rates of gull disturbance of goose broods were least in the year of highest gosling survival, and greatest during the year when gosling survival was poorest. Gosling survival was also correlated to average fall family size (n = 4). Using fall family size as a proxy for gosling survival, we then examined whether variation in fall family size during the past 30 years was related to selected weather parameters. Precipitation during early brood rearing was weakly related to fall family size ($R^2 = 0.22$, $P = 0.05$). Variation in fall family size does not correlate to variations in population surveys of emperor goose numbers, implying that gosling survival has not been a dominant influence on their population dynamics. Predator control (shooting of glaucous gulls) has been proposed as a means of increasing goose populations via increased gosling survival. We present projected results from such control measures.

POSTER - FRIDAY - 20:00

MOLECULAR STATUS OF THE DUSKY CANADA GOOSE: GENETIC ASSESSMENT OF A RELOCATION EFFORT

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The dusky Canada goose (*Branta canadensis occidentalis*) is believed to breed in one highly restricted locale on the Copper River Delta in coastal south-central Alaska. Population numbers have declined precipitously over the last three decades, due in part to alterations in nesting habitat subsequent to the earthquake of 1964. In 1981, a small population of large-bodied, "dusky-like" Canada Geese was reported nesting on Middleton Island, and historical evidence suggests this population became established between 1978 and 1981, some forty years after the removal of foxes from the island. Seeking to augment this young, putative "dusky" Canada goose population, and in accordance with the goals of cooperative inter-agency management of the dusky Canada goose, managers moved 106 dusky Canada geese from the Copper River Delta to Middleton Island in 1987 and 1988. A dramatic increase in population numbers of Canada geese on the island occurred subsequent to this relocation effort; however, it is unclear whether the increase is a direct result of the relocation effort or if it occurred independently. Using genetic data derived from the hypervariable portion of mtDNA control region, and 4 microsatellite loci, we examined the systematic relationships of dark, large-bodied Canada geese breeding in coastal habitats of south central Alaska, including birds from the Copper River Delta, the Anchorage area, and the south-eastern Alaskan panhandle, relative to geese nesting on the islands of Prince William Sound, including Middleton Island. Analysis of mtDNA shows that Canada Geese from the islands of Prince William Sound, including Middleton Island, possess a unique haplotype, and the Canada geese from the Copper River Delta possess several mtDNA haplotypes, one which is unique to the Copper River Delta and two which are observed in geese from other areas, including Admiralty Island of the Alexander Archipelago, and Anchorage, Alaska. These analyses suggest that 1) the geese of the Copper River Delta either share recent common ancestry with or are experiencing some gene flow from populations from other areas; and 2) the current Middleton Island population did not originate from transplantations from the Copper River Delta but rather are of a genetic background comparable with other island populations in Prince William Sound. In addition, microsatellite data suggest that geese from the Copper River Delta are more genetically similar in terms of allele frequency to other birds in Prince William Sound than to geese from the Anchorage area. The occurrence of a single, unique haplotype found in the island populations suggests they are isolated from populations on the mainland, including the Copper River Delta, and that the original colonization of Middleton Island may have been by birds inhabiting other island habitats within Prince William Sound. Given that the geese sampled from the Copper River Delta, the breeding locale for the subspecies *B. c. occidentalis*, share haplotypes with geese sampled from Admiralty Island, a breeding locale for the subspecies *B. c. fulva*, our genetic data raise questions about the validity of current systematic designations of dark, large-bodied Canada geese in the Pacific Flyway.

ORAL - SATURDAY - 11:00

PERMANENT EMIGRATION AND MARKOVIAN AGE-SPECIFIC BREEDING PROPORTIONS FOR BLACK BRANT FROM THE TUTAKOKE RIVER COLONY

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Understanding of life-histories and population dynamics has been hampered by the inability to understand movement of individuals outside the local study populations. Such movements include both permanent and temporary emigration from the local population. Capture-recapture techniques have recently been developed to address these shortcomings. These methods use (1) a combination of band recovery and recapture data to estimate permanent emigration and (2) multiple secondary sampling periods (e.g., nesting and banding) within primary periods (e.g., breeding season) to estimate temporary emigration. A further development includes estimation of Markovian emigration probabilities that estimate probability of absence based on presence or absence in the previous breeding season. We used these techniques to examine the proportion of individuals that never enter their natal breeding population and the age-specific proportion of individuals breeding each year, conditioned on status in the previous year for females from the Tutakoke River (TR) Brant colony. We estimated that an average of 11 + 4.8% of females permanently emigrated from the TR colony. Because dispersal to other breeding colonies is uncommon, permanent emigration likely reflects permanent non-breeding for most females. Markovian estimates of breeding probability showed that individuals that nested year i were more likely to nest in year i + 1 than individuals that did not nest in year i. Breeding probability of females that nested the previous year did not change with age, while breeding probability of females that did not nest the previous year increased from age 2 years through age 5. Permanent emigration and Markovian breeding proportions are consistent with an hypothesis of variation in quality among individual female Brant.

POSTER - FRIDAY - 20:00

SUMMER SEASON INTERACTIONS BETWEEN LESSER SNOW GEESE, CLIMATE AND VEGETATION AT LA PÉROUSE BAY, MANITOBA

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The Mid-Continent population of lesser snow geese (*Anser caerulescens caerulescens*) has tripled to nearly 6 million in the past thirty years. Large tracts of the coastal Hudson Bay lowlands are being degraded as a result of their rapidly increasing numbers and destructive feeding habits. The coastal lowlands are a major staging and breeding area for lesser snow geese, in particular, and waterfowl and shorebirds, in general. Snow geese that breed further north on Southampton Island and Baffin Island, use the Hudson Bay lowlands as staging sites, rendering these areas highly susceptible to the adverse effects of a terrestrial trophic cascade (Jefferies et al., 1995). This leads to runaway consumption of forage species beginning a process of habitat degradation and rapid ecological change. Decadal shifts in anomalous climatic patterns in spring have not been uniform over the Hudson Bay region. The past 15 years have experienced late snow melts in the south-western regions of Hudson Bay associated with a negative mean air temperature anomaly which intensifies in a north-east direction across the Bay (Jefferies et al. 1995). This sustained anomalous pattern has delayed northward-bound birds resulting in the enhancement of vegetation degradation. There is a strong link between increasing goose populations, the loss of vegetation and the presence of mudflats. Dramatic destructive effects on the landscape of La Pérouse Bay, Manitoba area have been identified (Jano et al. 1998). A high degree of predictability of goose reproductive variables from selected early spring season climatic variables has been identified (Skinner et al. 1997). This demonstrates both direct and indirect effects of climate on the reproductive biology of geese. Summer season interactions between indicators of gosling survival, climate variability, and vegetation degradation presents an even more complex problem. This study first examines the spatial and temporal nature of moisture availability and variability during summer in the Hudson Bay region through the annual progression of water surplus and deficit as calculated by the Thornthwaite water balance model. Secondly, the multivariate relationships between goose variables (egg survival, hatching success, gosling survival, goslings leaving the nest, brood size at banding), climatic conditions (air temperature and rainfall, drought severity (Palmer Drought Index)), and vegetation changes (standard crop data) during summer in the La Pérouse Bay area are examined.

POTENTIAL ENVIRONMENTAL IMPACTS OF RAPID GROWTH IN POPULATIONS OF ROSS' AND SNOW GEESE NESTING AT KARRAK LAKE, NORTHWEST TERRITORIES

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Colonial-nesting geese are often considered keystone species. At high densities, these species may alter their habitat through nesting or foraging and this environmental change may have large biotic and abiotic impacts on the ecosystem. We report potential effects of geese at a large nesting colony in central Arctic Canada. Since 1993, we annually monitored the spatial extent and nest densities of Ross' and Lesser Snow Geese breeding at Karrak Lake (67:14°N, 100:15°W). These data were used to estimate annual populations of birds nesting there from 1993-1996. Combined with intermittent estimates available for 1966, 1976, 1982, and 1988, we demonstrate a rapid exponential growth in population size of both species. When the colony was first discovered in 1966, 17 000 nesting geese were confined to a few islands in Karrak Lake amounting to 0.7 km^2 of terrestrial habitat; in 1996 there were 653 747 1 139 288 (95% CL) geese estimated to occupy 108.7 km^2 of terrestrial habitat; with approximate dimensions of the colony 16*16 km. LANDSAT imagery from 1989 suggests extensive alteration of habitat within the colony to exposed peat and mineral soil resulting from removal of vegetation by nesting geese. In 1996, pilot hydrological studies were initiated to examine the impact that such large numbers may have on direct nutrient inputs, and what effects presumably increased erosion associated with vegetation removal may have on watersheds. In addition, we examined utilization of geese or eggs by arctic fox, distribution of song birds within the colony boundary, and food availability on brood-rearing areas.

DO GASTRIC HELMINTHS REDUCE SURVIVAL OF IMMATURE ROSS' GEESE?

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Increasing populations of Snow and Ross' Geese are degrading arctic habitat in and around large nesting colonies. Reduced habitat quality could stress geese nutritionally and increase effects of parasites. Parasitism may be most detrimental to juvenile geese that must grow rapidly and obtain sufficient nutrients to survive long-distance migration. This negative effect of parasites may also be most prevalent for geese that remain near the colony where food may be scarce and, due to high goose densities, infective stages more abundant. In 1994-1997, we studied landscape-level variation in prevalence and intensity of gastric helminths in immature Ross' Geese and effects of tapeworms and nematodes on post-fledging gosling survival. Goslings were systematically captured about 40 days after hatch within 70 km of a large nesting colony located at Karrak Lake, NT. Goslings then were either collected for parasite surveys or, if large enough, marked with plastic neck bands for resighting during fall migration and winter. Collared goslings were alternately injected with either an anthelminthic (parasite reduced treatment) or physiological saline (control treatment). Observations of goslings with collars were made during fall migration and winter, primarily in Alberta, Saskatchewan, Montana, Oregon, California and New Mexico. Preliminary results from dissections and collar observations will be presented. For survival analyses, we assumed that resighting rate was an adequate index of relative survival between treatment groups.

ORAL - THURSDAY - 16:00

ESTIMATING RATIOS OF ROSS' AND LESSER SNOW GEESE ON NESTING COLONIES

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Recent increased overlap between breeding ranges of Ross' and Lesser Snow Geese has complicated nesting colony surveys. Breeding population inventories of mixed-species colonies often estimate white goose numbers, then partition counts between species based on species ratios (SR). Snow Goose estimates are then adjusted based on colour ratios (CR) to yield total species ratio (TSR) and total breeding population. If researchers are to reliably census such colonies, techniques used to estimate SR,CR, and TSR must be assessed. Ground-based visual scans of birds are the most commonly used technique to subsample geese and can provide rapid estimates of SR and CR. However, this method may be biased by resampling of birds disturbed by research activities or by presence of non-breeding geese which may vary both seasonally and interspecifically. An alternate method which combines SR and CR relies on species identification based on egg measurements. Nests are not likely to be resampled and thus this method may yield a more accurate estimate of TSR for breeding birds. Egg measurements, however, require more time to obtain large sample sizes and cannot provide CR. We compared results of visual scans and egg measurements for estimating TSR and examined potential biases caused by seasonal variation in number of nests and colony residents (breeders, non-breeders, failed breeders), sample size, and non-random distribution of species. Paired egg measurements and visual scans (n = 112 pairs) were conducted systematically throughout incubation. Sample sites were located along a 1 km2 grid covering an entire large colony of Ross' and Snow Geese located at Karrak Lake, NT. Each site was visited once during nesting. Scan and measurement data sets were randomly subsampled to determine effects of season, site location, and sample size on variance in TSR. To further examine colony dynamics from nest initiation to hatch, we conducted visual scans on four 200m x 200 m plots and monitored nest loss on 21 plots (20-30 m radius). Strengths and weakness of each technique will be discussed.

POSTER - FRIDAY - 20:00

BIAS IN SURVIVAL ESTIMATES FROM CONTINUOUS SAMPLES OF NECKBANDED GEESE

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Neckbands have been used on many species and populations of geese to answer questions on migration, habitat utilization, behaviour, and fidelity to breeding and wintering areas. Neckbands have also been used to obtain seasonal survival estimates which may give valuable insights on population ecology that annual survival estimates cannot. However, seasonal survival estimates usually require continuous sampling strategies, violating several open population model assumptions which, in turn, may bias parameter estimates.

We used individually-based simulation experiments to examine the effects of sample size, neckband retention, survival rates, number of sampling periods, selection of sampling periods, and calculation of sample period mid-points on mean survival and variance estimates. We recommend sampling and analytical strategies to minimize biases due to the use of inappropriate models.

ORAL - FRIDAY - 16:15

LOCAL AND REGIONAL TRENDS OF WHITE-FRONTED GEESE BASED ON AERIAL AND FLOAT SURVEYS IN WESTERN INTERIOR ALASKA

SPINDLER, MICHAEL, A., LOWE, JENNY M. & FUJIKAWA, JEAN Y. U.S. Fish and Wildlife Service, Galena, Alaska USA

STEHN, ROBERT, A. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA

Indices of white-fronted goose abundance in the lower Koyukuk River floodplain of western interior Alaska have declined in the last decade. We designed an intensive aerial survey with systematic placement of transects to obtain regional distribution and abundance estimates for white-fronts, and compared these with concurrent float surveys and prior aerial survey indices. Surveys were conducted during the moulting period when sightability of geese was greatest. We flew a total of 1452 km of parallel aerial transects (0.93 km wide) at an altitude of 164 m over the main nesting and brood rearing areas of Koyukuk National Wildlife Refuge (NWR) during 1994-97. After the first year the aerial survey was adjusted to include two strata, high and low goose density. These changes reduced variance and size of 90% confidence intervals (CI's) after 1994, but CI's were still 30-40% of the estimate even after stratification. Aerial surveys detected fewer geese than float surveys. The aerial survey accounted for 75% of adult white-fronts and 28% of goslings seen on corresponding float surveys. The aerial survey detected one of six radio-collared females with broods, suggesting they were not as detectable as non-breeders, which swam to the centre of a waterbody in response to aircraft overflight. Nevertheless, we believe that both types of survey, performed consistently over several years, would provide a reliable indicator of trends because they encompassed the main breeding and moulting areas for white-fronted geese. One float survey on a 100 km-long slough in the Koyukuk floodplain was repeated within 2-7 days of the initial survey. Within each year, 1994-96, considerable differences in goose counts between these repeated surveys were attributed to changes in crew experience, survey speed and thoroughness. In 1997, identical crew and survey intensity a week apart resulted in nearly identical float counts. We recommend standardization of both float and aerial surveys. Cost of both surveys were similar but the aerial survey was less expensive per unit area than the float survey. The aerial survey was easier to standardize and provided estimates of white-fronted geese with confidence intervals, while the float survey was simpler, and could better enumerate other species such as Canada geese. Each method was able to detect long-term changes in white-fronted goose abundance but the aerial survey offered potential to make statistical comparisons of white-fronted goose trends. We estimated a four-year mean of 7142±2617 total white-fronted geese in the study area (based on an aerial sightability correction factor of 3.6 used previously for white-fronts in the boreal forest). This compares with a mean estimated breeding population of 11,520 in the entire Koyukuk drainage, 1957-97 (based on similarly corrected data extracted from standardized aerial duck breeding-pair surveys). The last 14 years of aerial breeding pair survey data from this area showed a significant decline (R^2=0.51), a trend that agreed with both the 1994-97 intensive aerial surveys and with goose productivity float surveys during the same period on Koyukuk NWR.

POSTER - FRIDAY - 20:00

THE INTERACTION BETWEEN BRENT AND BARNACLE GEESE - FACILITATION OR COMPETITION? AN EXPERIMENTAL APPROACH

STAHL , JULIA Zoological Laboratory, University of Groningen, Haren, THE NETHERLANDS

Barnacle Geese (*Branta leucopsis*) and Brent Geese (*Branta bernicla*) winter in large numbers along the Dutch, German, English and Danish coast. During the spring staging period, the birds have to face a growing need to fill up body reserves in advance of their migration to the arctic breeding grounds. Nevertheless, favourable feeding sites must be shared among the two goose species. The salt marsh of the Dutch island Schiermonnikoog serves as a good example for a joint use of foraging areas by Brent and Barnacle Geese. Barnacle Geese start their spring staging on higher parts of the salt marsh in early March and remain on the island until the end of April. Brent Geese switch from polder to salt marsh sites in the beginning of April and do not leave for their breeding grounds before the end of May. Especially early spring staging on salt marsh sites coincides with an upsurge in the nitrogen content of salt marsh plants as *Festuca rubra* (Prins & Ydenberg 1985,Oecologia 66:122-125). During this early period, bot goose species feed on the same plants on higher parts of the marsh and plants have been shown to respond to grazing with increased production and protein content (Bazely et al., MS in prep.). This study tackles the question whether Barnacle Geese are competitors removing potential food for Brent Geese or facilitators enhancing food quality and availability. The described time window of overlapping use of salt marsh sites by both species provided the natural settings for an experimental trial with exclosures on Festuca meadows in spring 1997. Barnacle Geese were excluded from plots of 4 x 8 m stepwise for either 1 or 2 month. The same plots were accessible for Brent Geese after removal of the exclosures in the first week of May. Grazing pressure was measured by dropping counts on both experimental and control plots throughout the whole period. The observations were
supported by detailed vegetation monitoring (biomass, nitrogen content and ADF/NDF/lignin values).

ORAL - THURSDAY - 9:45

MONITORING NESTING POPULATIONS AND ANNUAL PRODUCTION OF GEESE ON THE YUKON-KUSKOKWIM DELTA, ALASKA

STEHN, ROBERT A. & BOWMAN, TIMOTHY D. U.S. Fish & Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA

WEGE, MICHAEL L. U.S. Fish & Wildlife Service, Yukon Delta National Wildlife Refuge, Bethel, Alaska, USA

Field crews searched randomly-located plots for nests to estimate breeding population size and annual production of young geese on the Yukon-Kuskokwim Delta (YKD), Alaska. Total number of nests, active nests, and eggs were estimated each year from 1986 to 1997 for cackling Canada geese (*Branta canadensis minima*), emperor geese (*Chen canagicus*), greater white-fronted geese (*Anser albifrons frontalis*), and black brant (*Branta bernicla nigricans*). Breeding populations of all 4 species have increased since 1988. Nesting success indices have remained consistently high, clutch sizes have shown minor variation, and nesting chronology has become progressively earlier during this period. Nest success did not correlate with estimated egg production, and egg production did not add significantly to predicting subsequent population size. Estimated total nesting population sizes were calculated from annual mean nest densities on plots sampling 670 km2 of the central coastal YKD, the estimated nest detection rate, and an expansion to entire YKD coast of 12,852 km2 based on the proportion of aerial survey observations.

POSTER - FRIDAY - 20:00

IMPROVEMENTS IN MONITORING ARCTIC HABITAT AND FORECASTING GOOSE PRODUCTION USING SATELLITE IMAGERY

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TROST, ROBERT E., U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Portland, Oregon, USA

The remoteness and extensive distribution of habitats for Arctic nesting geese makes the acquisition of direct, quantitative goose productivity data expensive and difficult. We developed digital image processing procedures to extend the early work by Reeves and others (1976) on the use of satellite imagery to monitor snow melt phenology of Arctic habitats and goose production. We use linear mixture models to estimate the proportions of snow, water, and land in each pixel of an Advanced Very High Resolution Radiometer (AVHRR) image. These data, when estimated for a series of images during the spring, provide information about snow melt, flooding, the availability of nest sites, and vegetation growth. We examine the accuracy of snow, water, and land proportion estimates from AVHRR imagery using Thematic Mapper imagery, a more than 1000% improvement in spatial resolution, acquired on the same date. We discuss obstacles to the estimation of the mixture model parameters.

ORAL - SATURDAY - 15:30

POPULATION DYNAMICS OF BLACK BRANT IN SIBERIA

SYROECHKOVSKI, E.E.,JR. Geese and Swan Study Group of Eastern Europe and North Asia, Bird Ringing Centre, Moscow, RUSSIA

Distribution and status of Black Brant (*Branta bernicla nigricans*) was poorly studied on the most of Arctic coasts of Asia. Research of the author in 1991, 1994, and 1996-97 helped to understand some spectacular changes within the breeding range in the last 30 years. Field work was done in Yana, Olenyok and Lena lower reaches as well as short time observations on the New Siberian Islands, Indigirka, Kolyma and Anabar coasts. Published literature, ring recoveries and a wide network of correspondents among local hunters and amateurs was involved. A colour ringing scheme was started. The following main results were obtained: Population trend 1) Decrease of the breeding population is recorded in the most of Eastern part of the breeding range, especially on Wrangel Island, North Chukotka and New Siberian Islands; 2) Increase of the breeding numbers is recorded at Yana delta and adjusting coasts and to a lesser extent at Northern and Eastern part of Lena delta and Indigirka lower reaches. Breeding range 1) For the American population of Black Brant, expansion is recorded in last 25 years for many km West. We can say that the core zone of the breeding range is most likely currently moving West in Asia. 2) The breeding range of the Asian population of Black Brant is most likely decreasing and now they are probably breeding with other races of Brent Geese. 3) The breeding range of the Dark-bellied Brent Goose (*Branta bernicla bernicla*) had increased in the last 25 years for at least 500 km East to the area which was formerly suggested to be the range of Black Brant. Now they are breeding together in mixed colonies in the Olenyok delta and West Lena delta as it was recorded in 1997. Migration routes have probably changed to some extent as well. Presently, Brent Goose, of all the races, are more often recorded on inland Yakutia. Birds with American rings were recorded south of the Arctic coast though they were suggested to be exclusively coastal migrants. There are more facts about the increasing exchange of birds from Asian and American wintering grounds. The increase of exchange with Dark-bellied Brent is also possible so it is necessary to make more observations on the subspecific differentiation of Brent Goose in winter in America and Japan. Systematic observations of mixed pairs of Black Brant and Dark-bellied Brent Geese in Olenyok delta as well as birds with hybrid features bring more arguments for the subspecific differentiation of these two forms of Brent Goose than for separation of them to the different species like it was recently suggested by some publications in the UK, the Netherlands and Russia.

ORAL - FRIDAY - 10:45

THE TERRITORIAL STRUCTURE OF THE TUNDRA BEAN GOOSE NESTING POPULATION IN VAIGACH ISLAND (RUSSIA)

SYROECHKOVSKY, EVGENY V. Institute of Ecology and Evolution of Russian Academy of Sciences, Moscow, RUSSIA

The investigation of the ecology and territorial structure of the nesting population of the Tundra Bean Goose took place in Vaigach Island in 1986-1988 and 1994-1997. In 1994-1997 that work was financed by National Geographic Society. The Bean Geese of Vaigach Island are represented by three morphological types that differ from each other by the extent of development of the orange stripe in their bills (Types B, C and D, Burgers et al., 1991). The percentage of birds with different types of bills is: B-5%, C-49% and D-46%. We couldn't find any differences in distribution of bill types in males and females. The males and females with different types of bill form the pairs randomly. While working in our control territory (18-20 km^2) in 1988, 1995 and 1996 we tried to register the types of bills of nesting geese. In total we managed to register the types of bills in 56 nesting females and 19 nesting males for three seasons. In 17 nesting pairs the types of bills were registered for both partners. While analyzing the distribution of the nests of the females with different types of bills over the control territory we found that that distribution differs significantly from the random one. The nests of birds with the bills of type C concentrated predominantly in the south-eastern part of that territory while the birds with bills of type D nested mostly in its north-western part. The difference in those distributions is statistically significant ($P < 0.01$, $n = 56$). We weren't able to connect that difference in distribution of nesting birds neither with the differences in the types of habitats of those parts of the control territory nor with the time of nest initiation of the females with different types of bills. It seems that that phenomenon could be explained by two suppositions: The first one is that in Bean Geese as in many other geese species the young females choose their nest sites near the nests of their parents, and the second one is that the young females inherit the types of bills from their mothers. If the suppositions are right we are meeting in Vaigach Island the clannish type of Bean Geese nesting and the peculiarities of the orange stripes of bills could say about the affiliation of the given birds with one or another clan. However these two suppositions need farther confirmation.

POSTER - FRIDAY - 20:00

OVER-WINTER SURVIVAL OF LESSER SNOW GEESE POPULATIONS IN CALIFORNIA: CAN WE EXPLAIN THIS EXCEPTION TO OVERABUNDANCE?

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ORTHMEYER, DENNIS L. U. S. Geological Survey, Biological Resources Division, Dixon Field Station, Dixon, California, USA

SAMUEL, MICHAEL D. U. S. Geological Survey, Biological Resources Division, National Wildlife Health Centre, Madison, Wisconsin, USA

BARANYUK, VASILY V. Wrangel Island Nature Reserve, Magadan Region, Ushakovskoye, RUSSIA

We radio-marked lesser snow geese (*Anser c. caerulescens*) from the Banks and Wrangel Island breeding populations to examine their distribution and survival in California during the winter. Geese were captured in drive traps during remigial moult in late July and early August, 1994-1996 at both breeding colonies. Adults were measured, sexed, banded, and marked with radio collars. Radio-marked geese were located during the autumn and winter in southern Oregon and the Central Valley of California from aircraft and trucks equipped with telemetry systems. We found that the two populations were temporally, but not spatially segregated during autumn migration. The Wrangel Island population arrived nearly a month earlier than the Banks Island population to the Summer Lake State Wildlife Area in southern Oregon. Geese from both populations thoroughly intermixed once they arrived in the Central Valley during the winter (November - April), but geese from Wrangel Island (Shat = 0.75) survived at a significantly lower rat than geese from Banks Island (Shat = 0.93). Over-winter survival of the Wrangel Island population was consistently lower than the Banks Island population in all years ($Chi^2 = 0.16$, $P = 0.92$) and was not explained by hunting mortality ($z = 2.9$, $P < 0.001$) or body weight at capture ($Chi^2 = 0.98$, $P = 0.32$). Our results suggest that differing over-winter survival of the Banks and Wrangel populations in California may be associated with factors outside of the wintering period. In addition, these California populations are not exhibiting the growth observed in the mid-continent. We discuss the importance of comparing lesser snow goose populations from California with mid-continent populations to identify factors driving exponential growth.

ORAL - FRIDAY - 15:30

EGG SIZE, GROWTH AND SURVIVAL OF LESSER SNOW GOOSE GOSLINGS

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ABRAHAM, KENNETH F. Ontario Ministry of Natural Resources, Peterborough, Ontario, CANADA

Intraspecific egg size variation is high for Lesser Snow Geese (*Chen caerulescens caerulescens*) and egg size might correlate positively with growth and/or survival of goslings. Ankney (1980) showed that captive Snow Goose goslings hatching from larger eggs survived starvation longer and experienced short-term growth advantages over those from smaller eggs, while Williams et al. (1993) found no fitness consequences of egg size variation in wild goslings. We are re-testing the hypothesis of egg size effects on growth and survival of goslings using data collected at a small breeding colony of Snow Geese on the north shore of Akimiski Island in James Bay. From 1995-1997, we located 3016 nests and from these, measured 8555 eggs to obtain egg volume estimates. During the pipping stage, we attached individually coded webtags to 5368 hatching goslings from eggs of known size. Goslings were captured during routine banding drives at 25-35 days of age. Measurements of culmen, skull, tarsus, mid-toe, ninth primary feather length and body mass were recorded for web tagged goslings. Results of egg size effects on gosling growth and survival will be presented and discussed. Among and within female variation in egg-size may be influenced by temperature during egg formation (Williams and Cooch, 1996). Thus, beginning in 1998, we will record hourly temperatures during egg-laying to determine if any correlation exists between temperature and egg size. Furthermore, to determine how much variation in gosling growth and survival is accounted for by parental quality, we will also perform a cross-fostering experiment.

REPRODUCTIVE EFFORT IN RELATION TO THE TIME OF SEASON: AN EXPERIMENTAL STUDY OF BARNACLE GEESE IN SVALBARD

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BLACK, JEFF M. Large Animal Research Group, Zoology Department, Cambridge University, UNITED KINGDOM

LOONEN, MAARTEN J.J.E., University of Groningen, Zoology Laboratory Groningen, THE NETHERLANDS

In long-lived species, a small reduction in an adult's survival will have a large negative impact on the number of future breeding prospects and, hence, lifetime reproductive success. Accordingly, long-lived species should not sacrifice their own survival and future fecundity for investment in the current offspring. In a stochastic environment, there would be a strong selection for long-lived species to respond to environmental cues to avoid investment in young when the prospects of offspring survival are low. As expected, several studies have documented a lower reproductive output for late-nesting geese. Late-hatched goslings have less time to grow and fledge which reduces their survival probabilities and hence their fitness. Late-nesting birds moult later and have a shorter period to rebuild their body reserves before autumn migration, and a poor body condition late in the season may decrease their survival probability. Accordingly, it has been suggested that as the season progresses, the parents should invest more in self-maintenance and survival and less in their offspring. However, experiments are needed to test the hypothesis and also to examine to what extent the lower fitness of late-hatched goslings is due to parental quality or the time of hatching per se. We performed an experimental study on barnacle geese *Branta leucopsis* breeding in Kongsfjorden, Svalbard. In 1996 and 1997 females of all laying dates were manipulated by prolonging their incubation period artificially by five days (26 + 26 nests). Unmanipulated nests were used as controls. We artificially prolonged incubation by replacing the eggs with dummy eggs for five days before incubation started. In this way, we increased the reproductive costs for the females. We predict that early-nesting geese should more readily increase their breeding effort, and overall, experimentally delayed females should invest less in their broods than controls. Late-nesting geese will have a higher gosling mortality, both on the breeding grounds and during winter migration; overall, mortality of the goslings of experimentally delayed females should be higher. Moreover, experimentally delayed females should contribute fewer recruits to the population than controls. In this experimental study we tested these predictions by recording body mass dynamics during incubation and parental behaviour during the brood rearing period. Furthermore, juvenile survival at the breeding ground, during autumn and spring migration were estimated as well as adult survival.

CRITICAL COMPONENTS IN THE DYNAMICS OF A BARNACLE GOOSE COLONY: A SENSITIVITY ANALYSIS.

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BLACK, JEFF M. Large Animal Research Group, Zoology Department, Cambridge University, UNITED KINGDOM

LOONEN, MAARTEN J.J.E., University of Groningen, Zoology Laboratory, Groningen, THE NETHERLANDS

Several arctic goose populations have increased considerably the last decades and their impact on the environment have induced large ecological and economical problems. A certain amount of knowledge about population dynamics is needed when managing arctic goose populations, and when studying changes in population size we need to explore which demographic parameters having the strongest effect on the population's growth rate. In this study we performed sensitivity/elasticity analyses on a colony of barnacle geese in Kongsfjorden, Svalbard. In that way we were able to 1) measure the sensitivity of the population's growth rate to changes in different demographic parameters, 2) measure how proportional changes in different demographic parameters influence proportional changes in growth rate, 3) evaluate which of the demographic parameters being responsible for the variation in population size the last eight years. The results from these analyses demonstrated that adult survival rates were the most important factors determining changes in the colony's growth rate. Juvenile survival rates and gosling survival during summer had less effects on the growth rate, whereas clutch size had the smallest effect. Furthermore, a proportional change in adult survival rates will have an impact on the growth rate almost 1.5 times greater than a proportional change in any of the other demographic parameters measured. When incorporating the between year variation, gosling survival during summer and clutch size had been responsible for most of the variation in growth rate. The variation was closely correlated to the presence of arctic foxes in the area. The results from this study illustrate the importance of securing good feeding habitats prior migration, both autumn and spring migration. Body reserves are important for successful migration, and a reduction in adult survival rates due to insufficient reserves could cause the barnacle goose colony in Kongsfjorden to decrease rapidly.

POSTER - FRIDAY - 20:00

RECENT CHANGES IN THE WINTERING DISTRIBUTION OF CACKLING CANADA GEESE

TROST, ROBERT E. & DRUT, MARTIN S. . U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Portland, Oregon, USA

The total number of Cackling Canada geese (*Branta canadensis minima*) has changed dramatically during the past several decades (Raveling 1984, Pamplin 1986, Raveling 1992). Numbers declined from > 350,000 in the 1960's to < 30,000 in 1983 and have now recovered to > 150,000 in 1996 (Caithamer and Dubovsky 1997). Along with these changes in population status, the wintering distribution has undergone a substantial change as well. As recently as the winter of 1988-89 we estimated that > 80% of the cackling Canada geese wintered in California, however, in 1996-97, our estimates suggest that > 80% wintered in the Willamette Valley- Lower Columbia River region of Oregon and Washington. Based on a total of 8,672 cackling Canada geese that were captured and marked with individually identifiable neckbands during the period 1982-1996, we examined the role of survival and movement on the observed change in wintering distribution.

ORAL - SATURDAY - 11:45

LESSER SNOW GOOSE BREEDING AND MOULTING IN KOLYMA LOWLAND

UEMURA, SACHIKO, SABANO, YUTAKA. & KURECHI, MASAYUKI. Japanese Association for Wild Geese Protection, Wakayanagi, Miyagi, JAPAN

ANDREEV, ALEXANDAR V. Eastern Paleoarctic Wetlands, Ecocentre, Magadan, RUSSIA

TAKEKAWA, JOHN Y. National Biological Service, Dixon, California, USA

KERBES, RICHARD H. Canadian Wildlife Service, Saskatoon, Saskatchewan, CANADA

BARANYUK, VASILY V. Wrangel Island Nature Reserve, Ushakovskoye, Magadan Region, Russia

Kolyma Lowland is one of the historically-used areas of Lesser Snow Goose (*Anser caerulescens caerulescens*). The study is conducted as a part of the Snow Goose restoration project to East Asia, which intends to restore the population of Lesser Snow Goose that breeds on the Arctic coast of Russia and migrates to East Asia. The aim of the study is to investigate the area that might be suitable for future translocation of the Snow Goose breeding in Wrangel Island. Field studies were operated in the north-west area of Kolyma Lowland in the summers of 1993-1995. In July 1993 an aerial survey was operated in order to find breeding and moulting Lesser Snow Goose. It recorded the sightings of 32 adults and 20 goslings. In 1994 summer, an aerial and ground survey recorded 113 Lesser Snow Geese including 29 goslings. And 50 non-breeders and 18 breeding adults with 20 goslings were captured. The adults were measured and marked with neck collars and metal legrings and the goslings were marked with plastic leg bands. Six adult males were equipped with miniature satellite transmitters. In July 1995 three non-breeders were captured and marked with neck collars and metal legrings. The marked geese migrated to North America. One miniature satellite transmitter worked for two months and showed the goose migrated to Cape Romanzof, Alaska. More than 80% of the geese marked with neck collars and 31% birds with plastic leg bands were recovered or resighted in western North America. The records of marked geese show that their migration route is almost the same as that of Lesser Snow Goose in Wrangel Island. Further, in June 1995, one of the marked geese was resighted in Wrangel Island. The measurements of Lesser Snow Goose in Kolyma Lowland and in Wrangel Island were compared. Although the sample size of Kolyma geese is small, the analysis showed no difference between geese in these two areas. This study indicates that there is a strong relation between Lesser Snow Goose breeding and moulting in Kolyma Lowland and Wrangel Island. It can e considered that the Kolyma geese are a part of the Wrangel Island population. The presence of the geese migrating to North America makes the area not suitable for the restoration project.

POSTER - FRIDAY - 20:00

EFFECTS OF AN INCREASING LESSER SNOW GOOSE POPULATION ON SHOREBIRD POPULATIONS AND FORAGING ECOLOGY AT LA PÉROUSE BAY

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The lowland coastal marsh of the La Pérouse Bay region is an important habitat for a variety of migrant and breeding shorebirds. Evidence suggests that habitat degradation caused by an increasing Mid-continent population of lesser snow geese (*Anser caerulescens caerulescens*) may be having an adverse affect on some shorebird species. In the La Pérouse Bay region, breeding pairs of red-necked phalaropes (*Phalaropus lobatus*) and semipalmated sandpipers (*Calidris pusilla*) have declined as much as 10% annually since 1983 (Gratto-Trevor 1994). Since 1977, there has also been a marked decline in June daily observations of stilt sandpipers (*Calidris himantopus*), dowitchers (*Limnodromus spp.*), and Hudsonian godwits (*Limosa haemastica*). Additionally, alterations in invertebrate species richness and abundance attributed to habitat degradation have been documented. In 1997, we began research to determine relationships between habitat degradation, invertebrate populations, and shorebird ecology. Initial collections included data on shorebird diets, richness, relative abundance, prey availability, foraging area selection, and foraging area characteristics. For temporal comparisons, these data were collected throughout the summer. Spatial comparisons were made between areas of moderate, severe, and total habitat degradation. Diet samples (n=203) were collected from 17 species of shorebirds. Relative abundance, richness and foraging area selection were gathered using a grid count/observation method. Core samples and pitfall traps were used to collect invertebrates for prey availability data. Vegetation assemblages, soil and water chemistry parameters, and landscape features will be used in establishing foraging area characteristics. Preliminary results indicate spatial and temporal variations in these data. These collections will be continued in 1998, along with the addition of an intact area. This is a contribution from the Hudson Bay Project.

POSTER - FRIDAY - 20:00

GOOSE SPRING FEEDING CONDITIONS AND THE IMPORTANCE OF FACILITATION

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According to conventional wisdom, herbivores using the same feeding areas are bound to compete with each other. However, facilitative effects have been widely overlooked. In spring, arctic breeding geese visit areas with high quality food plants to build up fat reserves for migration to their breeding grounds and subsequent breeding. Intake rate of geese responds to biomass with a quadratic function (Van der Wal et al. in press, Oikos). Intake rate increases with biomass at low levels, but decreases at high biomass. A decrease in foraging efficiency at high plant standing crop can for instance be caused by a high amount of litter, a drop in food quality, or by a gradual change in plant species composition. Slight reduction in intake rate can cause geese to abandon from these areas, because of limited option to increase foraging time further. In a case study, on the Dutch Island of Schiermonnikoog, winter grazing of Hares interfered with natural succession, which led to maintenance of suitable grazing lawns for Brent geese. Long term monitoring showed nevertheless that only the speed of vegetation succession was reduced by hare grazing; the geese finally had to give up certain areas. Another Dutch island, Ameland, has become one of the most important Brent Goose spring staging areas of Europe. Numbers in the salt marshes only marginally increased over the last 25 years. Yet, numbers in agricultural land increased dramatically over the last 10 years. This coincided with sheep farming becoming more intensive. The grass was shorter, and contained most likely less senescent tissue. In this case sheep facilitated for Brent Geese. Several other examples can be provided, indicating the importance of facilitation. However, all those examples come from incomplete systems. It is open to discussion whether similar effects would be operative if the spectrum of wild herbivores was more complete. Evidence might be found in spring staging areas where larger herbivores co-evolved with arctic breeding geese.

LOCALIZED DECLINE IN PRODUCTION OF EASTERN PRAIRIE POPULATION CANADA GEESE

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RUSCH, DONALD H. Wisconsin Cooperative Wildlife Research Unit, University of Wisconsin, Madison, Wisconsin, USA

Management of the Eastern Prairie Population (EPP) of Canada geese (*Branta canadensis interior*) has involved annual ground surveys of nesting geese on a study area near Cape Churchill, Manitoba from 1976-96. Although the EPP experienced substantial population growth during this period, nest density at Cape Churchill declined at a rate of 1.3 nests/year, going from a mean of 30 nests/100 ha during 1976-78 to 6 nests/100 ha during 1994-96. Data from ground surveys are being used to assess predictions made by each of seven hypotheses that we feel are capable of explaining this long-term decline in production: 1) investigator disturbance, 2 localized alteration of nesting habitat, 3) alteration of wintering areas, 4) breeding dispersal, 5) changes in patterns of natal philopatry, 6) arctic fox (*Alopex lagopus*) predation, and 7) competition with an expanding snow goose (*Anser c. caerulescens*) colony at nearby La Pérouse Bay. Nest success has also declined substantially at Cape Churchill, from a mean of 0.729 during 1976-78 to 0.289 during 1988-90, with >85% of nest losses being attributable to fox. Assuming 100% natal philopatry and a closed population, such a decline in nest success predicts a decline in nest density of the magnitude observed, implicating fox predation as a factor important to the decline in nest density. While fox harvest records suggest a cyclic regional fox population, predation rates on Canada goose nests at Cape Churchill were consistently high during 1981-93. Increasing numbers of snow geese at La Pérouse Bay may be leading to increased predation on Canada goose nests by altering the survival and/or distribution of fox in the area. We discuss each of these hypotheses relative to the decline in EPP nest density at Cape Churchill, and speculate on the potential impact of expanding snow goose numbers on Canada geese in critical nesting areas along the Hudson Bay coast.

SURVIVAL AND PRE-FLEDGLING BODY MASS IN JUVENILE BLACK BRANT

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Recent studies have indicated that pre-fledging body mass affects first-year survival of arctic nesting geese (Owen and Black 1989, Francis et al. 1992, Sedinger et al. 1992), but it is unclear when such mass-related mortality occurs. We studied first year survival of black Brant (*Branta bernicla nigricans*) and examined the relationship between pre-fledging body mass and survival during early (fledging to fall staging areas) and late (fall staging to wintering areas) fall migration. We marked goslings late in their growth period at 2 widely separated breeding areas in Alaska: Yukon-Kukokwim Delta and Arctic Coastal Plain in 1990-1993. Birds were resighted during fall staging (Sep-Nov) at Izembek Lagoon, Alaska; winter (Dec-Apr) in Baja California, Mexico; spring migration (Mar-May) at Humboldt Bay, California; nesting (May-Jun) in Alaska; and moulting (Jul) in Alaska, Russia, and Canada between 1990 and 1997. We will provide insight into the timing of mass-related mortality by partitioning survival of Brant over 2 discrete fall migration periods and comparing 2 different nesting populations.

ORAL - FRIDAY - 14:30

HEART RATES OF FREE-LIVING GREATER WHITE-FRONTED GEESE: IMPLICATIONS FOR STUDIES OF BEHAVIOURAL ECOLOGY AND ENERGETICS

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We implanted Tule greater white-fronted geese (*Anser albifrons gambeli*) with telemetry heart-rate transmitters to detect physiological responses to aircraft disturbance, and to better understand the relationship between activity and energy expenditure. Heart rates of 9 different individuals monitored during winter, ranged from less than 100 beats per minute (BPM) during resting, to over 400 BPM during flight. During non-strenuous activities such as walking, feeding and maintenance activities, heart rates varied from 80 to 140 BPM. Heart rates elevated to approximately 180 BPM when birds became alert, to over 400 BPM when birds were startled, even if they did not take flight. During agonistic encounters we recorded heart rates of up to 420 BPM; heart rates during social interactions were not predictable solely from postures, as they were context-dependent, and were likely highest in initial encounters between individuals. Continuous monitoring of up to 25 geese during the moulting period revealed a diurnal perodicity with basal heart rates being nearly 20 % lower during a daily quiescent period. Geese responded to low-level aircraft over-flights (helicopter and fixed wing) by rapidly increasing heart rate, and if stimuli was brief, a rapid recovery to normal. We also present information on heart rates of incubating females and birds at autumn staging areas. Instantaneous measures of physiological parameters such as heart rate, are often better indicators of the degree of response to external stimuli than simple observation data and can be used to improve estimates of energy expenditure based solely on activity data.

POSTER - FRIDAY - 20:00

ANNUAL FIDELITY OF BRANT, GREATER WHITE-FRONTED GEESE, AND CANADA GEESE TO MOULTING AREAS IN THE WESTERN CANADIAN ARCTIC

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Few studies have examined fidelity of individual geese to moulting locations. The object of this study was to quantify the annual movement of Brant (*Branta bernicla*), Greater White-fronted Geese (*Anser albifrons*), and Canada Geese (*B. canadensis*) among moulting locations in the Inuvialuit Settlement Region in the Western Canadian Arctic and to determine whether individuals in any of these species showed fidelity to specific moulting locations. We banded moulting geese in 1990-96 on the mainland of the Inuvialuit Settlement Region and Banks Island (Brant only). Geese were captured at multiple sites each year and many of our previously-banded geese were recaptured during banding operations in subsequent banding years. This enabled us to determine the moulting locations that individuals used in different years. Moulting flocks consisted of non-breeders or failed breeders except for Brant captured on the mainland, which were mostly parents with juveniles. Brant had high fidelity, with over 90% of recaptured gees caught in the same banding location (40 km area) where previously captured. Most Brant captured on Banks Island were captured within 10 km. However, many Brant captured on the mainland moved between two areas that were 30 km apart. Greater White-fronted Geese had the highest fidelity to moulting locations, with 97% of the recaptured geese being captured in the same banding location and more than 91% of recaptures less than 10 km from where previously captured. Canada Geese had high fidelity to moulting locations, with 77% of recaptured geese being captured in the same banding location where previously captured. We suggest that individual geese have high levels of fidelity to specific moulting locations, similar to the high fidelity that individuals show to nesting and wintering locations.

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INDIRECT EFFECTS OF FLUCTUATIONS IN LEMMING DENSITY ON THE NESTING SUCCESS OF WHITE-FRONTED AND CANADA GEESE

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Throughout most of the Arctic, lemming populations fluctuate cyclically in numbers with a period of three to five years. Many species of predators fluctuate in response to the changing lemming density. Other prey species may be affected both by the variation in availability of an alternative prey type, and by the resulting changes in numbers of shared predators. The breeding success of Brent geese and wading birds on the Taymyr Peninsula in Siberia appears to be highest during the peak year of the lemming cycle, and lowest the following year (Roselaar 1979, Summers 1986). In 11 years of observations at the Walker Bay research station on the Kent Peninsula in the Central Canadian Arctic, the nesting success of white-fronted and Canada geese has appeared cyclic but not entirely in synchrony with the lemming cycle. During a single lemming peak, the net indirect interaction between geese and lemmings could take one of two forms: (1) apparent mutualism, whereby when lemming density is high the per-predator consumption of eggs is reduced; or (2) apparent competition, whereby the rise in predator numbers in response to lemming abundance results in increased nest predation. Because the numerical response of some predators may be delayed, both effects could occur in sequence - the first during the lemming peak, and the second during the subsequent year. The magnitude of either effect will depend on the prey preferences of the predators and the degree and timing of their numerical response. We studied the behaviour and abundance of predators and estimated predation rates on real and artificial goose eggs through field experiments and observations during a complete lemming cycle. Predation on goose eggs was lowest during the lemming peak. The reduction was related to changes in the foraging behaviour of predators, to interspecific interactions among predators, and to large-scale spatial patchiness of habitat. Predation on goose eggs may be high or low in the year following the lemming peak, depending on the timing of the lemming decline and on the winter survival of predators alive during the peak. Variation in these factors, and in others including the suite of predators present and the timing of the lemming increase, makes goose nesting success difficult to predict in this system.

ORAL - FRIDAY - 9:30

EFFECTS OF MIGRATORY GEESE ON PLANT COMMUNITIES AND NITROGEN- CYCLING PROCESSES WITHIN A COASTAL SALT-MARSH ECOSYSTEM

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Lesser snow geese (*Chen caerulescens caerulescens*) and Canada geese (*Branta canadensis*) use the salt marshes of Upper Cook Inlet, Alaska as stopover areas during spring migration. Intensive feeding on emergent shoots and below-ground plant parts, particularly grubbing by snow geese, may affect plant community composition and nitrogen cycling. We used paired exclosed/open plots (n=88) to investigate the effects of feeding, trampling, and defecation by geese in the salt marshes of Susitna Flats, Upper Cook Inlet. Exclosures were erected in the springs of 1995, 1996, and 1997, and plant communities were sampled in August of those years. (A pre-treatment sample was obtained in August of 1994.) In addition, we measured rates of net nitrogen mineralization and N2 fixation on a subset of plots three times throughout the summer of 1997. Data from 1995 and 1996 indicate that use by geese changed plant community composition and species abundance without an overall reduction in net aboveground primary productivity (NAPP or a decrease in the availability of preferred forage species. Preliminary data show N_2-fixation rates were higher in open plots compared to exclosed plots, indicating that alterations to ecosystem structure by geese may have affected nitrogen-cycling processes. Because NAPP in salt marshes is often nitrogen limited, these alterations may be important to the long-term stability of Susitna Flats to sustained bird use.

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