Alaska Cooperative Fish and Wildlife Research Unit

Annual Report—1999

May 2000

Alaska Cooperative Fish and Wildlife Research Unit
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Annual Report, 1999
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Unit Roster

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Staff

F. Joseph Margraf, Unit Leader, Effective September 12, 1999
James B. Reynolds, Unit Leader, Retired June 30, 1999
Brad Griffith, Assistant Leader–Wildlife
Jacqueline D. LaPerriere, Assistant Leader–Fisheries, RIP, October 30, 1999
A. David McGuire, Assistant Leader–Ecology
Karen R. Enochs, Administrative Assistant, Effective July 1, 1999
Norma L. Mosso, Administrative Assistant, Retired April 30, 1999
Kathleen R. Pearse, Administrative Assistant
Judy D. Romans, Secretary/Receptionist
Elizabeth A. Sturm, Research Technician
Whitney M. Madison, Student Assistant, Spring and Fall 1999
Cheryl A. Dion, Student Assistant, Summer 1999

Sponsors

Alaska Department of Fish and Game
University of Alaska Fairbanks
U.S. Fish and Wildlife Service
U.S. Geological Survey, Biological Resources Division
Wildlife Management Institute

Graduate Students

William Anker (MS)
Allison Bidlack (MS)
Gail Blundell (PhD)
Randy Brown (MS)
John Burch (MS)
Catharine Copass (PhD)
Fiona Danks (MS)
Cheryl Dion (MS)
Blair Flannery (MS)
Matthew Foster (MS)
H. Blair French (MS)
F. Michael Holliman (PhD)
Claudia Ihl (MS)
Mark Keech (MS)
Rebecca Kelleyhouse (MS)
MeiMei Li (MS)
Judy Lum (MS)
Edward Mallek (MS)
Thomas McDonough (MS)
William Morris (MS)
Dana Nordmeyer (MS), OSU
David Person (PhD)
Amy Runck (MS)
James Savereide (MS)
Brendan Scanlon (MS)
C. Tom Seaton (MS)
Pamela Seiser (MS)
Cherie Silapaswan (MS)
Karen Stone (PhD)
Troy Tydingco (MS)

Matthew Whitman (MS)
Alexander Wilson (PhD)
Scott Wolfe (MS)
Amy Zacheis (MS)
Xinxian Zhang (PhD)
Qianlai Zhuang (PhD)

Faculty Cooperators

W. Scott Armbruster, IAB
R. Terry Bowyer, IAB/DBW
Terry Chapin, DBW/IAB
Joseph A. Cook, UAM/DBW
Lawrence K. Duffy, IAB/DCB
Erich H. Follmann, DBW/IAB
Anthony J. Gharrett, SFOS
Nicholas F. Hughes, SFOS
David R. Klein, IAB
Terrance J. Quinn II, SFOS
Eric A. Rexstad, DBW/IAB
Daniel D. Roby, ORCFWRU
James B. Reynolds, SFOS
Roger W. Ruess, DBW/IAB
William W. Smoker, SFOS
David Verbyla, FSD

Coordinating Committee

Michael W. Tome, Eastern Region Supervisor, Cooperative Research Units, Biological Research Division, U.S. Geological Survey, Leetown, West Virginia

Frank Rue, Commissioner, Alaska Department of Fish and Game, Juneau, Alaska

James S. Sedinger, Interim Director, Institute of Arctic Biology, University of Alaska Fairbanks

Rollin D. Sparrowe, President, Wildlife Management Institute, Washington, D.C.

Janet Hohn, Science Officer, Alaska Regional Office, U.S. Fish and Wildlife Service, Anchorage, Alaska

Introduction

This is the Annual Report for the Alaska Cooperative Fish and Wildlife Research Unit, highlighting activities for 1999. The Unit engages in research on living natural resources for a variety of State and Federal agencies. As an unbiased research organization, the Unit provides information requested and funded by these agencies. When studies are completed, the agencies use the information to assist in their natural resource management efforts. Most of the research is conducted by graduate students, many of whom go on to work for the agencies upon graduation.

The Alaska Unit was established in 1950, providing half a century of research dedicated to helping conserve and enhance the living natural resources of the State and the Arctic Region. The Unit is part of a larger and even older program, the U.S. Department of the Interior's Cooperative Research Unit Program. Established in

1935, Cooperative Research Units were created to fill the vacuum of wildlife management information and the shortage of trained wildlife biologists. In 1960, the Unit Program was formally sanctioned by Congress with the enactment of the Cooperative Units Act. Each unit is a partnership among the Biological Research Division of the U.S. Geological Survey, a State fish and game agency, a host university, and the Wildlife Management Institute. Staffed by Federal personnel, Cooperative Research Units conduct research on renewable natural resource questions; participate in the education of graduate students destined to become natural resource managers and scientists; provide technical assistance and consultation to parties who have legitimate interests in natural resource issues; and provide continuing education for natural resource professionals. Presently, there are Cooperative Research Units in 38 states, conducting research on virtually every type of North American ecological community. The Program is staffed by more than 110 PhD scientists who advise as many as 600 graduate student researchers per year.

This past year was a time of change for the Alaska Unit. In May, Norma Mosso retired as administrative assistant, following nearly 30 years of service with the Unit. Norma is enjoying retirement in Deming, New Mexico, where she and her husband Gerry enjoy gardening in a temperate climate and traveling in their motorhome. She was replaced by Karen Enochs in July. Karen came to the Unit with 12 years of UAF experience in accounting and management of State-appropriated funds. In June, Unit Leader Jim Reynolds retired and accepted a 2-year appointment as the Frank and Marjorie Meek Endowed Chair with the School of Fisheries and Ocean Sciences. In September, Joe Margraf took over as Unit Leader. Joe is a fisheries scientist who has been in the Unit Program since 1980, having served at the Ohio, West Virginia, and Maryland units. Sadly, in October Jackie LaPerriere, Assistant Leader for Fisheries, passed away after a valiant fight against cancer. Jackie and Jim had been the only fisheries scientists to serve in their respective positions at the Unit.

Statement of Direction

The research program of the Unit will be aimed at understanding the ecology of Alaska's fish and wildlife; evaluating impacts of land use and development on these resources; and relating effects of social and economic needs to production and harvest of natural populations.

In addition to the expected Unit functions of graduate student training/ instruction and technical assistance, research efforts will be directed at problems of productivity, socioeconomic impacts, and perturbation on fish and wildlife populations, their habitats and ecosystems. Fisheries research will emphasize water quality, habitat characteristics, and life history requirements of arctic and subarctic fish populations. Wildlife research will focus on evaluation of habitat quality and ecology of northern birds and mammals. Unit research will also be directed at integrated studies of fish and wildlife at the ecosystem level.

Unit Cost-Benefit Statement

Base Funds—FY99

U.S. Geological Survey/BRD/CRU (10/1/98-9/30/99	$381,500
Alaska Department of Fish and Game (7/1/98–6/30/99)	98,300
University of Alaska Fairbanks (7/1/98-6/30/99)	154,930
Total	$634,703

Reimbursable Funding—CY99*

	Direct	Indirect	Total
U.S. Geological Survey/BRD	$227,470	$25,275	$252,745
U.S. Geological Survey/WRD	14,963	1,663	16,625
U.S. Geological Survey/CRU	27,000	3,000	30,000
National Park Service	108,000	12,000	120,000
U.S. Fish and Wildlife Service	39,518	4,391	43,909
U.S. Forest Service	33,333	3,704	37,037
Total	$450,284	$50,032	$500,316

* Funding received during the reporting period, January 1–December 31, 1999. The University of Alaska Fairbanks provided support by waiving an estimated $150,094 in overhead during CY99, under the terms of the cooperative agreement.

Grant Funding through IAB—CY99*

	Direct	Indirect	Total	Overhead Rate
National Science Foundation	$23,688	$15,792	$39,480	40%
National Science Foundation	37,500	37,500	75,000	50%
NASA	28,438	28,438	56,875	50%
West Kitikmeot/Slave Study Society	72,194	0	72,194	0%
Total	$161,820	$81,730	$243,549	

* Funding received during the reporting period, January 1–December 31, 1999.

In-Kind Support

In-kind support, usually operational support of field activities, is critical to the success of the Alaska Cooperative Fish and Wildlife Research Unit. Although the monetary value of this support is not known, a listing of the assistance is provided for each project in this report.

Benefits

Students Graduated 5 MS; 1 PhD

- John R. Demboski, PhD: Postdoctoral Fellow, Department of Biological Sciences, University of Idaho, Moscow
- Claudia Ihl, MS: enrolled as PhD student at UAF/DBW
- Mark Keech, MS: employed by ADFG/WC Anchorage
- Edward J. Mallek, II, MS: employed by USFWS/Waterfowl Management Fairbanks
- T. Christopher Stark, MS: employed by UAF/IMS

- Troy Tydingco, MS: employed by ADFG/SF Sitka

Publications/Reports: 30
Presentations 60
Honors/Awards 5

Unit Benefits

Scientific Publications

Blundell, G. M., J. H. Kern, R. T. Bowyer, and L. K. Duffy. 1999. Capturing river otters: A comparison of Hancock and leg-hold traps. Wildlife Society Bulletin 27(1):184-192.

Brown, R. and K. P. Severin. 1999. Elemental distribution within polymorphic inconnu (*Stenodus leucichthys*) otoliths is affected by crystal structure. Canadian Journal of Fisheries and Aquatic Sciences 56:1898-1903.

Conroy,* C. J. and J. A. Cook. 1999. MtDNA evidence for repeated pulses of speciation within arvicoline and murid rodents. Journal of Mammalian Evolution 6(3):221-245.

Conroy,* C. J., J. R. Demboski, and J. A. Cook. 1999. Mammalian biogeography of the Alexander Archipelago of Alaska: A north temperate nested fauna. Journal of Biogeography 26:343-352.

Cook, J. A. and D. R. Klein. 1999. Beach vole/*Microtus breweri*. Pages 624-625 in D. E. Wilson and S. Ruff, eds. The Smithsonian Book of North American Mammals. Smithsonian Institution Press, Washington, D.C.

Demboski,* J. R., B. K. Jacobsen, and J. A. Cook. 1998. Implications of cytochrome b sequence variation for biogeography and conservation of the northern flying squirrels (*Glaucomys sabrinus*) of the Alexander Archipelago, Alaska. Canadian Journal of Zoology 76:1771-1777.

Demboski,* J. R., K. D. Stone,* and J. A. Cook. 1999. Further perspectives on the Haida Gwaii glacial refugium hypothesis. Evolution 53:2008-2012.

Duffy, L. K., M. K. Hecker, G. M. Blundell, and R. T. Bowyer. 1999. An analysis of the fur of river otters in Prince William Sound, Alaska: Oil related hydrocarbons 8 years after the *Exxon-Valdez* oil spill. Polar Biology 21:56-58.

Halanych, K. M., J. R. Demboski, B. J. van Vuuren, D. R. Klein, and J. A. Cook. 1999. Cytochrome b phylogeny of North American hares and jackrabbits (*Lepus*, Lagomorpha) and the effects of saturation in outgroup taxa. Molecular Phylogenetics and Evolution 11(2):213-221.

Kicklighter, D. W., A. Bondeau, A. L. Schloss, J. Kaduk, A. D. McGuire, and others. 1999. Comparing global models of terrestrial net primary productivity (NPP): Global pattern and differentiation by major biomes. Global Change Biology 5:16-24.

Kicklighter, D. W., M. Bruno, S. Dönges, G. Esser, M. Heimann, J. Helfrich, F. Ift, F. Joos, J. Kaduk, G. H. Kohlmaier, A. D. McGuire, and others. 1999. A first-order analysis of the potential role of CO_2 fertilization to affect the global carbon budget: A comparison of four terrestrial biosphere models. Tellus 51B:343-366.

Kildaw,* S. D. 1999. Competitive displacement? An experimental assessment of nest site preferences of cliff-nesting gulls. Ecology 80:576-586.

Klein, D. R. 1999. Comparative social learning among arctic herbivores: The caribou, muskox and arctic hare. Pages 126-140 in H. O. Box and K. R. Gipson, eds. Mammalian Social Learning: Comparative and Ecological Perspectives. Cambridge University Press, Cambridge.

Klein, D. R., D. F. Murray, R. H. Armstrong, and B. A. Anderson. 1998. Regional trends of biological resources—Alaska. Pages 707-745 in M. J. Mac, P. A. Opler, C. E. Puckett Haecker, and P. D. Doran, editors. Status and Trends of the Nation's Biological Resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, VA.

Lance,* E. W. and J. A. Cook. 1998. Biogeography of tundra voles (*Microtus oeconomus*) of Beringia and the southern coast of Alaska. Journal of Mammalogy 79:53-65.

Mörschel,* F. M. 1999. Use of climatic data to model the presence of oestrid flies in caribou herds. Journal of Wildlife Management 63:588-593.

Nungesser, M. K., L. A. Joyce, and A. D. McGuire. 1999. Effects of spatial aggregation on predictions of forest climate change response. Climate Research 11:109-124.

Post,* E. and D. R. Klein. 1999. Caribou calf production and seasonal range quality during a population decline. Journal of Wildlife Management 63:335-345.

Reynolds, P. E., R. T. Bowyer, and D. R. Klein. 1999. Muskox/*Ovibos moschatus*. Pages 346-347 in D. E. Wilson and S. Ruff, eds. The Smithsonian Book of North American Mammals. Smithsonian Institution Press, Washington, D.C.

Tian, H., J. M. Melillo, D. W. Kicklighter, A. D. McGuire, and J. Helfrich. 1999. The sensitivity of terrestrial carbon storage to historical climate variability and atmospheric CO2 in the United States. Tellus 51B:414-452.

Tian, H., J. M. Melillo, D. W. Kicklighter, A. D. McGuire, B. Moore III, and C. J. Vörösmarty. 1999. Reply to Crutzen et al. and Schulman et al. (re: Tian et al., Nature 396:664-667). Nature 399:536.

Tian, H., J. M. Melillo, D. W. Kicklighter, A. D. McGuire, J. V. K. Helfrich III, B. Moore III, and C. J. Vörösmarty. 1998. Effect of international climate variability on carbon storage in Amazonian ecosystems. Nature 396:664–667.

Vapalahti, O., Å. Lundkvist, V. Fedorov, C. J. Conroy,* S. Hirvonen, A. Plyusina, K. Nemirov, K. Fredga, J. A. Cook, J. Niemimaa, A. Kaikusalo, H. Henttonen, A. Vaheri, and A. Plyusnin. 1999. Isolation and characterization of a hantavirus from *Lemmus sibiricus*: Evidence for host-switch during hantavirus evolution. Journal of Virology 73:5586-5592.

Wolf, C. M., T. Garland Jr., and B. Griffith. 1998. Predictors of avian and mammalian translocation success: Reanalysis with phylogenetically independent contrasts. Biological Conservation 86:243-255.

Xiao, X., J. M. Melillo, D. W. Kicklighter, Y. Pan, A. D. McGuire, and J. Helfrich. 1998. Net primary production of terrestrial ecosystems in China and its equilibrium responses to changes in climate and atmospheric CO_2 concentration. Acta Phytoecologica Sinica 22:97–118.

* former student using Unit-sponsored thesis data

Theses

Demboski, J. R. 1999. Molecular systematics and biogeography of long-tailed shrews (Insectivora: *Sorex*) and northern flying squirrels (Rodentia: *Glaucomys*). PhD dissertation, University of Alaska Fairbanks. 150 pp.

Ihl, C. 1999. Comparative habitat and diet selection of muskoxen and reindeer on the Seward Peninsula, western Alaska. MS thesis, University of Alaska Fairbanks. 81 pp.

Keech, M. A. 1999. Life-history consequences of maternal condition in Alaskan moose. MS thesis, University of Alaska Fairbanks. 46 pp.

Mallek, E. J. III. 1999. Plant architecture and forage selection by moose. MS thesis, University of Alaska Fairbanks. 63 pp.

Stark, T. C. 1999. Spawning stocks and juvenile summer habitat of rainbow trout and steelhead, Gulkana River, Alaska. MS thesis, University of Alaska Fairbanks. 119 pp.

Tydingco, T. A. 1999. The effects of timber harvest practices on fish habitat in Kenai Peninsula streams. MS thesis, University of Alaska Fairbanks. 56 pp.

Reports

Bowyer, R. T., G. M. Blundell, M. Ben-David, S. C. Jewett, T. A. Dean, and L. K. Duffy. 1999. Effects of the *Exxon Valdez* oil spill on river otters: Injury and recovery of a sentinel species. Final report to BRD/USGS, RWO 40. 108 pp. + 22 figs.

French, H. B. and E. H. Follmann. 1999. Assessing and managing the impact of humans along national park coastlines in southcentral Alaska: Bears as an indicator. Annual report to NPS, RWO 86. 9 pp.

LaPerriere, J. D. 1999. Inlet contributions of ions to Becharof Lake in relation to its fisheries. Final report to the Cooperative Research Units/BRD/USGS and the Rapid Response Program, Alaska Regional Office, U.S. Fish and Wildlife Service, RWO 74. 15 pp.

LaPerriere, J. D. 1999. Water quality inventory and monitoring—Gates of the Arctic National Park and Preserve, 1992–1995. Final report to the National Park Service, RWO 4. 108 pp.

McGuire, A. D., P. E. Seiser, and L. K. Duffy. 1999. Mechanisms of impact and potential recovery of nearshore vertebrate predators: Final report for the pigeon guillemot (*Cepphus columba*) component. Final report to BRD/USGS, RWO 40. 27 pp. + 8 figs.

Murphy, E. C. 1999. Population numbers and reproductive success of common murres and black-legged kittiwakes at Bluff, Alaska, in 1998. Final report to the U.S. Fish and Wildlife Service, RWO 79. 15 pp.

Presentations

Bidlack, A. L. and J. A. Cook. June 1999. Population genetics of an island endemic, the Prince of Wales flying squirrel (*Glaucomys sabrinus griseifons*). Seventy-ninth Annual Meeting, American Society of Mammalogists, Seattle, WA.

Blundell, G. M. May 1999. Effects of food resources on the spacing behavior of river otters: Does forage abundance control home range size? Fifteenth International Symposium on Biotelemetry, Juneau, AK.

Blundell, G. M., M. Ben-David, and R. T. Bowyer. September 1999. Social organization in river otters: Cooperative foraging or reproductive strategies? AAAS, 50th Arctic Science Conference, Denali National Park, AK.

Blundell, G. M., R. T. Bowyer, L. K. Duffy, T. A. Dean, S. C. Jewett, and J. J. Stegeman. April 1999. River otters ten years after the *Exxon Valdez* oil spill: Recovery or continued exposure? Annual Meeting, Alaska Chapter, The Wildlife Society, Fairbanks, AK.

Blundell, G. M., R. T. Bowyer, L. K. Duffy, T. A. Dean, S. C. Jewett, and J. J. Stegeman. April 1999. River otters ten years after the *Exxon Valdez* oil spill: Recovery or continued exposure? A Symposium of Women in Science, Fairbanks, AK.

Blundell, G. M., R. T. Bowyer, L. K. Duffy, T. A. Dean, S. C. Jewett, and J. J. Stegeman. June 1999. Chronic effects of the *Exxon Valdez* oil spill: Is recovery complete? Annual Meeting, Society for Conservation Biology, University of Maryland, College Park, MD.

Blundell, G. M., R. T. Bowyer, L. K. Duffy, T. A. Dean, S. C. Jewett, and J. J. Stegeman. September 1999. River otters ten years after the *Exxon Valdez* oil spill: Recovery or continued exposure? Sixth Annual Conference, The Wildlife Society, Austin, TX.

Blundell, G. M., R. T. Bowyer, M. Ben-David, T. A. Dean, and S. C. Jewett. April 1999. Effects of food resources on the spacing behavior of river otters: Does forage abundance control home range size? Annual Meeting, Alaska Chapter, The Wildlife Society, Fairbanks, AK.

Blundell, G. M., R. T. Bowyer, M. Ben-David, T. A. Dean, and S. C. Jewett. April 1999. Effects of food resources on the spacing behavior of river otters: Does forage abundance control home range size? A Symposium of Women in Science, Fairbanks, AK.

Blundell, G. M., R. T. Bowyer, M. Ben-David, T. A. Dean, and S. C. Jewett. June 1999. Sociality in river otters: Cooperative foraging or reproductive strategies? Seventy-ninth Annual Meeting, American Society of Mammalogists, Seattle, WA.

Brown, R. May 1999. Performance of Yukon River inconnu equipped with external versus esophageal radio transmitters. Fifteenth International Symposium on Biotelemetry, Juneau, AK.

Clein, J. S., B. L. Kwiatkowski, A. D. McGuire, J. E. Hobbie, and E. B. Rastetter. August 1999. Modeling carbon response of tundra ecosystems to historical and projected climate: A comparison of a regional- and a global-scale ecosystem model applied to the Kuparuk Basin. Eighty-fourth Annual Meeting, Ecological Society of America, Spokane, WA.

Copass, C., A. D. McGuire, and F. S. Chapin III. March 1999. A dynamic vegetation model for the Pan-Arctic. LAII (Land-Atmosphere-Ice Interaction) Workshop and ATLAS (Arctic Transitions in the Land-Atmosphere System) Meeting, Seattle, WA.

Danks, F. S. and D. R. Klein. August 1999. Development of a muskox habitat map for northern Alaska using GIS. Tenth Arctic Ungulate Conference, Trømso, Norway.

Debevec, E. M. and E. A. Rexstad. August 1999. Modeling temporal patterns in microtine abundance in Denali National Park and Preserve. Eighty-fourth Annual Meeting, Ecological Society of America, Spokane, WA.

Debevec, E. M. and E. A. Rexstad. September 1999. Detecting change in the small mammal population of Denali's Rock Creek watershed: Can it be done? AAAS, 50th Arctic Science Conference, Denali National Park, AK.

Debevec, E. M. and E. A. Rexstad. September 1999. Modeling temporal patterns in microtine abundance in Denali National Park and Preserve. AAAS, 50th Arctic Science Conference, Denali National Park, AK.

Debevec, E. M. and E. A. Rexstad. September 1999. Two avian components of Denali's long-term ecological monitoring program: Congruence of constant-effort mistnets and point-count routes. AAAS, 50th Arctic Science Conference, Denali National Park, AK.

Griffith, B. January 1999. Integrating the effects of climate and development a subsistence resource for Arctic communities. President’s Seminar, Institute of Arctic Biology, University of Alaska Fairbanks.

Griffith, B. February 1999. The need for herd specific predictive models that integrate the effects of climate and development on caribou as a subsistence resource for arctic communities. Invited Plenary Lecture, Workshop on Human Role in Reindeer/Caribou Systems, sponsored by the International Arctic Science Committee, Rovaniemi, Finland.

Griffith, B. April 1999. Habitat and foraging ecology of the Bathurst caribou herd on calving grounds: I. West Kitikmeot Slave Study Society, Investigators Meeting, Yellowknife, YT, Canada.

Griffith, B. May 1999. Effects of recent climate warming on caribou habitat and calf survival. BRD Status and Review Meeting, Tucson, AZ.

Griffith, B. August 1999. Effects of recent climate warming on caribou habitat and calf survival. Invited Paper, Workshop on Biota and Climate Change, 84th Annual Meeting, Ecological Society of America, Spokane, WA.

Griffith, B. August 1999. Landscape distribution of ungulates: Influence of forage and predation. Invited Plenary Lecture, Ecology and Management of Ungulates: Integrating Across Spatial Scales Conference, Nelson, BC, Canada.

Griffith, B. September 1999. Assessing effects of oil development on June calf survival for the Porcupine caribou herd. Final Cooperator Community Meeting, Sustainability of Arctic Communities Project, Old Crow, YT, Canada.

Griffith, B., D. C. Douglas, D. E. Russell, R. G. White, T. R. McCabe, and K. R. Whitten. September 1999. Implications of recent climate warming for caribou habitat, demography, and population size. Invited Plenary Lecture, The Norwich Conference: Climate Change and Wildlife, University of East Anglia, Norwich, United Kingdom.

Griffith, B. and D. E Russell. August 1999. Integrating the effects of climate and development on the Porcupine Caribou Herd. Tenth Arctic Ungulate Conference, Trømso, Norway.

Griffith, B., D. E. Russell, and R. G. White. September 1999. Assessing effects of calving ground displacement on June calf survival for the Porcupine caribou herd. AAAS, 50th Arctic Science Conference, Denali National Park, AK.

Ihl, C. and D. R. Klein. August 1999. Comparative habitat and diet selection of muskoxen and reindeer on the Seward Peninsula, western Alaska. Tenth Arctic Ungulate Conference, Trømso, Norway.

Ihl, C. and D. R. Klein. August 1999. Summer feeding habits of a muskox herd on the Seward Peninsula, western Alaska. Tenth Arctic Ungulate Conference, Trømso, Norway.

Ihl, C., R. G. White, and D. R. Klein. August 1999. Lichen digestibility in muskoxen and reindeer. Tenth Arctic Ungulate Conference, Trømso, Norway.

Johnstone, J., D. E. Russell, and B. Griffith. August 1999. Modelling caribou response to seasonal and long-term changes in vegetation: II. Estimating seasonal changes in forage quality. Tenth Arctic Ungulate Conference, Trømso, Norway.

Keech, M. A., R. D. Boertje, R. T. Bowyer, and B. W. Dale. February 1999. Effects of birthweight on growth of moose calves: Do low-weight neonates compenstate? Annual Meeting, Oregon Chapter, The Wildlife Society, Lincoln City, OR.

Keech, M. A., R. T. Bowyer, J. M. Ver Hoef. April 1999. Life-history consequences of maternal condition in Alaskan moose. Annual Meeting of the Alaska Chapter, The Wildlife Society, Fairbanks, AK.

Klein, D. R. August 1999. Resolving complexity in reindeer and caribou grazing systems: The role of interdisciplinary research. Tenth Arctic Ungulate Conference, Trømso, Norway.

Klein, D. R. February 1999. Arctic grazing systems and industrial development: Can we minimize conflicts? Human Role in Reindeer/Caribou Systems Workshop, Rovaniemi, Finland.

Klein, D. R. September 1999. Walking in the footsteps of Aldo Leopold. Sixth Annual Conference, The Wildlife Society, Austin, TX.

Klein, D. R., P. Valkenburg, C. Bay, and F. S. Danks. August 1999. Climatic influences on forage quality for arctic ungulates: Implications of climate change. Tenth Arctic Ungulate Conference, Trømso, Norway.

Laursen, G. A., S. L. Stephenson, R. D. Seppelt, R. G. Treu, H. H. Burdsall, J. C. Landolt, L. H. Geiser, K. L. Dillman, B. A. Morrison, D. L. Moore, and R. V. Harris. October 1999. The Fungi, Lichenized Fungi, Slime Molds, Bryophyta, Mycorrhizae, and Mycophagy of Fungi in Alaska's Western Arctic, Riparian, Sand Dune, and Boreal Forests, Beringian Shared Heritage National Parks. Beringia Days, sponsored by the National Park Service, Anchorage.

Lenart, E. A., R. T. Bowyer, J. Ver Hoef, and R. W. Ruess. April 1999. Climate and caribou: Effects of summer weather on the Chisana caribou herd. A Symposium of Women in Science, Fairbanks, AK.

Maier, J. A. K., R. G. White, S. M. Murphy, and M. D. Smith. August 1999. Effects of overflights by low-altitude jet aircraft on habitat and terrain use by caribou. Tenth Arctic Ungulate Conference, Trømso, Norway.

McDonough, T. and E. Rexstad. June 1999. Response of *Clethrionomys rutilus* to spruce beetle infestations in the Copper River Basin, Alaska. Seventy-ninth Annual Meeting, American Society of Mammalogists, Seattle, WA.

McGuire, A. D. June 1999. The role of high latitude ecosystems in the global carbon cycle: Insights and uncertainties identified from retrospective analyses. How Nutrient Cycles Constrain Carbon Balances in Boreal Forests and Arctic Tundra Conference, Obispo National Park, Sweden.

McGuire, A. D. and CCMLP Participants. December 1999. The response of terrestrial carbon storage between 1980 and 1989 to changes in atmospheric carbon dioxide, climate, and agricultural land use: A comparison among terrestrial biosphere models in the Carbon Cycle Model Linkage Project (CCMLP). American Geophysical Union conference, San Francisco, CA.

McGuire, A. D., J. M. Melillo, J. T. Randerson, W. J. Parton, M. Heimann, R. A. Meier, J. S. Clein, D. W. Kicklighter, and W. Sauf. February 1999. Modeling the effects of snow on heterotrophic respiration across northern temperate high latitude regions: Measurements of atmospheric carbon dioxide in high latitudes. BOREAS (Boreal Ecosystem Atmosphere Study) Synthesis Workshop, Tallahassee, FL.

McGuire, A. D., J. M. Melillo, J. T. Randerson, W. J. Parton, M. Heimann, R. A. Meier, J. S.Clein, D. W. Kicklighter, and W. Sauf. March 1999. Modeling the effects of snow on heterotrophic respiration across northern temperate high latitude regions: Measurements of atmospheric carbon dioxide in high latitudes. LAII (Land-Atmosphere-Ice-Interactions) Workshop, Seattle, WA.

McGuire, A. D., J. S. Clein, J. M. Melillo, and D. W. Kicklighter. August 1999. The sensitivity of simulated net ecosystem production in mature black spruce (*Picea mariana*) to two different formulations of soil nitrogen transformations in the Terrestrial Ecosystem Model. Annual Meeting, North American Chapter, International Society for Ecological Modeling.

McGuire, A. D., J. S. Clein, J. Melillo, D. Kicklighter, R. A. Meier, C. J. Vörösmarty, and M. C. Serreze. February 1999. Modeling carbon responses of tundra ecosystems to historical and projected climate: The sensitivity of Pan-Arctic carbon storage to temporal and spatial variation in climate. BOREAS (Boreal Ecosystem Atmosphere Study) Synthesis Workshop, Tallahassee, FL.

McGuire, A. D., J. S. Clein, J. Melillo, D. Kicklighter, R. A. Meier, C. J. Vörösmarty, and M. C. Serreze. March 1999. Modeling carbon responses of tundra ecosystems to historical and projected climate: The sensitivity of Pan-Arctic carbon storage to temporal and spatial variation in climate. LAII (Land-Atmosphere-Ice-Interactions) Workshop, Seattle, WA.

Morris, W. May 1999. Surgical implantation of radio-transmitters in Arctic broad whitefish in Alaska. Fifteenth International Symposium on Biotelemetry, Juneau, AK.

Runck, A. M., J. A. Cook, and C. J. Conroy. June 1999. Molecular phylogeny of red-backed voles (*Clethrionomys* spp.). Seventy-ninth Annual Meeting, American Society of Mammalogists, Seattle, WA.

Scanlon, B. February 1999. The ecology and habits of the Arctic char and Dolly Varden in the Becharof Lake drainage, Alaska. Annual Meeting, Midnight Sun Flycasters Association, Fairbanks, AK.

Seiser, August 1999. The relationship between pigeon guillemot breeding success and Pacific herring, Clupea pallasi, abundance in Prince William Sound. One-hundred-seventeenth Meeting, American Ornithologists' Union, Ithaca, NY.

Seiser, P. E. February 1999. Interannual variability in the reproductive success of pigeon guillemots nesting on Jackpot Island in southwestern Prince William Sound, Alaska, 1994-98. Pacific Seabird Group Conference, Blaine, WA.

Stone, K. D. and J. A. Cook. June 1999. Characterizing a region of contact between two lineages: Marten of the Pacific Northwest. Evolution '99 Joint Meeting, Madison, WI.

Stone, K. D. and J. A. Cook. June 1999. Nuclear and mitochondrial perspectives of a contact zone of marten (*Martes americana*). Seventy-ninth Annual Meeting, American Society of Mammalogists, Seattle, WA.

White, R. G., J. Johnstone, D. E. Russell, B. Griffith, H. Epstein, M. Walker, F. S. Chapin III, and C. Nicolson. August 1999. Modelling caribou response to seasonal and long-term changes in vegetation: I. Development of an algorithm to generate diet from vegetation composition and application to projections of climate change. Tenth Arctic Ungulate Conference, Trømso, Norway.

Wolfe, S. A., B. Griffith, R. D. Cameron, R. G. White, and S. M. Murphy. August 1999. Habitat selection by calving caribou of the Central Arctic Herd, 1980-1995. Tenth Arctic Ungulate Conference, Trømso, Norway.

Zacheis, A. B., J. W. Hupp, and R. W. Ruess. August 1999. Nitrogen cycling in an Alaskan coastal marsh: Effects of herbivory, landscape, and season. Eighty-fourth Annual Meeting, Ecological Society of America, Spokane, WA.

Zacheis, A. B., J. W. Hupp, and R. W. Ruess. September 1999. Nitrogen cycling in an Alaskan coastal marsh: Effects of geese on soil pools and fluxes. AAAS, 50th Arctic Science Conference, Denali National Park, AK.

Zhang, X., A. D. McGuire, and R. W. Ruess. September 1999. The pattern of canopy nitrogen in Alaskan black spruce ecosystems. AAAS, 50th Arctic Science Conference, Denali National Park, AK.

Zhuang, Q., V. E. Romanovsky, A. D. McGuire, J. S. Clein, and X. Zhang. September 1999. A completed model of soil thermal and biogeochemical dynamics for application to boreal forest ecosystems: Evaluation of temporal and spatial scaling conference. AAAS, 50th Arctic Science Conference, Denali National Park, AK.

Zhuang, Q., V. E. Romanovsky, J. S. Clein, A. D. McGuire, J. M. Melillo, D. W. Kicklighter, and S. Wofsy. March 1999. Coupling a soil thermal model with a large-scale biogeochemical model: Comparison of simulated and field-based monthly soil temperatures and carbon fluxes in an old black spruce stand. LAII (Land-Atmosphere-Ice-Interactions) Workshop, Seattle, WA.

Honors and Awards

Allison Bidlack (MS); Karen Stone (PhD); and Amy Zacheis (PhD), all Biology students: Recipients of the UAF Thesis and Completion Fellowships and Graduate School Tuition Scholarships for academic year 1999–2000

Gail Blundell (PhD Wildlife) and Amy Zacheis (PhD Biology): Recipients of Honorable Mentions for their presentations at the AAAS Arctic Science Conference, September 1999. Gail Blundell also received a student travel award from the AAAS Arctic Science Division.

Cheryl Dion (MS Fisheries): Recipient of the Alaska Fly Fishers Natural Sciences Scholarship for academic year 1999–2000. She also received the Cultural Diversity Travel Award from the Alaska Chapter, American Fisheries Society, to attend the 1999 annual meeting.

David R. Klein; IAB Faculty Cooperator and former Senior Scientist: Recipient of the 1999 Aldo Leopold Memorial Award, presented by the Wildlife Society at the North American Wildlife and Natural Resources Conference, March 29, 1999, in recognition of "distinguished service to wildlife conservation."

Gary A. Laursen, DBW Faculty Cooperator: Appointed National Director for the Junior Science and Humanities Symposium Executive Board, 1999.

James B. Reynolds, SFOS Faculty Cooperator and former Unit Leader: Recipient of the Frank and Marjorie Meek Endowed Chair with the School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, July 1, 1999.

Research Reports

Reports are listed as Completed or Ongoing, in Aquatic, Terrestrial, or Integrated categories. The List of Abbreviations comprises the final pages of this report.

Completed Projects—Aquatic

The Ecology of the Arctic Char and the Dolly Varden in the Becharof Lake Drainage, Alaska

Personnel:

Dr. Jacqueline D. LaPerriere, Principal Investigator, AKCFWRU
Dr. James B. Reynolds, Principal Investigator, AKCFWRU
Brendan Scanlon, Student Investigator (MS), SFOS

Funding Source: USFWS (RWO 77)

Note: Brendan Scanlon defended his thesis June 7, 1999. His thesis abstract follows.

Abstract—Becharof Lake, located on the Alaska Peninsula, is home to both the Arctic char (*Salvelinus alpinus*) and the closely related Dolly Varden (*Salvelinus malma*), two species known not only to be similar in appearance but also to exhibit both anadromous and strictly freshwater life histories. The body morphometry, otolith microchemistry, and stomach contents of both species were studied in fish collected from May to September 1998. Morphometric and meristic analysis revealed clear separation in body structure between the two species, as well as potential sub-populations within each species. Otolith microchemistry revealed incidences of anadromy in both species. Stomach content analysis revealed a broad feeding niche but smaller ranges in food types in Arctic char with little seasonal preference, whereas Dolly Varden showed strong seasonality in food choices. Data suggest that both species can move in and out of the lake system, and that virtually no competition for food or habitat occurs between the two species in the summer months.

The Effects of Timber Harvest Practices on Fish Habitat in Kenai Peninsula Streams

Personnel:

Dr. James B. Reynolds, Principal Investigator, AKCFWRU
Troy A. Tydingco, Student Investigator (MS), SFOS

Funding Source: ADFG/SF

Note: Troy Tydingco graduated from UAF in May 1999. His thesis abstract follows.

Abstract—I evaluated the effects of logging on fish habitat in streams of the lower Kenai Peninsula, Alaska, during the summers of 1997 and 1998. Large woody debris, V* (the proportion of a pool filled with fine sediment), RASI (a measure of riffle particle composition as a function of the stream's capacity to transport it), and temperature were chosen as variables that would reflect fish-related changes in

habitat that might result from logging. Only temperature was significantly (α = .05) different (higher) in treatment areas. While I intended to assess the effects of logging on habitat under the protection of the Alaska Forest Resources and Practices Act, the logging operations that I investigated provided greater habitat than required. Therefore, although I was not able to fully evaluate protection provided to stream habitat by the Act, baseline habitat characteristics will be useful for evaluation of effects of future logging.

Completed Projects—Terrestrial

Effects of Jet Aircraft Overflights on Nesting Behavior and Productivity of Peregrine Falcons in Interior Alaska

Personnel:

Dr. Daniel D. Roby, Principal Investigator, ORCFWRU
Dana Nordmeyer, Student Investigator (MS), OSU

Funding Source: USAF (RWO's 30 and 73)

Completion Report:

In order to examine the potential impact of military jet overflights on productivity of peregrine falcons, we observed behavioral reactions of peregrines to disturbances at nests along the Tanana River, Alaska, during the 1995-1997 breeding seasons. Military jets conducted low-altitude flights over a sample of nests under observation in each year (experimental nests), while other nests were not intentionally overflown (reference nests). Animal Noise Monitors (ANMs) were deployed at each observed nest to measure noise dose level. A total of 878 above threshold (>85 dB) overflights were recorded by the ANMs during the course of the study. A total of 401 close (defined as <1000 m slant distance from nest) overflights by subsonic jet aircraft were recorded during observations. Peregrine falcons responded differently to animate and inanimate sources of disturbance, and responded most intensely and most frequently to other raptors. Flight reactions were common, but not in response to military jets. Intense behavioral responses to military jet overflights were rarely observed in this study, even at slant distances < 500 m, and no intense behavioral responses were observed at slant distances > 500 m. Peregrine falcon productivity in the study area was within the normal range for interior Alaska and the Tanana River. Dose of jet aircraft disturbance was not correlated with productivity. Productivity was, however, negatively correlated with reactivity: those falcons that responded more intensely to overflights tended to have lower productivity. The sensitivity of breeding peregrine falcons to low-altitude jet overflights was a better indicator of subsequent productivity than actual dose of overflights. This is likely a reflection of lower parental quality/investment among breeding pairs with high reactivity.

Effects of Migratory Geese on Plant Communities of an Alaskan Salt Marsh

Personnel:
Dr. Roger Ruess, Principal Investigator, IAB
Amy Zacheis, Student Investigator (PhD), DBW

Funding Source: USGS/BRD/ABSC (RWO 27)

Completion Report:

Snow geese feed on plant roots in winter and spring when there is little aboveground shoot growth, resulting in uprooting and destruction of forage plants. Expanding populations of snow geese in some areas of North America have degraded habitat along migratory routes and in nesting areas. We studied the effects of a stable population of snow geese and several populations of Canada geese on two salt marsh plant communities in Cook Inlet, Alaska, an area used during spring migration. We compared plots where geese were excluded by fencing to plots where grazing could occur. We also counted numbers of birds using the marsh, and determined the type of vegetation they fed on. Grazing intensity, or the number of goose-days per km^2, was low. Canada geese fed mainly on aboveground shoots of salt marsh plants, while snow geese fed on belowground plant tissues. Plant communities responded differently to goose herbivory. In the sedge meadow community, where feeding was primarily on aboveground shoots, there was no effect of grazing on plant biomass. In the herb meadow community, where snow geese fed on belowground plant tissues, there was a shift in the relative abundance of plant species. Plant species less tolerant to herbivory decreased in biomass, while more tolerant plants increased. The type of herbivory (above- or belowground) was important in determining plant community response to herbivory. This study illustrates that even light herbivore pressure can alter plant communities and possibly affect forage availability for herbivores. However, snow geese are not rapidly destroying habitat in this Cook Inlet marsh.

Molecular Systematics and Biogeography of Long-Tailed Shrews (Insectivora: *Sorex*) and Northern Flying Squirrels (Rodentia: *Glaucomys*)

Personnel:
Dr. Joseph A. Cook, Principal Investigator, DBW
John R. Demboski, Student Investigator (PhD), DCB

Funding Source: USFWS (RWO 67)

Note: John Demboski graduated from UAF in August 1999. His dissertation abstract follows.

Abstract—Insight into phylogenetic and biogeographic relationships among several mammalian taxa in western North America was provided with DNA sequences of two mitochondrial genes (cytochrome b and ND4). Members of two species complexes of long-tailed shrews (genus *Sorex*) and northern flying squirrels (genus *Glaucomys*) were examined, and a common theme of responses to past climate changes and glacial cycles was evident. Diversification events indicated by the DNA sequences provide new perspectives regarding the deep and shallow history of these taxa.

Analysis of seven species of the *Sorex cinereus* complex (and related species) revealed two major clades within the complex, Northern and Southern. These generally corroborate proposed morphological relationships and correspond to broadly defined habitat affiliations (xeric and mesic), respectively. Within the Northern clade, amphiberingian species represented a monophyletic group suggesting Beringia was a center of endemism. Next, five species of the *S. vagrans* complex and related species were assessed. Significant molecular variation was revealed that does not correspond to morphological differences within the complex. Two major clades within *S. monticolus* were observed, a widespread Continental clade (Arizona to Alaska, including *S. neomexicanus*) and a restricted Coastal clade (Oregon to southeast Alaska, including *S. bairdi* and *S. pacificus*). A regional examination of genetic variation in the northern flying squirrel in southeast Alaska was also performed. Results suggested that southern islands in the Alexander Archipelago were the result of recent colonization (founder event). Finally, a comparative phylogeographic analysis of a reduced data set (*S. monticolus*), a moledular data set for the American Pine Marten, *Martes americana*, and other published molecular studies were used to reexamine the role of glacial refugia in the biogeography of the north Pacific coast. Previous ideas regarding purported refugia may be overstated and may be the result of limited geographic sampling. This thesis provides new perspectives on processes (e.g., post-glacial colonization) driving mammalian phylogenetic and biogeographic structuring in western North America.

Life-History Consequences of Maternal Condition in Alaskan Moose

Personnel:

Dr. R. Terry Bowyer, Principal Investigator, IAB
Mark A. Keech, Student Investigator (MS), DBW

Funding Source: ADFG/WC

Note: Mark Keech graduated from UAF in May 1999. His thesis abstract follows.

Abstract—We studied characteristics of life-history of Alaskan moose (*Alces alces gigas*) including the effects of maternal condition of adult females on survival and physical condition of young during their first year-of-life. We also examined the relation between maternal condition and reproductive parameters of individual adult moose. We found that females in better physical condition, as indexed by rump-fat thickness, had higher rates of pregnancy, gave birth to more twins, and produced young with higher birth masses than did females with less rump fat. Expected time-to-death for individual young increased as birth mass increased and decreased with increasing birth date and litter size. Our results indicated maternal condition influenced subsequent variables associated with birth, which ultimately influenced future survival of offspring. Timing of parturition also occurred earlier for individual females with greater rump-fat thickness. That outcome suggested that timing of parturition was the result of environmental factors acting on females prior to birth.

Plant Architecture and Forage Selection by Moose

Personnel:
Dr. David R. Klein, Co-Principal Investigator, IAB
Dr. Donald E. Spalinger, Co-Principal Investigator, UAA
Edward J. Mallek, II, Student Investigator (MS), DBW

Funding Source: None—All in-kind support

Note: Edward Mallek graduated from UAF in August 1999. His thesis abstract follows:

Abstract—The effects of plant architecture on browse selection and the extent of use of *Salix alaxensis* and *Salix planifolia* by moose foraging in winter in Interior Alaska were studied during 1997 and 1998. Three sampling techniques were employed to estimate forage availability and utilization. Sampling forage availability prior to use (in autumn) provided the best estimates of forage use in spring. In *Salix planifolia*, selection of current annual growth (CAG) twigs was significantly related to basal diameter of CAG, diameter of nearest neighbor, distance to nearest neighbor, and number of leaders per cluster. In contrast, CAG selection in *Salix alaxensis* was related only to basal diameter. The proportion of CAG biomass removed from stems of either species was not related to any measured plant architecture variables. Because plant architecture affects browse use by moose, it is an important factor in determining food availability, and thereby in assessing moose habitat.

Survey of Fungal Endophytes in Arctic and Subarctic Caribou Forages

Personnel:
Dr. Roger Ruess, Principal Investigator, IAB
Dr. Brad Griffith, Co-Principal Investigator, AKCFWRU

Funding Source: ADFG

Completion Report:

Over 250 species of graminoids contain endophytic fungi. These fungi (genus *Acremonium*) produce a series of alkaloids that can be highly toxic to herbivores. While mycotoxin-producing endophytes have long been a concern in animal husbandry, their significance in natural grazing systems has only recently been questioned. We initiated a pilot study to (1) establish the laboratory protocol for preparing and staining tissues for microscopic screening of fungal endophytes, and (2) begin a survey of endophyte infection in forages of caribou, particularly *Eriophorum vaginatum*. Difficulties arose with consistently achieving sufficient stain density in the fungus. After screening dozens of samples of Poa and Festuca from sites throughout interior and western Alaska, we found no evidence of *Acremonium* infection. Neither did we find endophyte infection in our samples of *Eriophorum vaginatum* from the North Slope. However, we are cautious about concluding that fungal endophytes play no role in the nutritional ecology of Alaskan grazers. We were not able to examine early-season reproductive shoots of *Eriophorum*. The literature emphasizes the tremendous temporal and spatial variability in mycotoxin-producing endophytes. One research group with whom we have discussed these issues uses an antibody-screening reaction specific to the endophyte protein coat that allows the processing of thousands of samples per day (as opposed to 10 with staining). We

would recommend that if this research question is to receive further attention, that this procedure be developed and coupled with a significantly more intensive collection program.

In-Kind Support:

Laboratory space and equipment from UAF.

Understanding the Response of Caribou to Human Activities: A Literature Review

Personnel:
Dr. Brad Griffith, Principal Investigator, AKCFWRU
Scott A. Wolfe, Student Investigator (MS), DBW

Funding Sources: Department of Indian Affairs and Northern Development, and Northwest Territories, Department of Resources, Wildlife, and Economic Development

Completion Report:

The objective of this project was to conduct a literature review of the response of arctic calving caribou to human disturbance, to interpret this literature, to assess the limits of published work, and to suggest most profitable areas for future research. The project was completed, a final report was delivered to the contractor, and a manuscript was submitted to Polar Research.

In-Kind Support:

Literature search access through UAF subscriptions.

Comparative Habitat and Diet Selection of Muskoxen and Reindeer on the Seward Peninsula, Western Alaska

Personnel:
Dr. David R. Klein, Principal Investigator, IAB
Claudia Ihl, Student Investigator (MS), DBW

Funding Sources: ABSC and CRU/USGS and NPS (RWO 50)

Note: Claudia Ihl graduated from UAF in May 1999. Her thesis abstract follows.

Abstract—Factors influencing choice of feeding sites, cratering microsites and diets of reindeer (*Rangifer tarandus*) and reintroduced muskoxen (*Ovibos moschatus*) were examined on the Seward Peninsula, western Alaska, during late winters of 1996 and 1997. Both ungulates foraged primarily in upland habitats with low snow depth, relatively high occurrence of lichens and low occurrence of graminoids. Both selected against snow depth when choosing feeding sites and against snow depth and hardness when selecting cratering areas within feeding sites. Diet selection differed between species. Reindeer selected mainly lichens while muskoxen selected more sedge and moss. Few behavioral interactions between species were observed, and

none seemed to result in displacement of either species. Despite similar use of late winter feeding sites, competition between muskoxen and reindeer in this study area is not likely at the moment, but may occur if severe snow conditions or increasing densities of either species restrict available winter habitat.

Completed Projects—Integrated

National Projections of Forest Productivity under Climate Change

Personnel:
Dr. A. David McGuire, Principal Investigator, AKCFWRU

Funding Source: USFS (RWO 87)

Completion Report:

The purpose of this study was to apply the Terrestrial Ecosystem Model (TEM) in examining the effect of climate change on forest productivity within the United States and to establish a set of ecological scenarios that could be used to examine impacts on the services, needs, and goods in the forest sector nationally. The study, which was part of the USDA Forest Service's 1998 Resource Planning Act (RPA) Assessment, has also contributed to the efforts by the National Assessment Synthesis Team to assess the impacts of potential climate change on the forest sector of the United States. In 1998, Dr. A. David McGuire of AKCFWRU assisted Dr. Linda Joyce of the USDA Forest Service Rocky Mountain Range and Experiment Station in obtaining and organizing transient climate scenarios (1900 to 2100) for application with TEM. The projected period of these scenarios is based on transient climate simulations by a climate model that incorporates the effects of sulfate aerosols and a fully coupled ocean model. Simulations with TEM have been conducted using a projected climate scenario produced by simulations of climate model from the Hadley Centre and the Canadian Climate Center. Dr. McGuire assisted Dr. Joyce in interpreting the results of these simulations and in summarizing the results for incorporation into economic simulations of the forest sector. These results of the ecological simulations appear in Chapter 11 (Forests) in the National Assessment Synthesis Team Foundation Document, which is a draft report (Climate Change and America) of the U. S. Global Change Research Program to Congress.

Chemical/Physical Limnology and Zooplankton Ecology of Lake Clark

Personnel:

Dr. Jacqueline D. LaPerriere, Principal Investigator, AKCFWRU
Dr. Nicholas F. Hughes, Principal Investigator, SFOS
Alexander Wilson, Student Investigator (MS), DBW

Funding Source: NPS (RWO 84)

Progress Report:

Lake Clark, the sixth largest lake in Alaska, plays a critical role in the largest sockeye salmon fishery in the world. Sockeye salmon are a keystone species for which Lake Clark National Park and Preserve was established to protect. For unknown reasons, during the last four years the number of sockeye salmon returning to Lake Clark has been 75-95% lower than the previous 10-year average. Changes in the water quality of Lake Clark have the potential to alter its productivity and suitability for juvenile salmon, which spend the first 1-3 years rearing in freshwater before migrating to sea. Unfortunately, there is little baseline water quality information available for the lake. This study attempts to describe the current limnological conditions of Lake Clark, focusing on the chemical/physical factors, zooplankton ecology, and the seasonal distribution of temperature in the lake. Samples were taken during June, July, and August 1999 during weekly forays to each of five stations on the lake, where measurements of color, light, oxygen, pH, conductivity, oxidation/reduction potential, and temperature were made, and triplicate samples were taken for zooplankton, phytoplankton, and suspended solids. All data have been compiled and all samples, except zooplankton, have been processed. Preliminary analysis of chemical/physical data has begun. The results from the 1999 field season will determine the direction and extent of the 2000 field season. Soon after that, final conclusions will be drawn and management implications made.

In-Kind Support:

- AKCFWRU provided gear, instrumentation, budget management, and shipping services.
- Lake Clark NPP provided 3 months of field housing; 400 hours of boat support; 300 hours of volunteer time; 1 hour overflight time; boat, bear, and gun training; computer time; and materials support.
- NPS Regional Office, Anchorage, provided materials for a winch and the buoy sets, as well as technical information.
- Arctic Wire Rope & Supply donated 30 hours of facilities time.
- Eric McCallum of Arctic Wire Rope & Supply volunteered 20 hours for technical support for setting buoys.
- IAB provided cost transfer services.

The Ecological Role of Natural Reefs and Oil and Gas Production Platforms on Rocky Reef Fish of Southern California: Genetics Subsection

Personnel:
Dr. Anthony J. Gharrett, Principal Investigator, SFOS
MeiMei Li, Student Investigator (MS), SFOS

Funding Source: USGS/BRD/Western Regional Office (RWO 32)

Progress Report:

There are more than 70 species of rockfish in the Eastern Pacific Ocean and many share morphological similarities, especially during the early life stages (larval and juvenile). In order to better understand their early life history and phylogenetic history, I worked on the development of a key for identification of rockfish species (Genus *Sebastes*) by mapping restriction sites and the assessment of the validity of their taxonomic assignment. The species I studied include six of the subgenus *Pteropodus*, *S. maliger*, *S. caurinus*, *S. carnatus*, *S. chrysomelas*, *S. nebulosus*, and *S. rastrelliger*, and *S. atrovirens* of the subgenus *Mebarus*, and *S. auriculatus* and *S. dalli* of the subgenus *Auctospina*, all of which occur in the Eastern Pacific. *Pteropodus* and *Mebarus* species that occur in the Western Pacific were also examined, including *S. hubbsi*, *S. nivosus*, *S. trivitattus* (*Pteropodus*), and *S. taczanowski*, *S. thompsoni*, *S. joyneri*, and *S. inermis* (*Mebarus*). Ten restriction enzymes were used to examine the NADH-dehydrogenase-3 and NADH-dehydrogenase-4 regions and 12s/16s regions of mitochondrial DNA. Variation in restriction patterns revealed distinguishing features for all pairs of species except for *S. carnatus* and *S. chrysomelas*. Preliminary cladistic studies show that the Eastern Pacific *Pteropodus*, *Mabarus*, and *Auctospina* species are similar genetically and differ from other subgenera in the same region, while the Western Pacific species differ from their Eastern Pacific relatives and should probably be assigned to different subgenera.

In-Kind Support:

The Auke Bay Lab, University of California at Santa Barbara, and Alaska Fishery Science Center at Sandpoint, Seattle provided rockfish tissue samples.

The Application of New DNA Methodologies for the Stock Identification of Alaska Salmonids

Personnel:
Dr. Anthony J. Gharrett, Principal Investigator, SFOS
Blair Flannery, Student Investigator (MS), SFOS

Funding Source: USFWS (RWO 92)

Progress Report:

Genetics is a tool used in fishery management. Using genetics, managers are often able to distinguish among stocks of salmon and improve their ability to protect a stock from being overfished, thereby ensuring that salmon continue to thrive in Alaskan waters. This project resulted from the inability of older genetic techniques to distinguish baseline stocks of Yukon River chum salmon that spawn in the area

around the U.S./Canada border. The Pacific Salmon Treaty mandates that the salmon resource be fairly allocated between the two countries. The ability to determine the country of origin for the chum stocks is essential for fulfilling this mandate. In order to accomplish this, a baseline of all stocks must be established. In the future, salmon coming into the Yukon will be compared against the baseline to determine where that school of salmon is headed. This information will enable managers to make better decisions. My experiment consists of identifying new genetic procedures useful for stock identification. I am assessing several DNA-based analyses. The methods that I find promising in a pilot study will be further evaluated using nine Yukon River stocks of chum salmon that are adjacent to the U.S./Canada border. The techniques that best define the stocks will be deployed on the remaining samples. Final results will be based on 900 samples and analyzed using established statistical procedures. Currently, DNA has been extracted from the samples and preliminary lab work is underway.

An Age-Structured Model for Assessment and Management of Copper River King Salmon

Personnel:

Dr. Terrance J. Quinn II, Principal Investigator, SFOS
James W. Savereide, Student Investigator (MS), SFOS
Dr. Margaret Merritt, Cooperator, ADFG/SF Fairbanks

Funding Source: ADFG/SF (RSA)

Progress Report:

In May, I flew to Cordova to collect chinook salmon scales from the Copper River commercial fishery. I spent the rest of the summer collecting scales from the Gulkana and Klutina River sport fisheries and the Copper River personal use fishery. At the end of the field season all the samples were sent to Cordova to be aged. Data were combined with previous years', and the age composition of the catch by year was determined. At this point, a conceptual model is constructed that uses catch-age analysis with auxiliary information (indices of spawning abundance) to estimate total return. Age-structured assessment models can combine a variety of information about fish populations to estimate population parameters. This model provides predictions of these various information sources based on important population processes, like the spawner-recruit relationship, age at maturity, as well as vulnerability to harvest or exploitation fraction. Using the age composition of the catch, initial parameter estimates of total brood return by year are estimated. These initial estimates are used to estimate population parameters by applying the appropriate catch-age model formulas. Final parameter estimates are obtained by optimizing an objective function that minimizes the differences between observed and model predicted estimates of catch and escapement. The goal is to estimate the total return each year from information about spawning and catch. At this time, the model is only utilizing catch data from the commercial fishery. The addition of sport, subsistence, and personal use fisheries needs to be completed, along with a variety of sensitivity analyses. I hope to be done in fall 2000.

In-Kind Support:

- ADFG/SF Fairbanks (especially Peggy Merritt, Matt Evenson, Tom Taube, and Tim Viavant) provided airplane travel to and from Cordova. They also provided all the sampling gear, accommodations, and a truck and 6-wheeler for travel between Glennallen, Chitina, and Fairbanks. I was also given an office and computer to work on my research at ADFG Fairbanks.
- ADFG/CFMD Cordova (especially Steve Moffitt) provided accommodations in Cordova, the opportunity to participate in the commercial fishery scale sampling, and determining the ages of sampled chinook.

Seasonal Movements of Broad Whitefish in Freshwater Systems of the Prudhoe Bay Oil Field

Personnel:

Dr. Erich H. Follmann, Principal Investigator, IAB
Dr. James B. Reynolds, Co-Principal Investigator, AKCFWRU
William A. Morris, Student Investigator (MS), DBW

Funding Source: ADFG/HR (RSA)

Progress Report:

Little is known about broad whitefish seasonal migrations and overwintering site selection in the Prudhoe Bay area of the Beaufort Sea coast, Alaska. Broad whitefish, a highly used subsistence fish along the northcentral coast of Alaska, move to spawning and overwintering areas in the Prudhoe Bay region that may be impacted by oil field development through ice-road and other construction projects that occur during winter. The object of this study was to determine the timing of seasonal migrations to better understand when fish are moving in and between river systems as well as to locate specific overwintering sites. Fish were implanted with radio-transmitters and tracked for over a year, in most cases. Results are based on 28 months of tracking involving two groups of broad whitefish, one group tagged in 1997 (6 fish) and one group tagged in 1998 (31 fish). Results indicate that broad whitefish may move between overwintering areas as late as December and that some fish move between far-distant river systems, as at least two fish moved to the Colville River, over 100 km away. Water quality of overwintering sites was marginal at best; dissolved oxygen was usually much reduced by May, salinity levels were often increased, and water depth under the ice was often about a foot. Thus, slight environmental fluctuations could have dramatic consequences to overwintering success at these sites. Similarly, oil field construction of ice-roads on or across rivers can have similar impacts; thus, overwintering sites should be avoided and on-river construction should not occur until after late December.

In-Kind Support:

ADFG/HR Fairbanks provided about 5 hours of air time in a Cessna 206 to radio-track broad whitefish.

Habitat Characteristics Selected by Arctic Grayling Fry and Fingerling in Badger Slough, near North Pole, Alaska

Personnel:

Dr. James B. Reynolds, Principal Investigator, AKCFWRU
Dr. Nicholas F. Hughes, Co-Principal Investigator, SFOS
Cheryl A. Dion, Student Investigator (MS), SFOS

Funding Source: ADFG/SF (RSA)

Progress Report:

Badger Slough is a result of flood control projects initiated in the early 1940s. Since then it has become a highly productive spawning and rearing habitat for Arctic grayling and local fishery. However, establishment of the fishery coincided with residential and commercial development along its shore and ADFG/SF has expressed concern over the apparent decline in grayling numbers. The quality and quantity of favorable spawning and rearing habitat may be declining due to anthropogenic (e.g. urbanization, road culverts) and/or successional (e.g., beaver dams, filling in of gravel riffles/pools with sediment, eutrophication) changes. In this study, we are examining interactive effects of drifting prey and physical habitat characteristics (water depth, velocity, temperature, and substrate) on foraging, growth, and habitat selection of grayling. This knowledge will be essential for restoring/enhancing habitat and understanding early life history energetics of grayling. In 1999, average daily temperature, weekly fish growth, discharge measurements, and fish distribution was documented; 64 fish were preserved for diet analysis. Gravel cleaning/vegetation removal was conducted in September, using a suction dredge and garden rakes. The objectives for 2000 are to (1) test cleaned versus uncleaned gravel areas for fish preference and invertebrate density; and (2) examine difference in temperature, depth, velocity, and food in areas with high, intermediate, and low fish density, then put into a bioenergetics model. The model will be used to explain differences in fish abundance and growth between habitats and to test its ability to predict habitat quality for use as a guide for restoration.

In-Kind Support:

Curtis Josaitis and Jim Spence approved the deposition of sediment on their property.

Standardized Evaluation of Electrofishing Injury among North American Freshwater Sport Fishes

Personnel:

Dr. James B. Reynolds, Principal Investigator, AKCFWRU
F. Michael Holliman, Student Investigator (PhD), SFOS

Funding Source: USFWS (RWO 57)

Progress Report:

Electrofishing is a fish population sampling technique used widely by freshwater fisheries managers. In recent years, fisheries managers have expressed concerns about electrofishing-induced injuries in fish. In some cases, moratoriums on electrofishing have been enacted without evidence of significant injury, thereby eliminating the use of a likely effective management tool. In 1999, the second year of our three-year study, we conducted three experiments to evaluate risk factors associated with electrofishing injury. Injury was defined in the experiments as muscle hemorrhage or spinal damage and was evaluated via filleting and radiography. An experiment on rainbow trout *Oncorhynchus mykiss* indicated that waveform, size group, and voltage level had significant effects on injury rates. In contrast, an experiment on Nile tilapia *Tilapia nilotica*, using voltage levels similar to those employed in the rainbow trout experiment, revealed no injuries in these resilient fish. An electrofishing injury and short-term mortality experiment was conducted on hatchery-reared Cape Fear shiner *Notropis mekistocholas*, an endangered minnow. No mortality occurred in eight of the 10 experimental groups, but in two groups involving the highest voltage used (340 volts) some mortality (25-38%) did occur. No muscle hemorrhage or spinal damage was found in both surviving and non-surviving fish. Our results indicate that the injurious effects of electrofishing are minimal or nonexistent in some species. Proper selection of technical factors (e.g., waveform, voltage) can reduce electrofishing injury and mortality to acceptable levels.

In-Kind Support:

- ADFG/SF: Use of an electrofishing boat and operator for calibration of electric field measurements. Use of facilities and supplies at the Fort Richardson Hatchery, Anchorage, AK.
- FWS: Use of facilities and supplies at the Edenton National Fish Hatchery, Edenton, NC.
- NCCFWRU: Use of facilities and supplies at the Reedy Creek Fish and Wildlife Research Lab, Raleigh, North Carolina. Provision of ground transportation and supplies for research conducted in Edenton, NC.
- NCSU-Fish Barn: Donation of Nile tilapia for experimental use.
- IAB: Use of radiographic and autopsy facilities of the LARS.
- Smith-Root, Inc: Use of electrofishing control box for all experiments.

Development and Evaluation of National Guidelines for Electrofishing

Personnel:

Dr. James B. Reynolds, Principal Investigator, SFOS
F. Michael Holliman, Student Investigator (PhD), SFOS

Funding Source: None

Progress Report:

Electrofishing is a widely used assessment method for freshwater sport fisheries in the U.S. and Canada. Many agencies have expressed keen interest in the “standardization” of electrofishing for comparative purposes. True standardization (i.e., widely regulated equipment and methods) is an unrealistic goal, given the diversity of electrofishing techniques and operational rules among state and federal agencies. Nevertheless, our understanding and use of electrofishing have reached

the point where national guidelines could be developed, thus providing a basis for widespread comparison and communication of data, something that is now difficult to obtain without guidelines. Two primary obstacles remain in establishing such guidelines: authentication (operational validity) and acceptance (operational value). The basic approach of this study is to achieve authentication of national guidelines for electrofishing through the practical application of power transfer theory. The guidelines will be based on the basic elements of electrofishing: power density, electrical waveform, electrode design, and fish response. Authentication, and this project, will be completed by December 2001. Acceptance of the guidelines will only occur after this project has been completed, given time for use and trust of the guidelines by a wide variety of agencies and organizations.

Effects of Smolt Size and Emigration Timing on Marine Survival and Age at Maturity of Wild Coho Salmon (*Oncorhynchus kisutch*) at Auke Creek, Southeast Alaska

Personnel:

Dr. William W. Smoker, Principal Investigator, SFOS
Judith Lum, Student Investigator (MS), SFOS

Funding Source: ADFG/SF (RSA)

Progress Report:

Survival, age of males at maturity, and adult size of coho salmon may be influenced by their size as smolts (young salmon leaving freshwater for the ocean) and by their ocean entry time. Understanding differences in survival, age, and size over years is important to fishery managers also charged with conserving stocks, and to scientists trying to explain and predict effects of natural and human-caused ecological changes. How these factors vary within or between populations of wild coho salmon, particularly for Alaskan stocks, is unclear. As part of ongoing NMFS research, I am examining effects of smolt size and ocean entry time on marine survival, age, and size of return, in a population of wild coho salmon at Auke Creek, Alaska. Beginning in 1993, smolts were captured daily during their seaward migration by five inclined perforated-fan traps, sorted into four size groups, and tagged with uniquely coded microwires so that recovery information could be related to time and size of fish leaving the stream. We decoded tags from returning adults found after spawning above Auke Lake and determined the number of returning fish within each time and size category. ADFG provided information on tagged fish recovered in the commercial and sport fishery harvests. During 1993-1997, the average smolt migration was 5,980, range 3,919 to 7,844. Total survival averaged 28.8%, range 47.8 to 14.2%. Preliminary results indicate a change in annual survival over a five-year period, justifying a closer examination of differences related to size or ocean entry date.

In-Kind Support:

- ADFG/SF Juneau funded Judith Lum as student intern for a year and is funding 7 months of the fishery biologist's salary at the weir.
- NOAA/NMFS, Auke Bay Laboratory, Juneau and SFOS/Juneau Center provided 2 months each of salary for the fishery biologist at the weir.

- NOAA/NMFS, Auke Bay Laboratory, Juneau provided use of the Auke Creek weir facilities for the collection of samples, tagging, and the recovery of coded wire tags. Four months of work effort each year of the study by facility personnel was provided.
- NOAA, NMFS, Auke Bay Laboratory, Juneau provided expertise in tagging, sampling, and aging procedures. Four months of work effort each year of the study by facility personnel was provided.
- ADFG/SF Juneau provided sequential coded wire tags for coho salmon smolt tagging from 1993-1997 at a cost of approximately $2000/year for five years of study.
- ADFG/CFMD Juneau provided expertise and time on the aging and analysis of collected scales. A month of salary cost for a Fish Technician III was provided in each of the five years.
- ADFG/CFMD, Coded Wire Tag Lab, Juneau provided information on CWT recoveries from the commercial and sport fishery.
- SFOS/Juneau Center provided expertise in data analysis.

Effects of Urbanization on Small Stream Salmonid Communities in Southcentral Alaska

Personnel:

Dr. Nicholas F. Hughes, Principal Investigator, SFOS
Matthew Whitman, Student Investigator (MS), SFOS

Funding Source: USGS/WRD (RWO 95)

Progress Report:

Urban development can have a variety of direct and indirect effects on stream-dwelling salmonids. It can modify habitat structure, degrade water quality, and cause shifts in food resources that can alter the size and structure of the salmonid community. Anadromous Pacific salmon as well as resident trout and char inhabit streams in the Anchorage area where urbanization is a significant issue. It is important to recognize the pressures on these fish that have commercial, recreational, ecological, and aesthetic importance. This study will investigate the impacts of urbanization on Anchorage streams and examine how this is affecting the salmonid communities. Fourteen study sites were established within five stream systems in summer 1999, ranging from pristine to highly urbanized. Preliminary information was collected regarding primary productivity, invertebrates, water and sediment chemistry, and presence of fish species. Full implementation of the planned project will occur in summer 2000. Results will be useful for fisheries management and urban planning.

Ongoing Projects—Terrestrial

Pigeon Guillemots and River Otters as Bioindicators of Nearshore Ecosystem Health in Prince William Sound

Personnel:

Dr. A. David McGuire, Principal Investigator, AKCFWRU
Dr. R. Terry Bowyer, Co-Principal Investigator, IAB
Dr. Lawrence Duffy, Co-Principal Investigator, IAB
Gail M. Blundell, Student Investigator (PhD), DBW
Pamela E. Seiser, Student Investigator (MS), DBW
Howard Golden, Cooperator, ADFG/WC/Anchorage
Lisa Thomas, Cooperator, USGS/BRD/ABSC

Funding Source: USGS/BRD/ABSC (RWO 40)

Progress Report:

The purpose of this study is to determine to what extent demography, food availability, or the physiological effects of oil exposure may be constraining recovery of pigeon guillemots (*Cepphus columba*) and river otters (*Lutra canadensis*) from the Exxon Valdez oil spill (EVOS). For pigeon guillemots, we evaluated the significance of these factors by comparing the census counts, nesting success, diet, food availability, and blood chemistry of pigeon guillemots among an oil site at Naked Island in Prince William Sound (PWS) and an unoiled site in PWS (Jackpot Island). For river otters, we compared morphology, diet, food availability, blood chemistry, and home range of river otters in PWS between heavily oiled areas (Herring Bay) and unoiled areas (Jackpot Bay). This study includes two of four nearshore vertebrate predators that have been studied as part of the project "Mechanisms of impact and potential recovery of nearshore vertebrate predators," which has been funded through the Alaska Biological Science Center of USGS-BRD in Anchorage, Alaska. During the last year, a final report on the project has been prepared with contributions from the pigeon guillemot and river otter research components. A number of papers have already been published from the pigeon guillemot and river otter research components of the larger project, and manuscripts are currently being prepared for a special issue of a journal that synthesizes the research findings of the overall project.

Sociality in River Otters: Cooperative Foraging or Reproductive Strategies?

Personnel:

Dr. R. Terry Bowyer, Co-Principal Investigator, IAB
Gail M. Blundell, Student Investigator (PhD), DBW

Funding Source: USGS/BRD/ABSC (RWO 40)

Progress Report:

Final analyses were completed for the Nearshore Vertebrate Predator (NVP) project. A synthesis of that project and previous research on the effects of the *Exxon Valdez*

oil spill (EVOS) on river otters is currently in review as a Wildlife Monograph. Results from early post-spill studies revealed that otters inhabiting oiled areas in Prince William Sound had higher liver enzymes, lower body mass, and larger home ranges compared with otters in nonoiled areas. Results from data collected from 1996 to 1998 indicated that those differences between areas no longer existed. Although some biomarkers suggested that otters continued to be exposed to low levels of crude oil, the effects of that exposure were no longer sufficient to cause obvious injury. We cautiously conclude that river otters have recovered from the more pernicious effects of EVOS. As NVP was wrapped up, we continued to radio-track river otters in three areas until the transmitter batteries expired. Those telemetry data will contribute to the PhD research conducted by Gail Blundell for a thesis tentatively entitled "Social Organization and Spatial Relationships in River Otters: Effects of Gender, Relatedness, and Prey Availability." Preliminary results from some of those analyses revealed that social otters had better quality diets, significantly higher in pelagic fishes, and had smaller home ranges, suggesting that social otters may be cooperatively foraging. Telemetry data will also be used in collaboration with Merav Ben David in which the survival rates of otters re-released after 11 months in captivity are compared with survival of wild otters.

Population Genetics of an Island Endemic, the Prince of Wales Flying Squirrel

Personnel:

Dr. Joseph A. Cook, Principal Investigator, DBW
Allison L. Bidlack, Student Investigator (MS), DBW

Funding Source: USFWS (RWO 67)

Progress Report:

The Prince of Wales flying squirrel has a restricted distribution in Southeast Alaska. The purpose of this project is to investigate this subspecies' genetic divergence from other flying squirrels in the region and to investigate historical levels of gene flow among the islands. I spent summer 1999 in the field collecting specimens on Prince of Wales, Tuxekan, Heceta, and El Capitan islands, as well as on areas of the mainland east of Revillagigedo Island. My field crews and I collected 97 squirrels, five of which are new island records. At the end of June, in the middle of the field season, I flew to Seattle to attend the American Society of Mammalogists Annual Meeting and presented a poster of my research there. Much of this past fall was spent extracting DNA from the squirrels collected during the summer. During the spring and fall, a portion of the mitochondrial genome was sequenced for 77 squirrels from Southeast and Interior Alaska. These sequences show a genetic break between populations on Prince of Wales and surrounding islands and the rest of Southeast squirrels. This break suggests that the Prince of Wales subspecies has been separated from the mainland subspecies for a substantial amount of time. I also spent several weeks this fall developing nuclear DNA markers for in-depth gene flow analyses. Before Christmas, I began typing 250 squirrels from 9 populations using these markers. That work continues now and should be completed by the AKCFRWU research review in March 2000.

In-Kind Support:

- USFS: Lodging (4 weeks), flights in/out of field camps, field assistance, and boat transportation (1 week)
- USFWS: Logistical support, storage space for field equipment.

Systematics of the Endemic Red-Backed Voles of Southeast Alaska

Personnel:
Dr. Joseph A. Cook, Principal Investigator, DBW
Amy M. Runck, Student Investigator (MS), DBW

Funding Source: USFWS (RWO 68)

Progress Report:

In Southeast Alaska two island endemic subspecies of red-backed voles (*Clethrionomys gapperi solus* and *C. g. wrangeli*) and three subspecies largely restricted to the mainland (*C. g. phaeus*, *C. g. stikinensis*, and *C. rutilus glacialis*) have been described. There has been confusion over the validity of these taxa and some have suggested that the two species may intergrade. Because the original descriptions of *C. gapperi* and *C. rutilus* were based on small sample sizes from limited locations, and there is concern regarding the potential impact of loss of habitat on the Tongass National Forest due to timber harvests, we are examining genetic divergence among populations of these species. In 1999, we sampled populations of 3 island endemic and 7 mainland populations in the apparent contact zone. Collecting efforts focused on Revillagigedo Island, Cleveland Peninsula, and the mainland east of Behm Canal. Three-hundred-fifty DNA extractions were completed last year. A total of 118 partial and complete sequences have been generated. Restriction enzyme screening of 335 individuals was completed to determine the distribution of these species. Sequence data show a 7.5% sequence divergence between *C. gapperi* and *C. rutilus*, thus supporting that they are distinct species. The island endemic populations (*C. g. solus* and *C. g. wrangeli*) show 0.5% sequence divergence from conspecific mainland populations, supporting their subspecific designations. Some specimens in the apparent contact zone between species have been identified morphologically as *C. gapperi* but have the cytochrome b gene sequence of *C. rutilus*.

In-Kind Support:

- John Bender II, Daniel Dowler, and Richard Runck: Volunteer field help.
- Matt Carlin: Field vehicle donation.
- UAM: Curatorial services.
- USFS: Personnel, specimens, boat and air transportation to field sites, lodging.

Interpopulation Divergence of Marten in Southeast Alaska

Personnel:
Dr. Joseph A. Cook, Principal Investigator, DBW
Karen D. Stone, Student Investigator (PhD), DBW

Funding Sources: USFWS (RWO 70); USFS, UAF Graduate Research Fellowship

Progress Report:

The Tongass National Forest and surrounding regions of British Columbia comprise the largest tract of old-growth temperate rainforest remaining in the world. Timber harvests fragment the forest and have the potential to harm many species of this region. Furthermore, trappers and hunters annually harvest thousands of fur-bearers (e.g., marten and mink) and trophy animals (e.g., brown and black bears). Because of deforestation and hunting/trapping pressures placed on sport animals, population attributes (e.g., density estimates and population genetics) should be monitored. We are using several molecular markers to characterize the genetic relationships among island and mainland populations of American pine marten, *Martes americana*, from the Pacific Northwest (N>680 individuals). In Southeast Alaska, marten have been managed as one large population; however, our genetic data suggest that two divergent evolutionary lineages exist. These lineages are so distinct that they have been suggested to represent different species. One lineage exists on only two islands of the archipelago (Admiralty and Kuiu islands), whereas the other lineage is much more widespread including island and mainland locations. Our data also suggest: (1) the two lineages are interbreeding on Kuiu Island, (2) some island populations are isolated (e.g., Admiralty Island), (3) island populations in close proximity to the mainland maintain gene flow with mainland populations, and (4) gene flow exists between mainland Southeast Alaska and interior British Columbia (possibly using river corridors as immigration routes). Management of these two different lineages is necessary to maintain the genetic diversity that has developed over thousands of years of evolution.

In-Kind Support:

- UAM: Curatorial services.
- ADFG: Tissue collection.

Assessing and Managing the Impacts of Humans along National Park Coastlines in Southcentral Alaska: Bears as an Indicator

Personnel:
Dr. Erich H. Follmann, Principal Investigator, IAB
H. Blair French, Student Investigator (MS), DBW

Funding Sources: NPS; USGS/BRD/ABSC and CRU (RWO 86)

Progress Report:

Human visitation to the coast of Katmai National Park has been steadily increasing for several years. Most of this visitation has been directed at viewing coastal grizzly bears in a natural, pristine environment. Managers at Katmai NP need to understand

the effects of these human activities on coastal resources, particularly grizzly bears. This study was initiated to address management concerns about potential effects associated with these human activities. Hallo Bay was selected as the study site because it allowed us to observe large numbers of bears at once. We used several methods to assess effects on coastal grizzly bears. The population of bears was divided into four groups: large males, sows with young-of-the-year, sows with older cubs, and single bears. Focal samples collect behavior, habitat use, and other variables associated with bear behavior in half-hour sessions. Scan samples provide a slice-in-time picture of bear demographics, habitat use, and spatial separation of bears. Theodolite locations (using surveyor's equipment) will provide us with precise locations of bears using the study area. These locations will be mapped onto a GIS vegetation layer to help describe habitat use of the area. Over the two field seasons, we collected 1,500 scans samples, 780 focal samples, and 1,100 theodolite locations. We also recorded 100 grazing bouts where we noted every bite, step, and alert posture of the observed bear over a 10-minute span. These data will provide a more detailed assessment of the effects of human presence on bear foraging efficiency.

In-Kind Support:

- USFWS/Kodiak NWR provided housing for technicians for 3 nights at their bunkhouse.
- NPS/Katmai NPP provided a vehicle for use in Kodiak, AK.
- NPS/Denali NPP provided shotgun training.

Range Condition Assessment for GMU20A Moose

Personnel:

Dr. Brad Griffith, Principal Investigator, AKCFWRU
C. Tom Seaton, Student Investigator (MS), DBW

Funding Sources: ADFG/WC (RSA)

Progress Report:

Moose density in GMU20A is currently very high. Some moose in this unit are migratory between Tanana Flats summer ranges and winter ranges in the adjacent foothills of the Alaska Range. Other moose in this unit are year-long residents of the Tanana Flats. The resident moose have shown lower productivity than migratory moose for the past three years. This difference in productivity may be related to forage productivity and use on winter range. This project will (1) develop a winter browse utilization model for Unit 20A that assesses the effect of current and historical moose density, seasonal range (flats, foothills), and vegetation type on browse production and utilization, and (2) document the temporal change in winter food habits of the resident and migratory segments of the herd. To date about 960 radio-relocations of moose, 80 fecal pellet samples, and 19 browse samples for estimating the relationships among twig length, diameter, and biomass during have been collected. During 2000, field data collection will continue, with emphasis on developing the browse utilization model.

In-Kind Support:

ADFG/WC: Snowmachine (80 hr), fixed-wing aircraft support of radiotelemetry relocations (240 hr), helicopter support of field operations (30 hr), and travel funds to attend a moose browse research meeting in Anchorage.

Climate Change Effects on Caribou Habitats and Population Processes

Personnel:
Dr. Brad Griffith, Principal Investigator, AKCFWRU

Progress Report:

This is an umbrella project that covers miscellaneous portions of Griffith's programmatic work. Eleven presentations at regional, national, and international scientific meetings (including 2 international, 2 national, and one regional invited paper) were given in 1999 as a result of this program emphasis. In addition, during 1999, final funding approval was obtained for "Relative strength of effects of spring and fall forage conditions on population demography of the Porcupine Caribou Herd" through the renewal of NSF Grant OPP-9521459, and funding for "Impact of climate change on migratory caribou: herd-specific assessments and application of tools to evaluate public policy options" was obtained from the Canadian national Climate Change Action Fund (CCAF). During 2000, graduate students (PhD) will be selected to pursue the funded components of the program.

In-Kind Support:

UAF: Library facilities and services.

Habitat Selection by Calving Caribou of the Central Arctic Herd, 1980–1995

Personnel:
Dr. Brad Griffith, Principal Investigator, AKCFWRU
Scott A. Wolfe, Student Investigator (MS), DBW

Funding Source: NSF

Progress Report:

Habitat selection by calving caribou of the Central Arctic caribou herd was compared between zones with (treatment) and without (reference) oilfield development, 1980-1995. Distance between concentrated calving areas was greatest in the treatment zone, reflecting an inland shift in distribution through time. Moreover, habitat selection was more variable in the treatment than in the reference zone. Initially, caribou in both zones selected wet graminoid communities. Beginning in 1987, however, caribou in the treatment zone shifted to moist graminoid-shrub communities, whereas those in the reference zone continued to select wet graminoid communities. Caribou selected above-median NDVIrate (an estimate of the daily increase in green plant biomass) in 9 of 11 years in the reference zone, but in only 3 of 9 years in the treatment zone. Within concentrated calving areas, the proportion

of area with above-median NDVIrate was significantly lower in the treatment zone than in the reference zone during 7 of 9 years. Caribou did not consistently select any particular class of snow cover (0-24%, 25-49%, 50-74%, or 75-100%) in either zone. Suitability of the landscape may vary among years. Caribou need unrestricted access to respond to those changes, thereby maximizing use of the best habitats. Increased variability in habitat selection by caribou in the developed zone may be a cumulative, population level, expression of individual caribou response to development infrastructures and activities.

In-Kind Support:

- ABR, Inc. (Brian Lawhead, Steve Murphy) provided annual reports on caribou distributions and calf:female ratios.
- ADFG/WC (Beth Lenart) provided data including estimates of caribou population size.
- Tundra Ecosystem Analysis and Mapping Lab (TEAML) and Arctic System Science Data Coordination Center (ARCSS) (Steve Muller, Skip Walker) provided a digital grid of the landcover in the Kuparuk watershed and a preliminary grid of the landcover on Alaska's Arctic Slope.
- IAB provided financial support.
- BLM Fairbanks (Tim Hammond), provided digital elevation models.
- USFWS Fairbanks (Janet Jorgenson) provided a thematic map of the area west of the Arctic NWR and samples of vegetation communities in that area.
- USGS/BRD/ABSC (David Douglas), provided training and consulting in GIS project management and analyses.
- USGS/EROS Data Center, South Dakota, provided digital raster graphics, coastline coverages, river coverages, and other spatial data.

Calving Ground Selection and Fidelity: Teshekpuk and Western Arctic Caribou Herds

Personnel:

Dr. Brad Griffith, Principal Investigator, AKCFWRU
Rebecca Kelleyhouse, Student Investigator (MS), DBW

Funding Source: ADFG/WC (RSA)

Progress Report:

As part of a larger research effort to identify and describe calving habits of northern caribou, I will investigate calving ground selection and fidelity of the Teshekpuk Lake and Western Arctic caribou herds. While the Western Arctic Herd calves in an upland area similar to that used by the Porcupine Caribou Herd, the Teshekpuk Lake Herd calves at a much lower elevation in an area dominated by wet sedge meadows. The food habits of the Western Arctic Herd have previously been described, although those of the Teshekpuk Lake Herd are relatively unknown. With fecal pellet analysis, diet composition of this herd will be estimated and compared to that of other caribou herds. I will use annual census data and satellite locations provided by ADFG, BLM, and the NSB to quantitatively estimate annual calving distributions both temporally and spatially. Two forms of satellite imagery will be used to assess habitat selection and distribution. By using the Normalized Difference Vegetation Index (NDVI) from successive AVHRR images, I can detect high rates of increase in NDVI and possible

inter-annual warming trends in terms of the relative amount of green plant biomass. A separate vegetation classification based on a combination of Landsat-TM and SPOT XS imagery will be used to determine habitat selection.

Bathurst Caribou Calving Ground Studies: Influence of Nutrition and Human Activity on Calving Ground Location

Personnel:

Dr. Brad Griffith, Principal Investigator, AKCFWRU
Scott A. Wolfe, Student Investigator (MS), DBW
Anne Gunn, Cooperator, Department of Resources, Wildlife, and Economic Development, NWT
Dr. Knut Kielland, Cooperator, UAF/IAB
Dr. Don Russell, Cooperator, Environment Canada, CWS

Funding Source: West Kitikmeot Slave Study Society, Yellowknife, NWT

Progress Report:

Calving grounds of the Bathurst caribou herd in Nunavut, Canada, are located within a region with substantial potential for mineral exploration and development. The objectives of this study are to estimate activity patterns, forage availability and quality, caribou diet, and habitat use and selection of caribou within the calving grounds of the Bathurst herd. In addition, we will use energetics modeling to assess hypothetical effects of shifts in calving ground location on caribou body condition. We completed the second and final field season of sampling during May-June 1999. Calving ground size, location (Hood River), and calving season (1-10 June) were nearly identical to that observed in 1998. As in 1998, cows spent about one-half the time foraging and one-third of the time bedded. Analysis of the isotropic signatures of heavy nitrogen in the antlers of cows, forage that they eat, and in the soils on the calving ground suggested a dramatic diet shift to grass-like plants after they leave the calving ground, and showed that in high-density areas caribou may leave a nitrogen signature in the soil from urinary deposition. During 2000, we will continue our laboratory analysis of samples collected to date, conduct statistical analysis of processed data, and incorporate these results to model the energetic performance of cows on the calving ground, and to assess the nutritional implications of calving ground shifts.

Development of Potential Muskox Habitat in the NPR-A (National Petroleum Reserve-Alaska): A GIS Analysis

Personnel:

Dr. David R. Klein, Principal Investigator, IAB
Fiona S. Danks, Student Investigator (MS), DBW
Dr. David Yokel, Cooperator, BLM

Funding Sources: BLM (RWO 72) and ADFG/WC (RSA)

Progress Report:

The population and distribution of muskoxen (*Ovibos moschatus*) in northern Alaska have been increasing since their reintroduction into the area nearly 30 years ago. However, their distribution and habitat selection within the local landscape remain inadequately documented. Furthermore, no accurate historical distribution record exists. Consequently, it is difficult to establish a knowledge base to project potential future habitats and to assure their potential productivity for management and land-planning purposes. This GIS (Geographical Information Systems) project will provide information for a resource base as it relates to proposed oil, gas, and other mineral exploration and development, and the management of muskox populations. Proper management of the muskox population is critical: the tendency of muskoxen to remain in suitable local habitats, combined with their sedentary disposition, makes them vulnerable to over-harvest and disturbance. In areas where muskoxen are found, conditions are likely favorable for other wildlife, increasing the areas' importance, need for preservation, and likely use by native people for their sustained way of life. Existing and new muskox location, vegetation, topographical, and terrain characteristic data was compiled into a GIS database and assimilated, providing information about the interactive effects of these characteristics. Fieldwork to establish familiarity with muskox habitat and conduct vegetation analyses for comparison with satellite vegetation data was done. Based on confirmed presence of muskoxen, and existing literature on habitat, a model of muskox habitat characteristics in an occupied region east of the NPR-A is being developed and will be extrapolated and applied to the NPR-A to reveal potential muskox habitat, information crucial to effective management and sustainability of the population.

In-Kind Support:

ADFG and ABR, Inc. provided data on muskox locations.
BLM , Skip Walker, and Steve Muller provided vegetation maps.

Ongoing Projects—Integrated

The Role of Wildfire in Alaska: Experimental and Regional Approaches to Improved Understanding of Boreal Feedbacks to Climate

Personnel:

Dr. Terry Chapin, Lead Investigator, IAB
Dr. A. David McGuire, Co-Principal Investigator, AKCFWRU
Qianlai Zhuang, Student Investigator (PhD), DBW (partial support)

Funding Source: NSF

Progress Report:

The purpose of this project is to develop a predictive understanding of the major classes of feedbacks from boreal fire to climate as a basis to improve understanding of the changing role of the boreal forest in the Earth System. Dr. McGuire's role in this study is to assist with both retrospective analyses and future assessments of climatic impacts on carbon storage in high latitude regions. Dr. McGuire has

developed a version of the Terrestrial Ecosystem Model (TEM) that is capable of modeling post-fire carbon dynamics for boreal forest stands. Field work during the last two years has measured pre-fire and post-fire carbon pools in the area that was burned during summer 1999. Dr. McGuire, who is serving as a Co-Principal Investigator, is providing assistance from his NSF-funded ARCSS project and his NASA-funded project in the third of the study. One of Dr. McGuire's graduate students on his NASA project is assisting him with model simulations of the post-fire response of carbon storage. During the past year, Dr. McGuire has also helped the project recruit one post-doc who will be using inversion models of the global carbon cycle to help elucidate how fire disturbance in high latitudes influences the global carbon cycle. The investigations by this post-doc, who has been working in Dr. McGuire's laboratory since July 1999, will complement the forward modeling research on the role of fire being conducted by Dr. McGuire and his student.

Land-Cover Change in High Latitude Ecosystems: Implications for the Global Carbon Cycle

Personnel:

Dr. A. David McGuire, Co-Principal Investigator, AKCFWRU
Dr. David Verbyla, Co-Principal Investigator, FSD
Dr. W. Scott Armbruster, Co-Principal Investigator, IAB
Qianlai Zhuang, Student Investigator (PhD), DBW (partial support)
Matt Macander, Student Investigator, FSD
Cherie Silapaswan, Student Investigator (MS), DBW (partial support)
Aaron Woods, Student Investigator, FSD

Funding Source: NASA

Progress Report:

The purpose of this study is to develop a prototype spatially explicit modeling framework focused on Alaska that is capable of using satellite-derived data to estimate how changes in land cover cause changes in ecosystem carbon storage at high latitudes. This study involves four tasks: (1) development of spatially explicit contemporary land-cover data sets in Alaska; (2) development of transient spatially explicit land-cover data sets for the historical satellite record in Alaska; (3) development of a successional biogeochemical model; and (4) application of the modeling framework for estimating the consequences of land-cover change on terrestrial metabolism in retrospective, contemporary, and prognostic analyses. Four students have been recruited for this project. Three of the students are working on tasks 1 and 2 and the other student is working on tasks 3 and 4. The project has developed a formal collaboration with the Alaska Field Office of the EROS data center for assistance with acquisition of satellite scenes. A memorandum of understanding has been developed to share data and analyses with the Alaska System Support Office of the National Park Service. These data and analyses are related to the bark beetle infestations in the vicinity of Wrangell-St. Elias National Park. Dr. McGuire has developed a successional version of the Terrestrial Ecosystem Model that uses a spatially explicit data set of historical fires in Alaska fire data set to simulate the historical response of carbon dynamics to rising atmospheric CO_2, climate variability, and fire in Alaska. The development and testing of a successional version of TEM that includes a soil thermal regime are being conducted by the student working on tasks 3 and 4. The student is currently preparing two papers that describe the

development and testing of a version of TEM that simulates the interaction between the soil thermal regime and biogeochemical dynamics for mature forest stands in interior Alaska. Remote-sensing research by the other students continues to focus on developing change-detection algorithms for fire, logging, insect infestation, and natural vegetation dynamics. Research during the next year will focus on coupling transient vegetation data sets developed from the remote sensing research with the successional biogeochemical version of TEM.

The Role of High Latitude Ecosystems in the Global Carbon Cycle

Personnel:

Dr. A. David McGuire, Principal Investigator, AKCFWRU
Xinxian Zhang, Student Investigator (PhD), DBW (partial support)

Funding Source: NSF

Progress Report:

The goals of this project are (1) to elucidate the role of high latitude ecosystems in the global carbon cycle and (2) to assess the sensitivity and uncertainty of terrestrial carbon storage responses in high latitudes to potential transient climate change. This project synthesizes and integrates data from investigations of carbon cycling in high latitudes (NSF-LAII, NASA-BOREAS, NSF-LTER, NSF-PADS, and ITEX) with efforts in other regions of the biosphere (EPRI-CCMLP, NASA-EOS, NOAA, and MIT Joint Program on the Science and Policy of Global Change). One modeling experiment from this study has demonstrated that winter processes are important in the seasonal dynamics of carbon dioxide that is measured at high latitude monitoring stations (McGuire et al. 2000. Biogeochemistry 48:91-114). In a second investigation, the dynamics of a large-scale biogeochemical model, the Terrestrial Ecosystem Model (TEM), were compared with the dynamics of a fine-scale model of tundra biogeochemistry in transient simulations from 1921 to 1994 (historical climate) and 1995 to 2100 (projected climate) for the Kuparuk Basin of northern Alaska and for pan-Arctic tundra (McGuire et al. 2000. Global Change Biology. In press; Clein et al. 2000. Global Change Biology. In press). In a third investigation, the carbon exchange measured by flux towers in the Land-Atmosphere-Ice-Interactions (LAII) project and the Boreal Ecosystem Atmosphere Study (BOREAS) have been compared with the estimates of carbon exchange by TEM. During the past year, we have focused our effort on simulating carbon exchange for black spruce stands measured as part of BOREAS. Our results show good agreement with carbon fluxes throughout the year (paper submitted to Plant and Soil), and we have participated in a model inter-comparison study that compares the simulations of different models for black spruce stands in the BOREAS study (two papers submitted to the Journal of Geophysical Research). We are continuing to evaluate simulations of carbon fluxes for other forest stands in BOREAS and different tundra vegetation types in LAII.

Development of Forest Disturbance Scenarios for the United States

Personnel:

Dr. A. David McGuire, Principal Investigator, AKCFWRU
Cherie Silapaswan, Student Investigator (MS), DBW

Funding Source: USFS (RWO 94)

Progress Report:

The purpose of this study is to (1) develop spatially and temporally explicit data sets of historical forest disturbance for a subregion of the United States, and (2) to use these data to assess the role of forest management in historical changes in carbon storage for the subregion. The study is part of a USFS Resource Planning Act (RPA) Special Study, which has been granted to Dr. Linda Joyce of the USFS Rocky Mountain Forest and Range Experiment Station. The initial phase of the work focuses on using regional data on inventory and harvest to develop the disturbance data sets. Dr. Joyce's lab is currently evaluating different methods for developing the data sets, with advice from Dr. A. David McGuire of AKCFWRU, who has worked with others to develop data sets for assessing the role of cropland establishment and abandonment on global carbon storage. As data sets are developed, Dr. McGuire will conduct simulations with the Terrestrial Ecosystem Model (TEM) to evaluate how different disturbance data sets influence carbon storage. This study will provide a methodology that can be applied nationally to develop historical forest disturbance scenarios for the United States. The development of these scenarios is necessary for providing the USFS with the capability to simultaneously assess the effects of rising atmospheric CO_2, climate, and land-use on historical U.S. carbon storage.

Arctic Transitions in the Land Atmosphere System

Personnel:

Dr. Terry Chapin, Lead Investigator, IAB
Dr. A. David McGuire, Co-Principal Investigator, AKCFWRU
Catharine Copass, Student Investigator (PhD), DBW (partial support)
Cherie Silapaswan, Student Investigator (MS), DBW (partial support)

Funding Source: NSF

Progress Report:

This project employs a hierarchy of modeling approaches to produce credible scenarios for altered ecosystem, permafrost, snow, and atmospheric circulation distributions under a changing climate. These models include stand-alone permafrost, vegetation and land surface models, vegetation dynamics models, and regional and global climate system models. Dr. McGuire, who is a Co-Investigator on this project, is advising one of the graduate students in the development of a spatially explicit model of tundra vegetation dynamics. The other graduate student, who is partially funded on Dr. McGuire's NASA project, is using a radiometric technique based on change vector analysis to analyze historical vegetation changes on the Seward Peninsula of Alaska with existing satellite data. This model of tundra vegetation dynamics, which incorporates competitive interactions for water, light, and nutrients among different plant functional types, will use the results of the

satellite analyses in development and testing. The dynamic vegetation model will generate spatially explicit distributions of plant functional types and suggest possible future vegetation distributions in response to potential climate change scenarios. In addition, the dynamic vegetation model will be used to provide the land surface parameterizations for a regional climate model. During summer 1999, one of the graduate students on the project conducted field work at Council on the Seward Peninsula of Alaska to study competitive interactions among plant functional types that represent transitions in vegetation types between tundra and closed forest. During summer 1999, biophysical measurements (height, percent cover) and biogeochemical measurements (biomass carbon and nitrogen) were made in tundra, low shrub tundra, and woodland vegetation types. Additional field work will be conducted in summer 2000 at Council to extend these measurements for tall shrub and forest sites. Information from the field studies will be incorporated into the conceptualization, formulation, and parameterization of the dynamic vegetation model.

List of Abbreviations

ADFG	Alaska Department of Fish and Game
	CFMD Commercial Fisheries Management Division
	HR Habitat and Restoration Division
	SF Sport Fish Division
	WC Wildlife Conservation Division
ADNR	Alaska Department of Natural Resources
AKCFWRU	Alaska Cooperative Fish and Wildlife Research Unit
BLM	Bureau of Land Management
CMI	Coastal Management Institute, UAF
CWS	Canadian Wildlife Service
DBW	Department of Biology and Wildlife, UAF
DCB	Department of Chemistry and Biochemistry, UAF
FAO	Fisheries Assistance Office, USFWS
FSD	Forestry Sciences Department, UAF
IAB	Institute of Arctic Biology, UAF
IMS	Institute of Marine Science, UAF
LTER	Taiga Long Term Ecological Research Program
MBL	Marine Biological Laboratory, Woods Hole, MA
MMS	Minerals Management Service
MOU	Memorandum of Understanding
MSD	Mathematical Sciences Department, UAF
MSL	Marine Science and Limnology Program, IMS, UAF
NASA	National Aeronautical Space Agency
NCCFWRU	North Carolina Cooperative Fish and Wildlife Research Unit
NCSU	North Carolina State University
NOAA	National Oceanographic and Atmospheric Administration
	NMFS National Marine Fisheries Service

NPP	National Park and Preserve
NPR-A	National Petroleum Reserve-Alaska
NPS	National Park Service
NSB	North Slope Borough
NSF	National Science Foundation
NWR	National Wildlife Refuge
ORCFWRU	Oregon Cooperative Fish and Wildlife Research Unit
OSU	Oregon State University, Corvallis, OR
PI	Principal Investigator
RSA	Reimbursable Services Agreement
RWO	Research Work Order
SFOS	School of Fisheries and Ocean Sciences, UAF
UAA	University of Alaska Anchorage
UAF	University of Alaska Fairbanks
UAM	University of Alaska Museum
UAS	University of Alaska Southeast
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service FAO Fisheries Assistance Office NWR National Wildlife Refuge
USGS	U.S. Geological Survey BRD Biological Resources Division ABSC Alaska Biological Science Center CRU Cooperative Research Units WRD Water Resources Division
WRC	Water Research Center, UAF