Alaska Cooperative Fish and Wildlife Research Unit

Annual Report: 2000–2001

May 2002

Alaska Cooperative Fish and Wildlife Research Unit
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Annual Report, 2000–01

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Unit Roster

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Staff

F. Joseph Margraf, Unit Leader
Brad Griffith, Assistant Leader–Wildlife
A. David McGuire, Assistant Leader–Ecology
Karen R. Enochs, Administrative Assistant
Kathleen R. Pearse, Administrative Assistant
Abby N. Powell, Assistant Leader-Wildlife (effective October 2000)
Michelle M. Propst, Secretary/Receptionist (effective August 2001)
Judy D. Romans, Secretary/Receptionist
Elizabeth A. Sturm, Research Technician
Whitney M. Madison, Student Assistant, Spring 2000
Theresa L. Tanner, Student Assistant, Fall 2000–Present

Sponsors

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

Graduate Students

Corey Adler (MS)
Allison Bidlack (MS)
Gail Blundell (PhD)
Randy Brown (MS)
John Burch (MS)
Peter Cleary (MS)
Catharine Copass (PhD)
Fiona Danks (MS)
Cheryl Dion (MS)
Blair Flannery (MS)
Matthew Foster (MS)
H. Blair French (MS)
F. Michael Holliman (PhD)
Rebecca Kelleyhouse (MS)
Kalin Kellie (MS)
MeiMei Li (MS)
Judith Lum (MS)
Thomas McDonough (MS)
Julie Meka (MS)
William Morris (MS)
David Person (PhD)
Laura Phillips (MS)
Amy Runck (MS)
James Savereide (MS)
Brendan Scanlon (MS)
C. Tom Seaton (MS)
Pamela Seiser (MS)
Cherie Silapaswan (MS)
Karen Stone (PhD)
Miranda Terwilliger (MS)
Jeff Villepique (PhD)
Brad Wendling (MS)

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

Faculty and Research Associate Cooperators

W. Scott Armbruster, IAB
Merav Ben-David, University of Wyoming
R. Terry Bowyer, IAB/DBW
Raymond D. Cameron, IAB
Terry Chapin, DBW/IAB
Joseph A. Cook, Idaho State University
Pat Doak, DBW/IAB
Lawrence K. Duffy, IAB/DCB
Bruce P. Finney, IMS
Erich H. Follmann, DBW/IAB
Anthony J. Gharrett, SFOS
Nicholas F. Hughes, SFOS
David R. Klein, IAB
Gary A. Laursen, DBW
Julie A. K. Maier, IAB
Terrance J. Quinn II, SFOS
Eric A. Rexstad, DBW/IAB
James B. Reynolds, SFOS
Roger W. Ruess, DBW/IAB
William W. Smoker, SFOS
Karen D. Stone, Southern Oregon University
David Verbyla, FSD
Kevin S. Winker, UAM/DBW

Coordinating Committee

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

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

Brian Barnes, Interim Director, Institute of Arctic Biology, University of Alaska Fairbanks (effective July 2001)

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 Biannual Report for the Alaska Cooperative Fish and Wildlife Research Unit, highlighting activities for 2000-2001. 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 over 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 37 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.

In October 2000, Dr. Abby Powell joined the Alaska Unit's scientific staff as the second Assistant Unit Leader for Wildlife. Abby's expertise is in wildlife ecology, particularly avian ecology. She came to the Unit from the USGS Northern Prairie Science Center field station in Fayetteville, AR. At the close of the reporting period for this report, efforts were still underway to hire a scientist for the Assistant Unit Leader for Fisheries position.

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 northern fish populations. Wildlife research will focus on the ecology of northern birds and mammals and their habitats. Unit research will also be directed at integrated studies of fish and wildlife at the ecosystem level.

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: 18 (4 PhD, 14 MS)

- Allison Bidlack (MS), pursing PhD degree at University of California Berkeley.
- Gail Blundell (PhD), Research Associate, IAB, publishing and seeking employment
- Randy Brown (MS), employed by Fairbanks Fishery Resources Office, USFWS, Fairbanks
- John Burch (MS), employed the National Park Service, Fairbanks
- Fiona Danks (MS), employed by environmental consulting firm, Vancouver, BC
- Rebecca Kelleyhouse (MS), employed in private industry, Anchorage
- Thomas McDonough (MS), employed by ADFG/WC, Glennallen
- Bill Morris (MS), employed by ADFG/HR, Fairbanks
- Amy Runck (MS), pursing PhD degree at Idaho State University, Pocatello
- James Savereide (MS), employed by ADFG/SF, Fairbanks
- Brendan Scanlon (MS), employed by ADFG/SF, Fairbanks
- Pam Seiser (MS), employed by ABR, Inc., Fairbanks
- Cherie Silapaswan (MS), employed as Research Technician, IAB/UAF
- Karen Stone (PhD), employed as Assistant Professor, Department of Biology, Southern Oregon University, Ashland
- Scott Wolfe (MS), self-employed, Anchorage
- Amy Zacheis (PhD), Research Associate, IAB, publishing and seeking employment
- Xinxian Zhang (MS), ADFG/CFMD, Douglas
- Qianlai Zhuang (PhD), Postdoctoral Research, Marine Biological Lab, Woods Hole, MA

Publications/Reports: 46
Presentations: 82
Honors/Awards: 10

Unit Benefits

Scientific Publications

Amthor, J. S., J. M. Chen, J. S. Clein, S. E. Frolking, M. L. Goulden, R. F. Grant, J. S. Kimball, A. W. King, A. D. McGuire, and others. 2001. Boreal forest CO_2 exchange and evapotranspiration predicted by nine ecosystem process models: Intermodel comparisons and relationships to field measurements. Journal of Geophysical Research 106(D24):33,623-33,648.

Barten, N. L., R. T. Bowyer, and K. J. Jenkins. 2001. Habitat use by female caribou: Tradeoffs associated with parturition. Journal of Wildlife Management 65:77-92.

Ben-David, M., L. K. Duffy, G. M. Blundell, and R. T. Bowyer. 2001. Exposure of coastal river otters to mercury: Relation to age, diet, and survival. Environmental Toxicology and Chemistry 20:1986–1992.

Bidlack, A. and J. A. Cook. 2001. Reduced genetic variation in insular northern flying squirrels (*Glaucomys sabrinus*) along the North Pacific coast. Animal Conservation 4:283-290.

Blundell, G. M., R. T. Bowyer, M. Ben-David, T. A. Dean, and S. C. Jewett. 2000. Effects of food resources on spacing behavior of river otters: Does forage abundance control home-range size? Pages 325–333 *in* J. H. Eiler, D. J. Alcorn, and M. R. Neuman, editors. Biotelemetry 15: Proceedings of the 15th International Symposium on Biotelemetry, Juneau, Alaska. International Society on Biotelemetry, Wageningen, the Netherlands.

Blundell, G. M., J. A. K. Maier, and E. M. Debevec. 2001. Linear home ranges: Effects of smoothing, sample size, and autocorrelation on kernel estimates. Ecological Monographs 71:469–489.

Chapin, F. S., A. D. McGuire, J. Randerson, R. Pielke Sr., D. Baldochhi, S. E. Hobbie, N. Roulet, W. Eugster, E. Kasischke, E. B. Rasterrer, S. A. Zimova, and S. W. Running. 2000. Arctic and boreal ecosystems of western North America as components of the climate system. Global Change Biology 6(Suppl. 1):211-223.

Clein, J. S., B. L. Kwiatkowksi, A. D. McGuire, J. E. Hobbie, E. B. Rastetter, J. M. Melillo, and D. W. Kicklighter. 2000. Modelling carbon responses of tundra ecosystems to historical and projected climate: a comparison of a plot- and a global-scale ecosystem model to identify process-based uncertainties. Global Change Biology 6(Suppl. 1):127-140.

Conroy, C. J., Y. Hortelano, F. Cervantes, and J. A. Cook. 2001. The phylogenetic position of southern relictual species of *Microtus*. Mammalian Biology (Zeitschrift für Säugetierkunde) 66(6):332-334.

Cook, J. A. and S. O. MacDonald. 2001. Should endemism be a focus of conservation efforts along the North Pacific coast of North America? Biological Conservation 97:207-213.

Cook, J. A., A. L. Bidlack, C. J. Conroy, J. R. Demboski, M. A. Fleming, A. M. Runck, K. D. Stone, and S. O. MacDonald. 2001. A phylogeographic perspective on endemism in the Alexander Archipelago of the North Pacific. Biological Conservation 97:215-227.

Demboski, J. and J. Cook. 2001. Phylogeography of the dusky shrew, *Sorex monticolus* (Insectivora, Soricidae): Insight into deep and shallow history in northwestern North America. Molecular Ecology 10:1227-1240.

Hupp, J. W., A. B. Zacheis, R. M. Anthony, D. G. Robertson, W. P. Erickson, and K. C. Palacios. 2001. Snow cover and snow goose *Anser caerulescens caerulescens* distribution during spring migration. Wildlife Biology 7(2):65-76.

Ihl, C. and D. R. Klein. 2001. Habitat and diet selection by muskoxen and reindeer in western Alaska. Journal of Wildlife Management 65:964-972.

Keech, M. A., R. D. Boertje, R. T. Bowyer, and B. W. Dale. 1999. Effects of birth weight on growth of young moose: Do low-weight neonates compensate? Alces 35:51-57.

Keech, M. A., R. T. Bowyer, J. M. Ver Hoef, R. D. Boertje, B. W. Dale, and T. R. Stephenson. 2000. Life-history consequences of maternal condition in Alaskan moose. Journal of Wildlife Management 64(2):450-462.

Klein, D. R. 1999. The role of climate and insularity in establishment and persistence of *Rangifer tarandus* populations in the High Arctic. Ecology Bulletin 47:96-104.

Klein, D. R. 2000. The muskox. Pages 545-558 *in* S. Demarais and P. R. Krausman, eds. Ecology and Management of Large Mammals in North America. Prentice Hall, Upper Saddle River, NJ.

LaPerriere, J. D. (deceased) and J. A. Edmundson. 2000. Limnology of two lake systems of Katmai National Park and Preserve, Alaska: Part II. Light penetration and Secchi depth. Hydrobiologia 418:209–216.

McGuire, A. D., J. S. Clein, J. M. Melillo, D. W. Kicklighter, R. A. Meier, C. J. Vorosmarty, and M. C. Serreze. 2000. Modelling carbon responses of tundra ecosystems to historical and projected climate: Sensitivity of pan-Arctic carbon storage to temporal and spatial variation in climate. Global Change Biology 6(Suppl. 1):141-159.

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. 2000. Modeling the effects of snowpack on heterotrophic respiration across northern temperate and high latitude regions: Comparison with measurements of atmospheric carbon dioxide in high latitudes. Biogeochemistry 48:91-114.

McGuire, A. D., S. Sitch, J. S. Clein, R. Dargaville, G. Esser, J. Foley, M. Heimann, F. Joos, J. Kaplan, D. W. Kicklighter, R. A. Meier, J. M. Melillo, B. Moore III, I. C. Prentice, N. Ramankutty, T. Reichenau, A. Schloss, H. Tian, L. J. Williams, and U. Wittenberg. 2001. Carbon balance of the terrestrial biosphere in the twentieth century: Analyses of CO_2, climate and land use effects with four process-based ecosystem models. Global Biogeochemical Cycles 15:183-206.

Morris, W. A., E. H. Follmann, J. C. George, and T. O'Hara. 2000. Surgical implantation of radio transmitters in arctic broad whitefish in Alaska. Pages 193-201 *in* J. H. Eiler, D. J. Alcorn, and M. R. Neuman, editors. Biotelemetry 15: Proceedings of the 15th International Symposium on Biotelemetry, Juneau, Alaska. International Society on Biotelemetry, Wageningen, the Netherlands.

Oswood, M. W., J. B. Reynolds, J. G. Irons III, and A. M. Milner. 2000. Distributions of freshwater fishes in ecoregions and hydroregions of Alaska. Journal of the North American Benthological Society 19(3):405–418.

Pan, Y.-D., J. M. Melillo, D. W. Kicklighter, X.-M. Xiao, and A. D. McGuire. 2001. Modeling structural and functional responses of terrestrial ecosystems in China to changes in climate and atmospheric CO2. Acta Phytoecologica Sinica 25:175–189.

Powell, A. N. 2001. Habitat characteristics and nest success of snowy plovers associated with California least tern colonies. Condor 103:785–792.

Reynolds, J. B. and F. M. Holliman. 2000. Guidelines for assessment and reduction of electrofishing-induced injuries in trout and salmon. Pages 235-240 *in* D. Schill et al., editors. Management in the New Millennium: Are We Ready? Proceedings of the Wild Trout VII Conference, October 1-14, 2000, Yellowstone National Park, WY.

Russell, D., G. Kofinas, and B. Griffith. 2000. Need and opportunity for a North American caribou knowledge cooperative. Polar Research 19:117-129.

Schimel, D., J. Melillo, H. Tian, A. D. McGuire, D. Kicklighter, T. Kittel, N. Rosenbloom, S. Running, P. Thornton, D. Ojima, W. Parton, R. Kelly, M. Sykes, R. Neilson, and B. Rizzo. 2000. Contribution of increasing CO_2 and climate to carbon storage by ecosystems in the United States. Science 287:2004-2006.

Seiser, P. E., L. K. Duffy, A. D. McGuire, D. D. Roby, G. H. Golet, and M. A. Litzow. 2000. Comparison of pigeon guillemot, *Cepphus columba,* blood parameters from

oiled and unoiled areas of Alaska eight years after the *Exxon Valdez* oil spill. Marine Pollution Bulletin 40(2):152-164.

Seppelt, R. D. and G. A. Laursen. 1999. *Riccia cavernosa Hoffm. emend Raddi,* new to the Arctic and the bryoflora of Alaska. Hikobia 13:71-76.

Sheffield, G., F. H. Fay, H. Feder, and B. P. Kelly. 2001. Laboratory discussion of prey and interpretation of walrus stomach contents. Marine Mammal Science 17:310-330.

Silapaswan, C. S., D. L. Verbyla, and A. D. McGuire. 2001. Land cover change on the Seward Peninsula: The use of remote sending to evaluate the potential influences of climate warming on historical vegetation dynamics. Canadian Journal of Remote Sensing 27:542-554.

Taylor, C., L. K. Duffy, R. T. Bowyer, and G. M. Blundell. 2000. Profiles of fecal porphyrins in river otters following the *Exxon Valdez* oil spill. Marine Pollution Bulletin 40:1132-1138.

Tian, H., J. M. Melillo, D. W. Kicklighter, A. D. McGuire, J. Helfrich III, B. Moore III, and C. J. Vorosmarty. 2000. Climatic and biotic controls on annual carbon storage in Amazonian ecosystems. Global Ecology and Biogeography 9:315-335.

Wolfe, S. A., B. Griffith, and C. A. G. Wolfe. 2000. Response of reindeer and caribou to human activities. Polar Research 19:63-73.

Zacheis, A., J. W. Hupp, and R. W. Ruess. 2001. Effects of migratory geese on plant communities of an Alaskan salt marsh. Journal of Ecology 89:57–71.

Theses

Bidlack, Allison L. 2000. Phylogeography and population genetics of northern flying squirrels (*Glaucomys sabrinus*) in southeast Alaska. MS thesis, University of Alaska Fairbanks. 53 pp.

Blundell, Gail M. 2001. Social organization and spatial relationships in coastal river otters: Assessing form and function of social groups, sex-biased dispersal, and gene flow. PhD thesis, University of Alaska Fairbanks. 245 pp.

Brown, Randolph J. 2000. Migratory patterns of Yukon River inconnu as determined with otolith microchemistry and radio telemetry. MS thesis, University of Alaska Fairbanks. 80 pp.

Burch, John W. 2001. Evaluation of wolf density estimation from radiotelemetry data. MS thesis, University of Alaska Fairbanks.

Danks, Fiona S. 2000. Potential muskox habitat in the National Petroleum Reserve-Alaska: A GIS Analysis. MS thesis, University of Alaska Fairbanks. 133 pp.

Kelleyhouse, Rebecca A. 2001. Calving ground habitat selection: Teshekpuk Lake and Western Arctic caribou herds. MS thesis, University of Alaska Fairbanks. 124 pp.

McDonough, Thomas. 2000. Response of northern red-backed vole (*Clethrionomys rutilus*) populations to a major spruce beetle infestation in the Copper River basin, Alaska. MS thesis, University of Alaska Fairbanks. 100 pp.

Morris, William A. 2000. Seasonal movements of broad whitefish (*Coregonus nasus*) in the freshwater systems of the Prudhoe Bay oil field. MS thesis, University of Alaska Fairbanks. 71 pp.

Runck, Amy M. 2001. Molecular and morphological perspectives on post-glacial colonization of *Clethrionomys rutilus* and *Clethrionomys gapperi* in southeast Alaska. MS thesis, University of Alaska Fairbanks. 89 pp.

Savereide, James W. 2001. An age structured model for assessment and management of Copper River chinook salmon. MS thesis, University of Alaska Fairbanks. 122 pp.

Scanlon, Brendan P. 2000. The ecology of the Arctic char (*Salvelinus alpinus*) and the Dolly Varden (*Salvelinus malma*) in the Becharof Lake drainage, Alaska. MS thesis, University of Alaska Fairbanks. 103 pp.

Seiser, Pamela E. 2000. Mechanism of impact and potential recovery of pigeon guillemots (*Cepphus columba*) after the Exxon Valdez oil spill. MS thesis, University of Alaska Fairbanks. 102 pp.

Silapaswan, Cherie S. 2000. Land cover change on the Seward Peninsula: The use of remote sensing to evaluate the potential influences of climate change on historical vegetation dynamics. MS thesis, University of Alaska Fairbanks. 68 pp.

Stone, Karen D. 2000. Molecular evolution of martens (genus *Martes*). PhD thesis, University of Alaska Fairbanks. 118 pp.

Wolfe, Scott A. 2000. Habitat selection by calving caribou of the Central Arctic Herd, 1980–95. MS thesis, University of Alaska Fairbanks. 83 pp.

Zacheis, Amy B. 2000. Effects of migratory geese on plant communities and nitrogen dynamics in an Alaskan salt marsh. PhD thesis, University of Alaska Fairbanks. 170 pp.

Zhang, Xinxian. 2001. Modeling stand-level canopy maintenance respiration of black spruce ecosystems in Alaska: Implications for spatial and temporal scaling. MS thesis, University of Alaska Fairbanks. 40 pp.

Zhuang, Qianlai. 2001. Modeling the influences of climate change, permafrost dynamics, and fire disturbance on carbon dynamics of high latitude ecosystems. PhD thesis, University of Alaska Fairbanks. 218 pp.

Reports

Finney, B. P. 2001. Stable isotope analysis of components of the lacustrine food web in Becharof Lake, Alaska. Final Report, RWO 90, to the U.S. Geological Survey. 10 pp.

French, H. B. and E. H. Follmann. 2000. Assessing and managing the impacts of humans along national park coastlines in southcentral Alaska: Bears as an indicator. Progress Report for 1999, Research Work Order 86, to the National Park Service, Alaska Regional Office, Anchorage, AK.

Griffith, B. 2001. Movement, activity, behavior, and habitat use of Dall's sheep in relation to military overflights in interior Alaska. Annual report for 2000, RWO 99, to the Yukon Charley National Park, National Park Service, Fairbanks, AK. 1 p.

Griffith, B., A. Gunn, D. Russell, K. Kielland, and S. A. Wolfe. 2000. Bathurst calving ground studies: Influence of nutrition and human activity on calving ground location. Final Report to West Kitikmeot Slave Study Society, Yellowknife, NWT, Canada. 118 pp.

Heimann, M. and CCMLP Participants, including A. D. McGuire. 2000. The Carbon Cycle Model Linkage Project (CCMLP). Research GAIM (Newsletter of the Global Analysis Integration and Modelling Task Force) 4(1):7-9, 12-15.

Overton, A. S., F. J. Margraf, J. C. Griffin, and E. B. May. 2000. Changes in feeding habits of striped bass in the Chesapeake Bay: A health assessment. Final Report to the Maryland Department of Natural Resources, Annapolis, MD. Maryland Cooperative Fish and Wildlife Research Unit, University of Eastern Shore, Princess Anne, MD.

Reynolds, J. B. 2001. Standardized evaluation of electrofishing injury among North American freshwater sport fishes. Final Report, RWO 57, to the U.S. Fish and Wildlife Service. 92 pp.

Villepique, J. T. and E. H. Follmann. 2001. Assessing and managing the impacts of humans along national park coastlines in southcentral Alaska: Bears as an indicator. Kenai Fjords National Park Black Bear Study. Final Report for 2000, RWO 96, to the Kenai Fjords National Park, National Park Service, Seward, AK.

Presentations

Alix, C. and G. A. Laursen. October 2001. From Bering Strait to Greenland: Wood resources in the Arctic and their uses by non-Eskimo people. Beringian Days, sponsored by the National Park Service, Anchorage, AK.

Ben-David, M. and G. M. Blundell. June 2001. Pacific salmon and small carnivores: Influence on behavior, body condition and reproduction. Restoring Nutrients to Salmonid Ecosystems Workshop, Eugene, OR.

Ben-David, M., G. M. Blundell, and J. E. Blake. June 2001. Post-release survival of river otters: Effects of exposure to crude oil and captivity. Oiled Wildlife Care Symposium, Sacramento, CA.

Ben-David, M., G. M. Blundell, and J. E. Blake. September 2001. Post-release survival of river otters: Effects of exposure to crude oil and captivity. Eighth Annual Conference of the Wildlife Society, Reno, NV.

Ben-David, M., L. K. Duffy, G. M. Blundell, and R. T. Bowyer. September 2001. Natural exposure of coastal river otters to mercury: Relations to age, diet, and survival. Eighth Annual Conference of the Wildlife Society, Reno, NV.

Beringer, J., F. S. Chapin III, C. D. Copass, and A. D. McGuire. December 2000. A comparison of surface energy exchanges across a structural transition of arctic vegetation. Annual Meeting, American Geophysical Union, San Francisco.

Bidlack, A. June 2000. Population genetics of an island endemic, the Prince of Wales flying squirrel. Annual Meeting, American Society of Mammalogists, Durham, NH.

Blundell, G. August 2000. Sexual dietary partitioning in river otters: Dimorphism or cooperative foraging? Annual Meeting, Animal Behavior Society, Atlanta, GA.

Blundell, G. M., M. Ben-David, R. T. Bowyer, P. Groves, and E. Geffen. January 2001. Sociality in coastal river otters (*Lontra canadensis*): Kinship or cooperative foraging. (Abstract published)

Blundell, G. M., R. T. Bowyer, M. Ben-David, T. A. Dean, and S. C. Jewett. January 2001. Effects of food resources on the spacing behavior of river otters: Does forage abundance control home-range size? (Abstract published)

Blundell, G. M., R. T. Bowyer, L. K. Duffy, T. A. Dean, S. C. Jewett, and J. J. Stegeman. January 2001. Chronic effects of the *Exxon Valdez* oil spill on river otters: Is recovery complete? (Abstract published)

Blundell, G. M., J. W. Kern, R. T. Bowyer, and L. K. Duffy. January 2001. Capturing river otters: A comparison of Hancock and leg-hold traps. (Abstract published)

Bruner, B. L., G. A. Laursen, E. Follmann, E. Rexstad, W. Smith, and J. Nichols. November 2001. Small mammals and forest interactions: Mycorrhizal fungi as model organisms for understanding natural webs. Alaska's First Non-Timber Forests Meeting, Anchorage.

Chambers, S. D., M. L. Durant, F. S. Chapin III, and A. D. McGuire. December 2000. Post-fire net carbon exchange of Alaskan boreal forests. Annual Meeting, American Geophysical Union, San Francisco.

Chapin, F. S., M. L. Gotholdt, S. Rupp, E. Zaveleta, R. Naylor, A. M. Starfield, A. D. McGuire, and D. Verbyla. May 2000. Interaction of vegetation and human controls over fire regime in the Alaskan boreal forest. International Boreal Forest Research Association Conference: The Role of Boreal Forests and Forestry in the Global Carbon Budget, Edmonton, AB, Canada.

Chapin, F. S., S. Chambers, J. Beringer, D. Dissing, D. Verbyla, A. Lynch, and A. D. McGuire. August 2000. Effects of landscape structure and heterogeneity on terrestrial feedbacks to regional climate. Invited Paper, Annual Meeting of the Ecological Society of America, Snowbird, UT.

Chapin, F. S. III, A. D. McGuire, and J. Randerson. December 2000. Feedbacks from high-latitude ecosystems to climate. Invited paper. Annual Meeting, American Geophysical Union, San Francisco.

Clein, J. S., A. D. McGuire, X. Zhuang, D. W. Kicklighter, J. M. Melillo, S. C. Wofsy, and P. G. Jarvis. August 2000. The role of nitrogen dynamics in modeling historical and projected carbon balance of black spruce ecosystems across North America: Comparisons with CO_2 fluxes measured in the Boreal Ecosystem Atmosphere Study (BOREAS). Annual Meeting of the Ecological Society of America, Snowbird, UT.

Clein, J. S., A. D. McGuire, R. J. Dargaville, D. W. Kicklighter, J. M. Melillo, J. E. Hobbie, and E. B. Rastetter. December 2000. Modeling the effect of snowmelt dynamics on the seasonality of carbon fluxes across northern temperate and high latitude regions. Annual Meeting, American Geophysical Union, San Francisco.

Clifton, A., A. N. Powell, and M. Williamson. September 2001. The use of GRASS GIS software to map avian survey data. Eighth Annual Conference of the Wildlife Society, Reno, NV.

Copass, C. D., J. Beringer, A. D. McGuire, F. S. Chapin III, and D. A. Walker. December 2000. Characterization of vegetation biomass and structure along a gradient from tundra to forest at treeline in Council, Alaska. Annual Meeting, American Geophysical Union, San Francisco.

Copass, C. D., J. Beringer, F. S. Chapin III, A. D. McGuire, and D. A. Walker. August 2001. Functional type contributions to production, biomass and carbon flux along a structural gradient from tundra to forest at treeline in Council, Alaska. Annual Meeting of the Ecological Society of America, Madison, WI.

Copass, C. D., F. S. Chapin III, A. D. McGuire, and S. Zimov. December 2001. Carbon storage in successional landscapes following disturbance by fire in the Cherskii region, northeast Siberia. Fall Meeting of the American Geophysical Union, San Francisco.

Dargaville, R. J., A. D. McGuire, P. Rayner, and CCMLP Participants. May 2000. Comparison of high latitude large scale flux estimates from ecosystem models and an inversion of atmospheric CO2 measurements. International Boreal Forest Research Association Conference: The Role of Boreal Forests and Forestry in the Global Carbon Budget, Edmonton, AB.

Dargaville, R. J., A. D. McGuire, and P. J. Rayner. December 2001. Uncertainties in high-latitude net CO_2 fluxes, seasonality and interannual variability from a Bayesian inversion. Invited paper, Fall Meeting of the American Geophysical Union, San Francisco.

Debevec, E. and E. A. Rexstad. December 2000. Measuring the status of the Denali National Park and Preserve ecosystem through combining multiple LTEM datasets. Invited symposium. Alaska Biological Science Center, BRD/USGS, Anchorage.

Eyler, S. M., L. Vogel, and F. J. Margraf. April 2001. Effectiveness of a fish passage facility for anadromous river herring. Fifty-seventh Northeast Fish and Wildlife Conference, Saratoga Springs, NY.

French, H. B. May 2001. Effects of humans on activity budgets of brown bears (*Ursus arctos*) at Hallo Bay, Katmai National Park and Preserve, Alaska. Thirteenth International Conference on Bear Research and Biology, Jackson Hole, WY.

Griffith, B. February 2000. Global change and caribou habitat relationships. National Science Foundation, Investigators Meeting, Land Atmosphere Ice Interactions, Seattle, WA.

Griffith, B. February 2000. Remote sensing applications for monitoring biodiversity in the Arctic. Invited Paper, CAFF/MAP Workshop on Circumpolar Biodiversity Monitoring, Reykjavik, Iceland.

Griffith, B. March 2000. Ecology of arctic *Rangifer*: Continental heterogeneity and implications for ecosystem processes. Invited Paper, David R. Klein Honorary Symposium, Fairbanks, AK.

Griffith, B. April 2000. Habitat and foraging ecology of the Bathurst caribou herd on calving grounds: II. Investigators Meeting, West Kitikmeot Slave Study Society, Yellowknife, NT, Canada.

Griffith, B., K. Kielland, D. E. Russell, and A. Gunn. September 2000. Caribou and heterogeneity in arctic ecosystem processes. American Association for the Advancement of Science, 51st Arctic Science Conference, Whitehorse, YT, Canada.

Griffith, B. April 2001. Potential cumulative effects of oil development on the Arctic National Wildlife Refuge. Invited lecture to the Committee on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope, National Research Council, National Academy of Sciences, Fairbanks, AK.

Griffith, B., D. E. Russell, and G. Kofinas. April 2001. A continental system for barren-ground caribou habitat assessment. Ninth North American Caribou Workshop, Kuujjuaq, Quebec, Canada.

Heimann, M., I. C. Prentice, J. Foley, T. Hickler, D. W. Kicklighter, A. D. McGuire, J. M. Melillo, N. Ramankutty, and S. Sitch. December 2001. Carbon Cycle Model Linkage Project (CCMLP): Evaluating biogeochemical process models with atmospheric measurements and field experiments. Invited paper, Fall Meeting of the American Geophysical Union, San Francisco.

Holliman, F. M. and J. B. Reynolds. August 2000. Standardized evaluation of electrofishing injury in coldwater and warmwater fishes. Annual Meeting, American Fisheries Society, St. Louis, MO.

Holliman, F. M., J. B. Reynolds, and T. J. Kwak. August 2000. Electrofishing injury and short-term mortality of an endangered species. Annual Meeting, American Fisheries Society, St. Louis, MO.

Holliman, F. M. November 2000. Electrofishing juvenile chinook salmon: Fish injury, mortality, and growth. 27th Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Joyce, L. A., D. Coulson, A. D. McGuire, and B. Smith. December 2001. U.S. timber harvest from 1750 to 1997. Fall Meeting of the American Geophysical Union, San Francisco.

Kicklighter, D. W., M. D. Webster, A. D. McGuire, H. Tian, J. M. Reilly, J. M. Melillo, and R. G. Prinn. December 2000. Potential responses of terrestrial net primary production and carbon storage to increasing atmospheric carbon dioxide concentration and variable climate: Sensitivity to changes in vegetation nitrogen concentration. Annual Meeting, American Geophysical Union, San Francisco.

Kicklighter, D., M. Webster, M. Sarofim, A. McGuire, J. Melillo, J. Reilly, R. Prinn, and H. Tian. July 2001. Potential responses of terrestrial carbon storage to increasing atmospheric CO_2 concentration and variable climate: Sensitivity to changes in vegetation nitrogen concentration. International Geosphere-Biosphere Programme Global Change Open Science Conference, Amsterdam.

Laursen, G. A. October 2000. Beringian microbes: From high latitude ashes to sub-polar dust. Beringia Days, National Park Service, Anchorage.

Laursen, G. A., S. Yamin, C. Alix, O. Afonina, H. H. Burdsall, K. L. Dillman, L. H. Geiser, J. C. Landolt. D. L. Moore, J. Riley, R. D. Seppelt, S. L. Stephenson, R. G. Treu, Y. K. Novozhilov, and M. P. Zhurbenko. October 2001. Beringian cryptograms: High latitude spore producers, uses, and history. Beringian Days, sponsored by the National Park Service, Anchorage, AK.

Laursen, G. A. November 2001. Sustainability of cryptograms in high latitude Alaskan forests: Unregulated botanical forest products. Alaska's First Non-Timeber Forests Meeting, Anchorage.

Laursen, G. A., R. D. Seppelt, and M. Hallam. November 2001. Cycles in the forest: Mammals, mycophagy, and mycorrhizae. Alaska's First Non-Timeber Forests Meeting, Anchorage.

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 of the Carbon Cycle Model Linkage Project (CCMLP). Fall Meeting of the American Geophysical Union, San Francisco, CA.

McGuire, A. D., R. A. Meier, Q. Zhuang, M. Macander, T. S. Rupp, E. Kasischke, D. Verbyla, D. W. Kicklighter, and J. M. Melillo. May 2000. The role of fire disturbance, climate, and atmospheric carbon dioxide in the response of historical carbon dynamics in Alaska from 1950 to 1995: A process-based analysis with the Terrestrial Ecosystem Model. International Boreal Forest Research Association Conference: The Role of Boreal Forests and Forestry in the Global Carbon Budget, Edmonton, AB, Canada.

McGuire, A. D., R. A. Meier, Q. Zhuang, M. Macander, T. S. Rupp, E. Kasischke, D. Verbyla, D. W. Kicklighter, and J. M. Melillo. August 2000. The role of fire disturbance, climate, and atmospheric carbon dioxide in the response of historical

carbon dynamics in Alaska from 1950 to 1995. Annual Meeting of the Ecological Society of America, Snowbird, UT.

McGuire, A. D. October 2000. The role of atmospheric carbon dioxide, climate, and disturbance in the carbon balance of the terrestrial biosphere in the twentieth century: Global and regional perspectives. Invited colloquium. Center for Climate and Global Change Research, McGill University, Montreal, Quebec.

McGuire, A. D., R. A. Meier, Q. Zhuang, M. Macander, T. S. Rupp, E. Kasischke, D. Verbyla, D. W. Kicklighter, and J. M. Melillo. December 2000. The role of fire disturbance, climate, and atmospheric carbon dioxide in the response of historical carbon dynamics in Alaska from 1950 to 1995: The importance of fire history. Annual Meeting, American Geophysical Union, San Francisco.

McGuire, A.D. April 2001. Effects of climate change on the function and structure of ecosystems in Alaska. Invited lecture to the Committee on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope, National Research Council, National Academy of Sciences, Fairbanks.

McGuire, A. D. May 2001. Interactions between arctic terrestrial ecosystems and the climate system. Invited paper, Arctic Forum 2001, ARCUS 13th Annual Meeting, Arlington, VA.

McGuire, A. D. and the IGBP High Latitude Transect Working Group. August 2001. Environmental variation, vegetation distribution, carbon dynamics, and water/energy exchange in high latitudes. Annual Meeting of the Ecological Society of America, Madison, WI.

McGuire, A. D., and the IGBP High Latitude Transect Working Group. October 2001. Environmental variation, vegetation distribution, and carbon dynamics in high latitudes. International Symposium on Arctic Feedbacks to Global Change, Rovaniemi, Finland.

McGuire, A. D. November 2001. Monitoring the Biosphere. Invited paper, Study of Environmental Arctic Change (SEARCH) Workshop on Large-scale Atmosphere/Cryosphere Observations, Seattle, WA.

McGuire, A. D. December 2001. Environmental variation, vegetation distribution, and carbon dynamics in high latitudes. Invited Paper, Fall Meeting of the American Geophysical Union, San Francisco.

Meier, R., J. Harden, C. Silapaswan, D. Swanson, Q. Zhuang, and A. D. McGuire. December 2000. Characterization of soil drainage classes for the study of soil carbon storage in Alaska. Annual Meeting, American Geophysical Union, San Francisco.

Melillo, J. M., H. Tian, D. W. Kicklighter, A. D. McGuire, B. Moore III, and C. J. Vorosmarty. December 2000. Ecological constraints on carbon sequestration in North America. Annual Meeting, American Geophysical Union, San Francisco.

Melillo, J., H. Tian, A. McGuire, and D. Kicklighter. July 2001. Nitrogen controls on carbon sequestration. International Geosphere-Biosphere Programme Global Change Open Science Conference, Amsterdam.

Neilson, R., S. Running, D. Schimel, D. Bachelet, T. Hickler, A. King, D. Kicklighter, T. Kittel, J. Lenihan, D. McGuire, J. Melillo, D. Ojima, W. Parton, W. Post, I. Prentice, M. Sykes, P. Thornton, and H. Tian. July 2001. Potential impacts of climate change on carbon sequestration and ecosystems in the conterminous U.S.: Analyses from six VEMAP models. International Geosphere-Biosphere Programme Global Change Open Science Conference, Amsterdam.

Powell, A. N. and C. L . Fritz. September 2001. Breeding biology and population trends of western snowy plovers on Marine Corps Camp Pendleton, 1994-1999. Eighth Annual Conference of the Wildlife Society, Reno, NV.

Ramankutty, N., A. McGuire, and Carbon Cycle Model Linkage Project Participants. July 2001. The effects of historical changes in global agricultural land on the terrestrial carbon cycle. International Geosphere-Biosphere Programme Global Change Open Science Conference, Amsterdam.

Rexstad, E. A. and E. Debevec. October 2000. Small mammal investigations in Denali National Park. Denali LTEM Meeting, Fairbanks.

Rexstad, E. A. and E. Debevec. October 2000. Integration of multiple datasets in ecological system monitoring. Denali LTEM Meeting, Fairbanks.

Rexstad, E. and E. M. Debevec. September 2001. Heuristic metric for ecological monitoring. Eighth Annual Conference of the Wildlife Society, Reno, NV.

Reynolds, J. B. and F. M. Holliman. October 2000. Guidelines for assessment and reduction of electrofishing-induced injuries in trout and salmon. Invited paper. Wild Trout VII Meeting, Yellowstone Park, MT.

Reynolds, J. B. November 2000. Guidelines for assessment and reduction of electrofishing-induced injuries in salmonids. 27th Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Savereide, J. November 2000. An age-structured model for assessment and management of Copper River chinook salmon. 27th Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Savereide, J. June 2001. An age-structured model for assessment and management of Copper River chinook. 2001 World Conference on Natural Resource Modeling, Logan, UT.

Silapaswan, C. S., D. L. Verbyla, and A. D. McGuire. December 2000. Land cover change on the Seward Peninsula: The use of remote sensing to evaluate the potential influences of climate change on historical vegetation dynamics. Annual Meeting, American Geophysical Union, San Francisco.

Tian, H., J. M. Melillo, D. W. Kicklighter, A. D. McGuire, and B. Moore III. August 2000. Terrestrial carbon dynamics of North America from 1860 to 1992: Quantifying mechanisms responsible for carbon sinks. Annual Meeting of the Ecological Society of America, Snowbird, UT.

Tian, H., J. Melillo, D. Kicklighter, S. Pan, J. Liu, A. McGuire, and B. Moore III. July 2001. Regional carbon dynamics in monsoon Asia and its implications to the global carbon cycle. International Geosphere-Biosphere Programme Global Change Open Science Conference, Amsterdam.

Walsh, J. E., C. Elfring, C. J. Vorosmarty, and A. D. McGuire. December 2001. Enhancing NASA's contribution to arctic terrestrial hydrology and the study of polar change. Fall Meeting of the American Geophysical Union, San Francisco.

Wilkens, A., N. Hughes, R. Smith, B. Finney, N. Deschu, and J. LaPerriere (in absentia). February 2001. Chemical/physical limnology of Lake Clark, Alaska. Annual Meeting of the American Society of Limnology and Oceanography, Albuquerque, NM

Wolfe, S. A., B. Griffith, R. D. Cameron, and R. G. White. September 2001. Habitat selection by caribou of the Central Arctic Herd: Shifts in distribution and habitat quality." Eighth Annual Conference of the Wildlife Society, Reno, NV.

Yamin, S. and G. A. Laursen. October 2001. Like pickles go with vodka: An introduction to Beringian mycophagy. Beringian Days, sponsored by the National Park Service, Anchorage, AK.

Zhang, X., A. D. McGuire, and R. W. Ruess. December 2000. Maintenance respiration of black spruce ecosystems in Alaska: Implications for spatial and temporal scaling. Annual Meeting, American Geophysical Union, San Francisco.

Zhuang, Q., V. E. Romanovsky, J. S. Clein, A. D. McGuire, J. M. Melillo, D. W. Kicklighter, and S. Wofsy. August 2000. Modeling permafrost and carbon dynamics in an old black spruce ecosystem. Annual Meeting of the Ecological Society of America, Snowbird, UT.

Zhuang, Q., A. D. McGuire, J. Harden, K. P. O'Neill, and J. Yarie. December 2000. Modeling the carbon dynamics of a fire chronosequence in interior Alaska. Annual Meeting, American Geophysical Union, San Francisco.

Zhuang, Q., A. D. McGuire, J. Harden, K. P. O'Neill, V. E. Romanovsky, and J. Yarie. August 2001. Modeling the carbon dynamics of a fire chronosequence in interior Alaska. Annual Meeting of the Ecological Society of America, Madison, WI.

Zhuang, Q., J. S. Clein, A. D. McGuire, R. J. Dargaville, D. W. Kicklighter, J. M. Melillo, J. E. Hobbie, and E. B. Rastetter. December 2001. Modeling the effects of soil thermal dynamics on the seasonality of carbon fluxes across northern temperate and high latitude regions. Fall Meeting of the American Geophysical Union, San Francisco.

Honors and Awards

Gail Blundell (PhD Wildlife student), recipient of 3 scholarships for academic year 2000-2001: Thesis Completion Scholarship, Jay Hammond Scholarship, and McIntosh-Jessie O'Bryan Scholarship.

R. Terry Bowyer (Faculty Cooperator), recipient of the Distinguished Moose Biologist Award, 37th North American Moose Conference, 2001.

F. Michael Holliman (PhD Fisheries student), recipient of a UAF Graduate School Travel Grant to attend the American Fisheries Society annual meeting in St. Louis, MO, August 2000.

Gary Laursen (Faculty Cooperator), recipient of a Golden Key International Honour Society Award, 2001.

F. Joseph Margraf (Unit Leader), recipient of the Distinguished Service Award, American Fisheries Society, August 2001.

James Savereide (MS Fisheries, 2001), shared the Best Student Paper Award with another student, 2001 World Conference on Natural Resource Modeling, June 2001.

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

Migratory Patterns of Yukon River Inconnu as Determined with Otolith Microchemistry and Radio Telemetry

Personnel:
Dr. James B. Reynolds, Principal Investigator, AKCFWRU
Randolph J. Brown, Student Investigator (MS), SFOS
Funding Source: None
Note: Randy Brown graduated from UAF in May 2000. His thesis abstract follows.

Abstract—Migratory patterns of Yukon River inconnu (*Stenodus leucichthys*) were evaluated using otolith aging and microchemical techniques and radio telemetry. Research was conducted each fall between 1997 and 1999, on inconnu captured at a study site 1,200 river km from the Bering Sea. Biological data were collected to establish maturity and spawning condition. Sagittal otoliths were analyzed optically to determine age distribution, and microchemically to determine amphidromy. Inconnu were tagged with radio transmitters and located in upstream spawning destinations. Inconnu captured at the study site were uniformly large, mature fish preparing to spawn. Age estimates ranged from 7 to 28 years. Microchemical analyses suggested that the population was amphidromous rather than freshwater only. Preliminary testing of radio transmitter attachment methods showed that the internal method (pushed through the esophagus into the stomach) was superior to the external method (attached behind the dorsal fin) for use with migrating inconnu. Most radio-tagged inconnu were located during their spawning time in a common region of the Yukon River. Inconnu captured at the study site each fall were mature fish engaged in a spawning migration that originated in the lower Yukon River or associated estuary regions, and continued towards a common spawning destination in the Yukon River, approximately 1,700 river km from the sea.

Seasonal Movements of Broad Whitefish (*Coregonus nasus*) in the Freshwater Systems of the Prudhoe Bay Oil Field

Personnel:
Dr. James B. Reynolds, Co-Principal Investigator, AKCFWRU
Dr. Erich H. Follmann, Co-Principal Investigator, DBW
William A. Morris, Student Investigator (MS), DBW
Funding Source: ADFG/HR
Note: Bill Morris graduated from UAF in May 2000. His thesis abstract follows.

Abstract—Adult broad whitefish were tagged with radio transmitters in the Little Putuligayuk and Putuligayuk rivers along the Beaufort Sea coast of the Prudhoe Bay area, Alaska. Thirty-two fish were tagged in Lake Judith, a shallow tundra lake in the Little Putuligayuk River system. An additional 5 fish were tagged in the Putuligayuk

River near a suspected spawning and overwintering site. Many fish left the tundra system to overwinter in the west channel of the Sagavanirktok River; however, unexpected movements also occurred. Six (20%) of the fish found in overwintering areas moved to the east channel of the Sagavanirktok River, an area long disregarded as having much potential for overwintering fish. Additionally, 2 fish traveled west over 100 km along the coast to the Colville River. Broad whitefish in this study wintered in marginal habitat and exhibited the ability to travel between distant coastal river systems along the arctic coast of Alaska.

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

Personnel:
Dr. Terrance J. Quinn II, Principal Investigator, SFOS
James W. Savereide, Student Investigator (MS), SFOS
Funding Source: ADFG/SF (RSA)
Note: James Savereide graduated from UAF in August 2001. His thesis abstract follows.

Abstract—Chinook salmon in Alaska support human uses through a variety of fisheries. Age-structured assessment models are rarely used for estimating the abundance of exploited stocks. This thesis develops a model for the Copper River salmon population to show its advantages over typical assessment models. Information consists of catch-age data from three fisheries (commercial, recreational, subsistence) and two sources of auxiliary data (escapement index, spawner-recruit relationship). Four approaches utilizing different information sources are explored. Results suggest that an approach utilizing pooled catch-age data with time-varying brood-year proportions produces the best estimates, although retrospective and sensitivity analyses suggest that all four approaches explored are robust. The model should assist managers when making management decisions, because it integrates all sources of information, accounts for uncertainty, and provides estimates of optimal escapement. The model shows promise as a method for assessing and forecasting chinook salmon populations.

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

Personnel:
Dr. Jacqueline D. LaPerriere, Co-Principal Investigator, DBW
Dr. James B. Reynolds, Co-Principal Investigator, SFOS
Brendan P. Scanlon, Student Investigator (MS), SFOS
Funding Source: ADFG/SF (RSA)
Note: Brendan Scanlon graduated from UAF in December 2000. His thesis abstract follows.

Abstract—Becharof Lake is home to both 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 similar 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 subpopulations within each species. Otolith microchemistry revealed incidences of anadromy nad non-anadromy in both species. Stomach content analysis revealed a broad feeding niche but smaller ranges in food types in individual Arctic char with little seasonal preference, whereas Dolly Varden showed seasonality in food choices. Data suggest that both species can move in and out of the lake system, and that little competition for food or habitat occurs between the two species in the summer months.

Completed Projects—Terrestrial

Phylogeography and Population Genetics of Northern Flying Squirrels (*Glaucomys sabrinus*) in Southeast Alaska

Personnel:
Dr. Joseph A. Cook, Principal Investigator, DBW (now at Idaho State University)
Allison L. Bidlack, Student Investigator (MS), DBW
Funding Source: USFWS (RWO 67)
Note: Allison Bidlack graduated from UAF in August 2000. Her thesis abstract follows.

Abstract—The Prince of Wales flying squirrel (*Glaucomys sabrinus griseifons*), a forest associated species, is endemic to several islands in the Alexander Archipelago of Southeast Alaska. Mitochondrial and nuclear markers were examined to assess the genetic uniqueness of this subspecies and its geographic extent and to investigate gene flow among island and mainland populations of flying squirrels. Data from both sets of markers are congruent, and agree with the subspecific designation. The data also indicate that the Prince of Wales subspecies is isolated from other populations in Southeast Alaska, but that there may be gene flow among islands on which it occurs. This island lineage is likely the result of a founder event after the retreat of the Pleistocene ice sheets. The fact that this subspecies is isolated and divergent from mainland populations has potential implications for the design and planning of timber harvests on these islands.

Evaluation of Wolf Density Data Estimation from Radiotelemetry Data

Personnel:
Dr. Erich H. Follmann, Principal Investigator, IAB/DBW
John W. Burch, Student Investigator (MS), DBW
Funding Source: NPS
Note: John Burch graduated from UAF in May 2001. His thesis abstract follows.

Abstract—Density estimation of wolves (*Canis lupus*) requires a count of individuals and an estimate of area those individuals inhabit. With radiomarked wolves, the count is straightforward but estimation of area is more difficult and often given inadequate attention. The population area, based on the mosaic of pack territories, is influenced by sampling intensity similar to individual home ranges. If sampling intensity is low, population area will be underestimated and wolf density will be inflated. Using data from studies in Denali National Park and Preserve, I investigated these relationships using Monte Carlo simulation to evaluate effects of radiolocation effort and number of marked packs on density estimation. As the number of

adjoining pack home ranges increase, fewer relocations are necessary to define a given percentage of population area. I evaluated the utility of nonlinear regression to adjust for biases associated with under sampling and present recommendations for monitoring wolves via radiotelemetry.

Potential Muskox Habitat in the National Petroleum Reserve-Alaska: A GIS Analysis

Personnel:
Dr. David R. Klein, Principal Investigator, IAB
Fiona S. Danks, Student Investigator (MS), DBW
Funding Sources: BLM (RWO 72) and ADFG/WC (RSA)
Note: Fiona Danks graduated from UAF in August 2000. Her thesis abstract follows.

Abstract— Muskoxen (*Ovibos moschatus*), reestablished in northern Alaska in recent decades, have been increasing in number and distribution. However, their selection of habitat within the landscape, historically and presently, remains inadequately documented. This project produced maps of predicted muskox habitat in the National Petroleum Reserve-Alaska (NPR-A) that provide a basis for management of muskoxen and protection of their habitat in relation to proposed oil, gas and mineral interactions between vegetation and terrain. Within a geographical information systems (GIS) database, muskox locations, satellite-based vegetation maps and terrain data for the Kuparuk River drainage basin were assimilated, and a maximum likelihood classification developed to produce a habitat selection model incorporating the interactive effects of these characteristics. Using NPR-A GIS data, the model was extrapolated to produce maps showing suitable summer habitat in lower-lying drainages and wetter areas, and suitable winter habitat in drier, more rugged, exposed areas.

Response of Northern Red-Backed Vole (*Clethrionomys rutilus*) Populations to a Major Spruce Beetle Infestation in the Copper River Basin, Alaska

Personnel:
Dr. Eric A. Rexstad, Principal Investigator, IAB
Thomas J. McDonough, Student Investigator (MS), DBW
Funding Source: USGS/BRD/ABSC (RWO 65)
Note: Thomas McDonough graduated from UAF in August 2000. His thesis abstract follows.

Abstract—A spruce bark beetle (*Dendroctonus rufipennis*) epidemic in the Copper Basin of Alaska beginning in the late 1980's has infested over 200,000 ha of white spruce forests in the region. The impact of spruce beetle-induced habitat changes on the northern red-backed vole (*Clethrionomys rutilus*) was investigated using mark/recapture techniques for 2 field seasons. Vole abundance and recruitment was significantly greater on low versus heavily infested sites but a large vole survival response was lacking. Vole food resources and protective vegetative cover did not vary substantially in areas with different levels of spruce mortality. Male movement distances were influenced by sex ratio, and females appeared to respond to food resources (epigeous sporocarps). Beetle infestations alone did not influence vole movements, but female movement distances decreased when heavy infestation

levels were coupled with female age and sporocarp availability. The impact of beetle infestations on red-backed vole populations in the Copper Basin appears to be relatively small.

Molecular and Morphological Perspectives on Post-glacial Colonization of *Clethrionomys Rutilus* and *Clethrionomys Gapperi* in Southeast Alaska

Personnel:
Dr. Joseph A. Cook, Principal Investigator, UAM/DBW
Amy M. Runck, Student Investigator (MS), DBW
Funding Source: USFWS (RWO 68)
Note: Amy Runck graduated from UAF in May 2001. Her thesis abstract follows.

Abstract—Pleistocene events had a significant impact on the geographic distributions of high latitude organisms. Recently deglaciated, southeast Alaska has been colonized by two species of red-backed voles, *Clethrionomys rutilus* and *C. gapperi.* With distinct biogeographic histories, post-glacial colonization of *C. rutilus* and *C. gapperi* into this region would have occurred by different routes. Variation in the mitochondrial cytochrome b gene, the MYH2 nuclear intron, and the post palatal bridge were assessed to examine phylogeographic patterns of these two species, and a proposed contact zone in southeast Alaska. Low, but consistent, levels of sequence divergence of the cytochrome b gene were found among four endemic populations, which corresponded with the complex topography of southeast Alaska. Asymmetrical introgression of the mitochondrial genome diagnostic of *C. rutilus* was observed in *C. gapperi.* Post glacial contact resulting from the retreat of the Cordilleran and Laurentide ice sheets has apparently led to the formation of this hybrid zone.

Molecular Evolution of Martens (Genus *Martes*)

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
Note: Karen Stone graduated from UAF in August 2000. Her thesis abstract follows.

Abstract—Molecular studies provide the opportunity to re-evaluate and further investigate hypotheses such as those related to phylogenetic relationships, inter- and intra-continental colonizations, population differentiation, and the dynamics of hybrid zones. Three sets of molecular markers, nuclear and mitochondrial, were used to examine phylogenetic relationships among species within a holarctically distributed genus (*Martes*), and intraspecific diversification and population differentiation within American marten (*Martes americana*). In American marten, two morphological groups ("*americana*" and "*caurina*") have been recognized, though the level of distinctiveness between them has been debated.

My data supported the fossil record's indication that early radiations gave rise to two subgenera of the genus *Martes* (*Pekania* and *Charronia*) and that a more recent, possibly rapid, radiation gave rise to species of the third subgenus (*Martes*). Two colonizations of North America are evident, one by members of the subgenus *Pekania*, and another by the subgenus *Martes*. However, contrary to hypotheses based on morphological evidence, the "*americana*" and "*caurina*" subspecies groups

of *Martes americana* represent only one colonization. Cytochrome b data were consistent with the recognition of these as monophyletic clades; however, aldolase C sequences and microsatellite data indicated that these generally parapatric groups interbreed in at least one region of limited geographic overlap. These clades probably were isolated during the late Pleistocene in eastern and western glacial refugia, but geographic separation apparently has not led to reproductive isolation.

My data also indicated two colonization events for the Pacific Northwest by American martens (one by each clade). Due to patterns of genetic variation, I hypothesize that the "*caurina*" clade spread along the North Pacific coast, including southeastern Alaska, earlier than the "*americana*" clade, and that these clades have now formed a zone of secondary contact on Kuiu Island in southeastern Alaska. Microsatellite data revealed population differentiation among many island populations in the Pacific Northwest, but possible gene flow among several near-shore island and mainland populations was suggested. Analyses of genetic and geographic distances suggested that colonization history had a strong effect on present day population structure and that oceanic straits and possibly other physiographic features posed significant barriers to gene flow.

Calving Ground Habitat Selection: Teshekpuk Lake and Western Arctic Caribou Herds

Personnel:
Dr. Brad Griffith, Principal Investigator, AKCFWRU
Rebecca A. Kelleyhouse, Student Investigator (MS), DBW
Funding Source: ADFG/WC (RSA)
Note: Rebecca Kelleyhouse graduated from UAF in December 2001. Her thesis abstract follows.

Abstract—Barren-ground caribou (*Rangifer tarandus granti*) exhibit relative fidelity to calving grounds each spring. The Western Arctic Herd (WAH) and Teshekpuk Lake Herd (TLH) calve separately on Alaska's north slope, each selective of the dominant vegetation type. The WAH consumed mostly sedges, though the TLH diet varied. Despite differing snow conditions between the calving grounds, both herds were selective of the lowest snow cover class. Rugged terrain was avoided by both herds. While the TLH selected a high rate of increase in biomass, the WAH selected high biomass at calving and at peak lactation. Climate trends (1985-2001) were variable. There was a warming trend on the WAH calving ground, though no significant trends were present on the TLH calving ground, as expressed by median NDVI on 21 June. These herds have similar winter ranges and population trends, yet they differ in respect to habitat composition, selection and climate patterns during calving.

Habitat Selection by Calving Caribou of the Central Arctic Herd, 1980–95

Personnel:
Dr. Brad Griffith, Co-Principal Investigator, AKCFWRU
Dr. Raymond D. Cameron, Co-Principal Investigator, IAB
Anne Gunn, Cooperator, Department of Resources, Wildlife, and Economic Development, NWT
Dr. Knut Kielland, Cooperator, UAF/IAB
Dr. Don Russell, Cooperator, Environment Canada, CWS
Scott A. Wolfe, Student Investigator (MS), DBW
Funding Source: West Kitikmeot Slave Study Society, Yellowknife, NWT
Note: Scott Wolfe graduated from UAF in December 2000. His thesis abstract follows.

Abstract—Habitat selection by calving caribou (*Rangifer tarandus granti*) of the Central Arctic Herd, Alaska, was assessed in relation to distance from roads, vegetation type, relative plant biomass (NDVI; Normalized Difference Vegetation Index), accumulation of plant biomass during early lactation (NDVIrate), snow cover, and terrain ruggedness. From 183 calving sites of 96 radio-collared females, 1980-95, calving distribution was estimated in reference (no development) and treatment (oilfield) zones east and west of the Sagavanirktok River, respectively. In the reference zone, caribou regularly selected wet-graminoid vegetation, above-median NDVIrate, and non-rugged terrain; concentrated calving remained in habitats with zonal average NDVI on 21 June (NDVI621). In the treatment zone, selection patterns were inconsistent; concentrated calving shifted inland to rugged terrain with low NDVI621 and away from development. Repeated use of lower-quality habitats in the treatment zone could compromise nutrient intake by calving females, thereby depressing reproductive success of the western-segment of the herd.

Effects of Migratory Geese on Plant Communities and Nitrogen Dynamics in an Alaskan Salt Marsh

Personnel:
Dr. Roger Ruess, Principal Investigator, IAB
Amy Zacheis, Student Investigator (PhD), DBW
Funding Source: USGS/BRD/ABSC (RWO 27)
Note: Amy Zacheis graduated from UAF in December 2000. Her thesis abstract follows.

Abstract—Herbivory is an integral component of ecosystems that impacts plant communities and ecosystem processes, and affects forage availability and quality for the herbivore. I investigated the effects of lesser snow geese (*Anser caerulescens caerulescens*) and Canada geese (*Branta canadensis*) on two salt marsh communities, a sedge meadow and an herb meadow, in Cook Inlet, Alaska. Geese used the marshes during spring migration for a brief period, and foraging intensity was low compared to other goose-grazing systems. Seventy percent of the snow goose diet was on belowground plant tissues, whereas 92% of the Canada goose diet was on aboveground shoots.

In the sedge meadow, where feeding was primarily on aboveground shoots, there was no effect of grazing on biomass of the dominant species *Carex ramenskii* and *Triglochin maritimum,* or on shoot nitrogen concentrations in these species (an index

of forage quality). An experiment with captive geese found no effect of herbivory on biomass or nitrogen concentrations at low foraging intensity ten times greater than that imposed by wild geese, indicating that this community is highly resilient to herbivory.

In the herb meadow, where snow geese fed on belowground tissues, biomass of *Plantago maritima* and *Potentilla egedii* was lower, and biomass of *Carex ramenskii* higher, on grazed compared to ungrazed plots. Plant species' response to herbivory was determined by plant growth form, the type of herbivory (above- or belowground), and competitive interactions. Light herbivore pressure in this community altered the relative abundance of forage species for geese.

In the sedge meadow community, geese increased nitrogen mineralization rates by trampling litter into wet soils. Litter incorporated into soils increased organic nitrogen pool size, decreased soil C:N ratios, and facilitated the growth of nitrogen-fixing cyanobacteria, all of which led to increased mineralization rates in grazed areas. Fecal nitrogen in-puts were small and did not affect nitrogen availability. A captive goose experiment found that fecal additions ten-fold larger also had no effect on nitrogen availability. In the herb meadow, geese did not affect nitrogen mineralization because soils were dry with little standing water, so that incorporation of litter into soils through trampling was less important.

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)

The purpose of this study was 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, we responded to reviewers comments on the final report on the project that had 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 separate synthesis manuscripts on the pigeon guillemots and river otter components of the project have been submitted to journals. One of the students

(Seiser) graduated with an MS degree in Wildlife Biology, and the other student (Blundell) is nearing completion of her PhD degree.

Mechanism of Impact and Potential Recovery of Pigeon Guillemots (*Cepphus columba*) after the *Exxon Valdez* Oil Spill

Personnel:
- Dr. A. David McGuire, Principal Investigator, AKCFWRU
- Dr. R. Terry Bowyer, Co-Principal Investigator, IAB
- Dr. Lawrence Duffy, Do-Principal Investigator, IAB
- 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)
Note: Pam Seiser graduated from UAF in May 2000. Her thesis abstract follows.

Abstract—The abundance of pigeon guillemots in oiled areas of Prince William Sound, Alaska, failed to increase after the 1989 *Exxon Valdez* oil spill. Population growth may be constrained by the physiological effects of oil exposure, food availability, and nest predation. I conducted a comparative study among unoiled, oiled, and pre-spill data sets, to provide insight on factors limiting population recovery in oiled areas. Blood samples from chicks in oiled and unoiled areas provided little evidence of physiological effects of exposure to oil. Pigeon guillemot diet, productivity, growth rates, and fledging weights in unoiled areas of southwestern Prince William Sound from 1994 to 1998 indicate oiled areas had a lower proportion of high-lipid fish in the chick diet and lower fledging weights, compared to unoiled and pre-spill studies. These results suggest that the lack of recovery in oiled areas is associated with a prey base that results in lower fledging weights, which may reduce juvenile survival.

Social Organization and Spatial Relationships in Coastal River Otters: Assessing Form and Function of Social Groups, Sex-biased Dispersal, and Gene Flow

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

Funding Source: USGS/BRD/ABSC (RWO 40)
Note: Gail Blundell graduated from UAF in May 2001. Her thesis abstract follows.

Abstract—River otters (*Lontra Canadensis*) inhabiting marine environments are top-level predators foraging in the nearshore ecosystem and recently have been recognized as indicators of environmental health. Otters were extirpated from much of their historic distribution because of exposure to pollution and urbanization, resulting in expansive reintroduction programs that continue today. Without an understanding of the influence of factors such as social structure, mating systems, or six-biased dispersal on genetic variation and gene flow among populations, effects of local extirpation and the potential for natural recolonization (i.e., the need for reintroductions) cannot be determined. The objective of this study was to assess social organization and evaluate the importance of factors such as prey availability and kinship on formation of social groups and dispersal of individuals. Fifty-five

otters were radio-tracked in three study areas in Prince William Sound, Alaska, from 1996 to 1999, to determine social organization and dispersal rates. Data from 111 individual otters (seven study areas) were obtained to assess relatedness and gene flow (with microsatellite DNA) and diet (with stable isotope analysis of $\delta^{13}C$ and $\delta^{15}N$). DNA analysis indicated that kinship had no effect on social organization or spatial relationships among otters. Analyses of diet and home-range size indicated that social groups may be formed to facilitate cooperative foraging, enabling social otters to obtain a better-quality diet more efficiently (i.e., social otters had diets higher in schooling pelagic fishes and had smaller home ranges, compared to nonsocial otters). Male otters were more social than females, but reproductive constraints likely limited opportunities for sociality among females. Both telemetry and genetic data indicated that male and female otters had an equal, low probability of natal dispersal and male otters also exhibited breeding dispersal resulting in gene flow to nearby populations. Genetic data indicated distances for natal dispersal were bimodal; most males and some females settled nearby (within 16-30 km), but some females dispersed 60-90 km. Despite lack of geographic barriers to dispersal in a marine system, dispersal distances were relatively short, indicating that extirpation of local populations would be difficult to correct via natural recolonization unless viable otter populations were available nearby.

Completed Projects—Integrated

Development of Forest Disturbance Scenarios for the United States

Personnel:
Dr. A. David McGuire, AKCFWRU
Cherie S. Silapaswan, Student Investigator (MS), DBW (partial support)
Funding Source: USFS (RWO 94)

The purpose of this study was 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 was part of a USDA Forest Service Resource Planning Act (RPA) Special Study, which had been granted to Dr. Linda Joyce of the USDA Forest Service Rocky Mountain Forest and Range Experiment Station. Dr. Joyce's lab has used regional data on inventory and harvest to develop the several alternative disturbance 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. Dr. McGuire has used these data sets to conduct simulations with the Terrestrial Ecosystem Model (TEM) to evaluate how different disturbance data sets influence carbon storage. This study has provided a methodology for national application that provides the USDA Forest Service with the capability to simultaneously assess the effects of rising atmospheric CO_2, climate, and land-use on historical U.S. carbon storage.

Land Cover Change on the Seward Peninsula: The Use of Remote Sensing to Evaluate the Potential Influences of Climate Change on Historical Vegetation Dynamics

Personnel:
Dr. Terry Chapin, Lead Investigator, IAB
Dr. A. David McGuire, Co-Investigator and Faculty Advisor, AKCFWRU
Dr. David Verbyla, Co-Investigator, FSD
Cherie S. Silapaswan, Student Investigator (MS), DBW
Funding Sources: USFS (RWO 94), NASA, and NSF
Note: Cherie Silapaswan graduated from UAF in December 2000. Her thesis abstract follows.

Abstract—Vegetation on the Seward Peninsula, Alaska, which is characterized by transitions from tundra to boreal forest, may be sensitive to the influences of climate change on disturbance and species composition. To determine the ability to detect decadal-scale structural changes in vegetation, Change Vector Analysis (CVA) techniques were evaluated for Landsat TM imagery of the Seward Peninsula. Scenes were geographically corrected to sub-pixel accuracy and then radiometrically rectified. The CVA results suggest that shrubbiness is increasing on the Seward Peninsula. The CVA detected vegetation change on more than 50% of the burned region on TM imagery for up to nine years following fire. The use of both CVA and unsupervised classification together provided a more powerful interpretation of change than either method alone. This study indicates that CVA may be a valuable tool for the detection of land-cover change in transitional regions between tundra and boreal forest.

The Role of High Latitude Ecosystems in the Global Carbon Cycle

Personnel:
Dr. A. David McGuire, Faculty Advisor, AKCFWRU
Xinxian Zhang, Student Investigator (MS), DBW
Funding Source: NSF

The goals of this project were (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 synthesized and integrated 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* 6:S141-159; Clein et al. 2000. *Global Change Biology*. 6:S127-140). 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 (Amthor et al. 2001. *Journal of Geophysical Research*. 106:33, 623-33, 648; Potter et al. 2001. *Journal of Geophysical Research - Atmospheres*. 106:33, 671-33, 688; Clein et al. 2001. *Plant and Soil*. In press.).

Modeling Stand-Level Canopy Maintenance Respiration of Black Spruce Ecosystems in Alaska: Implications for Spatial and Temporal Scaling

Personnel:
Dr. A. David McGuire, Faculty Advisor, AKCFWRU
Xinxian Zhang, Student Investigator (MS), DBW
Funding Source: NSF
Note: Xinxian Zhang graduated from UAF in May 2001. His thesis abstract follows.

Canopy respiration represents an important part of the carbon budget of black spruce forests. In this study I scaled hourly models of foliar maintenance respiration (R_m) to estimate canopy R_m for individual stands, and investigated issues in scaling the models to estimate canopy R_m using mean monthly temperature data. I used data from several stands to develop hourly stand-specific and stand-independent models of canopy Rm. Analysis of simulated canopy R_m indicated that stand-level controls over foliar N concentration should be considered in models that estimate canopy R_m of black spruce stands across the landscape. Uncertainty analyses indicated that the parameter that describes maintenance respiration rate at 0°C per g N has the greatest influence on annual estimates of canopy maintenance respiration. Finally, comparisons of monthly R_m between the hourly and monthly versions of the models indicated that mean monthly temperature can be used to drive models of canopy R_m with little loss of precision.

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

Personnel:
Dr. A. David McGuire, Faculty Advisor, AKCFWRU
Qianlai Zhuang, Student Investigator (PhD), DBW
Funding Source: NSF

The purpose of this project was 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 was 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 previous years measured pre-fire and post-fire carbon pools in the area that was burned during summer 1999. The model has been used to estimate emissions from the fire and shows good agreement with at least two different field methods used to estimate emissions. One of Dr. McGuire's graduate students on his NASA project has assisted him with model simulations of the post-fire response of carbon storage. The simulations agree with field measurements of soil respiration before and after the

fire. The model has also been used to model carbon dynamics for a chronosequence of burn sites in interior Alaska, and a paper that describes this research has been accepted for publication in the *Journal of Geophysical Research Atmospheres* (Zhuang et al. In press.). During previous years, Dr. McGuire has also worked with a postdoc who used 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 worked in Dr. McGuire's laboratory between July 2000 and July 2001, resulted in the development of two papers, one of which has been accepted for publication (Dargaville et al. In press. *Climatic Change*) and the other which is still in review. These papers indicate that there is good agreement with the forward modeling research on the role of fire 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-Investigator, AKCFWRU
Qianlai Zhuang, Student Investigator (MS), DBW (partial support)
Cherie Silapaswan, Student Investigator (MS), DBW (partial support)
Dr. David Verbyla, Co-Investigator, FSD
Matt Macander, Student Investigator, FSD
Aaron Woods, Student Investigator, FSD
Dr. W. Scott Armbruster, Co-Investigator, IAB

Funding Source: NASA

The purpose of this study was 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 worked on various aspects of this project. Three of the students worked on tasks 1 and 2, and the other student worked on tasks 3 and 4. Two of these students have completed their degrees. 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 has being conducted by the student working on tasks 3 and 4. This student, who graduated with a PhD degree this year, has published one paper (Zhuang et al. 2001. *Journal of Geophysical Research - Atmospheres*. 106:33,649-33,670) and has submitted another paper to the *Journal of Geophysical Research – Atmospheres*. These papers describe the development and testing of a version of TEM

that simulates the interaction between the soil thermal regime and biogeochemical dynamics for mature and disturbed forest stands in interior Alaska. Remote-sensing research by the other students has focused on developing change-detection algorithms for fire, logging, insect infestation, and natural vegetation dynamics. One of the students has completed her thesis research for an MS degree, and has published a paper based on this research (Silapaswan et al. 2001. *Canadian Journal of Remote Sensing* 5:542-554) that describes a study in which remote sensing change detection analyses indicate that shrubs are expanding in transitional regions between tundra and boreal forest in Alaska. Other change detection research conducted by this project indicates that the area occupied by wetlands appears to getting smaller.

Modeling the Influences of Climate Change, Permafrost Dynamics, and Fire Disturbance on Carbon Dynamics of High Latitude Ecosystems

Personnel:

Dr. A. David McGuire, Faculty Advisor, AKCFWRU

Qianlai Zhuang, Student Investigator (PhD), DBW

Note: Qianlai Zhuang graduated from UAF in December 2001. His thesis abstract follows.

Abstract—A Soil Thermal Model (STM) with the capability to operate with a 0.5-day internal time step and to be driven with monthly input data was developed for applications with large-scale ecosystem models. The use of monthly climate inputs to drive the STM resulted in an error of less than 1^{o}C in the upper organic soil layer and in an accurate simulation of seasonal active layer dynamics. Uncertainty analyses identified that soil temperature estimates of the upper organic layer were most sensitive to variability in parameters that described snow thermal conductivity, moss thickness, and moss thermal conductivity. The STM was coupled to the Terrestrial Ecosystem Model (TEM), and the performance of the STM-TEM was verified for the simulation of soil temperatures in applications to black spruce, white spruce, aspen, and tundra sites. A 1^{o}C error in the temperature of the upper organic soil layer had little influence on the carbon dynamics simulated for a black spruce site. Application of the model across the range of black spruce ecosystems in North America demonstrated that the STM-TEM has the capability to operate over temporal and spatial domains that consider substantial variations in surface climate. To consider how fire disturbance interacts with climate change and permafrost dynamics, the STM was updated to more fully evaluate how these factors influence ecosystem dynamics during stand development. The ability of the model to simulate seasonal patterns of soil temperature, gross primary production, and ecosystem respiration, and the age-dependent pattern of above-ground vegetation carbon storage was verified. The model was applied to a post-fire chronosequence in interior Alaska and was validated with estimates of soil temperature, soil respiration, and soil carbon storage that were based on measurements of these variables in 1997. Sensitivity analyses indicate that the growth of moss, changes in the depth of the organic layer, and nitrogen fixation should be represented in models that simulate the effects of fire disturbance in boreal forests. Furthermore, the sensitivity analyses revealed that soil drainage and fire severity should be considered in spatial application of these models to simulate carbon dynamics at landscape to regional scales.

Ongoing Projects—Aquatic

Limnology and Zooplankton Ecology of Lake Clark, Alaska

Personnel:
Dr. Jacqueline D. LaPerriere, Principal Investigator, AKCFWRU (deceased)
Dr. Nicholas F. Hughes, Principal Investigator, SFOS
Alexander Wilkens, Student Investigator (MS), DBW
Funding Source: NPS (RWO 84)

Little baseline water quality information has been collected on Lake Clark, although it plays a critical role in the largest sockeye salmon fishery in the world and is the sixth largest lake in Alaska. 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. Sockeye salmon are a keystone species for which Lake Clark National Park and Preserve was established to protect. 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. 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 and 2000 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 have been processed. Analysis of limnological data is complete, and analysis of zooplankton data has begun.

In-Kind Support:
- AKCFWRU provided research assistantship support, and accounting and office support.
- IAB provided accounting services.

Phylogenetics and Identification of Juveniles of the Genus Sebastes Based on mtDNA Variation

Personnel:
Dr. Anthony J. Gharrett, Principal Investigator, SFOS
MeiMei Li, Student Investigator (MS), SFOS
Funding Source: USGS/BRD/Western Regional Office (RWO 32)

The genus *Sebastes* is a species-rich genus that includes more than 100 species worldwide, most of which occur along the Pacific coast of North America. Many of these species occur sympatrically and share morphological similarities. The systematics of the genus is not well established and it is difficult to identify early stages of the species morphologically. The objective of this study was to determine the phylogenetic relationship among the members of the subgenera *Pteropodus* and *Mebarus*, as well as the potential of using genetic markers to identify the species of the genus *Sebastes*. Mitochondrial DNA was extracted from tissue samples and PCR-amplified. The PCR products were digested with restriction enzymes to reveal intra-

and interspecific variation. A restriction site map was constructed using double digest results. Phylogenetic analysis was carried out based on the presence and absence of restriction sites. Identity of unknown juveniles was determined by comparing their restriction site patterns to those of known adults. Phylogenetic analyses suggest that the eastern North Pacific members and the western North Pacific members of the subgenus *Pteropodus* are not as closely related as their taxonomic assignments indicate; instead, the two groups are each more closely related to species of other subgenera in their own area. To date, restriction site analysis seems to be adequate at determining species identity, but the analysis is not yet carried out. The ability to identify juveniles of species of *Sebastes* will allow management agencies to conduct abundance survey, recognize critical habitats, such as kelp beds and oil platforms, and devise appropriate protection plans accordingly.

In-Kind Support:
The Auke Bay Lab, University of California at Santa Barbara, Kitasato University, Japan, and Alaska Fishery Science Center at Sandpoint, Seattle, provided rockfish tissue samples.

Applications of New DNA Methodologies to Identify Stocks of Alaskan Chum Salmon

Personnel:
Dr. Anthony J. Gharrett, Principal Investigator, SFOS
Blair Flannery, Student Investigator (MS), SFOS
Funding Source: USFWS (RWO 92)

Mixed stock allocations for Yukon River chum salmon have not been sufficiently accurate with previously used genetic markers. Chum salmon are a vital resource for both commercial and subsistence fisherman as well as to wildlife along the U.S. and Canadian portions of the Yukon. The U.S./Canada border populations of chum salmon are genetically quite similar, which has confounded efforts to manage and allocate chum salmon by country of origin. Also, implicit in effective resource management is conservation of the resource. The object of this study is to test genetic methods with which a baseline of U.S. and Canadian stocks of chum salmon might be developed for use in determining the relative contributions of stocks in a mixed fishery. Major chum salmon populations of the Yukon were sampled. The molecular technique—amplified fragment length polymorphism (AFLP)—was applied in an attempt to find markers that characterize the populations. The AFLP data separate the populations into the following regional groups: Lower, Middle, Border, and Upper Yukon. These groups do not clearly separate U.S. and Canadian stocks. These groupings correspond with the run-timing and geographic location of the populations and are concordant with the results of previous studies that used allozymes, mtDNA-RFLPs, and microsatellites. The results indicate that the patterns of genetic structure mirror the life history patterns and geographic relationships of the fish in this region of the Yukon River. Article III of the Pacific Salmon Treaty of 1985 mandates that the salmon resources are to be conserved and fairly allocated between the two countries. Although identification of chum stocks by country of origin would simplify allocation and management, the combined results of all the genetic studies indicate that the population structure is driven by geographical and environmental forces that do not coincide with international boundaries. Genetic

stock identification does not hold promise for fine-scale allocation of chum salmon along the US-Canada boundary.

In-Kind Support:
In 2000, the USFWS provided laboratory chemicals and supplies ($8200); travel to UC Davis for instruction ($1000); summer salary ($10,000); study samples; and lab space in summer.

Predicting Growth and Habitat Selection of Juvenile Arctic Grayling in Chena Slough

Personnel:
Dr. James B. Reynolds, Principal Investigator, AKCFWRU and SFOS
Dr. Nicholas F. Hughes, Co-Principal Investigator, SFOS
Cheryl A. Dion, Student Investigator (MS), SFOS
Funding Source: ADFG/SF (RSA)

Chena Slough in interior Alaska may be the most productive spawning and rearing areas for Arctic grayling *Thymallus arcticus* in the Chena River drainage. However, the quality and quantity of favorable spawning and rearing areas may be declining due to natural and human-induced processes. Before the status of Chena Slough as a nursery area for juvenile grayling can be evaluated and trends in change projected, it is necessary to establish quantitative criteria for optimal growth and habitat selection of juvenile grayling. Mathematical modeling of a temperature-based growth (growth model) and habitat-based (foraging model) model will be tested for their suitability to predict growth and explain variation in habitat selection of grayling fry and fingerling. To test the fit of the growth model, fish length was measured weekly, and average daily water temperatures were obtained from data loggers. To predict fish distribution for the foraging model, velocity, depth and substrate were mapped; underwater video was used to obtain spatial variation in fish density; and stomach samples and invertebrate drift were collected to obtain drift density and size composition. All fieldwork was conducted during the 2000 and 2001 growing season. The growth model accurately predicted growth of juvenile grayling on the basis of estimating hatching date and temperature. Results from the foraging model suggest that energetic conditions varied among habitats, with higher growth in areas predicted to be near optimal. Knowledge of early life history characteristics of fish are essential for assessing the quality of specific habitats. The growth/foraging models provide an understanding of early life history energetics of grayling and can be used to assist in processes of restoration and enhancement of grayling habitat.

In-Kind Support:
- Dr. Russell Hopcroft for use of Microbiota program and his lab.
- Cheryl Clarke for zooplankton identification and program instruction.
- Dr. Sue Henrichs for her dissection microscope.

Standardized Evaluation of Electrofishing Injury in North American Freshwater Sport Fishes

Personnel:

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

Funding Sources: USFWS (RWO 57) and ADFG/SF (RSA)

Freshwater fishes may be injured when captured by electrofishing. This problem is perceived as a national issue, but most studies have been limited to salmonids; its true scope and importance are unknown. Electrofishing-induced injuries in fishes have caused some management agencies to place moratoria on the use of electrofishing. Managers do not want electrofishing restrictions unless necessary because electrofishing is a valuable assessment tool. This study aims to evaluate the injury issue through standardized, controlled experiments on a variety of coldwater and warmwater species, and to find ways reduce injury when appropriate. During 1999, experiments were conducted in Washington (white sturgeon, chinook salmon), Mississippi (channel catfish) and North Carolina (Cape Fear shiner). During 2000, experiments were conducted in Washington (juvenile chinook salmon), Texas (largemouth bass and bluegill) and North Carolina (hybrid striped bass and a threatened minnow, spotfin chub). Hatchery-produced fish were exposed to various treatment combinations of voltage and pulse rate. Injuries were evaluated by radiography (spinal fracture) and filleting (muscle hemorrhage). During 2001, effort was directed toward data analysis and development of risk for injury models. White sturgeon exposed to DC were at significantly lower risk for injury than those exposed to 60-Hz PDC. Electrical waveform and fish size were significant predictors of injury in channel catfish and chinook salmon. Voltage was a significant predictor for injury in channel catfish, but not for chinook salmon. A multivariable model including electrical waveform, voltage, and fish size had the best predictive capacity of the models evaluated. No injury occurred in Cape Fear shiners, but fish mortality was related to fish size, voltage gradient, and exposure period. Results indicate that the incidence of electrofishing injuries can be reduced to insignificant levels through careful selection of voltage and pulse rate.

In-Kind Support:

- Smith-Root, Inc., Vancouver, WA, provided a programmable electrofisher.
- Heart of the Hills Research Station, Texas Department of Parks and Wildlife; Pamlico Aquaculture Center, North Carolina State University; North Carolina Cooperative Fish and Wildlife Research Unit; and the Salmon Technology Development Center, USFWS, provided fish and/or hatchery facilities.
- Large Animal Research Station/IAB provided freeze space, and X-ray and necropsy facilities.

Evaluation of Urban Impacts on Coho Salmon in Chester Creek: A Criteria-based Approach

Personnel:
Dr. Nicholas F. Hughes, Principal Investigator, SFOS
Matthew Whitman, Student Investigator (MS), SFOS
Funding Source: USGS/WRD (RWO 95)

As recently as the mid-1900's coho salmon used to return in large numbers to Chester Creek in Anchorage, Alaska. Only a remnant population currently exists. Recent desires to rehabilitate and restructure Chester Creek have emphasized the goal of restoring the coho salmon population. A healthy return of coho each year would renew interest in the stream by tourists and local anglers. The objectives of this study were to determine which components of stream habitat might be most responsible for limiting coho salmon production in Chester Creek and to identify urban elements that can affect those components. A model for evaluating coho habitat for all life stages based on criteria established from past research was constructed and applied to one non-urban and two urban study reaches in Chester Creek. Urban elements that typically affect stream habitat were identified by other research, as well. Habitat parameters considered to be most limiting to coho include barriers, sedimentation, structural complexity, water quality, and flow regime. Urban elements that typically affect these parameters are impervious surface area, channelization, culverts, polluted storm runoff, construction, road maintenance, and streambank erosion. Efforts aimed at restoring the coho salmon population in Chester Creek should focus on mitigating the possible effects of urbanization on habitat so that improvements made by stream restoration and reconstruction can be maintained.

In-Kind Support:
In 2000, USGS/WRD, Anchorage, provided approximately 4 months of personnel, equipment, and technical support in a large-scale project contributing heavily to this sub-project. This included field work, laboratory processing efforts, and data organization.

The Effect of Fish Wheel Capture and Tagging on Stress Hormones in Fall Chum Salmon

Personnel:
F. Joseph Margraf, Principal Investigator, AKCFWRU
Peter M. Cleary, Student Investigator (MS), SFOS
Funding Source: ADFG/SF, Fairbanks

Approximately 15 test fish wheels are used annually in the Yukon River drainage to estimate run strength and timing as well as for mark recapture studies. Because of the number of fish wheels operated by various agencies, it is possible that large numbers of chum salmon and other species maybe affected by these projects. In this study we address the question of whether fish wheel capture and tagging cause lasting stress effects on fall chum salmon. The objective of the study is to determine if there is difference in blood plasma stress parameters and non-esterfied (metabolically active) fatty acids between tagged and untagged chum salmon captured at fish wheels on the Toklat River. In this work we use blood plasma stress

parameters and non-esterified fatty acid analysis as an evaluation of stress effects and energy expenditure in fall chum salmon (*Oncorhynchus keta)* on the Toklat River, Alaska. Blood plasma samples were collected in 2000 and 2001 from fall chum salmon. In 2000, samples were analyzed for stress parameters cortisol, lactate, chloride, and glucose. In 2001 blood samples were analyzed for non-esterified fatty acid. The results from 2000 suggested that chum salmon may still be recovery from the effects of tagging and capture by the time they migrate to the recovery wheels 114 km upstream on the Toklat River. The 2001 results indicated that tagged chum salmon captured at the Toklat River recovery wheels had lower non-esterified fatty acids values than untagged chum salmon. Because fish wheels are used so widely, modifications may be needed to fish wheels, as well as mark-recapture studies as a whole, to reduce stress effects on fall chum salmon and other species.

In-Kind Support:

- ADFG provides general funds for partial funding of all aspects of the project.
- Funds from the Western Alaska Disaster Relief Grant (WADG) through the USFWS provided partial funding for all aspects of the project, and funding for the entire Toklat River recovery wheel camp.
- The Bering Sea Fishermen's Association (BSFA) provides funding for the Kantishna River tagging wheel.
- NPS provides funding (through USFWS) for the upper Kantishna recovery wheel (although no blood sample data was collected from this wheel in 2000) and approximately 4 hours of fixed-wing aircraft support.
- UAF Fishery Industry Technology Center (Scott Smiley) processed chum salmon collected on the Tanana, Kantishna and Toklat Rivers for proximate analysis.

Effects of Catch-and-Release Fishing on the Physiology and Hooking Injury of Alagnak River Rainbow Trout, Katmai National Park

Personnel:

F. Joseph Margraf, Principal Investigator, AKCFWRU
Julie Meka, Student Investigator (MS), SFOS

Funding Source: USFWS

The Alagnak River is one of the most heavily fished in the southwest Alaska wild trout management area. Rapidly increasing angler use of the Alagnak River rainbow trout fishery led to concerns about the health of the population and resulted in recent regulatory changes to catch-and-release fishing only. Hooked fish are subjected to stresses including handling, exhaustion, and repeated air exposure during capture and a high probability of hook injury with heavy catch-and-release fishing pressure. Detrimental aesthetics of mutilated trout have greatly reduced the overall appreciation of the Alagnak River and Katmai National Park by anglers and visitors. The goal of this study is to assess acute and chronic stress, behavioral modifications, incidence of hooking injury, and changes to seasonal growth trajectories associated with a catch-and-release fishery, and relate those factors to the overall health of the population. We also will address the issues of whether different tackle, method of fishing, time fish are played and landed, experience level of anglers, and surface temperature of water influences physiological stress levels (cortisol and glucose) and hooking injuries. Based on preliminary results of physiology data from 2000, there was a significant relationship between the total amount of time fish are handled and the level of plasma cortisol and glucose. There was no significance in the levels of

plasma lactate and total time handled. Twenty-three percent of fish captured had at least one previous hooking scar and 62% of fish captured experienced at least one new hooking injury (which would lead to a scar). Degree of injury, as indicated by the number of scars, was twice as high in fish caught with barbed hooks as compared with barbless hooks regardless of the fishing method (fly or spin). The results of this study will have direct application for management decisions regarding catch-and-release fishing throughout cold-water regions and will provide specific recommendations for management tools to restore the naturally occurring rainbow trout population in the Alagnak Wild River to a more pristine state.

Ongoing Projects—Terrestrial

Effects of Human Activities on Brown Bears at Hallo Bay, Katmai National Park and Preserve, Alaska

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)

Human visitation to the coast of Katmai National Park and Preserve is increasing rapidly, and resource managers need to understand what effects this use has on park resources. ANILCA states that animals within the park be managed for "natural and healthy" populations. Increased human visitation could potentially reduce viability of bear populations by displacing bears from prime habitats or reducing their feeding efficiency. The objective of this study was to determine the effects of human activities, primarily bear viewing, on habitat use and activity budgets of a population of brown bears. On an hourly basis, we observed bears for half-hour sessions and recorded activities, habitats used, and distances to nearest humans and nearest bear. Every half hour, we counted all bears visible on the study site and recorded activity, habitat used, and distances to nearest humans and bears. We are still analyzing data. but a preliminary analysis indicates that most bears' activity budgets are not affected by human presence. Aircraft flying at low altitudes (<300 feet) may cause bears to abandon prime habitats on a short-term basis. In order to manage a sustainable bear viewing industry, the activities of the user groups cannot reduce viability of the bear population. Identifying key areas and activities potentially deleterious to the bears is critical to managing this industry.

Influences of Visitor Use on Resource Selection by Black Bears in Kenai Fjords National Park

Personnel:
Dr. Erich H. Follmann, Principal Investigator, IAB
Jeff T. Villepique, Student Investigator (PhD), DBW
Funding Sources: NPS and USGS/BRD/CRU (RWO 96)

Black bears may come into conflict with humans when people occupy favored feeding areas or bring attractants into bear country. Resource managers at Kenai Fjords National Park (KEFJ) want to understand the effects of increasing human activities on

coastal resources, particularly black bears. This study was initiated to evaluate possible impacts of onshore visitors on the activity patterns of black bears. The objective of the study is to compare resource selection by black bears between two areas of the park: one with a high concentration of tour boats, kayakers, and campers, and one in an area of low human use. Black bears were fitted with GPS collars (13 bears in 2000) designed to collect intensive movement and activity data from May to September, the period of peak activity for bears and park visitors. Habitat assessments were conducted to evaluate the timing and availability of resources (berries, salmon). One bear collar provided a full season of movement information, seven collars provided up to one month's data, four collars are missing and assumed to have failed, and one remains on a bear as of September 2000. The majority of 227 vegetation survey plots measured provided information on vegetation cover but did not show the timing of resource availability, due to logistical failures that limited our ability to sample. Park resource managers could possibly use the results of this study to direct backcountry visitors to areas that minimize the likelihood of conflict with black bears.

In-Kind Support:

- AKCFWRU provided 2 Telonics TR-2 receivers (1 w/TS-1 scanner), 2 GPS units, an 8-hp "kicker" motor, a generator, 3 tents and sleeping bags, miscellaneous camping gear and vegetation survey materials, and a truck for transporting traps to Seward. A defensive driving course was also provided to Jeff Villepique.
- IAB provided a laptop computer and 6 barrel-type bear traps, a dart rifle, and a trailer for transporting traps to Seward.
- GAAR acquired immobilants and provided a pole-syringe for chemical immobilization of bears.
- NPS, Alaska Support Office, provided KEFJ GIS coverages on CD-ROM, as well as 2 shotguns.
- KEFJ provided a biotech and boat for logistical support during 3 days of collar recovery. Backcountry rangers in Aialik Bay provided logistical support on several occasions and helped transport traps. KEFJ provided several trips on the M/V Serac. Two food-storage lockers, 2 weatherports, and materials to build a weatherport floor were also provided. Mustang suits and jackets were provided as well as a marine handheld and 2 park radios and a charger. A photovoltaic power system was also provided. KEFJ provided 2 1987 Zodiac MK3GR rafts. A third boat, a Coast Guard surplus 17-foot rigid-hulled inflatable used for offshore work, was provided. KEFJ provided small boat safety and shotgun training to Jeff Villepique and a bear technician.

Range Condition Assessment for GMU20A Moose

Personnel:

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

Funding Source: ADFG/WC (RSA)

Moose density in the central Tanana Flats and adjacent Alaska Range Foothills is currently very high. Some moose in this area are migratory between Flats summer ranges and winter ranges in the Foothills. Other moose in this area are year-long residents of the Flats. The resident moose have shown lower March calf weights than migratory moose for the past 5 years. Both segments of the population exhibit low

twinning rates, suggesting poor forage availability area-wide. This difference in growth and overall low productivity may be related to browse productivity and use on the winter range. The objectives of this study were to (1) collect browse distribution, production, removal, and architecture data, and model the relationships between these browse data and current moose distribution, historic moose distribution, fire history, and seasonal range (Flats and Foothills) and to (2) document winter food habits of the resident and migratory segments of the herd. About 1480 radio-relocations of moose, 221 fecal pellet samples, and 75 browse samples were collected. Stratified random sites (480) were visited by air to estimate browse distribution. Of the 480 sites, 95 were sampled for browse production and removal. Browse was collected at 75 independent sites, and 14 regression equations relating twig diameter to twig mass were developed from those browse samples for use in predicting browse biomass per land area. Fire history was more strongly correlated with browse production and removal than was recent or historical moose distribution; recent (<50 years) burns had higher browse production and removal. Browse distribution was patchy in the Foothills, but those patches had greater removal by moose than areas with browse in the Flats. Browse components in the diet were similar between the Flats and Foothills. The diet of both winter ranges combined was 43% willow, 25% birch, 22% poplar, and 6% alder. Diets did not change through the winter. Browse plant architecture showed that 75% of browse plants were heavily affected by repeated moose browsing. The ability of moose to remove more browse per unit area in the hills may contribute to the difference in March calf weights between migratory and resident moose. Additionally, understanding browse characteristics on the range of this uniquely high moose population is of value for comparison with other moose ranges.

In-Kind Support:
ADFG/WC provided a snow machine (100 hours); fixed-wing support of radio-telemetry relocations (305 hr); helicopter support of field operations (41 hr); travel funds to attend a moose browse research meeting in Anchorage ($500); and a computer, software, and network technician help ($2000).

Evaluation of Moose-Habitat Models on the Alaska Peninsula/Becharof National Wildlife Refuge

Personnel:
Dr. Abby Powell, Principal Investigator, AKCFWRU
Corey Adler, Student Investigator (MS), DBW
Funding Source: USFWS

No quantitative data have been collected on moose/habitat relationships on the Alaska Peninsula for the past 20 years. Little is known about the current moose population and its habits. Moose are an important part of subsistence and recreational hunting on the Alaska Peninsula. With the current decline of the Northern Alaska Peninsula Caribou Herd (NAPCH), residents of the area are seeking to have increased use of the moose in the area. The objective of this study is to create a predictive model of moose use areas in relation to the surrounding habitats available. This model can then be used to predict important moose arrears throughout the Peninsula and help influence future management strategies developed for the herd. Twenty adult cow moose will be fitted with Global Positioning System (GPS)/ VHF collars. Moose movements will be tracked for 2 years and habitat

characteristics will be assessed in the various use areas. Digital satellite images will be used to identify key vegetation characteristics of the use areas and then will be used to locate other similar areas throughout the refuge. Moose use areas will be classified based on overall moose use and corresponding habitat characteristics. The satellite images can then be used to locate similar use areas, based on specific habitat signatures, without the burden of having to perform extensive ground surveys. Since the NAPCH is currently in a decline, and since many people want to increase their use of moose on the Peninsula, the results of this study will develop a method to identify high use areas by local moose. By identifying these areas the refuge can concentrate their efforts on increased protection of these areas, or they can use the characteristics of these high use areas to develop habitat management procedures for other low use areas on the refuge.

Moose Movements at High Density in the Tanana Flats and Alaska Range Foothills

Personnel:
Dr. Patricia Doak, Principal Investigator, IAB/DBW
Kalin Kellie, Student Investigator (MS), DBW
Funding Source: ADFG/WC (RSA)

Little is known about the seasonal movements and consistency of migratory patterns in this partial migratory population. Moose in the Tanana Flats and Foothills are an important food resource for the Fairbanks area. Consistent patterns and differences in behavior between the resident and migratory individuals may be important when making management decisions about harvest. The main goals of this study are to (1) determine the consistency and timing of seasonal migration; (2) determine if cow moose are faithful to birth sites in consecutive years; and (3) measure the degree of natal dispersal at current high population density to that measured in the mid-1970's when the population was at low but increasing density. A radiocollaring program for this population began in March 1996 with a sample of 40 adult females as part of a calf mortality study. Every March, additional moose (a combination of adults and a cohort of 40 ten-month-old calves were collared. Some of these calves were offspring of collared cows. In May of each study year, a sample of adult cow moose was radiotracked on a daily basis until their parturition date and the calving location had been recorded.. The majority of data has now been collected and analysis should begin in late spring 2002. The moose population south of Fairbanks, Alaska is an important subsistence resource for the Fairbanks area. The population is closely managed to ensure sustainability, and harvest regulations may be closely fitted to local abundance in some places. Timing and consistency of migration are important for making decisions about local harvest and planning surveys. Fidelity to calving areas could be important for land planning and resource use. Determining natal dispersal at high densities will be important for predicting how habitat made available through harvest or fire will be populated by dispersing moose.

Climate Change Effects on Caribou Habitats and Population Processes

Personnel:
Dr. Brad Griffith, Principal Investigator, AKCFWRU

The effects of global and regional climate may exert substantial influence on caribou habitats and populations and make it difficult to identify the effects of industrial development on performance of Arctic calving caribou. The goals of this umbrella project, which covers various portions of Griffith's programmatic work, are to estimate the effects of climate warming on Arctic caribou calving grounds throughout North America, to assess the value of these habitats to the annual nutritional profile of herds, and to estimate the effects of potential industrial displacement of caribou. During 2000, two manuscripts were published in Polar Research, one manuscript was accepted by Rangifer, and four presentations were made at scientific and technical meetings. This work is funded principally by NSF Grant OPP-9521459 and the Canadian national Climate Change Action Fund (CCAF). During 2001, graduate students (PhD) will be selected to pursue the funded components of the program. The results of this work may be utilized to rank the relative importance of various portions of Arctic calving caribou annual ranges and to provide guidance for use of remotely sensed data to monitor Arctic habitats.

In-Kind Support: UAF library facilities and services.

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

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 (BCH). In addition, we will use energetics modeling to assess hypothetical effects of shifts in calving ground location on caribou body condition. We continued our data analyses in 2000. Calving ground locations, 1996-1999, were quite similar. 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 2001, we will 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. This work can be used to assess the impact of industrial development on the BCH and to suggest mitigation measures.

Habitat Selection of Dall's Sheep Within and Adjacent to the Yukon Charley National Preserve

Personnel:
Dr. Brad Griffith, Principal Investigator, AKCFWRU
Brad Wendling, Student Investigator (MS), DBW
Jim Lawler, Cooperator, NPS

Funding Source: NPS (RWO 99)

We are investigating temporal and spatial habitat selection of female Dall's sheep (*Ovis dalli dalli*) within and adjacent to the Yukon Charley National Preserve. We have two study populations: West Point (WP) and Cirque Lakes (CL). Preliminary data have shown the WP sheep are significantly larger, have a higher body reserve index (BRI), have higher pregnancy rates, and have more lambs per 100 ewes. Using GIS and remote sensing we are describing similarities and differences of habitat use across a hierarchy of scales; from the landscape (study area) to the 95% utilization distribution areas, to concentrated use areas, to used sites within concentrated use areas. We are identifying seasonal use, shifts in use, and attempting to correlate shifts in use with military major flying exercises ("Cope Thunder"). We are investigating differences in sheep size and condition based on a combination of remotely sensed data and field samples. We have obtained the 1999 and 2000 GPS collar locations. There were 10 satellite-collared ewes in each study area for each year from which we collected a pooled total of 54,957 locations. We will be receiving the 2001 locations in March 2002. We have collected vegetation (*Dryas spp., Carex spp.,* Grass spp., and Forb spp.) and fecal samples to develop indices of forage quality. Vegetation samples have been analyzed for nitrogen content (N), *in vitro* dry matter digestibility (IVDMD), neutral detergent fiber (NDF), acid detergent fiber (ADF), and gross energy (GE). Preliminary analyses have shown no significant difference in forage quality between study areas. Fecal samples have been analyzed for (N), (NDF) and (ASH). Microhistological analyses have been conducted on replicate fecal samples.

In Kind Support:
NPS has provided transportation to and from study areas (10 hr of helicopter time and 10 hr of flight time in Cessna 185), field gear necessary for camps, and access to GIS hardware and software.

Assessing Habitat Suitability for Dall Sheep in Wrangell-St. Elias National Park and Preserve

Personnel:
Dr. Brad Griffith, Principal Investigator, AKCFWRU
Miranda Terwilliger, Student Investigator (MS), DBW

It is prohibitively expensive to monitor population density and composition for all sheep ranges in Wrangell-St. Elias National Park & Preserve (WRST). Some objective, quantitative, and large scale method of assessing habitat quality is needed. Current "expert opinion" models do not correlate well with sheep population characteristics (e.g. density, productivity, horn size). Although WRST is world-

renowned for it's trophy sheep, biologists currently have no quantitative expectations of the relative suitability of various survey units for sheep and are thus hampered in their management decisions. The objective of this study is to estimate a habitat suitability index (HSI) for Dall sheep that can be used to rank the relative suitability of all thirty-one survey units in the Park for sheep. We will compare biophysical variables among six survey units that vary in terms of density, productivity and horn size. We will survey the literature to estimate the habitat suitability for sheep based on biophysical variables (e.g. elevation, terrain ruggedness, snow cover, phenology of vegetation) and use Geographical Information Systems (GIS) and remote sensing to inventory and rank the sample areas. We will then compare this rank model to expected rankings based on estimated sheep density, productivity, and horn size from our six sample areas and current expert knowledge of the species.

Beringian Shared Heritage Program: Inventory and Survey of Fungi, Lichenized Fungi, Lichenicolous Fungi, Mycetozoans, and Bryophytes

Personnel:
Dr. Gary Laursen, Principal Investigator, IAB
Funding Source: NPS (RWO 93)

Little is known about cryptogamic botany in Beringia (Alaska's Seward and Russia's Chukotka Peninsulas). In the fourth year of our 3-year funded program on Beringian cryptogams (i.e., mushrooms, lichens, lichenicolous fungi/lichens, slime molds, mosses and liverworts), our multi-investigator, multi-discipline, and multi-national team moved from Western Alaska's Seward Peninsula (Nome and Kotzebue regions) across the Bering Strait to Russia's Far Eastern Chukotka Peninsula, and specifically locations in the vicinity of Provideniya, New Chaplino, and Inachpak Cape to examine, document, database, and inventory this large group of organisms. Cryptogams are important to mega- and macro-fauna in Arctic coastal systems. They photosynthesize under the worst of conditions, harbor micro-organisms that replenish nutrients (N, in particular), form important symbiotic relationships (mycorrhizae, parasitic, and saprobic decomposers) that mean the very survival of other larger organisms. The object of this study was to maximized information gathering, data processing, research and publication (56 over the 4-yr. course) and research productivity, all within a framework of collegial sharing of information through 15 individual Research Units (RU's) and 20 investigators. Countries with PI representation are Australia (1), Germany/Papua New Guinea (1), Russia (3), and the US (10). Productivity is in part visualized in a poster medium selected to communicate scientific information for lay and scientific communities alike. Research on all cryptogams is conducted in two phases, field and laboratory. This research represents the first effort to categorize Cryptogams in the Kobuk Valley National Park & Wilderness. Along with additional samples collected, we're beginning to elucidate the association of cryptogams with microhabitats in high latitude ecosystems in Alaska as compared with information from Russia, Hawaii, Arkansas, Costa Rica, and Puerto Rico. Understanding this trend may allow us to better understand the role of the cryptogamic organisms in cold-dominated ecosystems. Research on all cryptogams has yielded significant taxonomic findings. These findings include (1) several new records for Western Alaska, for the state of Alaska, and for North America; (2) several new species are being or have been described; (3) aboriginal and/or indigenous peoples' uses of these organisms and wood substrates altered by them are being recorded as oral histories; (4) seven posters have been produced

and displayed as titled: Beringian Fungi, Beringian Lichens, Beringian Slime Molds, Living With Fungi, Cesium 137 in Lichens, Recycling Fungi, and Cycles in the Forest; (5) a CD-ROM of cogent species has been produced for both 1999 and 2000 studies conducted on the Kobuk River; (6) the project's web page is under construction as www.memberserviceadvantage.com/diversity for High Latitude Cryptogams; (7) the Beringian Fungi Project and Lichen Query mgd.NACSE.ORG/qml/lichenair/arctic and www.nacse.org./lichenair/index1.html web pages will be linked to the Beringian Mycology web page; (8) curation, data matrix, and database construction continue; (9) angiosperm Mycorrhizal studies resulted in root collections for ongoing winter analysis; and (10) Chukotka 2002-4 preparations are underway. Management implications are (1) providing the Shared Beringian Heritage Program with new information on Beringian cryptogams; (2) information on cryptogams is needed for documenting rare and endangered species; (3) establishing a working relationship with local and/or indigenous peoples for lending and sharing expertise and to present new information; (4) providing US and Russian students, shareholders, and scientists opportunities to collect and/or study cryptogams from throughout parts of subarctic RFE and AFW; (5) developing a complete and comprehensive species inventory of the cryptoflora of subarctic RFE and AFW; (6) making statistical comparisons of cryptogams, their frequencies, relative abundance and host association and then publishing the information derived in refereed journals and presenting select information at major scientific meetings; (7) sharing collaboratively between three primary institutions: the Institute of Arctic Biology-UAF Fairbanks, AK, the Komarov Botanical Institute, St. Petersburg, RU, and the Department of Anthropology, UAF Fairbanks, AK; (8) combining efforts of scientists in training (undergraduate, MS and PhD graduate, and Post Doctoral students) by providing valuable experiences as well as leadership from senior scientists in the field for young professionals and training in monographic floristic, geobotanical, and ethnomycological studies; (9) discerning uniqueness in similarities and dissimilarities reflected in dominant groups of high latitude spore producing cryptogamic plant and plant-like organisms and continental overlaps in their use by indigenous peoples; (10) encouraging development in interests and training future scientific community members for high latitude investigations; (11) increasing our technological capabilities, soundness, and understanding of resources that may reflect or demonstrate the magnification of global/continental warming effects or climate change over the near term; (12) constructing and developing an internet/web-based database for sharing information exchange amongst members of our global scientific communities; (13) providing impetus for molecular based genetic analyses to be made from properly collected and preserved botanical materials for DNA extraction; (14) ascertaining presence, abundance, and synergistic symbioses between specific cryptogamic and non-specific phanaerogamic taxa; (15) comparing populations of otherwise disjunct or relic species for the purpose of attempting to unravel origins; and (16) furthering our understanding of circumpolar cryptogam species by continuing the development of a species repository and information leading toward future studies of cryptogamic organisms as indicators for (a) global climate change, (b) high latitude magnification of climate change, (c) pharmacological uses in particular by indigenous peoples of high latitude communities, and (d) outcome-based systematic and taxonomic study.

Ongoing Projects—Integrated

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)
Funding Source: NSF

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 a PhD graduate student in the development of a spatially explicit model of tundra vegetation dynamics. The 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. The focus over the last year has been to analyze field data for the purpose of parameterizing the model. Also, during summer 2001, the PhD graduate student on the project conducted a summer of field work at Cherskii in northeast Siberia to study competitive interactions among plant functional types that represent a disturbance chronosequence. The 2001 field season complemented three previous field seasons that were conducted in Alaska and which focused on transitional vegetation types from tundra to closed forest. Biophysical measurements (height, percent cover) and biogeochemical measurements (biomass carbon and nitrogen) were made during summer 2001 in a newly disturbed forest, a forest that burned 15 years ago, a forest that burned 60 years ago, and a forest that hasn't burned for over 200 years. Information from the Russian field studies will allow disturbance to be incorporated into the conceptualization, formulation, and parameterization of the dynamic vegetation model.

Fate of Carbon in Alaskan Landscapes

Personnel:
Dr. A. David McGuire, Principal Investigator, AKCFWRU
Qianlai Zhuang, Student Investigator (PhD), DBW (partial support)
Funding Source: USGS/Geological Division (RWO 97)

The purpose of this study is to model how soil drainage influences carbon dynamics in Alaskan landscapes. This study is part of a larger global change study funded by the USGS Geologic Division, which has been granted to Dr. Jennifer Harden of USGS Geologic Division in Menlo Park. Dr. Harden is conducting field work in Alaska to determine soil drainage controls on (1) decomposition rates and fuel storage, (2) fire severity, (3) permafrost degradation and recovery after fire, and (4) successional

responses after fire. The understanding from these field studies will be transferred into a successional version of the terrestrial ecosystem model (TEM), which is being enhanced to consider interactions between fire severity, the soil thermal regime, and carbon dynamics. Model development is represented in two manuscripts, one of which has been published (Zhuang et al. 2001. *Journal of Geophysical Research* 106:33, 649-33, 670) and one accepted for publication in the *Journal of Geophysical Research* (Zhuang et al. In press.). The first manuscript reports on a study that indicates that the soil thermal regime in Alaskan landscapes appears to be most sensitive to moss and snow thermal properties. The second manuscript reports on a study that uses the model to evaluate how fire influences soil thermal and ecosystem dynamics during forest stand development after fire disturbance. These developments have allowed the incorporation of interactions among fire, permafrost dynamics, and soil drainage into a framework that is being used to model carbon dynamics at large spatial scales in Alaska. The graduate student has completed his PhD degree and is now employed in a postdoctoral research position with the Marine Biological Laboratory. We are in the process of recruiting a graduate student for the last three years of the project.

Landscape Analysis of Moose Distribution Relative to Fire History in Interior Alaska

Personnel:
Dr. A. David McGuire, Principal Investigator, AKCFWRU
Dr. Julie A. Maier, Postdoctoral Researcher, IAB
Funding Source: USFWS (RWO 108)

The overall purpose of this study is to determine if moose distribution in interior Alaska is related to fire history and topographic features in interior Alaska. The strategy in the project is evaluate relationships by combining existing databases on the distribution of moose (e.g. survey and telemetry data) with Geographic Information System (GIS) data on vegetation and other topographic features including the age and configuration of burns. The project will harmonize vegetation classifications that are being used by USFWS and BLM within interior Alaska into a database relevant for understanding the distribution of fire and moose. Data on the timing and location of fire events are available from the Alaska Fire Service (AFS), which is an interagency consortium for fire management in interior Alaska. This data base extends from 1950 to present and is operationally updated by AFS each year; it has been used in studies of the fire regime in interior Alaska. Location data of moose in 2001 will be brought into GIS (ARC/INFO) from existing electronic data sets and via digitization. The moose point coverages will then be overlain upon habitat, fire, topographic and other relevant coverages that have been derived from remotely sensed data and other data sources. Analyses will evaluate effects of patch size, shape, and configuration and age of burns on moose distribution and density. Log-likelihood models and analyses based on spatial statistics will be used to determine which characteristics of the landscape have been most influential in determining the spatial distribution and density of moose. The first six months of this project have focused on organizing the data sets for the analyses. The remaining six months of the project will focus on conducting analyses.

Sensitivity of ATLAS to Alternative Climate Change Scenarios and Alternative Assumptions with Climate Change Scenarios

Personnel:

Dr. A. David McGuire, Principal Investigator, AKCFWRU

Gregg Christopher, Student Investigator (partial support for graduate student programmer)

Funding Source: USFS

The overall purpose of this study is to (1) determine the sensitivity of the ATLAS-T model, which is a national forest inventory model that provides inputs to a national forest economic model, to alternative climate scenarios, and (2) to determine the sensitivity of the ATLAS-T model to alternative ecological assumptions at a finer geographic level than previous Resource Planning Act (RPA) analyses. The study is part of a USDA Forest Service RPA Special Study, which has been granted to Dr. Linda Joyce of the USDA Forest Service Rocky Mountain Forest and Range Experiment Station. In support of the first objective, Dr. McGuire's lab will apply version 4.2 of the Terrestrial Ecosystem Model (TEM) driven by alternative climate scenarios from the National Assessment to calculate deltas for *mature* stands of forest types in the United States. The deltas will be developed for the regional scale spatial units of ATLAS and the county-scale spatial units of ATLAS-T. In support of the second objective, Dr. McGuire's lab will apply version 4.2 of TEM driven by the alternative climate scenarios from the National Assessment to calculate deltas for *specific ages* of forest stand types in the United States. The results of these simulations will be provided to Dr. Joyce's laboratory, where they will be used to modify ATLAS and ATLAS-T.

List of Abbreviations

ADFG	Alaska Department of Fish and Game CFMD Commercial Fisheries 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
ANILCA	Alaska National Interest Lands Conservation Act
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
GIS	Geographical Information System
GPS	Global Positioning System
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 KEFJ Kenai Fjords National Park
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