Alaska Cooperative Fish and Wildlife Research Unit

Annual Research Report—2008




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Alaska Cooperative Fish and Wildlife Research Unit
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This report is dedicated to Shelly Szepanski, 1967–2008, who while battling cancer, continued to work on her doctorate degree with Dr. Brad Griffith focusing on statewide winter habitat capacity for moose. Shelly began her doctoral program in January 2004, after serving as Assistant Area Biologist in McGrath for the Wildlife Conservation Division, Alaska Department of Fish and Game. Shelly leaves behind many friends and colleagues who miss her and her dedication to the natural resources profession and her enthusiasm for the outdoors and Alaska.

Contents

Unit Roster

Federal Scientists

- Brad Griffith: Assistant Leader-Wildlife
- F. Joseph Margraf: Leader
- A. David McGuire: Assistant Leader-Ecology
- Abby Powell: Assistant Leader-Wildlife
- Mark Wipfli: Assistant Leader-Fisheries

University Staff

- Karen Enochs: Fiscal Technician
- Jennifer Miller: Travel Coordinator
- Kathy Pearse: Administrative Assistant

Unit Students

Current

- Matthew Albert, MS Fisheries (Margraf)
- Elizabeth Benolkin, MS Fisheries (Margraf)
- Emily Benson, MS Biology (Wipfli)
- Rebecca Bentzen, PhD Biology (Powell)
- Jeremy Carlson, MS Fisheries (Margraf)
- Roy Churchwell, PhD Biology (Powell)
- Samantha Decker, MS Fisheries (Margraf)
- David Esse, MS Fisheries (Margraf)
- Heather "River" Gates, MS Biology (Powell)
- Jonathon Gerken, MS Fisheries (Margraf)
- Laura Gutierrez, MS Biology (Wipfli)
- Christie Hendrich, MS Fisheries (Margraf)
- Meagan Krupa, PhD Biology (Wipfli and Chapin)
- Elizabeth Green Markley, MS Biology (Wipfli)
- Teri McMillan, MS Biology (Powell)
- Jason Neuswanger, MS Biology (Wipfli and Hughes)
- Jonathan O'Donnell, PhD Biology (McGuire)
- Megan Perry, MS Biology (Wipfli)
- Jeff Perschbacher, MS Fisheries (Margraf)
- Dan Rinella, PhD Biology (Wipfli)
- Jennifer Roach, MS Biology (Griffith)
- David Roon, MS Biology (Wipfli)
- Lisa South, MS Fisheries (Margraf)
- Valerie Steen, MS Biology (Powell)
- Jason Stolarski, PhD Fisheries (Margraf)
- Audrey Taylor, PhD Biology (Powell)
- Jason Valliere, MS Fisheries (Margraf and Prakash)
- Emily Weiser, MS Biology (Powell)

Graduated in CY 2008

- Christopher Latty, MS Wildlife (Powell and Hollmen)
- Steffen Oppel, PhD Biology (Powell)
- Theresa Tanner, MS Fisheries (Margraf)
- Brad Wendling, MS Wildlife (Griffith)

Post-Doctoral Researchers

- Kirsten Barrett (USGS Mendenhall Postdoctoral Fellow, co-sponsored with Carl Markon, USGS Alaska Science Center) (McGuire)
- Daniel Hayes (McGuire)
- Kris Johnson (McGuire)
- Shuhua Yi (McGuire)
- Fengming Yuan (McGuire)

Research Associates

- Eugénie Euskirchen, Institute of Arctic Biology (IAB)

Faculty Cooperators

- Perry Barboza, Department of Biology and Wildlife(DBW)/Institute of Arctic Biology (IAB)-UAF
- F. Stuart Chapin, III, DBW/IAB
- Falk Huettmann, DBW/IAB
- Tuula Hollmen, Institute of Marine Science (IMS)-UAF
- Kris Hundertmark, DBW/IAB
- Christine Hunter, DBW/IAB
- Glenn Juday, Forest Sciences Department-UAF
- Gordon Kruse, School of Fisheries and Ocean Sciences (SFOS)-UAF
- Mark Lindberg, DBW/IAB
- Anupma Prakash, Geophysical Institute-UAF
- James Reynolds, Emeritus UAF
- Amanda Rosenberger, SFOS
- Amy Tidwell, Institute of Northern Engineering-UAF

Affiliated Students

Current

- Todd Brinkman, PhD Biology (Chapin and Hundertmark)
- Nathan Coutsoubos, PhD Biology (Huettmann)
- David Gustine, PhD Biology (Barboza)
- Aleya Nelson, MS Biology (Lindberg)

Cooperators

- Brian Barnes–Director, Institute of Arctic Biology, University of Alaska Fairbanks
- Robert Davison–Northwest Representative, Wildlife Management Institute

- McKie Campbell–Commissioner, Alaska Department of Fish and Game
- Tom Melius–Director, Region 7, US Fish and Wildlife Service
  Geoff Haskett-Director, Region 7, US Fish and Wildlife Service
  (effective October 2008)
- Michael Tome-Unit Supervisor, Cooperative Research Units, US Geological Survey

Introduction

This is the Annual Report for the Alaska Cooperative Fish and Wildlife Research Unit, highlighting activities for calendar year 2008. 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 Resources Discipline 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 40 Cooperative Research Units in 38 states, conducting research on virtually every type of North American ecological community. The Program is staffed by more than 100 PhD scientists who advise as many as 675 graduate student researchers per year.

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.

Unit Cost-Benefit Statements

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: 4
Presentations: 50
Scientific and Technical Publications: 21

Courses Taught

- Quantitative Fisheries Science (3 credit hours, Spring 2008, Margraf)
- Interdisciplinary Modeling of High Latitude Global Change (4 credit hours, Fall 2008, McGuire)
- Scientific Writing, Reviewing, and Editing (3 credit hours, Spring 2008, Powell)
- Aquatic Entomology (2 credit hours, Fall 2008, Wipfli)
- Freshwater Ecosystems Seminar (1 credit hour, Spring 2008, Wipfli)

Honors and Awards

- River Gates, Third Place, Best Student Paper Awards, 13th Alaska Bird Conference, Fairbanks, Alaska.
- A. David McGuire, 2008 Performance Award for improving the understanding of national ecosystems and resources through integrated disciplinary assessment. Awarded by the Cooperative Research Units Program, USGS.
- Steffen Oppel, First Place, Best Student Paper Awards, and First Place, Best Student Poster Awards, 13th Alaska Bird Conference, Fairbanks, Alaska.
- Lisa South, Best Student Poster Award, 2008 Annual Meeting of the Alaska Chapter, American Fisheries Society, Anchorage, Alaska.
- Emily Weiser, Recipient of the 2008 Angus Gavin Memorial Migratory Bird Research Grant for her research proposal, "Diet of glaucous gulls (*Larus hyperboreas*) on Alaska's North Slope."

Outreach and Info Transfer

- Wipfli, M. S. November 3-5, 2008. USFWS Biological Review Panel for the Yukon Delta National Wildlife Refuge.
- Wipfli, M. S. September 2008. Assisted with World Water Monitoring Days at the Chena River, Fairbanks, Alaska, in conjunction with Alaska Department of Environmental Conservation and Tanana Valley Advisory Board.

Papers Presented

Brehm, N. C., R. P. Daanen, E. Kane, K. Shea, M. Waddington, D. Misra, and A. D. McGuire. December 2008. Water and energy budget under a manipulated water table of a wetland in interior Alaska. Fall Meeting of the American Geophysical Union, San Francisco, California.

Chapin, F. S. III, A. D. McGuire, E. S. Euskirchen, and R. W. Ruess. September 2008. The changing global carbon cycle: Linking local plant-soil processes to

global consequences. British Ecological Society Annual Meeting, London, England. Invited.
Dickson, L., S. Oppel, G. Raven, A. Powell, and T. Bowman. November 2008. Importance of eastern Chukchi Sea and southeastern Beaufort Sea as spring staging areas for king and common eiders. 3rd North American Sea Duck Conference, Quebec City, Canada.
Euskirchen, E. S., A. D. McGuire, T. S. Rupp, F. S. Chapin III, M. Oleson, J. S. Clein, and T. Burnside. September 2008. Changes in atmospheric heating and carbon dynamics under future climate scenarios in fire-disturbed northern boreal forests. 14th International Boreal Forest Research Association Conference, Harbin, China.
Euskirchen, E. S., A. D. McGuire, F. S. Chapin III, and S. Yi. March 2008. Changes in plant communities in northern Alaska under scenarios of climate change 2003-2100: Implications for climate feedbacks. International Geosphere-Biosphere Programme Workshop on Plant Functional Types, Paris, France. Invited.
Geiger, H. J. and M. S. Wipfli. October 2008. Ratcheting down escapements: More realistic goals, marine derived nutrient effects, or artifact of the analysis procedure? Annual Meeting, Alaska Chapter, American Fisheries Society, Anchorage, Alaska.
Green, E. C., M. S. Wipfli, and K. M. Polivka. August 2008. Ecological linkages between fishless headwaters and downstream fish communities. 138th Annual Meeting, American Fisheries Society, Ottawa, Ontario, Canada.
Green, E. C., M. S. Wipfli, and K. M. Polivka. May 2008. Do drifting invertebrates originating from fishless headwater streams affect downstream fish? Annual Meeting, North American Benthological Society, Salt Lake City, Utah.
Griffith, B. and J. M. Scott. April 2008. Climate change and wildlife refuges: managing for resilience in the face of uncertainty. Invited presentation, Desert Managers Group Climate Change Symposium, Laughlin, Nevada.
Hayes, D. J., A. D. McGuire, D. W. Kicklighter, and T. J. Burnside. March 2008. Effects of climate, natural disturbance, forest management, and land use on carbon dynamics in terrestrial ecosystems of northern Eurasia. First Workshop of the NEESPI Focus Research Center for Biogeochemical Cycles, Max-Planck Institute for Biogeochemistry, Jena, Germany. Invited.
Hayes, D. J., A. D. McGuire, D. W. Kicklighter, K. R. Gurney, T. J. Burnside, and J. M. Melillo. December 2008. A recent shift in the carbon balance of high-latitude terrestrial ecosystems in response to changes in climate and disturbance regime. Fall Meeting of the American Geophysical Union, San Francisco, California.
Jain, A., X. Yang, H. Kheshgi, A. D. McGuire, and W. M. Post. December 2008. Nitrogen attenuation of terrestrial carbon cycle response to global environmental change. Fall Meeting of the American Geophysical Union, San Francisco, California.
Kasischke, E. S., S. J. Goetz, A. D. McGuire, and D. J. Hayes. December 2008. An overview of the role of disturbance in the terrestrial carbon budget. Fall Meeting of the American Geophysical Union, San Francisco, California. Invited.
Kilinc, M., J. Beringer, L. Hutley, N. Tapper, A. D. McGuire, K. Kurioka, S. Wood, and N. D'Argent. December 2008. Biophysical controls of carbon exchange in old growth mountain ash stands. Fall Meeting of the American Geophysical Union, San Francisco, California.
Latty, C. J., T. E. Hollmen, M. R. Petersen, A. N. Powell, and R. D. Andrews. November 2008. Dive performance of common eiders implanted with satellite transmitters. 3rd North American Sea Duck Conference, Quebec City, Canada.
Latty, C. J., T. E. Hollmen, M. R. Petersen, A. N. Powell, and R. D. Andrews. November 2008. Biochemical and clinical responses of common eiders to

implanted satellite transmitters. 3rd North American Sea Duck Conference, Quebec City, Canada.
Latty, C. J., T. E. Hollmen, M. R. Petersen, A. N. Powell, and R. D. Andrews. March 2008. Abdominally implanted transmitters affect the dive performance of common eiders. 13th Alaska Bird Conference, Fairbanks, Alaska.
Latty, C. J., T. E. Hollmen, M. R. Petersen, A. N. Powell, and R. D. Andrews. February 2008. Abdominally implanted transmitters with percutaneous antenna affect dive performance of common eiders. Pacific Seabird Group, Blaine, Washington.
Manies, K., S. Yi, J. Harden, and A. D. McGuire. December 2008. Boreal forest organic soil properties: Variation within soil profiles and across landscapes. Fall Meeting of the American Geophysical Union, San Francisco, California.
Margraf, F. J., K. J. Hartman, and M. K. Cox. February 2008. Nondestructive Field Estimation of Fat Content of Yukon River Salmon. Pink and Chum Salmon Workshop, Bellingham, WA.
McGuire, A. D. May 2008. Integrated regional changes in arctic ecosystem feedbacks: Implications for the global climate system. After the Melt: An International Conference on Ecological Responses to Arctic Climate Change, University of Aarhus, Aarhus, Denmark. Invited.
McGuire, A. D. April 2008. Ecosystem changes/processes in high latitudes. NASA Carbon Cycle and Ecosystems Joint Science Workshop, University of Maryland, College Park, MD. Invited.
McMillan, T., F. Huettmann, and A. N Powell. March 2008. Modeling Smith's longspur distribution in Alaska's Brooks Range. 13th Alaska Bird Conference, Fairbanks, Alaska.
O'Donnell, J. A., V. E. Romanovsky, J. W. Harden, K. Yoshikawa, and A. D. McGuire. June 2008. The effect of soil moisture and ice content on the thermal conductivity of organic soil horizons underlain by discontinuous permafrost. 9th International Conference on Permafrost, University of Alaska Fairbanks, Fairbanks, Alaska.
Oppel, S., R. Federer, A. N. Powell, and T. Hollmen. August 2008. Effects of lipid extraction on d13C, d15N, and d34S in avian egg yolk. International Conference on the Applications of Stable Isotope Techniques to Ecological Studies, Honolulu, Hawaii.
Oppel, S. and A. N. Powell. November 2008. Does choice of winter region affect nesting success of nesting king eiders in northern Alaska? 3rd North American Sea Duck Conference, Quebec City, Canada.
Oppel, S. and A. N. Powell. November 2008. Assigning sea ducks to wintering regions in the Bering Sea using stable isotopes of feathers. 3rd North American Sea Duck Conference, Quebec City, Canada.
Oppel, S. and A. N. Powell. November 2008. How important are body reserves for king eider egg formation in northern Alaska? 3rd North American Sea Duck Conference, Quebec City, Canada.
Powell, A. N. and S. Oppel. November 2008. Movements and survival of king eiders during their first year at sea. 3rd North American Sea Duck Conference, Quebec City, Canada.
Oppel, S, A. N. Powell, and D. L. Dickson. August 2008. Importance of the eastern Chukchi Sea for king eiders during spring and fall migration. AOU/COS/SCO, Portland, Oregon.
Oppel, S., A. N. Powell, and D. L. Dickson. March 2008. Importance of the eastern Chukchi Sea for king eiders during spring and fall migration. 13th Alaska Bird Conference, Fairbanks, Alaska.
Oppel, S., A. N. Powell, and D. M. O'Brien. August 2008. Individual variation in nutrient allocation to egg production in an arctic sea duck. International

Conference on the Applications of Stable Isotope Techniques to Ecological Studies, Honolulu, Hawaii.
Oppel, S., A. N. Powell, and D. O'Brien. March 2008. King eiders in northern Alaska depend on food from breeding grounds for egg production. 13th Alaska Bird Conference, Fairbanks, Alaska.
Powell, A. N., A. Taylor, and R. Lanctot. October 2008. Distribution and movements of staging shorebirds on Alaska's north slope. 11th Annual MMS Information Transfer Meeting, Anchorage, Alaska.
Rinella, D. J., M. S. Wipfli, C. Stricker, R. Heintz, and C. Walker. October 2008. Developing tools for monitoring marine-derived nutrients in Alaska watersheds. Annual Meeting, Alaska Chapter, American Fisheries Society, Anchorage, Alaska.
Rinella, D. J., M. S. Wipfli, C. Stricker, and C. Walker. May 2008. Evaluating stable isotopes and fatty acids for tracking marine-derived nutrient assimilation in stream-resident fish. Annual Meeting, North American Benthological Society, Salt Lake City, Utah.
Roach, J. K. and B. Griffith. August 2008. Heterogeneity in climate warming effects on arctic aquatic habitats. Invited Presentation, Symposium on Effects of Climated-related Drying and Surface Water Loss on Aquatic Ecosystems in Extreme Environments. 138th Annual Meeting, American Fisheries Society, Ottawa, Ontario.
Roon, D. A., M. S. Wipfli, T. L. Wurtz, M. Rasy, and W. Rice. October 2008. Ecological effects of an introduced tree, European birdcherry, on stream food webs in Campbell and Chester Creeks, Anchorage, Alaska. Annual Meeting, Alaska Chapter, American Fisheries Society, Anchorage, Alaska.
Rosenberger, A., S. Triebenbach, A. Prakash, F. Chapin, and F. J. Margraf. August 2008. Effects of water loss on fish communities in the Arctic—landscape perspectives and future research directions. 138th Annual Meeting, American Fisheries Society, Ottawa, ON.
Scott, J., B. Griffith, B. Adamcik, D. Ashe, B. Czech, R. Fischman, P. Gonzales, A. D. McGuire and A. Pidgorna. February 2008. Managing for change: climate change and the National Wildlife Refuge System. Invited presentation, U.S. Fish and Wildlife Service Region 2 Climate Change Workshop, Albuquerque, New Mexico.
Scott, J., B. Griffith, B. Adamcik, D. Ashe, B. Czech, R. Fischman, P. Gonzales, A. D. McGuire, and A. Pidgorna. July 2008. Managing for change: climate change and the National Wildlife Refuge System. Invited presentation, U.S. Fish and Wildlife Service Region 6 Climate Change Workshop, 31 July 2008, Denver, CO.
Taylor, A. R., R. B. Lanctot, and A. N. Powell. March 2008. Abundance and distribution of staging shorebirds on Alaska's Chukchi and Beaufort coasts. 13th Alaska Bird Conference, Fairbanks, Alaska.
Vorosmarty, C. J., A. D. McGuire, E. Rastetter, J. Hobbie, K. Farrow, and L. Hinzman. November 2008. The United States Arctic Research Commission Scaling Study. First International Symposium on Arctic Research. Tokyo, Japan. Invited.
Weiser, E. and A. N. Powell. November 2008. Effects of changes in garbage management on glaucous gull diet at Barrow, Alaska. 32nd Waterbird Society Meeting, South Padre Island, Texas.
Weiser, E. and A. N. Powell. March 2008. Diet of glaucous gulls breeding at two locations on Alaska's north slope. 13th Alaska Bird Conference, Fairbanks, Alaska.
Wipfli, M. S. November 2008. How will climate change affect trophic processes and productivity in freshwater-riparian ecosystems? USFWS WildREACH Climate Change Workshop, Fairbanks, Alaska.
Wipfli, M. S. August 2008. How important are fishless headwaters to downstream fishes and food webs? 138th Annual Meeting, American Fisheries Society, Ottawa, Ontario, Canada.

Wipfli, M. S., N. F. Hughes, M. Evenson, E. R. Benson, E. C. Green, L. Gutierrez, J. D. Neuswanger, and M. T. Perry. October 2008. Ecology and demographics of juvenile Chinook salmon in the Chena River, central Alaska. Annual Meeting, Alaska Chapter, American Fisheries Society, Anchorage, Alaska.

Yi, S., A. D. McGuire, and J. Harden. June 2008. Simulating the effects of wildfire on permafrost and soil carbon dynamics of black spruce over the Yukon River Basin using a terrestrial ecosystem model. 9th International Conference on Permafrost, University of Alaska Fairbanks, Fairbanks, Alaska.

Yi, S., A. D. McGuire, E. Kasischke, J. Harden, and K. Manies. December 2008. Simulating the effects of wildfire on permafrost and soil carbon dynamics over the Yukon River Basin using the Terrestrial Ecosystem Model. Fall Meeting of the American Geophysical Union, San Francisco, California.

Scientific Publications

Baron, J. S., S. H. Julius, J. M. West, L. A. Joyce, G. Blate, C. H. Peterson, M. Palmer, B. D. Keller, P. Kareiva, J. M. Scott, and B. Griffith. 2008. Some guidelines for helping natural resources adapt to climate change. International Human Dimensions Programme on Global Environmental Change Update 2:46-52.

Bentzen, R. L., A. N. Powell, R. S. Suydam. 2008. Factors influencing nest success of king eiders on northern Alaska's coastal plain. Journal of Wildlife Management 72(8):1781-1789.

Calef, M. P., A. D. McGuire, and F. S. Chapin III. 2008. Human influences on wildfire in Alaska from 1998 through 2005: An analysis of the spatial patterns of human impacts. Earth Interactions 12, Paper 1, 17 pages, doi:10.1175/2007EI220.1.

Chapin, F. S. III, J. T. Randerson, A. D. McGuire, J. A. Foley, and C. B. Field. 2008. Changing feedbacks in the climate-biosphere system. Frontiers in Ecology and the Environment 6:313-320, doi:10.1890/080005.

Chapin, F. S., III, S. F. Trainor, O. Huntington, A. L. Lovecraft, E. Zavaleta, D. C. Natcher, A. D. McGuire, J. L. Nelson, L. Ray, M. Calef, N. Fresco, H. Huntington, T. S. Rupp, L. DeWilde, and R. A. Naylor. 2008. Increasing wildfire in Alaska's boreal forest: Causes, consequences, and pathways to potential solutions of a wicked problem. BioScience 58:531-540.

CCSP (Climate Change Science Program). 2008. Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [S. H. Julius and J. M. West (eds.), J. S. Baron, B. Griffith, L. A. Joyce, P. Kareiva, B. D. Keller, M. A. Palmer, C. H. Peterson, and J. M. Scott (authors)]. U.S. Environmental Protection Agency, Washington, DC. 873 pp.

Corell, R. W., S. J. Hassol, J. M. Melillo, D. Archer, E. Euskirchen, F. S. Chapin III, A. D. McGuire, T. R. Christensen, V. P. Fichelet, K. Walter, Q. Zhuang, T. Callaghan, S. Bech, and C. McMullen. 2008. Methane from the Arctic: Global warming wildcard. Pages 37-48 *in* P. Harrison, ed. UNEP Year Book 2008. United Nations Environment Programme, Nairobi, Kenya.

Griffith, B. and A. D. McGuire. 2008. National Wildlife Refuges Case Study: Alaska and the Central Flyway. Annex A: Case Studies. Pages A-36 to A-46 in: Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [S. H. Julius and J. M West (eds.), J. S. Baron, B. Griffith, L. A. Joyce, P. Kareiva, B. D. Keller, M. A. Palmer, C. H. Peterson, and J. M. Scott (authors)]. U.S. Environmental Protection Agency, Washington, DC.

Julius, S. H., J. M. West, J. S. Baron, B. Griffith, L. A. Joyce, B. D. Keller, M. A. Palmer, C. H. Peterson, and J. M. Scott. 2008. Annex A: Case Studies. Pages A-1 to A-170 in: Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [S. H. Julius and J. M. West (eds.), J. S. Baron, B. Griffith, L. A. Joyce, P. Kareiva, B. D. Keller, M. A. Palmer, C. H. Peterson, and J.M. Scott (authors)]. U.S. Environmental Protection Agency, Washington, DC.

Julius, S. H., J. M. West, J. S. Baron, B. Griffith, L. A. Joyce, B. D. Keller, M. A. Palmer, C. H. Peterson, and J. M. Scott. 2008. Annex B: Confidence Estimates for SAP 4.4 Adaptation Approaches. Pages B-1 to B-36 in: Preliminary Review of Adaptation Options for Climate Sensitive Ecosystems and Resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [S. H. Julius and J. M. West (eds.), J. S. Baron, B. Griffith, L. A. Joyce, P. Kereiva, B. D. Keller, M. A. Palmer, C. H. Peterson, and J. M. Scott (authors)]. U.S. Environmental Protection Agency, Washington, DC.

Margraf, J. 2008. A new home for habitat. Fisheries 33:532.

McGuire, A. D., J. Walsh, J. Kimball, J. Clein, S. Euskirchen, S. Drobot, U. Herzfeld, J. Maslanik, R. Lammers, M. Rawlins, C. Vorosmarty, T. Rupp, W. Wu, and M. Calef. 2008. The Western Arctic Linkage Experiment (WALE): Overview and synthesis. Earth Interactions 12, Paper 7, 13 pages, doi:10.1175/2008EI239.1.

Mellon, C. D., M. S. Wipfli, J. L. Li. 2008. Forest fire effects on headwater stream subsidies in eastern Washington, USA: Movements of invertebrates to riparian and downstream habitats. Freshwater Biology 53: 2331-2343.

Myers-Smith, I. H., J. W. Harden, M. Wilmking, C. C. Fuller, A. D. McGuire, and F. S. Chapin III. 2008. Wetland succession in a permafrost collapse: Interactions between fire and thermokarst. Biogeosciences 5:1273-1286.

Oppel, S. and A. N. Powell. 2008. Assigning king eiders to wintering regions in the Bering Sea using stable isotopes of feathers and claws. Marine Ecology Progress Series 373:149-156.

Oppel, S., A. N. Powell, and D. L. Dickson. 2008. Timing and distance of king eider migration and winter movements. Condor 110:296-305.

Oppel, S., A. Powell, and D. O'Brien. 2008. Using eggshell membranes as a non-invasive tool for investigating nutrient allocation to egg production. Journal of Ornithology. DOI 10.1007/s10336-008-0325-7.

Scott, J. M., B. Griffith, R. S. Adamcik, D. M. Ashe, B. Czech, R. L. Fischman, P. Gonzalez, J. J. Lawler, A. D. McGuire, and A. Pidgorna. National Wildlife Refuges. 2008. National Wildlife Refuges. Pages 5-1 to 5-100 in: Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [S. H. Julius and J. M West (eds.), J. S. Baron, B. Griffith, L. A. Joyce, P. Kareiva, B. D. Keller, M. A. Palmer, C. H. Peterson, and J. M. Scott (authors). US Environmental Protection Agency, Washington, DC.

Turetsky, M. R., C. C. Treat, M. Waldrop, M. Waddington, J. W. Harden, and A. D. McGuire. 2008. Short-term response of methane fluxes and methanogen activity to water table and soil warming manipulations in an Alaskan peatland. Journal of Geophysical Research-Biogeosciences 113, G00A10, doi:10.1029/2007JG000496.

Wood, S. A., J. Beringer, L. B. Hutley, A. D. McGuire, A. Van Dijk, and M. Kilinc. 2008. Impacts of fire on forest age and runoff in mountain ash forests. Functional Plant Biology 35:483-492.

Technical Publications of Federal Staff

Powell, A. N. and S. A. Backensto. 2008. Productivity and locations of Common Ravens (*Corvus corax*) nesting on Alaska's North Slope. Final Report, U.S. Geological Survey, Alaska Cooperative Fish and Wildlife Research Unit, Fairbanks, AK. 32 pp.

Theses and Dissertations of Unit-Sponsored Graduate Students

Latty, Christopher J. 2008. Responses of captive common eiders to implanted satellite transmitters with percutaneous antennas. MS thesis, University of Alaska Fairbanks. 87 pp.

Oppel, Steffen. 2008. King eider migration and seasonal interactions at the individual level. PhD thesis, University of Alaska Fairbanks. 206 pp.

Tanner, Theresa L. 2008. Geomorphology and inconnu spawning site selection: An approach using GIS and remote sensing. MS thesis, University of Alaska Fairbanks. 51 pp.

Wendling, Bradley R. 2008. Effects of military overflights on habitat use and selection by female Dall’s sheep, Yukon-Tanana uplands, Alaska. MS thesis, University of Alaska Fairbanks. 80 pp.

Research Reports

Reports are listed as Completed or Ongoing, in the categories of Aquatic, Terrestrial, or Ecological Studies. The List of Abbreviations appears on the final page of the report.

Completed Aquatic Studies

Geomorphology and Inconnu Spawning Site Selection: An Approach Using GIS and Remote Sensing

Student Investigator: Theresa Tanner, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Fairbanks Fish and Wildlife Service Field Office/USFWS

Note: Theresa Tanner graduated from the University of Alaska Fairbanks in August 2008. Her thesis abstract follows:

This study examined the spatial components of inconnu *Stenodus leucichthys* spawning habitat use in the Selawik River, Alaska. Little is known about inconnu critical habitat needs; however, current studies of inconnu spawning behavior suggest a high level of habitat selectivity. This level of selectivity implies that there are specific habitat characteristics that these fish require for spawning. The purpose of this study was to build a heuristic habitat model that can be used to better understand inconnu spawning site selection in remote Alaskan watersheds. Using readily available, low- or no-cost remote sensing data layers, geographic information systems (GIS) were used in conjunction with multivariate statistics in an attempt to clarify relationships between geomorphologic features and spawning site selection. Spatial resolution of the remotely sensed data available in this study did not provide sufficient spatial detail to generate statistical correlations between spawning habitat selection and landscape characterizations. However, spawning occurred in areas of transition from high to low gradients, and in reaches typified as having very low slopes with very high sinuosity. Additionally, exploratory use of Radarsat fine beam 1 data favored its future application in fisheries investigations. This study is an initial step toward more research into inconnu spawning habitat.

Ongoing Aquatic Studies

Variation in Age at Maturity Among Sockeye Salmon (*Oncorhynchus nerka)* Spawning Populations from Lake Clark, AK

Student Investigator: Elizabeth Benolkin, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: USGS
Other Support: NPS

Poor returns of sockeye salmon to the Kvichak River watershed have been observed since 1996, and this decline is a priority concern for subsistence fishers and resource managers. Although the number of sockeye salmon that return to this system is highly variable, there is a lack of life history information characterizing various component populations of the Kvichak River. This study compared the marine age at maturity of sockeye salmon collected during 2002–2005 from nine Lake Clark, Alaska, spawning locations from three habitat types: rivers, tributary beaches, and main lake beaches. The influence of spawning location and brood year on marine age

distribution (2 or 3 years) was estimated for each sex using logistic regression using a major tributary as a reference spawning location. Marine age distribution significantly differed across spawning locations for both sexes. Among females, most spawning locations were more likely to be comprised of younger fish (marine age 2) as compared to the major tributary. Among males, only one spawning location was more likely to be comprised of younger fish, while two spawning locations were more likely to be comprised of older fish (marine age 3) as compared to the major tributary. Sockeye salmon marine age distribution differed significantly across brood years for females, but not for males. These results will be synthesized with other life history information, including length at age, fecundity, and egg size, to develop accurate population models of Lake Clark sockeye salmon.

Assessment of Fish Condition in Arctic Ocean Nearshore Lagoons Using Bioelectrical Impedance Analysis

Student Investigator: Jeremy Carlson, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Fairbanks Fish and Wildlife Field Office/USFWS (RWO 137)
In-Kind Support: Vehicle, bunkhouse and technical assistance provided by Arctic National Wildlife Refuge/USFWS

Arctic nearshore habitats are important for many fish species to feed and grow. Warming trends in the Arctic and the threat of development could directly impact fish populations. Healthy fish populations are important to subsistence users and the arctic ecosystem in general. The objects of this study are to evaluate and calibrate the use of Bioelectrical Impedance Analysis (BIA) for determining fat content of fish as a means of accurately measuring fish condition in the field. Fish examined include immature and mature Arctic cisco, Arctic cod, Arctic flounder and Dolly Varden. Fish were captured in nets set in Jago and Kaktovik lagoons in summer 2005. BIA measurements were taken on sampled fish. These fish were then euthanized, homogenized, and sent to a laboratory to determine fat, protein, water, and ash composition. Preliminary laboratory results show an average increase of 7% crude fat content in Dolly Varden from the early to late season. Laboratory results will be used to calibrate the BIA measurements. It is expected that BIA will provide researchers with a quick, minimally invasive technique to evaluate fish condition in the field. The prospect of oil development and the increase in Arctic temperatures may cause problems for fish species that use nearshore waters for feeding and growth. Reduction in the ability of fish to forage efficiently may directly affect subsistence users and the many arctic species that utilize them.

Thermal Limitations on Chinook Salmon Spawning Habitat in the Northern Extent of Their Range

Student Investigator: Sam Decker, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Sport Fish Division/ADFG (RSA Base Supplement)
In-Kind Support: Vehicle, technical assistance, and equipment provided by ADFG during the field season

Habitat limitations to spawning areas of Chinook salmon are largely unexplored in the northern regions where the runs remain strong and the habitats are generally in a natural state. Understanding the mechanism behind habitat selection will allow for

critical habitat to be identified and estimation of the effects of temperature changes on the area of spawning habitat for Chinook salmon in the Chena River. Much research has occurred on upper thermal limits of Chinook salmon on highly modified rivers in California, Oregon, Washington, and British Columbia, but little work has been done on cold, northern rivers with healthy stocks. The object of this study is to use accumulated thermal units to determine the upstream and downstream extents of the Chinook salmon spawning habitat. Temperature loggers were placed at intervals along the Chena River. Accumulated Thermal Units will be compiled and thermal zones mapped with GIS. We predict the results will show a length of the Chena River that reliably achieves the required thermal units for Chinook salmon egg development with marginal areas upstream and downstream that may or may not be suitable habitat on any given year. Although moderately urbanized in its lower reaches, the Chena River has many qualities that make it a typical interior Alaska stream. If the habitat use by Chinook salmon can be better understood here, then this information may be transferable to other more remote systems.

Mapping In-Stream Physical Habitat Characteristics with the Aid of Aerial Imagery of a Southcentral Alaskan Stream

Student Investigator: Jeff Perschbacher, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Sport Fish Division/ADFG, Region 2 (RSA)
In-Kind Support: Vehicle, technical assistance, and equipment provided by ADFG during field season; Quickbird satellite imagery provided by the Kenai Peninsula Borough

The collection of habitat data to map physical characteristics of streams that influence migration, rearing, and spawning of salmonids can be labor intensive, logistically difficult, and expensive at the scale resource managers require to map in-stream physical habitat quality and quantity essential to sustain healthy salmonid populations in areas of increased recreation, residential, and commercial development. The objective of this study is to develop a model that will generate a large scale in-stream physical habitat map by combining field collected habitat data and aerial imagery with ERDAS Imagine software. Habitat field measurements were collected August 2006 following EPA's (EMAP): Western Pilot Study Operations Manual for Wadeable Streams. On a single aerial image, habitat field measurements were used to generate six classes of physical habitat (run, riffle, shallow, gravel, shade, vegetation) using a supervised classification (spectral) technique. An additional habitat class of LWD (large woody debris) was generated using a texture filter (spatial) technique. The spectral and spatial models developed from the field referenced image were run on three consecutive upstream images. The four images were used to create a mosaic of an in-stream physical habitat map with seven different habitat classes. An accuracy assessment was carried out to determine how precise the models identified the seven different classes over a large scale. An accuracy assessment on the in-stream physical habitat mosaic, spectral and spatial, found an overall accuracy of 85.4%. The spectral classification technique had an overall accuracy of 92.8%. The spatial technique for LWD had an overall accuracy of 66.7%. The lower accuracy of detecting LWD with the spatial technique may be due to the small amounts of LWD in the study area. Although not satisfactory for mapping wood alone, it may prove useful when combined with the spectral classification technique if resource managers can accept an overall accuracy of 85%. The use of aerial imagery to assess habitat characteristics of wadeable streams can

be beneficial for mapping over large areas. The alternative approach of using aerial imagery offers an affordable way to assess habitat characteristics that can be easily repeatable to monitor change. Salmonid population densities and distributions can be combined with habitat characteristics in a GIS framework, for fisheries and land use managers, to help sustain healthy salmonid populations.

Alternative Escapement Goals for Unuk River Chinook Salmon (*Oncorhynchus tshawytscha*)

Student Investigator: Christie Hendrich, MS Fisheries
Co-Advisors: Gordon Kruse and F. Joseph Margraf
Funding Agency: Sport Fish Division/ADFG, Region I (RSA)
In-Kind Support: Field accommodations, logistical assistance, and riverboat and other field equipment provided by ADFG

Establishing Chinook salmon (*Oncorhynchus tshawytscha*) escapement goals based on spawner-recruit relationships requires intensive stock assessment over many years and does not address productivity potential or limitation as a function of environmental (i.e. habitat) constraints or changes. Alternative escapement goal methods should be explored and evaluated against established biological escapement goals (BEGs) from quality stock assessment information. Chinook salmon play a key role in marine and freshwater ecosystems while providing for commercial, sport, and subsistence users throughout the Pacific Northwest. Escapement goals are the tool by which valuable salmon stocks are managed for maximum sustained yield. The intent of this study is to explore habitat-based approaches to setting escapement goals for Chinook salmon on the Unuk River in southeast Alaska. The BEG for this system will serve as the benchmark against which alternative goals are measured. Spatially documented spawner densities on the Unuk River were recorded between 2003 and 2005. These densities and available habitat data are being investigated in three spawning habitat capacity models. The three habitat model approaches are intended to demonstrate variation in simplicity versus performance in contrast to each other and the spawner-recruit approach. Knowledge acquired about using the relationships between habitat and fish production in escapement goal models on the Unuk River may contribute techniques for using these types of models elsewhere in the future.

Population Characteristics of Inconnu in the Sulukna River, Alaska

Student Investigator: David Esse, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Central Yukon Field Office/BLM
Other Support: Technical assistance and equipment provided by USFWS

Population abundance and population characteristics, such as genetic structure, migratory movements, and age composition for spawning inconnu stocks within the Yukon River watershed, are largely unknown. Inconnu are an important subsistence, commercial, and sport fish within Alaska. With the lack of information on abundance and characteristics of inconnu stocks within the Yukon River drainage, fisheries managers lack the tools necessary for informed harvest management decisions. The objectives of this study are to (1) determine the abundance and outmigration timing of Sulukna River inconnu; (2) determine what percentage of this population migrates to saltwater areas; (3) determine the age structure of outmigrating inconnu; (4)

describe the genetic population structure of the Sulukna River population; and (5) determine post-spawning condition of outmigrants. In 2008, Dual-frequency Identification Sonar was used to document abundance of inconnu leaving the spawning grounds as well as the timing of outmigration. Sagittal otoliths were collected and will be analyzed to determine age and amphidromy. Fin clips were collected and sent to the USFWS genetics lab for analysis. Sacrificed outmigrants were also examined for post-spawning gonad condition. From 17 September to 10 October 2008, 2079 inconnu outmigrated past the sonar site with 96% moving between 8 p.m. and 9 a.m. Sagittal otoliths are currently being analyzed for age composition and amphidromy. With known inconnu spawning areas limited to five locations within the Yukon River drainage, these populations and associated spawning habitats are extremely susceptible to exploitation and detrimental land use activities. Land and fisheries managers must be conservative when it comes to harvest and land use decisions associated with inconnu and inconnu spawning habitat until a comprehensive population assessment can be completed.

Identification and Characterization of Inconnu (Sheefish) Spawning Habitat in the Sulukna River

Student Investigator: Jonathon Gerken, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Koyukuk/Nowitna National Wildlife Refuge/USFWS
In-Kind Support: Technical assistance and equipment during field season provided by the Fairbanks Fish and Wildlife Field Office/USFWS and the Northern Field Office/BLM

Sheefish are a highly valued resource by residents throughout the Yukon River drainage. Subsistence users have voiced concern regarding an increased dependence on sheefish and other whitefish populations due to declining salmon populations. If increases in sheefish harvest are occurring, then the preservation of the spawning areas and their unique habitat features becomes extremely important for the viability of the Yukon River sheefish population. However, spawning habitat site selection of sheefish is largely unknown in the Yukon River drainage. The object of this study is to quantify the habitat features of sheefish spawning sites and document spawning behavior. Information will be applied to identify other spawning areas within the Yukon River drainage using a GIS. Fifty-eight transects were sampled within the Sulukna River, covering a distance of 60 river miles. A common suite of habitat features was measured at each transect. Catch per unit effort (CPUE) was used via hook and line in September and October 2008 to identify presence/absence of spawning sheefish. Spawning behavior was documented using underwater video. Sheefish were present in approximately 13 miles of the Sulukna River (river mile 44 to 57). Spawning sheefish appeared to select areas with small cobble (2.5-5” in length), water depth of 4-5 ft, and mean water velocity near 2.0 ft/s. Measurements of conductivity (uS/cm) were significantly (p value<0.05) different between spawning and non-spawning areas. Sinuosity was significantly (p value<0.05) different between spawning and non-spawning areas. Management of a fishery for long-term sustainability requires an understanding of the species life history. This understanding does not exist for sheefish in the Yukon River drainage. Results of this project will assist managers in development of management plans and prescriptions.

A GIS/Remote-Sensing Based Approach to Identify Potential Spawning Habitat for Fall-Run Chum Salmon in the Mainstem Tanana River, Alaska

Student Investigator: Lisa South, MS Fisheries
Co-Advisors: F. Joseph Margraf and Amanda Rosenberger
Funding Agency: Commercial Fisheries Division/ADFG

Spawning habitat by fall chum salmon is largely unknown in the mainstem area of the Tanana River. Chum salmon are extremely important for subsistence and commercial fisheries in Alaska. Increasing development and recreational use along the Tanana River pose possible habitat degradation concerns, and a greater knowledge of this area is needed for better management and research. The objectives of this study are to determine if fall chum are keying in on areas of upwelling water, identify differences in habitat in areas of upwelling water and areas of non-upwelling water, and create a predictive model of habitat use. Fish are implanted with radio-transmitters and movements will be tracked through two spawning seasons. Upwelling areas are mapped during winter months (ice-free zones) by using Synthetic Aperture Radar (SAR) imagery provided by the Alaska Satellite Facility, and temperature regimes will be confirmed by temperature loggers and Forward Looking Infrared images. During the 2007/08 field season, it was confirmed that fall-chum salmon are using upwelling water areas for spawning. In 2009 we expect to identify temperature regimes within these upwelling areas from temperature loggers deployed in fall 2008. Temperature data and remotely sensed variables will be combined to create a predictive model of habitat use. Little research has been conducted on this species in the Tanana River, and due to the increased development pressures it is critical that a greater understanding is gained of chum salmon spawning habitat. Knowledge of spawning habitat will allow better management decisions and could possibly be applied to other rivers within Alaska to create more cost-effective research.

Seasonal Movements of Northern Pike in Minto Flats, Assessment of Mark-Recapture Experiment, and Effect of Selected Environmental Factors on Movement

Student Investigator: Matthew Albert, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Sport Fish Division/ADFG (Base Funding)
In-Kind Support: Personnel, vehicles, boats, and field equipment provided by ADFG

Northern pike are an important sport and subsistence fish in interior Alaska. Detailed study of seasonal movements of northern pike in Minto Flats is lacking. These movements need to be better understood to improve management of the fisheries that occur in Minto Flats and to improve stock assessment activities. Additionally, little is known regarding the effects of environmental factors upon northern pike movements in Alaska. The objectives of the study are to describe seasonal movements of northern pike in the Minto Lakes portion of Minto Flats, identify optimum time periods for stock assessment activities, evaluate assumptions of capture-recapture, and examine environmental effects on northern pike movements within the study area. In March 2008, 80 northern pike were implanted with radio-telemetry tags (in addition to the tagged individuals that survived from a 2007 telemetry project) and tracked with a boat daily for two 8-day periods each month from May-August. An additional boat survey occurred in September, and aerial surveys were flown in October and December. After freeze-up, tracking was

conducted with snowmachines. Thirty water temperature loggers were deployed throughout the study area for the open water season. Dissolved oxygen will be sampled regularly throughout the winter in overwintering areas identified by telemetry surveys. A portable weather station was deployed and will remain active in the study area until the completion of field work. Northern pike moved into the study area from overwintering areas in the Chatanika River from late April until early May. Post-spawn (late May/early June) fish dispersed to summer locations, primarily within the study area. Water temperatures varied widely by location and time of day. Tagged fish began outmigration in late September and continued into December. As of 11 December 2008, the majority of tagged fish were located in overwintering areas in the Chatanika River upstream of its confluence with Goldstream Creek. A better understanding of northern pike movements and what causes those movements will allow fishery managers to identify key areas and times when the pike are more vulnerable to harvest and to identify optimum times for stock assessment experiments.

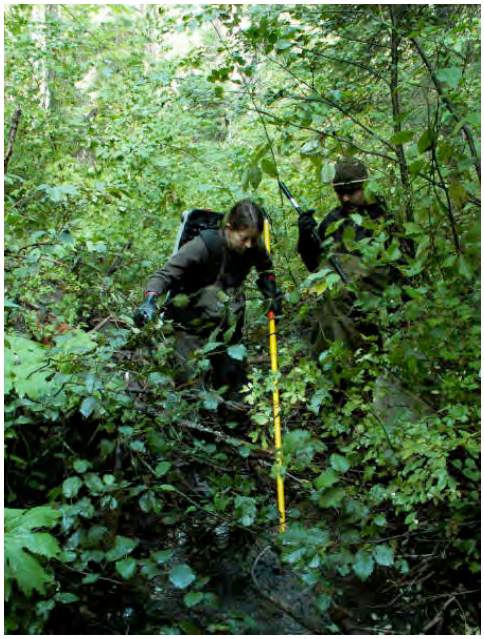
Investigations into Annual Energetic Cycles and Relationships Between Condition and Habitat Variables for Dolly Varden Char of the Arctic Coast

Student Investigator: Jason Stolarski
Co-Advisors: F. Joseph Margraf and Anupma Prakash
Funding Agency: USFWS (RWO 160)
In-Kind Support: Field logistics provided by the Arctic National Wildlife Refuge

Anthropogenic alterations of the thermal conditions within nearshore aquatic habitats of the Beaufort Sea have the potential to impact Dolly Varden char stocks. To date, little is known regarding the biological implications of altered thermal regimes or the degree to which fish condition varies seasonally and annually. These data will allow a greater understanding of the relationship between Dolly Varden char, an important subsistence species, and an increasingly changing Arctic environment. The objectives of this research are to measure fat content of Dolly Varden char to elucidate season and annual trends and attempt to correlate these measures to remotely collected habitat variables. Dolly Varden char will be collected twice annually (fall and spring) while residing within freshwater environments. Fat content will be estimated using proximate composition and bioelectrical impedance analysis, and large-scale habitat characteristics will be collected remotely via satellites. Through this research we hope to gain a better understanding of Dolly Varden char energetic cycles and the degree to which these cycles are influenced by habitat conditions. This research is of particular importance considering current and future oil exploration and extraction activities on the Arctic coast, global climate change, and the importance of this resource to native communities of the Arctic coast.

Do Drifting Invertebrates Originating from Fishless Headwater Streams Benefit Downstream Fish?

Student Investigator: Elizabeth Green Markley, MS Biology
Advisor: Mark Wipfli
Funding Agency: Bonneville Power Administration/DOE
In-Kind Support: Technician and equipment provided by US Forest Service during field season



Strength of the ecological connections between fishless headwater tributaries and downstream fish-bearing habitats is not well understood; hence, it is not clear how important these headwater habitats are for fish communities at the broader watershed scale. Often legal protection from activities such as timber harvest applies only to streams bearing fish. Yet the influence of small, fishless streams to fish in areas fed by those fishless headwaters is not clear. In order to understand how management activities in fishless streams affect fish downstream, we must understand trophic connections between organisms in these bodies of water. The objective of this study was to determine how the biomass of drifting invertebrates from fishless reaches affects the biomass of fish downstream. The biomass of drifting invertebrates at the uppermost barrier to fish within a stream was compared to fish biomass and growth downstream. Invertebrate biomass was also manipulated to determine the effects of altering the available food supply on fish. There was a positive relationship between density of drifting invertebrates and total mass of fish in study reaches. However, blocking drifting invertebrates at the fish barrier did not have a significant effect on fish abundance or mass downstream. If fishless headwater streams are important food sources for fish downstream, the fish-bearing criterion qualifying a stream for buffer protection may not be sufficient to protect fish.

Developing Monitoring Tools for Tracking Marine-Derived Nutrients in Alaska Watersheds

Student Investigator: Daniel J. Rinella, PhD Biology
Advisor: Mark Wipfli
Funding Agency: Gulf Ecosystem Monitoring Program/EVOS
In-Kind Support: Kachemak Bay Research Reserve; Environment and Natural Resources Institute/UAA

Spawning salmon deliver large quantities of marine-derived nutrients (MDN), primarily in the form of carcasses and eggs, to the otherwise nutrient-poor streams where they spawn. Optimizing methods for measuring MDN assimilation in stream foodwebs and understanding variation in MDN assimilation will foster the development of ecologically based watershed management strategies and escapement goals. The objectives were (1) to understand the factors that influence

stable isotope and fatty acid measures of MDN assimilation in stream-resident fish and (2) to examine the ability of these measures to track MDN and differentiate among sites that vary in the biomass of spawning salmon. Juvenile Dolly Varden were sampled spring through fall in nine streams on the Kenai Peninsula. Akaike Information Criterion (AIC_c) model selection was used to develop multiple linear regression models expressing C, N, and S stable isotope ratios and fatty acids (ω3:ω6 and multivariate distance from salmon flesh) as a function of spawning salmon abundance and selected covariates. Local spawner density, region, and Dolly Varden length were the best predictors of MDN assimilation in Dolly Varden. While confirming the importance of spawner abundance, these results indicate that MDN signals are maintained year-round, that inference must be made on a region-by-region basis, and that larger Dolly Varden assimilate proportionately more MDN. Of all dependent variables, $\delta^{15}N$ had the most precise relationship with spawner abundance, making this the best indicator of watershed-scale MDN assimilation. Results demonstrate quantifiable relationships between spawner abundance and MDN metrics, allowing for management strategies like large-scale tracking of MDN inputs and inferring spawner densities.

Interdisciplinary Approaches to River Management in Southcentral Alaska

Student Investigator: Meagan Boltwood Krupa, MS Environmental Science
Co-Advisors: Mark Wipfli and F. Stuart Chapin
Funding Agency: NSF IGERT Fellowship; UAF Graduate School Thesis Completion Fellowship

The current management framework of the Ship Creek Fishery is not effectively addressing the problems produced by high human use. This project is important because it will provide new insight into the management challenges of urban fisheries. The goals of this work are to (1) identify future management options, (2) decrease intra- and inter-agency conflict, and (3) increase the overall robustness of the Lower Ship Creek Fishery. These goals will be accomplished by (1) examining the environmental history of Ship Creek and identifying current social and ecological constraints; (2) analyzing how the current cost structure is creating intra- and inter-agency tension, and (3) applying published design principles to determine how to increase the robustness of the system. This study will make specific recommendations on how to refine the management structure to increase the socio-economic system's (SES) robustness. Data from this study will contribute to the long-term goal of conserving urban creeks and salmon populations for economic benefit, ecological integrity, and recreational enjoyment of future generations.

Environmental Variation, Metabolism, and Benthic Macroinvertebrates in the Chena River

Student Investigator: Emily Benson
Advisor: Mark Wipfli
Funding Agency: Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative
In-Kind Support: Boat, vehicle, and technical assistance during field season provided by Sport Fish Division/ADFG

How stream flow and other environmental variables relate to whole stream metabolism and aquatic macroinvertebrate communities is not well understood. This project is important because it will provide new insight into how the energy produced

and consumed at the base of stream foodwebs relates to environmental variation and aquatic macroinvertebrates, an important food source for fish. The goals of this work are to answer the following questions: (1) how are changes in light intensity, nutrient concentration, and stream flow related to changes in ecosystem metabolism (primary production and community respiration) in the Chena River? and (2) how are changes in primary production, community respiration, and stream flow related to changes in benthic macroinvertebrate communities in the Chena River? These goals will be accomplished by monitoring whole stream metabolism, light intensity, stream flow, nutrient concentrations, and benthic macroinvertebrate communities at four sites in the Chena River during summers 2008 and 2009. This study will enable a better understanding of how and to what extent environmental variables are related to the production and consumption of energy in aquatic foodwebs and aquatic macroinvertebrates. Data from this study will contribute to the long-term goal of understanding the environmental factors that affect river foodwebs in interior Alaska that support juvenile salmon populations, an important resource for Alaskans both ecologically and economically.

Importance of Terrestrial Invertebrates as Prey for Juvenile Chinook Salmon in the Chena River

Student Investigator: Laura Gutierrez, MS Biology
Advisor: Mark Wipfli
Funding Agency: Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative
In-Kind Support: Boat, vehicle, and technical assistance during field season provided by Sport Fish Division/ADFG

Terrestrial invertebrates may be an important food source for salmonids, especially where aquatic invertebrate production may not be sufficient to sustain viable fish communities in less productive sub-arctic streams. The role of terrestrial invertebrates for juvenile Chinook salmon, particularly in larger rivers, is not well understood within their range. Human activities in forests and riparian zones can influence invertebrate populations and communities, thereby influencing food resources for fish species that prey upon these invertebrates. Due to its proximity to Fairbanks, Alaska, there has been and will continue to be development on the Chena River that could affect food resources for juvenile Chinook. The objectives of this study are to determine (1) the seasonal influx (May through September) of terrestrial invertebrates into the Chena River, and (2) subsequent predation on terrestrial invertebrates by juvenile Chinook salmon. Fish stomach contents are being collected during the summer of 2008 and 2009. Additionally, floating pan traps are collecting terrestrial invertebrate infall into the river, and invertebrate drift in the Chena is being collected with drift nets. Preliminary results indicate that juvenile Chinook diet consists mainly of midges, stoneflies, mayflies, and a small percentage of terrestrial invertebrates. Seasonally, the importance of terrestrial invertebrates as fish prey increased in fall. Understanding terrestrial invertebrate input and the role of terrestrial invertebrates in juvenile Chinook diet in the Chena River is important for determining the effect that trophic and other environmental processes have on juvenile salmonid populations.

Process-based Modeling of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha)* Recruitment in the Chena River

Student Investigator: Jason Neuswanger, MS Biology
Co-Advisors: Mark Wipfli and Nick Hughes
Funding Agency: Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative
In-Kind Support: Boat, vehicle, and technical assistance during field season provided by Sport Fish Division/ADFG

The stock-recruitment data for the Chena River (and some similar systems) show such high variation that they defy meaningful analysis with standard statistical tools like the Ricker curve. Much of this variation in run strength may arise from poorly understood processes that act on the juveniles in freshwater during their first summer. Managers can use run forecasts to inform escapement goals and related regulations. More accurate run forecasts should lead to better policy decisions. Study objectives are to (1) build a predictive model of Chinook salmon cohort recruitment for the Chena River that works under novel annual combinations of flow, temperature, invertebrate drift, and initial population size; (2) provide mechanistic explanations for predicted responses; and (3) explain observed patterns in behavior, distribution, and size structure. Study methods are to (1) use extensive ad libitum observation and 3D video analysis, along with growth and diet data from other students, to identify patterns in the behavior, growth, and distribution of juvenile Chinook salmon that provide insight into the mechanisms driving the system; (2) synthesize this information with established ecological theory to construct a model that accurately reflects the primary mechanisms governing growth and survival, and the impact of environmental variables on those relationships; (3) apply the model to explain past trends in Chena River Chinook salmon returns; and (4) perform a sensitivity analysis to determine the importance of major environmental variables and ecosystem processes. This model will predict variations in recruitment that can be attributed to freshwater survival. The process of model construction will provide new insights into the detailed life history of juvenile Chinook salmon in this system. This model is expected to improve run forecasts by providing insight into the expected impact on future adult returns of the freshwater environmental conditions that affect juvenile Chinook salmon, including floods and abnormal temperatures.

Growth and Mortality of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) in an Interior Alaska River

Student Investigator: Megan Perry, MS Biology
Advisor: Mark Wipfli
Funding Agency: Arctic Yukon Kuskokwim Sustainable Salmon Initiative
In-Kind Support: Boat, vehicle, and technical assistance during field season provided by Sport Fish Division/ADFG

Stock-recruitment models do not take into account environmental conditions that affect juvenile Chinook salmon growth, and current literature lacks data demonstrating competition in juvenile Chinook salmon. This project will help us to understand some of the factors that regulate growth and the abundance of juvenile Chinook salmon in the Chena River. The objectives of this work are to (1) determine whether food and/or temperature limit juvenile Chinook salmon growth, (2) investigate if seasonal patterns of growth and/or changes in fish abundance give evidence of competitive bottlenecks that cause density dependent mortality, (3) develop a model capable of predicting the effect of stream temperature on the

growth of juvenile Chinook salmon, (4) test whether the growth model can be used to predict annual growth and annual variation in smolt size, and (5) determine whether there is a positive correlation between smolt size and the productivity of a brood year in terms of recruits per spawner. To accomplish these objectives I will determine the effect of food addition on the growth and abundance of juvenile Chinook salmon along the natural temperature gradient in the Chena River. Using a growth model, I will investigate the way temperature and food intake interact to determine the growth of juvenile Chinook salmon. This work will be supplemented with a retrospective analysis of the relationship between water temperature and growth to determine how fish productivity is related to growth in fresh water. Preliminary results show that both competition for food and temperature may be factors limiting juvenile Chinook salmon growth in the Chena River. If my growth model (objective 3) is capable of predicting how stream temperature affects smolt size, then I will have a method to predict the way an annually variable environmental characteristic translates into variability in salmon abundance. The ability to create estimates of smolt growth from an easily measurable environmental variable could be incorporated into a more rigorous model that would allow fisheries managers to better forecast future returns.

Ecological Effects of Introduced European Bird Cherry on Stream Food Webs in Salmon Streams within the Municipality of Anchorage

Student Investigator: David Roon, MS Biology
Advisor: Mark Wipfli
Funding Agencies: USFWS and USDA Forest Service
In-Kind Support: Municipality of Anchorage, Anchorage Parks Foundation, USFWS, USDA Forest Service, and the UAF Cooperative Extension Service

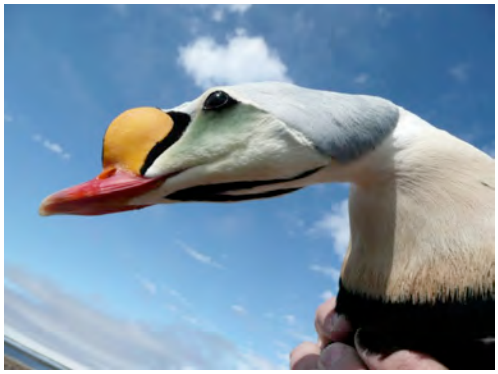
European Bird Cherry (*Prunus padus* L.) (EBC) is an introduced, ornamental tree that is quickly spreading and may be displacing the native riparian vegetation along several streams that flow through the municipality of Anchorage. Anchorage is home to several valuable recreational salmon fisheries. This change in riparian vegetation could affect stream food webs and ultimately the juvenile salmonids that these streams support. Objectives are to map the distribution of EBC in two of these urban watersheds, Campbell and Chester Creeks, and determine the ecological effects of EBC on stream food webs. The study will deploy leaf packs of EBC leaf litter and the leaf litter of native species to compare in-stream decomposition rates. The leaf packs will also compare aquatic invertebrate shredder community compositions associated with EBC and native vegetation. Branch samples of EBC and native vegetation will compare terrestrial invertebrate communities. Juvenile salmonid diet will be compared in reaches dominated by EBC to reaches dominated by native vegetation. It is expected that the spread of EBC will negatively affect the aquatic and terrestrial invertebrate communities and in turn will negatively affect food resources for juvenile salmonids. Results from this study will directly influence the future management of EBC. If this study demonstrates that EBC negatively affects stream food webs, it will provide strong incentive to control the current population and to prevent its future spread in adjacent watersheds.

Completed Wildlife Studies

King Eider Migration and Seasonal Interactions at the Individual Level

Student Investigator: Steffen Oppel, PhD Biology
Advisor: Abby Powell
Funding Agencies: USGS OCS Program
In-Kind Support: NSB

Note: Steffen Oppel graduated from the University of Alaska Fairbanks in December 2008. His dissertation abstract follows:



Seasonal interactions describe how events during one season of the annual cycle of a migratory bird affect its fitness in subsequent seasons. Understanding the strength and mechanism of seasonal interactions is important to predict how migratory birds will respond to future challenges caused by habitat loss and climate change.

This dissertation explores seasonal interactions between different stages of the annual cycle in an arctic-breeding sea duck, the King Eider (Somateria spectabilis). Concerns over recent population declines and potential effects of climate change on marine habitats used by the species highlight the need for a better understanding of its life history. I used satellite telemetry to describe migration routes, timing of migration events, and geographic regions used by King Eiders throughout the year. I found highly variable movement patterns, and wide dispersion of King Eiders to three regions in the Bering Sea during winter. I then developed stable isotope techniques to examine seasonal interactions at the individual level. First, I examined the relative contribution of body reserves to egg production using stable isotope analysis of egg components and blood. I found that most birds use only small proportions of body reserves to produce eggs, but rather rely on nutrients obtained on breeding grounds to form a clutch. Thus, contrary to general expectation, King Eiders use an income strategy to produce eggs, and I hypothesize that they may retain body reserves for incubation. Body reserves may reflect the residual body condition from the previous winter. I further examined whether females wintering in different regions in the Bering Sea had different rates of nest survival. The northern Bering Sea has a higher benthic biomass and is closer to breeding grounds than winter regions farther south. However, nest survival rates of female King Eiders in northern Alaska did not differ between females that had wintered in the northern or southern Bering Sea.

Overall, I found large individual variation in movement and breeding strategies, and little evidence for strong seasonal interactions between winter, spring, and summer. This indicates that King Eiders are a very adaptable species that depend on resources acquired on breeding grounds to a larger extent than previously assumed.

Responses of Captive Common Eiders to Implanted Satellite Transmitter with Percutaneous Antennas

Student Investigator: Christopher Latty, MS Biology
Co-Advisors: Abby Powell and Tuula Hollmen
Funding Agencies: Alaska Science Center/USGS; Alaska SeaLife Center; Fairbanks Field Office/USFWS
In-Kind Support: Alaska SeaLife Center

Note: Christopher Latty graduated from the University of Alaska Fairbanks in May 2008. His thesis abstract follows:

Implanted transmitters have been used for over a decade to track the migrations and habitat use of many sea duck species, but their effects remain largely unstudied. To address this, I assessed the physiological and behavioral responses and characterized the clinical responses of six Common Eiders implanted with a transmitter with a percutaneous antenna. To maintain a semi-natural feeding regime, I fed birds benthicly in a 4.9 m deep dive column. I collected blood, feces, mass, and video data prior to surgery to establish baselines and at staggered intervals for 3.5 months post-surgery to determine responses. All birds had some clinical complications, but most abated within 2 weeks of surgery. Mass increased in the first two weeks, but no trend was evident thereafter. Most biomarkers and dive performance metrics were altered at some point after surgery. While most biochemical values returned to baseline within weeks of surgery, a few remained deviated for longer. Additionally, dive speeds were slower for up to 3.5 months after implantation. Although it is uncertain how these changes would ultimately affect birds in the wild, effects on physiological condition and behavior seem likely in the first few weeks after surgery with longer-term effects also possible. Scientists should consider these responses and possible effects on the validity of PTT data when designing studies and analyzing information from implanted transmitters in sea ducks.

Effects of Military Overflights on Habitat Use and Selection by Female Dall's Sheep, Yukon-Tanana Uplands, Alaska Cooperative Fish & Wildlife Research Unit

Student Investigtor: Bradley Wendling, MS Wildlife
Advisor: Brad Griffith
Funding Agency: National Park Service: NPS

Note: Brad Wendling graduated from the University of Alaska Fairbanks in December 2008. His thesis abstract follows:

My objective was to assess the potential effects of military overflights on home range size, movement rates, habitat use, and habitat selection of female Dall's sheep (*Ovis dalli*) during 2-week sequential periods, April-July, 1999-2002. I examined sheep in 2 study areas overlain with designated military training airspace within the Yukon-Tanana uplands, Alaska. I examined the effects of study area, year, and sequential time period on: 1) mean home range size, 2) mean minimum hourly distance traveled by sheep, and 3) mean use and selection ratios for the habitat variables of elevation, slope, terrain ruggedness, aspect, and landcover class. Mean number of daily military sorties within sequential periods was used as a covariate in all analyses. I assessed habitat selection at 3 successive spatial scales defined as: 1)

the regional geographical range of female Dall's sheep in the Yukon-Tanana uplands, 2) study areas (defined as the distribution of sheep within a localized area), and 3) selection within individual 2-week home ranges. Sheep home range size, movement rates, habitat use and selection ratios at the scale of region and study area differed between study areas, among years within study areas, and among sequential time periods within years within study areas, but did not vary in relation to military overflight intensity. I detected an effect of sorties on selection ratios at the home range scale; however, sorties explained <4% of the residual variation in these variables. I conclude that increases in intensity of military training operations during Major Flying Exercises (MFE's) over the Yukon-Tanana uplands were a relatively insignificant source of variance in activity and habitat use compared to the effects of seasons, years, and study areas.

Ongoing Wildlife Studies

Ecology of Staging Shorebirds on Alaska's North Slope Coast

Student Investigator: Audrey Taylor, PhD Biology
Advisor: Abby Powell
Funding Agencies: Coastal Marine Institute, UAF/MMS; Angus Gavin Migratory Bird Research Fund, UA Foundation; Migratory Bird Management, and Arctic National Wildlife Refuge/USFWS; Arctic Field Office/BLM; BPXA, Inc.; and ConocoPhillips Alaska Inc.
In-Kind Support: Technical assistance and equipment use during the field season

Little information exists on the ecology of post-breeding shorebirds across Alaska's North Slope coast. This information is critical for evaluating the impacts of industrial development and climate change, which could affect shorebirds staging in coastal habitats. Our study objectives were to assess the abundance and distribution of post-breeding shorebirds, to document time to departure and movement patterns, and to examine staging site quality using triglyceride levels and/or corticosterone concentrations. We used a combination of ground camps and aerial surveys to examine abundance and distribution, to deploy and track radio-transmitters to determine time to departure and movement patterns, and to collect blood samples for analysis of physiological parameters. Concentrations of staging shorebirds occurred at Peard Bay, Elson Lagoon, Cape Simpson, Pitt Point/Pogik Bay, and the Jago and Kongakut river deltas. Time to departure (estimate, 95% CI) was 4.34 (3.22, 5.45) days for semipalmated sandpipers, 4.51 (3.32, 5.70) days for phalaropes, 7.87 (4.48, 11.26) days for western sandpipers, and 13.43 (8.61, 18.24) days for dunlin. Semipalmated sandpipers moved east along the Beaufort coast toward the Canadian border in 3-24 days post-capture, whereas dunlin moved both southwest and east in 20-70 days post-capture. Semipalmated sandpipers captured in Barrow had the highest triglyceride levels and high maximal corticosterone levels, suggesting that site quality was highest in Barrow. Human activity or environmental perturbation occurring at one of the concentration areas above may have disproportional effects on Arctic-breeding shorebird populations. Because time to departure and movement patterns are species-specific, effects of development and climate change should be evaluated at the species level. Lastly, triglyceride levels may be useful and easier to interpret than corticosterone levels as a physiological index of site quality.

Tundra-Nesting Shorebirds in Relation to Landscape Transformation and Climate Change

Student Investigator: Nathan Coutsoubos, PhD Biology
Advisor: Falk Huettmann
Funding Agency: BLM (RWO 155); USFWS; NSF; UAF IGERT
In-Kind Support: USFWS provided technical assistance, housing, and equipment in the field

Many shorebird species worldwide are in decline. Tundra-nesting shorebirds around Barrow, Alaska, are threatened by long-term trends like climate change and short-term trends such as landscape transformation via urbanization. Shorebirds are an important component of the tundra ecosystem. Species composition, abundance, and breeding timing and success may be affected at the local level by habitat changes due to climate change and landscape transformation, such as the expansion of Barrow and its new landfill. The objects of this study are to determine quantitatively if the abundance of local shorebirds has changed since 1979, and to determine if abundance and nesting success are affected by construction of a new municipal landfill. Birds were surveyed using Distance Sampling methods on survey routes from the 1970s, and in and around the new landfill. Nesting phenology and success were determined by monitoring shorebird nests in and around the new landfill. Landfill construction and associated landscape transformation have resulted in direct loss of some habitat and have created pockets of habitat that undergo snowmelt about a week earlier than the surrounding tundra, creating important early-season feeding habitat with dense, albeit temporary, concentrations of birds. There is no evidence that species composition has changed around the new landfill, although hatching success has improved markedly (most likely due to recent culling of Arctic fox around Barrow). Comparisons to 1970s data are ongoing. Given a warming environment and an increase in the urban footprint all across the Arctic, and given both legal and local interests in protecting wildlife, it is important to understand the impacts on shorebird species as their tundra habitat changes in order to manage proactively. Sustainability of local wildlife resources depends in part on the impacts of local-scale changes such as this study addresses.

Breeding Biology of King Eiders at Teshekpuk Lake and the Kuparuk Oilfields

Student Investigator: Rebecca McGuire Bentzen, PhD Biology
Advisor: Abby Powell
Funding Agencies: Coastal Marine Institute/UAF; ConocoPhillips Alaska, Inc.; BLM; NSB; MMS; and USGS

Little is known about the breeding biology of king eiders (*Somateria spectabilis*) and the potential impacts of development on their breeding grounds. The National Petroleum Reserve-Alaska (NPR-A) northeast planning area has the highest known density of nesting king eiders in Alaska and is being leased for oil and gas exploration. Our objectives were to estimate nest survival, factors influencing nest site choice, and incubation behavior in both an undisturbed and disturbed area. Additionally, we evaluated the nutritional state of incubating females at both sites. Accessible areas around Teshekpuk Lake and Kuparuk were searched for nesting King Eiders from 2002 through 2005. We located and monitored nests (~40/site/year), measured habitat characteristics of nest and random sites, placed data loggers in nests to monitor incubation constancy, and trapped females to take blood samples. Nest success was higher at Kuparuk, when nests were undisturbed by

observers, and post-fox control. Incubation constancy was slightly higher at Kuparuk than at Teshekpuk, and females appeared to be primarily reliant on endogenous reserves to maintain high nest attendance rates, but did feed during incubation. The NPR-A is the center of the breeding distribution and the area of greatest nest density of King Eiders in Alaska and is being leased for development, so it is important to have information on the reproductive parameters of King Eiders in both an undisturbed and a disturbed area.

Large-scale Habitat Requirements of Breeding Black Terns

Student Investigator: Valerie Steen, MS Wildlife
Advisor: Abby Powell
Funding Agency: Region 6/USFWS (RWO 156)
In-Kind Support: Personnel provided by USFWS

Black Terns are a species of concern due to habitat loss on the breeding grounds and population declines. They nest on floating mats in freshwater wetlands and forage in a larger area that includes neighboring wetlands and uplands. This indicates that Black Terns select habitat at two spatial scales—one at the local scale that requires suitable nesting habitat and one at the landscape scale that requires suitable foraging habitat. Because Black Terns commonly nest in areas where land is subject to intense agricultural pressure, knowledge of the limiting habitat requirements at both scales can help guide management decisions to mitigate against further population declines. The objective of this study is to develop a model of Black Tern occurrence and abundance based on local and landscape scale habitat features. Surveys for Black Terns were conducted on managed lands in 2008 in North Dakota, South Dakota, Nebraska, Montana, Wyoming, Colorado, and Utah and will be conducted again in 2009 and include private lands. Landscape-scale habitat features such as total area of wetland, upland habitat type (grassland or tilled), and local habitat features such as wetland size and presence and amount of nesting substrate are expected to be important predictors of Black Tern occurrence and abundance. The results of this multi-scale habitat analysis will be useful in guiding regional conservation planning for Black Terns.

Diet of Glaucous Gulls on Alaska's North Slope

Student Investigator: Emily Weiser, MS Wildlife Biology
Advisor: Abby Powell
Funding Agency: Department of Wildlife Management/NSB; BLM; Angus Gavin Migratory Bird Research Grant, UA Foundation
In-Kind Support: ConocoPhillips Alaska, Inc.

Glaucous Gulls are major predators on the North Slope and may benefit from human development. Currently, their diet and their population response to development are unknown in northern Alaska. Glaucous Gulls may be feeding on birds that are of conservation concern; they also may be feeding on species hunted for subsistence by

Native Alaskans. If gull population growth results from continuing oil development on the North Slope, increased gull predation could cause or exacerbate population declines for those other bird species. This study describes Glaucous Gull diet and reproductive output on the North Slope, and how gulls may be affected by development. We studied eight breeding colonies in four regions of the North Slope: Barrow (residential), Cape Simpson (undeveloped), Alpine (industrial/residential), and Deadhorse (industrial). At each colony, we collected regurgitated pellets to describe gull diet and monitored gull reproductive output to determine how development may affect gull populations. Glaucous Gulls in our study areas fed primarily on microtine rodents, birds (especially shorebirds and waterfowl), fish, and garbage. Diet included at least twelve bird species of conservation concern. Across colonies, the amount of garbage in diet had a significant positive effect on productivity. If more garbage becomes available to gulls with future oil and gas development, regional gull populations may increase. Managers and developers may be able to use these results to limit the gull population growth that may otherwise result from further development.

Smith's Longspur Distribution, Abundance, and Habitat Associations in the Brooks Range, Alaska

Student Investigator: Teri McMillan, MS Wildlife Biology
Advisor: Abby Powell
Funding Agencies: Arctic National Wildlife Refuge/USFWS; Gates of the Arctic National Park and Preserve/NPS
In-Kind Support: Technical assistance, vehicle, and logistical support provided by USFWS and NPS during field season

The distribution, abundance and habitat associations of Smith's Longspurs in the Brooks Range are largely unknown. Smith's Longspurs are a species of conservation concern that breeds in the Brooks Range. To develop effective conservation measures information is needed on population abundance, distribution, and habitat requirements. The object of this study is to measure Smith's Longspur abundance and distribution, identify habitat associations, and develop a predictive species distribution model. Bird and habitat surveys were conducted on four study sites in 2008. Five more sites will be studied in 2009. This data will be combined with agency survey data to determine abundance estimates, analyze habitat associations, and model distribution. Smith's Longspurs were found in dwarf shrub-tundra above treeline and within large tussock meadows in the tundra-treeline transition zone. Density estimates ranged from 0.07–0.47 birds/ha. Understanding breeding Smith's Longspur distribution and abundance is the critical first step in developing a conservation plan. Changes in the distribution and condition of breeding habitat due to climate change will be difficult to predict without an understanding of current habitat associations.

Renesting Rates in Response to Experimental Clutch Removal in Dunlin (*Calidris alpina arcticola*)

Student Investigator: Heather "River" Gates, MS Wildlife
Advisor: Abby Powell
Funding Agencies: Migratory Bird Program/USFWS; BLM Fairbanks
In-Kind Support: Vehicle, technical assistance, and equipment provided by USFWS during field season

Clutch replacement propensity in arctic-breeding shorebirds is largely unknown on the North Slope of Alaska. These shorebirds breed across the North Slope, and populations are reportedly declining. Data from this project will be used to better estimate population size and productivity. In 2007-08, we conducted a study to evaluate how arctic-breeding Dunlin responded to experimental clutch removal. We measured renesting propensity, mate and territory fidelity, and the interval between clutch removal and replacement clutch laying. We captured, radio-, and color-marked approximately 20 adult Dunlin pairs and removed approximately 20 clutches during early incubation (2007 and 2008) and late incubation (2008 only). Dunlin frequently (85 -91%) laid replacement clutches after clutches were removed during early incubation ($\bar{x}$ = 5.9d into incubation, range 3-10 d, n = 42). Only 35% of Dunlin whose clutches were removed later ($\bar{x}$ = 13 d into incubation, range 12 – 16d, n=19) replaced their clutch. In divorce (n=2), males remained on territory and females moved large distances to renest with a new mate. The average time between collection of the first clutch and initiation of the replacement clutch was 5.7 days and 6.5 days for early and late treatments, respectively. Our study revealed an unexpectedly high rate of clutch replacement, suggesting that a female's propensity to lay a replacement clutch is not likely due to physiological constraints but more strongly related to timing of nest loss. Studies focusing on arctic shorebird breeding ecology would benefit from investigating frequency and proportion of replacement clutches in different mating systems.

Ecology of Shorebird Use of Mudflats on Major River Deltas of the Arctic National Wildlife Refuge, Alaska

Student Investigator: Roy Churchwell, PhD Biology
Advisor: Abby Powell
Funding Agencies: National Fish and Wildlife Foundation; USFWS
In-kind Support: Labor provided by Manomet Center for Conservation Science; housing and logistical support provided by USFWS

There is little knowledge of shorebird biology in the Arctic and what draws these birds to littoral delta mudflats during the post-breeding period, although shorebird biologists suspect food resources may influence shorebird behavior at this time. The Arctic National Wildlife Refuge is investigating these questions to manage and preserve shorebird species and habitat along the refuge's coast. Interest in this question grows as potential negative impacts to the coast have developed through off-shore oil development and climate change. This study will determine shorebird distribution in relation to invertebrate food resources spatially and temporally and will investigate how resource differences between study sites influence length of stay and shorebird physiological parameters. We will conduct shorebird surveys regularly in conjunction with collecting invertebrate core samples on delta mudflats during the post-breeding season. We will calculate length of stay using color-banded birds and mark-recapture analysis and will measure physiological parameters using blood

samples from captured birds. This project is in the beginning stages of development as we prepare for our first field season in fall 2009. During a pilot study (fall 2008) we found differences in invertebrate species diversity between mudflats. Also, shorebirds seemed to concentrate in areas of higher invertebrate abundance. Several shorebird populations using this habitat are declining, and some are listed as species of concern in the US Shorebird Conservation Plan and by US Fish and Wildlife Service. With augmented climate change impacts along Alaska's northern coast, this research will give insight into how climate change influences shorebird habitat.

Development of Sampling Techniques for Prince of Wales Spruce Grouse

Student Investigator: Aleya Nelson, MS Wildlife
Advisor: Mark Lindberg
Funding Agencies: ADFG; DBW and IAB/UAF
In-kind Support: Thorne Bay Ranger District/USDA Forest Service provided a technician and logistics

Spruce grouse (*Falcipennis canadensis isleibi)* are infrequently detected on Prince of Wales (POW) Island in the Alexander Archipelago of southeast Alaska. Infrequent detection may be a testament to the elusive behavior of the bird or a reflection of low abundance or survival. Spruce grouse on POW Island were recently proposed as a distinct subspecies. Consequently, the Forest Service and Alaska Department of Fish and Game are interested in the population ecology of spruce grouse on the island. We conducted research on POW Island from May-December 2008 to monitor survival, develop an effective sampling technique to estimate abundance, and examine habitat selection. Sampling techniques tested for abundance estimation included systematically driving roads, walking habitat transects with dogs, mark-recapture, adaptive sampling, and occupancy modeling. We captured 21 grouse (14 female, 7 male) with a noosing pole and fitted them with necklace style radio-transmitters weighing 4.5 grams. Biological samples and photos were taken for ongoing taxonomic delineation of the subspecies. Three captures were the result of communicated locations by Forest Service personnel while 18 were detected through sampling techniques. We observed a total of 37 spruce grouse with the majority (11) sighted in October and found 4 nests. Collared birds were monitored monthly to determine levels and causes of mortality and to estimate survival. We used radio-marked birds to compare the detection error of various survey techniques. In an occupancy modeling experiment where the known location of a grouse was used to evaluate detection error, observation was 0.2857 on 14, 0.25 km x 0.25 km sampling units. The most effective sampling techniques, as determined by the highest detection rate, may be applied at a landscape scale to estimate population abundance. We also tracked radio-marked birds to identify habitat preferences. We collected a total of 162 relocations throughout the field season with specific relocations for habitat sampling ensured in August, October, and December. We will compare these points to available habitat to investigate selection at two spatial scales: home-range selection and used resource unit components. Recommendations for monitoring grouse and suitable habitat will be provided for the Tongass National Forest to inform management decisions related to harvest activity.

Developing a Method for Estimating Deer Abundance in Southeast Alaska

Student Investigator: Todd Brinkman, PhD Wildlife
Co-Advisors: F. Stuart Chapin III and Kris Hundertmark
Funding Agency: Wildlife Conservation Division/ADFG (RSA Base Supplement)
In-Kind Support: Vehicle, technical assistance, and equipment provided by ADFG during field season

In recent years, subsistence users on Prince of Wales (POW) Island have expressed concern about the difficulty in harvesting sufficient numbers of deer to meet their needs. Lack of information about Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) populations has hindered attempts to address subsistence hunting concerns and evaluate management practices. In particular, no reliable estimates of population abundance exist. Abundance is one of the most important population parameters because it serves as the currency by which success of management programs can be judged. Further, a reliable estimate of abundance leads to a better understanding of other variables (e.g., landscape change, cause-specific mortality) influencing the species of interest. Our primary objective is to develop a method to estimate density and population trends for deer in southeast Alaska. We are using pellet-group surveys along transects located on POW Island to count fecal pellets and collect pellets for DNA extraction. We are using DNA extracted from fecal pellets to identify individual deer. After individual deer can be linked back to a specific place and time, mark and recapture techniques will be used to estimate abundance. Our third and final field season was completed in May 2008. We have collected samples from roughly 3,000 pellet groups and counted over 7,000 individual pellet groups. We have completed DNA extraction from all pellets, and genotyping of individual deer is 75% complete. For the first time for Sitka black-tailed deer, we have estimates of deer abundance and sex ratios with confidence values useful at the management level. It is important to monitor deer population levels and trends in Southeast Alaska to help resolve subsistence harvest issues, manage sustainable harvests, and evaluate the effects of habitat change on population. Potentially, the monitoring protocol we developed will replace the current monitoring plan used by the US Forest Service and Alaska Department of Fish and Game in southeast Alaska.

Monitoring the Body Condition of Caribou in Late Winter: Developing and Evaluating a "Hands Off" Approach

Student Investigator: Dave Gustine, PhD Biology
Advisor: Perry Barboza
Funding Agency: USGS
In-Kind Support: Helicopter transportation to field sites in winter 2008

How does the body condition of caribou affect population dynamics? We are developing and refining a non-invasive technique to assess average body protein loss in caribou herds that will assist management agencies in predicting whether populations are growing or declining. We will examine how diet, demographic (age and reproductive status), and environmental parameters (winter severity and terrain variables) in late winter vary with body protein loss. Protein loss will be evaluated with isotopic measures of nitrogen metabolites in blood, snow urine, and feces. We are using blood samples from 160 adult female caribou of known reproductive status and age in the Denali herd across 12 years (1993-2005) to assess relationships between protein status and demographic or environmental parameters. These analyses will set the context for estimates of protein status using excreta collected

from four Alaskan caribou herds from 2006–2008. To date, we have collected 1,060 excreta samples (feces and snow urine) from the winter ranges of the Western Arctic, Central Arctic, Denali, and Chisana caribou herds. We have refined protocols for isolation and isotopic analysis of metabolites in excreta. We are continuing to develop the protocol for analyses of urea in blood. We predict that variation in all factors (diet, demography, and environment) will affect the protein status of female caribou. Specifically, we predict that severe winters will limit the resources (body protein) available for production of offspring, and this limitation will be evident in our isotopic measure of nutritional status. Climate changes in arctic and subarctic systems may increase the likelihood of more severe winters for caribou by affecting the type and timing of precipitation (e.g., rain-on-snow events in March and April) and, therefore, altering food availability. Management agencies need non-invasive tools to help predict how caribou populations may change in "warming" northern systems. This research will refine and provide a hands-off method to assess nutritional changes in Alaskan caribou herds.

Ongoing Ecological Studies

Wildfire Consumption of Ground-Layer Organic Matter in North American Boreal Forests and Peatlands: Implications for Atmospheric Trace Gas Emissions and Long-term Soil Carbon Storage

Postdoctoral Researcher: Shuhua Yi
Faculty: A. David McGuire
Funding Agency: NASA through the University of Maryland

One of the greatest uncertainties in modeling carbon cycling in boreal forests is the level of surface fuel consumption (SFC) that occurs during fires. The deep ground-layer of organic matter present in many boreal forests (consisting of litter, lichen, mosses, dead woody debris and organic soil) frequently burns during fire. The amount of carbon released directly to the atmosphere from SFC ranges between 5 and > 60 t C ha^{-1}. The spatial and temporal factors controlling variations in SFC require additional research. Researchers at the University of Maryland and Michigan State University have conducted field studies to evaluate the role of landscape characteristics (topography, soil texture, and presence/absence of permafrost) and climatic processes (seasonal weather patterns controlling fuel moisture and fire behavior and inter- and intra-annual climate patterns controlling seasonal permafrost thaw and drought) in controlling surface fuel consumption during individual fire events. We have incorporating the improved understanding from the field studies into the Terrestrial Ecosystem Model (TEM) to examine how recent increases in fire activity in interior Alaska are influencing the terrestrial carbon budget based on variations in assumptions concerning seasonal variations in area burned and surface fuel consumption. A postdoctoral researcher (Dr. Shuhua Yi) has modified the structure of TEM to better consider these issues. A dynamic soil layer structure has been implemented into TEM to investigate the effects of organic layer on soil temperature, moisture, and carbon dynamics. The modified version of TEM consists of four modules, i.e. environmental, ecological, disturbance and dynamic soil layer module. The environmental module calculates the water and radiation fluxes among atmosphere, canopy, snow and soil, and the simultaneous thermal and hydrological dynamics within soil layers. The modified TEM was tested on a tundra burn site and two black spruce fire chronosequences. Results showed that model can reasonably simulate evapotranspiration, soil temperature and soil moisture, and active layer depth was sensitive the thickness of organic layer. The ecological module of TEM has been validated using data from two black spruce fire chronosequences in interior Alaska. The model has been used to simulate historical carbon dynamics of black spruce forests in the Yukon River Basin. In comparison to previous versions of TEM, the new version of TEM provides the capability to better estimate fire emissions and subsequent carbon dynamics across landscapes in interior Alaska.

Synthesis of Arctic System Carbon Cycle Research Through Model-Data Fusion Studies Using Atmospheric Inversion and Process-Based Approaches

Postdoctoral Researcher: Daniel Hayes
Faculty: A. David McGuire
Funding Agency: NSF

A large release of carbon dioxide and methane from high latitude terrestrial and marine systems to the atmosphere has the potential to affect the climate system in a way that may accelerate global warming. To improve our ability to predict the

dynamics of carbon in high latitudes, this project will comprehensively analyze the carbon cycle of the arctic system, guided by the following two general questions: (1) What are the geographic patterns of fluxes of carbon dioxide and methane over the Pan-Arctic region and how is the balance changing over time; and (2) What processes control the sources and sinks of carbon dioxide and methane over the Pan-Arctic region and how do the controls change with time? To address these general questions, the project is integrating data on carbon dioxide and methane dynamics of the Arctic System using a combination of prognostic and inverse approaches to provide an integrative approach to estimating and understanding the exchanges of carbon dioxide and methane from terrestrial and marine components of the system. This study has brought together diverse regional data sets and understanding in the context of a linked set of numerical model studies, and is examining, and attempting to quantify, the fluxes and links between the terrestrial, atmospheric and oceanic components of the Arctic carbon and methane cycles. A postdoctoral researcher, Dr. Daniel Hayes, has conducted a series of historical simulations with the Terrestrial Ecosystem Model (TEM) for diagnosis and attribution of the response of arctic system C dynamics to recent changes in atmospheric chemistry, climate and disturbance regime. The results of the simulations suggest a shift in direction of the net flux from the terrestrial sink of earlier decades to a net source on between 1997 and 2006. The positive C balance (sink) estimated for tundra regions is consistent with observations suggesting a "greening" of, or an increase in productivity in, these ecosystems. However, the overall shift in regional C balance primarily to a large loss of carbon as a result of "browning" in boreal forest ecosystems. In addition to drought-induced declines in productivity, the substantial release of CO_2 as a direct result of the large area of boreal forest burned during the past decade was the largest signal in the overall negative carbon balance for the pan-arctic region. Our results emphasize the importance of changes in the disturbance regime (e.g., fire events and insect outbreaks) in lieu of a potential weakening, or disappearance, of the terrestrial C sink in high latitude ecosystems. The results of these simulations are being provided to other project components, and a model-data synthesis of all components is being undertaken for developing a comprehensive, contemporary C budget for the Arctic system.

Snow Cover and Biology in the Arctic

Research Associate: Eugénie Euskirchen
Faculty: A. David McGuire
Funding Agency: NSF

In terrestrial high-latitude regions, observations indicate recent changes in snow cover, permafrost, soil freeze-thaw transitions, and fire due to climate change. The responses of high latitude ecosystems to these changes may have consequences for the climate system. In the first study funded by this project (*Euskirchen et al., Global Change Biology, 2006*), we successfully simulated these changes and related them to changes in growing season length, productivity and net carbon uptake in extratropical regions (30°-90° N) for the period 1960 - 2100. We have conducted three follow-up studies. In the first follow-up study (*Euskirchen et al., Global Change Biology, 2007*) we found that increases in snow cover-climate feedbacks during 1970-2000 were nearly three times larger than during 1910-1940 because the recent snow-cover change occurred in spring, when radiation load is highest, rather than in autumn. These changes in energy exchange warrant careful consideration in studies of climate change, particularly with respect to associated changes in

vegetation cover. In the second follow-up study (*Euskirchen et al., in press*), we developed a new version of the Terrestrial Ecosystem Model (TEM, version 7.0) to include a dynamic vegetation component with competition among plant functional types for nitrogen and light. We performed model simulations for the years 2002–2100 under nine future climate scenarios for a region in northern Alaska extending from the ecotonal boreal forest to the Arctic Ocean. Our analysis indicates that the net primary productivity of the dominant plant functional types will increase to cause a decrease in summer albedo, leading to an overall atmospheric heating effect. However, this heating effect was smaller than that due to changes in the snow season, including both the melting of snow in the spring and the return of snow in the autumn. In the third follow-up study we examined how climate change effects on both fire regimes and snow cover duration will influence atmospheric heating effects of high latitude terrestrial ecosystems. Changes in summer heating due to changes in vegetation associated with fire showed a slight cooling effect due to increases in summer albedo. Over this same time period, decreases in snow cover caused a reduction in albedo, and result in a heating effect when holding the vegetation map from 2003 constant. Adding both the summer negative change in atmospheric heating due to changes in fire regimes to the positive changes in atmospheric heating due to changes in the length of the snow season resulted in a 3.4 W m^{-2} $decade^{-1}$ increase in atmospheric heating. These findings highlight the importance of gaining a better understanding of the relative influences of changes in surface albedo on atmospheric heating due to both changes in vegetation and changes in snow cover duration. These studies are generally relevant to climate change policy as they consider multiple ways in which terrestrial ecosystem responses to climate change can influence the climate system.

Assessing the Impacts of Fire and Insect Disturbance on the Terrestrial Carbon Budgets of Forested Areas in Canada, Alaska, and the Western United States

Postdoctoral Researcher: Fengming Yuan
Faculty: A. David McGuire
Funding Agency: USDA

The overall goal of the proposed research is to analyze the impacts of disturbances from insects and fire on the terrestrial carbon budget for the forested ecoregions of Canada, Alaska, and the western U.S. The following objectives will be addressed: (1) develop a consistent bottom-up methodology to estimate carbon consumed during fires; (2) modify a process-based dynamic vegetation/biogeochemistry model to more accurately depict fuel consumption during fires, mortality from fires and insect disturbance, effects of climate and insects on net primary production, and forest succession as a function of disturbance type and severity; and (3) assess the effects of fire/insect disturbance on terrestrial carbon cycling in the boreal and western temperate forests of North American using different modeling approaches. These objectives will be met through using satellite-derived information on the spatial and temporal characteristics of disturbance and recovery after disturbance as inputs for the Terrestrial Ecosystem Model (TEM). We will use satellite information products to map vegetation/fuel types, burned area, seasonality of fires, estimating fire severity, and mapping patterns of vegetation recovery after disturbance. We will update TEM to more accurately depict fuel consumptions in the forest types found in the study region, to account for tree mortality and variations in NPP induced by fire and insects, and to reflect variations in post-fire successions that are caused by

disturbance severity. We will then use TEM to assess the impacts of disturbance in forests on terrestrial cycling. We will compare the carbon estimates generated by TEM to satellite-derived NPP estimates and those from the Canadian Forest Service (CFS) carbon budget model to better understand uncertainties of the different modeling approaches. Our project will include collaborations with CFS scientists working on modeling of the carbon cycle, as well as scientists from the USGS and USFS who have expertise and field observations of fuel consumption during fires. It will aid in the implementation of the Joint North American Carbon Program through the continuation of existing joint research activities between U.S. and Canadian scientists, and reduce terrestrial carbon cycle uncertainties in a significant region of the Northern Hemisphere. We have recently recruited Dr. Fengming Yuan to conduct the research with TEM in this project.

Carbon Responses along Moisture Gradients in Alaskan Landscapes

Student Investigator: Jon O'Donnell, PhD Biology
Advisor: A. David McGuire
Funding Agency: Geologic Division/USGS

The Alaskan interior contains enormous carbon reserves in vegetation and soils. As a result of changing temperatures, we anticipate enhanced releases of carbon dioxide, methane, and dissolved organics to streams and ocean waters. How carbon responds to changing climate will affect carbon dynamics and will likely depend on interactions with soil moisture and permafrost extent, which are quite variable in Alaskan landscapes. To better understand these interactions, PhD student Jon O'Donnell is studying the implications of permafrost degradation on soil carbon (C) accumulation and loss from boreal ecosystems. The primary questions of his research are (1) How does water influence the stability of permafrost in upland and wetland ecosystems, (2) What is the net effect of permafrost degradation on C storage across a range of boreal ecoystems, and (3) What controls C loss from ecosystems where permafrost has degraded? In summer 2007, Jon examined permafrost conditions and C storage across an upland fire chronosequence at Hess Creek and characterized soil samples for bulk density, moisture/ice content, C and nitrogen concentration, and radioisotopes. During fall 2007, he conducted a laboratory experiment to evaluate the effect of soil moisture on thermal conductivity in different organic horizons. Findings from both the field and laboratory studies were presented at the Ninth International Conference on Permafrost held in summer 2008. In summer 2008, Jon examined permafrost conditions and C storage across a bog and fen thaw chronosequence at Koyukuk Flats National Wildlife Refuge and a second upland thaw chronosequence off the Taylor Highway. In fall 2008, Jon used the Terrestrial Ecosystem Model (TEM) to evaluate the potential effects of fire severity and frequency on permafrost and soil C dynamics at the Hess Creek study site. Findings from these studies will be used in conjunction with field measurements of temperature and moisture to refine conceptual models about the vulnerability of permafrost to thaw in response to a warming climate in interior Alaska and the fate of carbon upon thaw of permafrost. The insights from this research have the potential to inform models of C exchange in boreal landscapes.

Assessing the Role of Deep Soil Carbon in Interior Alaska: Data, Models, and Spatial/Temporal Dynamics (RWO 163)

Postdoctoral Researcher: Kris Johnson
Faculty: A. David McGuire
Funding Agency: Geologic Division/USGS

This study involves two efforts to improve the current state of knowledge of soil carbon in Alaska: (1) compilation and synthesis of available existing data in the development of statistical models that will estimate soil carbon storage at 1-km resolution across the landscape based on associations between landscape features and fire history; and (2) incorporation of this information into a biogeochemical modeling framework that can identify how strategies for additional sampling of soil organic carbon will reduce uncertainties in estimating regional carbon dynamics in interior Alaska. Our initial effort was to investigate the porosity, bulk density, and carbon fraction of organic soil horizons within vertical profiles of both mature and young black spruce (*Picea mariana*) stands that we had already compiled for boreal forests in Manitoba, Canada. We found that these properties can be best characterized by the generalized horizon types, as defined by the level of decomposition of the soil. We also found significant differences in thickness of organic soils between mature (>70 yr) and young (<70 yr) stands, and between dry and wet drainage conditions. Based on this analysis, we developed relationships between summed organic carbon content and summed thickness of organic soil layers for three generalized horizon types within two general ecosystem drainages. These relationships appear to provide generalized rules for biogeochemical models that describe spatial and temporal variations in organic soil layers that influence thermal, moisture, and biogeochemical behavior of North American boreal forests. To evaluate the generality of these rules, we have recruited Dr. Kris Johnson to conduct a similar study for interior Alaska. We have organized a workshop that will be held in March 2009 to compile carbon data on soil horizons that have been sampled in Alaska. We will analyze these data to develop statistical models that will allow us to generate maps of soil carbon distribution and uncertainties for interior Alaska. This activity will lead to recommendations for improvements in additional sampling of soil organic carbon that reduce uncertainties in estimating the regional dynamics of soil organic carbon in Interior Alaska. The research we are conducting is providing information that is relevant to the following priority theme that has been identified by the USGS Global Change Science Council: Provide knowledge to reduce the net transport of CO_2 from the biosphere and geosphere to the atmosphere.

Magnitude, Rate, and Heterogeneity of Surface Water Area Changes in National Wildlife Refuges in Interior Alaska

Student Investigator: Jennifer Roach, MS Biology
Advisor: Brad Griffith
Funding Agency: USFWS; USGS

Recent studies have identified substantial losses in surface water area in sub-Arctic boreal regions since 1950, and this trend has been coincident with climate warming in these regions. However, the magnitude, heterogeneity, and mechanisms behind changes in surface water area in Alaskan National Wildlife Refuges are not known. Changes in the amount of surface water in National Wildlife Refuges could alter critical summer breeding and nesting habitats for migratory waterfowl. The objectives of this study are to (1) identify potential mechanisms causing changes in surface water area and (2) characterize the magnitude and rate of changes in surface water area in Alaskan National Wildlife Refuges. Possible mechanisms will be identified by comparing field characteristics at lake sites with differential rates of drying in National Wildlife Refuges. The magnitude of surface water changes in nine National Wildlife Refuges will be estimated by comparing aerial photography and satellite imagery from 1950 to present. More extensive floating mat vegetation at drying lakes compared to non-drying lakes in study areas in Yukon Flats, Innoko, and Tetlin National Wildlife Refuges indicates that increased evapotransipration and terrestrialization may be the primary mechanisms behind observed rates of drying in these study areas. Greater surface area to volume ratios at drying lakes indicate that lakes with a shallow basin morphometry may be more susceptible to these drying effects. Changes in the amount of surface water in National Wildlife Refuges could substantially alter critical waterfowl habitat. In addition, terrestrialization and peatland formation could result in an increase in carbon storage on the landscape.

List of Abbreviations

ADFG	Alaska Department of Fish and Game
AKCFWRU	Alaska Cooperative Fish and Wildlife Research Unit
BLM	Bureau of Land Management
CMI	Coastal Marine Institute, UAF
DBW	Department of Biology and Wildlife, UAF
DOE	Department of Energy
GIS	Geographical Information System
IAB	Institute of Arctic Biology, UAF
IMS	Institute of Marine Science, UAF
MMS	Minerals Management Service
NASA	National Aeronautics and Space Administration
NPR-A	National Petroleum Reserve-Alaska
NPS	National Park Service
NSB	North Slope Borough
NSF	National Science Foundation
NWR	National Wildlife Refuge
PI	Principal Investigator
RSA	Reimbursable Services Agreement
RWO	Research Work Order
SFOS	School of Fisheries and Ocean Sciences, UAF
UAF	University of Alaska Fairbanks
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
	BRD Biological Resources Discipline

Photo Captions

Cover Page (left to right):

Aleya Nelson (MS candidate, Biology) uses radiotelemetry equipment to locate the strongest azimuth on a radio-collared Prince of Wales spruce grouse. Photo by Lori Lundin.

Josh Kill (US Forest Service, Pacific Northwest Research Station) marks a cutthroat trout with elastimer for future identification as part of a study on the effects of climate and logging on headwater stream fish in eastern Washington. Photo by Elizabeth Green.

Male Dolly Varden from the HulaHula River, Alaska, immediately after bioelectrical impedance measurements were taken. Photo by Jason Stolarski.

Steffen Oppel (UAF Post-Doctoral Researcher) releases a male King Eider in northern Alaska after capture and banding. Photo by Elizabeth Goldsmith.

Page 21:
Jason Stolarski (PhD candidate, Fisheries) prepares to perform bioelectrical impedance analysis (BIA) of a male Dolly Varden. Photo by Ben Miller.

Page 22:
Elizabeth Green (MS candidate, Biology) and Jake Layman sample fish by electrofishing. Photo by Stan Green.

Page 27:
Male King Eider captured on breeding grounds in northern Alaska. Photo by Steffen Oppel.

Page 31:
Black Tern at nest in western Montana. Photo by Jessica Miller.

Page 32:
Male Smith’s Longspur, Arctic National Wildlife Refuge. Photo by Teri Wild.