Alaska Cooperative Fish and Wildlife Research Unit

Annual Report—2005

July 2006

Alaska Cooperative Fish and Wildlife Research Unit
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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

- Michelle Das: Travel Coordinator
- Karen Enochs: Fiscal Technician
- Kathy Pearse: Administrative Assistant

Unit Students

Current

- Stacia Backensto, PhD Biology (Powell)
- Michael Balshi, PhD Biology (McGuire)
- Colin Beier, PhD Biology (McGuire)
- Elizabeth (Baney) Benolkin, MS Fisheries (Margraf)
- Meagan Boltwood, PhD Biology (Wipfli)
- Jeremy Carlson, MS Fisheries (Margraf)
- Samantha Decker, MS Fisheries (Margraf)
- Elizabeth Green, MS Biology (Wipfli)
- Dave Gregovich, MS Fisheries (Wipfli)
- Christie Hendrich, MS Fisheries (Margraf)
- Deena Jallen, MS Fisheries (Margraf)
- Christopher Latty, MS Wildlife (Powell)
- Andra Love, PhD Fisheries (Margraf)
- Aaron Martin, MS Fisheries (Wipfli)
- Rebecca McGuire, PhD Biology (Powell)
- Bruce Medhurst, MS Biology (Wipfli)
- Cassie Mellon, MS Fisheries (Wipfli)
- John O'Brien, MS Fisheries (Margraf)
- Steffen Oppel, PhD Biology (Powell)
- Lincoln Parrett, MS Biology (Griffith)
- Josh Peirce, MS Wildlife (Wipfli/Follmann)
- Morgan Peterson, MS Marine Biology (Finney)
- Miranda Plumb, MS Fisheries (Margraf)
- Dan Rinella, PhD Biology (Wipfli)
- Jennifer Roach, PhD Biology (Griffith)
- Kathy Smikrud, MS Fisheries (Margraf
- Shelly Szepanski, PhD Biology (Griffith)
- Theresa Tanner, MS Fisheries (Margraf)
- Audrey Taylor, PhD Biology (Powell)
- Jason Valliere, MS Fisheries (Margraf)

- Brad Wendling, MS Wildlife (Griffith)
- Heather Wilson, PhD Biology (Powell)

Graduated (during CY)

- Rachel Jones, MS Wildlife (Griffith)
- Julie Morse, MS Wildlife (Powell)
- Isla Myers-Smith, MS Biology (Chapin/McGuire)
- Jenny Neyme Polloczek, MS Fisheries (Hughes/Margraf)
- Laura Phillips, MS Wildlife (Powell)
- Miranda Terwilliger, MS Biology (Griffith)
- Catharine Copass Thompson, PhD Biology (McGuire)

Post-Doctoral Researchers

- Christopher Binckley (Wipfli)
- Monika Calef (McGuire)
- Eugénie Euskirchen (McGuire)

Faculty Cooperators

- R. Terry Bowyer, Department of Biological Sciences, Idaho State University, Pocatello
- Loren Buck, School of Fisheries and Ocean Sciences (SFOS), Fisheries Industrial Technology Center, UAF, Kodiak
- F. Stuart Chapin III, Department of Biology and Wildlife (DBW), Institute of Arctic Biology (IAB), UAF
- Bruce Finney, Marine Science and Limnology/Institute of Marine Science (IMS), UAF
- Erich Follmann, IAB/DBW, UAF
- Gordon Haas, SFOS and UA Museum, Fairbanks
- Falk Huettmann, DBW/IAB, UAF
- Nicholas Hughes, SFOS, UAF
- Gordon Kruse, SFOS, UAF
- Mark Lindberg, DBW/IAB, UAF
- Daniel Mann, IAB, UAF
- C. Peter McRoy, IMS, UAF
- Edward Murphy, DBW/IAB, UAF
- Eric Rexstad, University of Edinburgh, Scotland
- James Reynolds, Emeritus UAF
- Scott Rupp, Forest Sciences Department, UAF
- Kevin Winker, UA Museum/DBW/IAB, UAF

Affiliated Students

Current

- Blair French, MS Wildlife (Follmann)
- Brook Gamble, MS Wildlife (Buck/Murphy)
- Thomas Kurkowski, MS Natural Resource Management (Rupp/Mann)

- Kate Martin, MS Wildlife (Lindberg)
- Brandt Meixell, MS Biology (Lindberg)
- Susan Oehlers, MS Wildlife (Bowyer/Huettmann)
- Morgan Peterson, MS Biological Oceanography (Finney)
- Joy Ritter, MS Wildlife (Rexstad/Huettmann)

Graduated (during CY)

- Bryce Lake, MS Wildlife (Lindberg)
- David Safine, MS Wildlife (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
- Rowan Gould–Director, Region 7, US Fish and Wildlife Service
- 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 2005. The Unit engages in research on living natural resources for a variety of State and Federal agencies. As an unbiased research organization, the Unit provides information requested and funded by these agencies. When studies are completed, the agencies use the information to assist in their natural resource management efforts. Most of the research is conducted by graduate students, many of whom go on to work for the agencies upon graduation.

The Alaska Unit was established in 1950, providing over half a century of research dedicated to helping conserve and enhance the living natural resources of the State and the Arctic Region. The Unit is part of a larger and even older program, the U.S. Department of the Interior's Cooperative Research Unit Program. Established in 1935, Cooperative Research Units were created to fill the vacuum of wildlife management information and the shortage of trained wildlife biologists. In 1960, the Unit Program was formally sanctioned by Congress with the enactment of the Cooperative Units Act. Each unit is a partnership among the Biological Research Division of the U.S. Geological Survey, a State fish and game agency, a host university, and the Wildlife Management Institute. Staffed by Federal personnel, Cooperative Research Units conduct research on renewable natural resource questions; participate in the education of graduate students destined to become natural resource managers and scientists; provide technical assistance and consultation to parties who have legitimate interests in natural resource issues; and provide continuing education for natural resource professionals.

Presently, there are 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: 9
Presentations: 44
Scientific and Technical Publications: 15

Graduate Committee Assignments

- Richard Bernhardt, PhD (Margraf)
- Thomas Braille, PhD (Powell)
- Karen Clyde-Lien, MS (Griffith)
- Nathan Coutsoubos, PhD (Powell)
- Tom Dempsey, MS (Powell)
- Paul Duffy, PhD (McGuire)
- Greg Finstead, PhD (Griffith)
- Nancy Fresco, PhD (McGuire)
- Elizabeth Green, MS (Margraf)

- Dave Gregovich, MS (Margraf)
- Ron Heintz, PhD (Wipfli)
- Dawn Magness, PhD (McGuire)
- Kate Martin, MS (Powell)
- Bruce Medhurst, MS (Margraf)
- Kevin Petrone, PhD (McGuire)
- Miranda Plumb, MS (Wipfli)
- Brian Riordan, MS (McGuire)
- Shann Jones, MS (Wipfli)
- David Shaw, MS (Powell)
- Garrett Staines, MS (Margraf)
- Mark Stichert, MS (Wipfli)
- Tumi Traustason, PhD (McGuire)
- Jason Vogel, PhD (McGuire)
- Johann Walker, MS (Powell)
- James Walton, MS (McGuire)
- Sherri Wall, PhD (McGuire)
- Heidi Weigner, PhD (Margraf)
- Lijie Zhu -PhD (McGuire)

Courses Taught

- Research Design (Griffith, 2 credit hours, Fall 2005)
- Contemporary Issues in Fisheries Science (Margraf, 1 credit hour, Spring 2005)
- Independent Study (Margraf, 3 credit hours, Spring 2005)
- Ecological Background for Resilience and Adaptation (McGuire, 1 credit hour, Fall 2005)
- Ornithology (Powell, 4 credit hours, Spring 2005)
- Freshwater Foodwebs (Wipfli, 3 credit hours, Fall 2005)

Guest Lectures

- Caribou, climate and development in the Arctic National Wildlife Refuge. Presented to Wildlife 101, Survey of Wildlife Science, UAF, Spring 2005 (Griffith)
- Experiences at the interface between biological research and public policy in the 21st century. Presented to Anthropology 694, Adaptive Management, UAF, Spring 2005 (Griffith)
- Determining proximate composition of live fish using Bioelectrical Impedance Analysis. Presented to Fisheries Management class, SFOS, UAF, Fall 2005 (Margraf).
- How do we study migratory birds? Presented to Wildlife 101, DBW, UAF, Spring 2005 (Powell)

University Committees and Workgroups

- Affiliate Faculty, Institute of Social and Economic Research, University of Alaska Anchorage, 18 April 2005 (Griffith)
- Co-Chair, Research Advisory Committee, IAB, UAF (Griffith)
- Member, Faculty of the Future program planning committee, SFOS, UAF (Margraf)
- Member, Faculty Search Committee, Undergraduate Program Director for Fisheries (Margraf)
- Member, Executive Committee for the Regional Resilience and Adaptation Interdisciplinary Graduate Program, UAF (McGuire)
- Member, Leadership Committee for Bonanza Creek Long-Term Ecological Research Program (McGuire)
- Member, Master's Comprehensive Exam Committee, DBW, UAF (Powell)
- Member, Space Committee, Coop Unit Representative, IAB, UAF (Powell)
- Member, Search Committee for Assistant/Associate Professor in Quantitative Ecology, DBW/IAB, UAF (Powell)
- Member, Video Conferencing Committee, SFOS, UAF (Wipfli)

Editorships

- A. D. McGuire, Member, Board of Editors for *Ecological Applications*
- A. D. McGuire, Guest Editor for special issue of *Canadian Journal of Forest Research* associated with the 2004 Fairbanks meeting of the International Boreal Forest Association
- A. D. McGuire, Guest Editor for special issue of *Mitigation and Adaptation Strategies for Global Change* associated with the 2004 Fairbanks meeting of the International Boreal Forest Association

Invited Seminars

- Marine Subsidies in Riverine Ecosystems: Returning Salmon Fuel Freshwater and Riparian Food Webs. Given at University of Alaska Anchorage, March 5, 2004 (Wipfli)
- Marine-Derived Nutrients in Freshwater Ecosystems: Implications for Restoration. Given at Oregon State University and US Environmental Protection Agency, February 11, 2004 (Wipfli)

Non-Society Memberships

- Member, International Union for the Conservation of Nature and Natural Resources, Species Survival Commission (Griffith)
- North American Representative, Arctic Ungulate Society (Griffith)
- Member, Technical Advisory Team for Peer Review for U.S. Fish and Wildlife Service, Region 7, Refuges, Technical Advisory Team (Margraf)
- Member, Fisheries: Aquatic and Endangered Resources Advisory Committee, USGS, BRD (Margraf)

- Member, Technical Advisory Team for Fisheries for U.S. Fish and Wildlife Service, Region 7, Refuges Technical Advisory Team (Margraf)
- Member, Science Steering Committee for the Arctic Community-wide Hydrological Analysis and Monitoring Program (Arctic-CHAMP), a program supported through the Arctic System Science (ARCSS) Activity of the National Science Foundation (McGuire)
- Member, Science Steering Committee for the Study of Environmental Arctic Change (SEARCH), a research activity supported through several federal agencies (McGuire)
- Member, Science Steering Committee for the Community Arctic Modeling Project (CAMP), a project operated through the International Arctic Research Center (IARC), as part of a cooperative agreement between the University of Alaska Fairbanks and the National Science Foundation (McGuire)
- Member, Carbon Cycle Science Steering Group to provide advice to the Carbon Cycle Interagency Working Group of the U.S. Climate Change Science Program (McGuire)
- Member, Working Group 8 (Terrestrial Biosphere and Biodiversity) of the Second International Conference of Arctic Research Planning (ICARP II) to be held in November 2005 (McGuire)
- Member, Boreal Partners in Flight Task Force (Powell)
- Board Member, Scientific Advisory Committee, Alaska Bird Observatory (Powell)

Honors and Awards

- Thesis Completion Fellowship awarded to Heather Wilson, May 20, 2005, by the University of Alaska Graduate School
- Clarence J. Rhode Scholarship for the 2005-2006 Academic Year awarded to Miranda Plumb
- Graduate School Travel Grant awarded to Miranda Plumb, May 19, 2005, by the University of Alaska
- Angus Gavin Migratory Bird Research Grant awarded to Audrey Taylor by the University of Alaska Foundation

Outreach and Info Transfer

- Inconvenient answers: Experiences at the interface between biological research and public policy. Invited presentation to the All Hands Meeting, Cooperative Research Units, USGS, Jacksonville, FL, 3 March 2005 (Griffith)
- Remote sensing tools for assessing large scale habitat quality for ungulates. Invited presentation at the Terrestrial Scoping Workshop, Arctic Network, National Park Service, Fairbanks, AK, 27 March 2005 (Griffith)

- Member, Advisory Council, Wolong National Nature Reserve, Sichuan, China. Consultant on the reintroduction of Giant Pandas to the wild, 20-29 October 2005 (Griffith)
- Evidence of recent climate change in terrestrial regions of Alaska. Invited presentation to the Bureau of Land Management, Fairbanks, AK, 18 May 2005. (McGuire)
- USGS Workshop to Develop Draft Initiative for a 5-Year Plan to Study Terrestrial and Freshwater Interactions with Changing Climate in the Yukon River Basin of Interior Alaska, August 29–September 1, 2005, University of Alaska Fairbanks (McGuire)
- "Study says ravens thriving in Alaska oil fields", Reuters News Service, (http://www.planetark.com/dailynewsstory.cfm/newsid/29993/newsDate/18-Mar-2005/story.htm) (Powell)
- "UAF's most wanted birds", by Jennifer Miller, UAF Sun Star (http://www.uaf.edu/sunstar/archives/20050412/birds.htm) (Powell)
- Foraging ecology of common ravens on Alaska's North Slope – this study gets considerable press and stories have appeared in newspapers throughout the world: "Ravens interactions with oil rigs studied", by Dan Joling, Associated Press (http://www.enn.com/today.html?id=6946) (Powell)
- Radio – "Alaska's oil field ravens", Arctic Science Journeys (http://www.ualedu/seagrant/NewsMedia/05ASJ/04.01.05oil-ravens.html) (Powell)
- Web Site developed showing locations for king eider satellite telemetry study: http://mercury.bio.uaf.edu/kingeider (Powell)

Papers Presented

Backensto, S., A. Powell, C. Gerlach, and G. Kofinas. March 2005. Foraging ecology of Common Ravens (*Corvus corax*) on Alaska's Coastal Plain and its relationship to oil and gas development. Tenth Annual MMS Information Transfer Meeting, Anchorage, AK.

Calef, M. P., A. D. McGuire, F. S. Chapin, and La'Ona DeWilde. August 2005. The human footprint on wildfire in the boreal forest of interior Alaska. Annual Meeting, Ecological Society of America, Montreal, Canada.

Euskirchen, S. E., A. D. McGuire, D. W. Kicklighter, Q. Zhuang, J. S. Clein, R. J. Dargaville, D. G. Dye, J. S. Kimball, K. C. McDonald, J. M. Melillo, V. E. Romanovsky, and N. V. Smith. September 2005. Importance of recent shifts in soil thermal dynamics on growing season length, productivity, and carbon sequestration in terrestrial high-latitude ecosystems. Seventh International Carbon Dioxide Conference, Boulder, CO.

Joyce, L. A., A. D. McGuire, D. P. Coulson, J. Clein, and T. Burnside. September 2005. Historical changes in carbon storage of the eastern United States: Uncertainties associated with forest harvest and agricultural land use activities. Seventh International Carbon Dioxide Conference, Boulder, CO.

Kicklighter, D. W., J. M. Melillo, R. G. Prinn, A. D. McGuire, B. S. Felzer, and Q. Zhuang. August 2005. Relative importance of multiple stresses on

terrestrial carbon sequestration. Annual Meeting, Ecological Society of America, Montreal, Canada.

Knoche, M., A. N. Powell, P. Barboza, M. Wooller, and L. Quakenbush. January 2005. New insights into the molt migration of female King Eiders from stable carbon and nitrogen isotope analyses. Annual Meeting, Pacific Seabird Group/Waterbird Society Meeting, Portland, OR.

Lake, B., M. Lindberg, J. Schmutz, C. Ely, M. Anthony, W. Eldridge, and F. Broerman. January 2005. Spatial and temporal variation in body mass of prefledging emperor geese: Effects of interspecific goose densities and grazing lawn availability. North American Arctic Goose Conference, Reno, NV.

Lindberg, M. S. March 2005. Breeding ecology and survival of ducks in the boreal forest of Alaska. Pacific Flyway Conference, Otter Rock, OR.

McGuire, A. D. August 2005. Modeling responses of high latitude terrestrial ecosystems to global change. Annual Meeting, Ecological Society of America, Montreal, Canada.

McGuire, A. D. and the IGBP High Latitude Transect Working Group. April 2005. Responses of high latitude ecosystems to global change: Potential consequences for the climate system. Annual Meeting, European Geophysical Union, Vienna, Austria. Invited.

McGuire, R. and A. Powell. January 2005. Incubation behavior of king eiders on the North Slope of Alaska. Annual Meeting, Pacific Seabird Group/Waterbird Society Meeting, Portland, OR.

McGuire, R., A. Powell, and R. Suydam. November 2005. Incubation behavior of king eiders on Alaska's coastal plain. Second North American Sea Duck Conference, Annapolis, MD.

McGuire, R., A. Powell, and R. Suydam. March 2005. Breeding biology and habitat use of King Eiders on the coastal plain of northern Alaska. Tenth Annual MMS Information Transfer Meeting, Anchorage, AK.

Mellon, C. D., M. S. Wipfli, and J. L. Li. May 2005. Wildfire and headwater stream productivity: Effects of intense fire on food subsidies to downstream and riparian habitats in eastern Washington. American Geophysical Union/North American Benthological Society Joint Assembly Conference, New Orleans, LA.

Morse, J. A., A. N. Powell, and M. Tetreau. July 2005. The effects of recreational disturbance on beach nesters: A case study of the black oystercatcher in Alaska. Nineteenth Annual Meeting, Society for Conservation Biology, Universidade de Brasilia, Brazil.

Myers-Smith, I. H., A. D. McGuire, J. W. Harden, and F. S. Chapin. August 2005. The influence of disturbance on carbon exchange and succession in a permafrost collape. Annual Meeting, Ecological Society of America, Montreal, Canada.

O'Brien, J. P. and F. J. Margraf. February 2005. A habitat-based escapement for chum salmon in the Tuluksak River, Western Alaska. Pink and Chum Salmon Workshop, Ketchikan, AK.

O'Brien, J. P. and F. J. Margraf. September 2005. A spawning habitat-based escapement goal for chum salmon in the Tuluksak River, Southwestern Alaska. Annual Meeting, American Fisheries Society, Anchorage, AK.

Phillips, L. M. and A. N. Powell. October 2005. Use of the Beaufort Sea by king eiders. Twenty-ninth Waterbird Society Meeting, Jeckyll Island, GA.

Phillips, L. and A. N. Powell. January 2005. Large-scale movements and habitat use of King Eiders throughout the nonbreeding season. Annual Meeting, Pacific Seabird Group/Waterbird Society Meeting, Portland, OR.

Phillips, L., A. Powell, E. Taylor. March 2005. Use of the Beaufort Sea by King Eiders. Tenth Annual MMS Information Transfer Meeting, Anchorage, AK.

Phillips, L. M., A. N. Powell, and E. Taylor. November 2005. Use of the Beaufort Sea by king eiders. Second North American Sea Duck Conference, Annapolis, MD.

Phillips, L.M., A. N. Powell, and R. Rexstad. November 2005. Large scale movements and habitat characteristics of king eiders throughout the nonbreeding season. Second North American Sea Duck Conference, Annapolis, MD.

Plumb, M. and F. J. Margraf. September 2005. Distribution of resident salmonids in the Ugashik Lakes in Southwestern Alaska. Annual Meeting, American Fisheries Society, Anchorage, AK.

Powell, A. N. and S. A. Backensto. March 2005. Foraging ecology of common ravens (*Corvus corax*) on Alaska's coastal plain. CMI Annual Research Review, University of Alaska Fairbanks.

Powell, A. N., E. Rexstad, E. Taylor, and L. Phillips. March 2005. Importance of the Beaufort Sea to king eiders (*Somateria spectabilis*). CMI Annual Review, University of Alaska Fairbanks.

Powell, A. N., R. Suydam, and R. McGuire. March 2005. Breeding biology and habitat use of king eider on the coastal plain of northern Alaska. CMI Annual Research Review, University of Alaska Fairbanks.

Powell, A. N. and A. Taylor. March 2005. Pre-migratory movements and physiology of shorebirds staging on Alaska's North Slope. CMI Annual Review, University of Alaska Fairbanks.

Rinella, D. J., M. S. Wipfli, C. Walker, and C. A. Stricker. May 2005. Marine-derived nutrients (MDN) in riverine ecosystems: Developing monitoring tools for tracking MDN in Alaska watersheds. American Geophysical Union/North American Benthological Society Joint Assembly Conference, New Orleans, LA.

Rinella, D. J., M. S. Wipfli, C. Walker, and C. A. Stricker. January 2005. Tracking marine-derived nutrients in riverine ecosystems in Alaska. Exxon Valdez Oil Spill Trustee Council Symposium, Anchorage, AK.

Rosenberger, A. E., J. B. Dunham, M. S. Wipfli, and J. M. Buffington. May 2005. Effects of fire and subsequent channel-reorganizing events on invertebrate drift and rainbow trout diet in small headwater streams 10 years post-disturbance. American Geophysical Union/ North American Benthological Society Joint Assembly Conference, New Orleans, LA.

Russell, D. E., G. P. Kofinas, B. Griffith, and R. G. White. September 2005. Assessing the impacts of oil and gas development on wild *Rangifer* herds: Data requirements, assessment tools, and monitoring initiatives. Seventh International Conference and Exhibition of Offshore Oil and Gas Development—*RAO/CIS Offshore 2005.* International Symposium on Oil and Gas Activities in the Arctic, St. Petersburg, Russia.

Safine, D. E. and M. S. Lindberg. November 2005. Breeding ecology of white-winged scoters on the Yukon Flats National Wildlife Refuge, Alaska. Second North American Sea Duck Conference, Annapolis, MD.

Smikrud, K. M. and F .J. Margraf. September 2005. A remote sensing approach to detect potential salmon rearing habitat in the Unuk River, Southeast Alaska. Annual Meeting, American Fisheries Society. Anchorage, AK.

Szepanski, M. and B. Griffith. May 2005. Nutritional capacity of moose winter habitats in Alaska. Forty-first North American Moose Conference and Workshop, Whitefish, MT.

Taylor, A. R., A. N. Powell, R. B. Lanctot, T. D. Williams, and A. S. Kitaysky. January 2005. Using physiology to predict staging behavior of post-breeding shorebirds on Alaska's North Slope. Annual Meeting, Pacific Seabird Group/Waterbird Society Meeting, Portland, OR.

Turetsky, M., J. Harden, A. D. McGuire, and E. Kasischke. August 2005. Altered hydrology in boreal peatlands: Pervasive drought and the erosion of carbon stocks in high latitudes. Annual Meeting, Ecological Society of America, Montreal, Canada.

Walker, C., D. J. Rinella, M. S. Wipfli, and C. A. Stricker. April 2005. Tracking marine-derived nutrients in Alaska watersheds. State of the Salmon Conference, Anchorage, AK.

Walker, J. and M. S. Lindberg. November 2005. Sample size considerations for the use of satellite telemetry in avian research. Second North American Duck Conference, Annapolis, MD.

Wilson, H. M., T. L. Moran, P. L. Flint, and A. N. Powell. January 2005. Productivity of Pacific common eiders on the Yukon-Kuskokwim Delta, Alaska. Annual Meeting, Pacific Seabird Group/Waterbird Society Meeting, Portland, OR.

Wilson, H., A. N. Powell, P. Flint, and T. Moran. November 2005. Population dynamics of Pacific common eiders on the Yukon-Kuskokwim Delta, Alaska. Second North American Sea Duck Conference, Annapolis, MD.

Wipfli, M. S. September 2005. Predicted influence of environmental change on nutrient and energy flow in salmonid food webs in Alaska and the Pacific Northwest. Annual Meeting, American Fisheries Society, Anchorage, AK.

Wipfli, M. S. May 2005. Spatial subsidies in riverine food webs: consequences of disturbance and environmental change for stream fishes in Alaska and the Pacific Northwest. American Geophysical Union/North American Benthological Society Joint Assembly Conference, New Orleans, LA.

Zhuang, Q., J. M. Melillo, B. S. Felzer, D. W. Kicklighter, A. D. McGuire, A. Sokolov, R. G. Prinn, M. C. Sarofim, P. A. Steudler, and S. Hu. August 2005. Modelling CH4 and CO2 fluxes in northern high latitudes under contemporary climate conditions. Annual Meeting, Ecological Society of America, Montreal, Canada.

Scientific Publications

Apps, M. A. and A. D. McGuire. 2005. Climate-Disturbance Interactions in Boreal Forest Ecosystems. Peer-reviewed papers selected from the International Boreal Forest Research Association Conference, Fairbanks, AK, May 3-6, 2004. Canadian Journal of Forest Research 35:2073-2293.

Beringer, J., F. S. Chapin, C. C. Thompson, and A. D. McGuire. 2005. Surface energy exchanges along a tundra-forest transition and feedbacks to climate. Agricultural and Forest Meteorology 131(3-4):143-161.

Calef, M. P., A. D. McGuire, H. E. Epstein, T. S. Rupp, and H. H. Shugart. 2005. Analysis of vegetation distribution in interior Alaska and sensitivity to climate change using a logistic regression approach. Journal of Biogeography 32:863-878.

Cameron, R. D., W. T. Smith, R. G. White, and B. Griffith. 2005. Central Arctic caribou and petroleum development: Distributional, nutritional and reproductive implications. Arctic 58(1):1-9.

Hedrick, J. D., L. R. Hedrick, and F. J. Margraf. 2005. A sampler for capturing larval and juvenile Atlantic menhaden. North American Journal of Fisheries Management 25:245-250.

Hernandez, O., R. W. Merritt, and M. S. Wipfli. 2005. Benthic invertebrate community structure in headwater streams is influenced by forest succession after clearcut logging in southeastern Alaska. Hydrobiologia 533:45-59.

Hicks, B. J., M. S. Wipfli, D. W. Lang, and M. E. Lang. 2005. Marine-derived nitrogen and carbon in freshwater-riparian food webs of the Copper River Delta, southcentral Alaska. Oecologia 144:558-569.

Hinzman, L. D., N. D. Bettez, W. R. Bolton, F. S. Chapin, M. B. Dyurgerov, C. L. Fastie, D. B. Griffith, R. D. Hollister, A. Hope, H. P. Huntington, A. Jensen, G. J. Jia, T. Jorgenson, D. L. Kane, D. R. Klein, G. Kofinas, A. H. Lynch, A. H. Lloyd, A. D. McGuire, F. E. Nelson, W. C. Oechel, T. E. Osterkamp, C. H. Racine, V. E. Romanovsky, R. S. Stone, D. A. Stow, M. Sturm, C. E. Tweedie, G. L. Vourlitis, M. D. Walker, D. A. Walker, P. J. Webber, J. M. Welker, K. S. Winker, and K. Yoshikawa. 2005. Evidence and implications of recent climate change in northern Alaska and other arctic regions. Climatic Change 72(3):251-298. DOI: 10.1007/s10584-005-5352-2.

Maier, J. A. K., J. M. Ver Hoef, A. D. McGuire, R. T. Bowyer, L. Saperstein, and H. A. Maier. 2005. Distribution and density of moose in relation to landscape characteristics: Effects of scale. Canadian Journal of Forest Research 35:2223-2243. doi: 10.1139/X05-123

Walker, J. and M. S. Lindberg. 2005. Survival of scaup ducklings in the boreal forest of Alaska. Journal of Wildlife Management 69:574-581.

Walker, J., M. S. Lindberg, M. C. MacCluskie, M. J. Petrula, and J. S. Sedinger. 2005. Nest survival of scaup and other ducks in the boreal forest of Alaska. Journal of Wildlife Management 69:592-600.

Wipfli, Mark S. 2005. Trophic linkages between headwater forests and downstream fish habitats: Implications for forest and fish management. Landscape and Urban Planning 72:205-213.

Zhuang, Q., V. E. Romanovsky, and A. D. McGuire. 2001. Incorporation of a permafrost model into a large-scale ecosystem model: Evaluation of temporal and spatial scaling issues in simulating soil thermal dynamics. Journal of Geophysical Research--Atmospheres 106:33,649-33, 670.

Technical Publications of Federal Staff

Powell, A. N., L. M. Phillips, E. A. Rexstad, and E. J. Taylor. 2005. Importance of the Beaufort Sea to king eiders (*Somateria spectabilis*). Final Report, Coastal Marine Institute, University of Alaska Fairbanks.

Powell, A. N., R. Suydam, and R. L. McGuire. 2005. Breeding biology of king eiders on the coastal plain of northern Alaska. Final Report MMS #2005-060, Coastal Marine Institute, University of Alaska Fairbanks.

Theses and Dissertations of Unit Graduate Students

Jones, Rachel R. 2005. Daily heterogeneity in habitat selection by the Porcupine Caribou Herd during calving. MS Thesis, University of Alaska Fairbanks. 91 pp.

Morse, Julie A. 2005. Effects of recreational disturbance on breeding black oystercatchers: Species resilience and conservation implications. MS Thesis, University of Alaska Fairbanks. 61 pp.

Myers-Smith, Isla H. 2005. Carbon exchange and permafrost collapse: Implications for a changing climate. MS Thesis, University of Alaska Fairbanks. 67 pp.

Neyme, Jenny L. 2005. Environmental and evolutionary processes affecting population dynamics and life-history of Arctic grayling in western and interior Alaska. MS Thesis, University of Alaska Fairbanks. 61 pp.

Phillips, Laura M. 2005. Migration ecology and distribution of king eiders. MS Thesis, University of Alaska Fairbanks. 84 pp.

Terwilliger, Miranda L. N. 2005. Population and habitat analyses for Dall's sheep (*Ovis dalli*) in Wrangell-St. Elias National Park and Preserve. MS Thesis, University of Alaska Fairbanks. 153 pp.

Thompson, Catharine C. 2005. Vegetation-climate interactions along a transition from tundra to boreal forest in Alaska. PhD Thesis, University of Alaska Fairbanks. 82 pp.

Theses and Dissertations of Affiliated Graduate Students

Lake, Bryce C. 2005. Factors affecting body mass of prefledging emperor geese. MS Thesis, University of Alaska Fairbanks. 89 pp.

Safine, David E. 2005. Breeding ecology of white-winged scoters on the Yukon Flats, Alaska. MS Thesis, University of Alaska Fairbanks. 103 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

Environmental and Evolutionary Differences in Population Dynamics and Life History Traits of Western and Interior Arctic Grayling

Student Investigator: Jenny Neyme, MS Fisheries
Advisor: F. Joseph Margraf and Nicholas Hughes
Funding Agency: Sport Fish Division/ADFG, Region III
In-Kind Support: Vehicle, technical assistance and equipment provided by ADFG during field season

Note: Jenny Neyme graduated from the University of Alaska Fairbanks in August 2005. Her thesis abstract follows:

I compared the life-history and population dynamics of Arctic grayling *Thymallus arcticus* in Western and Interior Alaska. Fish in Western Alaska grew rapidly to a large maximum size, adult mortality rates were low and juvenile mortality rates were high. As a result, Western populations consisted mainly of larger, older fish. Fish in Interior streams grew more slowly to a smaller maximum size, adult mortality rates were higher and juvenile mortality rates lower than in Western streams. As a result, Interior populations consisted mainly of smaller, younger fish. The relationship between body size and ovary mass was similar between regions, but Interior fish allocated a greater proportion of their annual energy budget to reproduction.

I also used a foraging model to test the hypothesis that regional differences in drift-feeding opportunities were responsible for faster growth and larger size in Arctic grayling in Western Alaska and to determine the relative contribution of invertebrate drift density and physical habitat characteristics to regional differences in profitability. The model predicted that drift-feeding would be more profitable in Western Alaska and that regional differences in invertebrate drift density and size composition were responsible for this difference.

Ongoing Aquatic Studies

Ecological Factors Influencing Fish Distribution in a Large Subarctic Lake System

Student Investigator: Miranda Plumb, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: USFWS (RWO 111)

The coastal climate in southwest Alaska creates an atypical thermal environment (non-stratified in summer) in the remote Ugashik Lakes. The objective of this study was to determine how lake trout *Salvelinus namaycush,* Arctic char *S. alpinus,* Dolly Varden *S. malma,* Arctic grayling *Thymallus arcticus,* round whitefish *Prosopium cylindraeceum,* and pygmy whitefish *P. coulterii* were distributed according to depth, substrate particle size, food habits, length, and age given the absence of strong thermal structure. Sample sites were randomly chosen within sampling strata, and a gill net was set at each site. Lake trout and round whitefish were most abundant in my collections and had the oldest individuals. In more typically thermally stratified lake systems, lake trout and Arctic char usually move to colder, deeper water in the summer. However, in the Ugashik Lakes both species were abundant in shallow water all summer. Prior to this study pygmy whitefish were undocumented in this system. The Ugashik Lakes salmonids were opportunistic feeders, consuming abundant organisms such as isopods and amphipods. Fish in the Ugashik Lakes were found in locations different from what one would expect from predominant literature; fisheries managers may need to take this into account in their fisheries management.

A Spawning Habitat-Based Escapement Goal for Chum Salmon in the Tuluksak River, Southwestern Alaska

Student Investigator: John O'Brien, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: USFWS (RWO 112)

Due to diminishing returns of salmon and years of poor commercial and subsistence fishing in western Alaska, fishery management strategies are being reevaluated and new techniques are being sought. Management tools that recognize intricate life histories and incorporate environmental conditions at each particular life stage are needed. Toward that goal a study of spawning habitat for chum salmon *Oncorhynchus keta* was conducted from June 2002 to January 2005 on the Tuluksak River in western Alaska. Large-scale river features related to channel morphology were identified by aerial photographs, satellite images (LANDSAT-7), and synthetic aperture radar images (SAR) and mapped using a geographical information system (GIS). Small-scale river features that required on-site sampling were particle size of riverbed substrate, stream slope, width, depth, velocity, and redd location. Correlation analysis was employed to examine associations between large-scale variables and spawning areas. Spawning sites were associated with

moderate current velocity and stream strata that had a sinuosity greater than 1.5 but less than 2.5. Principal components analysis (PCA) suggested a strong association between channel intersections, gravel bars, islands, unstable stream reaches and spawning sites. A conceptual model was developed combining the habitat assessment with chum salmon habitat preferences stated in published scientific literature. The model suggested an escapement range of 15,329 to 25,328 individual adult chum salmon is appropriate for the Tuluksak River. The results of this study represent progress towards the development of management strategies that are sensitive to habitat-dependent production potential.

Population Characteristics and an Evaluation of Environmental Parameters on Newhalen River Sockeye Salmon (*Oncorhynchus nerka)*

Student Investigator: Libby Benolkin, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: None
Other Support: USGS, NPS, University of Washington

Average sockeye salmon escapement to the Kvichak River, Alaska, has declined since 1996. Sockeye salmon are the most important subsistence resource for Alaska Natives in the Kvichak drainage and the Newhalen River/Lake Clark area. This study is focused on determining life history characteristics, population structure, and mortality rates of the Lake Clark component and comparing these characteristics to those of the overall Kvichak River return. We will also examine possible trends in age and size at maturity of sockeye salmon from the Newhalen River over time (1973-2006) and test relationships between size at age and environmental variables, including Bristol Bay air temperatures, sea surface temperatures, index strength of Aleutian low pressure system, and the Pacific Decadal Oscillation. We collected sockeye salmon age and size data from Newhalen River subsistence gill nets from June 30 to July 24 during 2001-2005. The Fisheries Research Institute of the University of Washington collected and shared age and size data from the Newhalen River subsistence fishery for the years 1973-1999 for use in correlation analyses. Preliminary analysis indicates there is variability in age composition and average length from year to year. A better understanding of the life history characteristics, population structure, and the environmental processes affecting this fishery could provide better scientific information to aid managers in the conservation and perpetuation of sockeye salmon originating in the Newhalen River/Lake Clark area.

Assessment of Fish Condition in Two Arctic Lagoons using Bioelectrical Impedance Analysis, Kaktovik, Alaska

Student Investigator: Jeremy Carlson, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: 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 object of this study is to develop a model that relates fish condition as a measure of lipid content to bioelectrical impedance analysis measurements. The model will be developed to include both immature and mature Arctic cisco, Arctic cod, Arctic flounder and Dolly Varden. Fish were captured in five fyke nets set in Jago and Kaktovik lagoons. Bioelectrical impedance analysis measurements were taken on sampled fish. These fish were then euthanized, homogenized and will be sent to the laboratory for proximate composition analysis. Proximate analysis results will be used to calibrate the model. It is expected that bioelectrical impedance analysis 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 the 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.

Geomorphology and Selection of Spawning Habitat by Inconnu: A Heuristic Model

Student Investigator: Theresa L. Tanner, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: USFWS (RWO 127)

Current studies of inconnu (*Stenodus leucichthys*) spawning behavior suggest a high level of habitat selectivity. This implies that there are specific habitat characteristics that these fish require for spawning. The purpose of this study is to build a heuristic habitat model that can be used to better understand inconnu spawning site selection within Alaskan watersheds. Drainage basin morphology influences finer-scale habitat attributes, which in turn, influence biologic communities. Using readily available, low- or no-cost remote sensing data layers, geographical information systems (GIS) were used in conjunction with multivariate statistics to elucidate relationships between geomorphologic features and spawning site selection.

Linking Chinook Spawner Density to Habitat Limitations

Student Investigator: Sam Decker, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: ADFG (RSA Base Supplement)

Habitat models for determining carrying capacity are gaining interest in fisheries. Currently, research is focused on statistical models with mixed results. This study focuses on determining what processes limit the upstream range of Chinook salmon spawning habitat in the Chena River. River conditions that are required for egg survival will be measured: available oxygen, resistance to freezing, and accumulated thermal units for development. We will track use of the habitat through the arrival timing of the run. We predict that habitat suitable to chinook salmon spawning is spatially limited and will shift temporally by conditions that promote egg survival. Understanding the processes that limit the suitable spawning habitat will provide a firm foundation for future development of habitat models and predictions of change in spawning habitat range with changing climate regimes.

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
In-Kind Support: Field accommodations, logistical assistance, and riverboat provided by ADFG

In Alaska, management of chinook salmon is based on harvest or escapement goals designed to ensure spawning abundance that produces maximum sustainable yield. These goals have historically been determined using spawner-recruit relationships. Intensive stock-assessment and many years of data are required to construct a robust model through this approach. Establishing a measurable relationship between a river system's spawner carrying capacity and fish production could provide an alternative means for setting management goals, while adding insight into the stock's population dynamics. 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 Unuk River provides a good study site in that it has been the location of a full stock-assessment program by the Alaska Department of Fish and Game for chinook salmon since 1997. Additionally, the department has been doing habitat assessment on the Unuk's spawning tributaries since 2001. This and other available habitat information are being investigated for potential use in a habitat-based model. Three years of spatially documented spawner densities have been recorded for this study. The task of structuring these data into analyses is ongoing. By spring 2006, new stock-assessment analyses should be complete and a traditional biological escapement goal

established that will provide a benchmark for comparison with habitat-based reference points. Knowledge acquired about the relationships between spawning area, habitat, and fish production on the Unuk River may provide tools and techniques for defining these relationships elsewhere in the future.

A Remote Sensing/GIS-based Approach to Predicting and Estimating Juvenile Chinook Salmon Rearing Habitat in Southeast Alaska

Student Investigator: Kathy Smikrud, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Sport Fish Division/ADFG (RSA Base Supplement)
In-Kind Support: Technical assistance and equipment provided by ADFG

Remote sensing offers a desirable alternative to researchers and managers in monitoring large rivers and the aquatic habitat within. Large rivers are not accommodating for traditional (foot) fish habitat surveys due to their size and typically complex habitat. This study investigates the capabilities of using various remote sensing instruments (e.g., high-spatial resolution digital aerial photography and thermal infra-red data) to spatially map and quantify juvenile salmon habitat in the Unuk River, Southeast Alaska. Multiple data sources provide the ability to obtain both fine-scale and larger-watershed scale habitat indicators. Geomorphic and fish habitat explanatory variables derived from the imagery are assessed in their ability to predict and estimate juvenile salmon habitat within the main stem floodplain. Commercial image processing software and a geographic information system (GIS) are used to process and analyze the digital images. Results relate spatial and temporal data on large woody debris dynamics (quantity and distribution), surface water temperature, geomorphic variables, and locations of juvenile salmon. The final output map will estimate potential juvenile salmon habitat based upon predictive modeling using GIS analysis. Development of an alternative methodology for monitoring changes in salmon habitat will assist managers in the ability to link freshwater habitat conditions with salmon production.

Reconstructing Salmon Runs and Regional Climate Change using Stable Isotopes in Freshwater Mussel Shells

Student Investigator: Andra Love, PhD Fisheries
Advisor: F. Joseph Margraf
Funding Agency: None
In-Kind Support: HDR-Inc provided field equipment and office equipment

Alaska's Bristol Bay region supports a world-class salmon fishery that has recently experienced variable returns. A gold mining project is proposed in a portion of the fishery's headwaters, creating a need to research baseline conditions in the region. Freshwater mussels are an effective tool for water quality monitoring and are being used for several studies in the area. *Anodonta beringiana* mussels were collected from Iliamna Lake and Katmai

National Park in 2005. The purpose of these studies was to establish a nutrient baseline in the tissue of the mussels for this region and to explore the use of nitrogen ($\delta^{15}N$) and sulfur ($\delta^{34}S$) isotopes (marine derived nutrient indicators) in the annual rings of the mussel shells for reconstruction of historical fluctuations in Bristol Bay salmon escapement. Available salmon escapement estimates will be compared with the results of these analyses to examine the potential differences in signatures from waters receiving marine derived nutrients and waters that do not. In addition, $\delta^{18}O$ will analyzed to reconstruct historical records of regional climate change over the life history of these mussels. Carbon and hydrogen isotopes will be assessed and compared with this data set.

Paleolimnology of Selected Lakes in the Southwest Alaska Network: Understanding Past Trends of Salmon Abundance and Lake Productivity

Student Investigator: Morgan Peterson, MS Biological Oceanography
Advisor: Bruce Finney
Funding Agency: Southwest Alaska Network/NPS
In-Kind Support: Vehicle, technical assistance, and equipment provided by NPS during field season

Long-term data is needed to better understand long-term population trends in Pacific salmon, relationships to climatic change, and the effects of salmon-derived nutrients on freshwater productivity in the Southwest Alaska Network of the National Park Service. Because salmon play an important role in the ecology and economy of this region, this study focuses on reconstructing sockeye salmon abundance over the past 500 to 10,000 years. This project uses paleolimnological techniques to develop long-term records for a suite of 15 lakes. Lake types included in this study include clearwater, glacial, anadromous, formerly anadromous and non-anadromous. A comparison of past sockeye abundance trends along with the role salmon-derived nutrients play in lake productivity among the various lake types will be inferred using stable nitrogen isotope analysis ($\delta^{15}N$) and primary productivity proxies. Studies of non-anadromous, control lakes will help assess what other factors, such as climate, natural disturbances and human impact, influence freshwater systems in the absence of salmon. Variations in salmon abundance will be compared to climate and environmental histories documented from other studies. Overall, the data generated will be useful in designing viable monitoring programs by defining natural sockeye salmon variability and its relationship to past changes in climate, landscape processes, oceanic condition, and commercial fishing.

Spatial Subsidies from Headwater Streams to Fish-Bearing Habitats across Climatic and Disturbance Gradients in the North Cascade Mountains

Investigator: Christopher Binckley, Postdoctoral Fellow
Principal Investigator: Mark Wipfli
Funding Agency: Bonneville Power Administration/DOE

An increasingly important theme in ecology concerns the extent to which different habitat types are linked by energy and nutrient exchanges. Such spatial subsidies are particularly germane to stream ecosystems where consumers in valley bottom habitats may be subsidized by resource flow from headwater streams. Information regarding how the magnitude of headwater subsidies varies across climatic and disturbance gradients is needed to assess their potential impact on these consumers. We measured the amount of invertebrate, organic and inorganic material transported to fish habitats from 60 fishless headwater streams in the Wenatchee River Basin of the North Cascade Range. Streams were categorized into four groups based on ecological sub-region (wet or dry), and extent of past timber harvest (high or low). More invertebrates were transported from dry ecoregion streams, while organic and inorganic material transport was significantly higher in high timber harvest sites. Preliminary fish sampling indicated a significant and positive relationship between amount of invertebrates transported and downstream fish abundance. These data suggest that headwater stream subsidies transported downstream reflect both the smaller scale land use surrounding headwater streams and the larger scale climatic region in which they occur.

Influence of Landscape Factors on the Presence of Threespine Stickleback in Small Lakes of Northern Southeast Alaska

Student Investigator: Dave Gregovich, MS Fisheries
Advisor: Mark Wipfli
Funding Agency: Sport Fish Division/ADFG (RSA Base Supplement)

Threespine stickleback are common throughout the northern hemisphere and comprise a significant component of the diet of a long list of predators. In Southeast Alaska, the rugged landscape promotes the existence of a great variety of isolated, potentially unique stickleback populations valuable from both scientific and conservation perspectives. To detect patterns in stickleback occurrence, 18 small (0.5-5 ha) lakes were sampled across an elevation gradient from 10-880 m in northern Southeast Alaska during summer 2005. Fish were sampled with minnow traps and through snorkel surveys. Preliminary models illustrate the importance of elevation, length of lake outlet streams, and the slope of lake riparian areas as predictors of stickleback presence. For 2006, sample size will be doubled, likely resulting in a more robust distribution model applicable to a greater geographic area. This research will result in a stickleback-presence likelihood model based on

lake geographic attributes that can be used by managers to assess the risk of management actions on stickleback and their habitats.

Freshwater Community Development in Response to Salmon Carcass Additions in Newly Created Fish Habitats in Southcentral Alaska

Student Investigator: Aaron Martin, MS Fisheries
Advisor: Mark S. Wipfli
Funding Agency: Chugach National Forest/USDA
In-Kind Support: Housing, vehicle, sampling equipment

We tested the effectiveness of adding salmon carcasses to newly created off-channel habitats for accelerating aquatic community development and habitat productivity. High quality juvenile salmonid rearing habitat was lost from a century of intense placer mining throughout a 1.5-km reach of Resurrection Creek, Kenai Peninsula, during the late 1800s to present day. In conjunction with a U.S. Forest Service stream restoration project, off-channel habitats (alcoves) were constructed and experimentally enriched with salmon carcasses to help achieve habitat restoration goals. The objectives of this project were to (1) measure aquatic community development (biofilm, invertebrates, fish) in newly created alcoves, (2) compare community development and productivity between carcass-enriched and non-enriched alcoves, and (3) measure the movement of juvenile salmonids to and from treatments. Biofilm, macroinvertebrates, and juvenile salmonids were sampled during summer and fall 2005 following enrichment, which began in early summer. Colonization of alcoves was rapid, with substantial invertebrate and fish colonization occurring in less than a week in most sites. Preliminary results also indicated that food web productivity was higher in carcass-treated alcoves. The results of this project will provide insight on the importance of marine derived nutrients to freshwater food webs and as a means of increasing productivity and community colonization in streams undergoing habitat restoration.

Headwater Invertebrate Communities across a Gradient of Logging Disturbance in Wet and Dry Ecoregions of the Wenatchee River Subbasin, Washingto

Student Investigator: R. Bruce Medhurst, MS Biology
Advisor: Mark Wipfli
Funding Agency: Bonneville Power Administration/DOE
In-Kind Support: Pacific Northwest Research Station/USDA Forest Service

Headwater stream invertebrate assemblages are strongly influenced by surrounding terrestrial environments. These dynamics are, in part, governed by large-scale ecoregional characteristics (e.g. climate) and land use histories. Although numerous studies have investigated forest management (e.g. timber harvest) effects on aquatic biota, few have compared these

effects under different ecoregional conditions. The objectives of this study were to determine (1) how headwater stream communities (taxa richness, numeric abundance, and functional feeding group composition) differ between subbasins under high (HMI) and low (LMI) timber management intensity, and (2) how the magnitude of potential dissimilarity between communities within HMI and LMI subbasins varies by ecoregion. Benthic and drifting invertebrate assemblages were examined from 24 headwater streams in the Wenatchee River subbasin, spanning two ecoregions. Preliminary results indicate headwater streams exposed to timber harvest have reduced taxa richness and increased numeric abundance relative to controls. Further, the magnitude of dissimilarity does not appear to be the same for all invertebrate community metrics. These data suggest headwater invertebrate communities are influenced by timber harvesting, and ecoregional conditions may partly dictate how headwater stream invertebrate communities respond to harvest.

Invertebrate Subsidies from Fishless Headwater Streams to Fish-rearing Habitats in the Cascade Mountains

Student Investigator: Elizabeth Green, MS Biology
Advisor: Mark Wipfli
Funding Agency: Bonneville Power Administration/DOE
In-Kind Support: USDA Forest Service

Fishless headwater streams comprise over 80% of drainage networks, yet their role in supporting fish populations downstream is not understood. These upland aquatic habitats receive little if any riparian buffer protection during timber harvest, unlike fish streams that do receive protection. In order to understand how management activities along fishless streams affect fish communities downstream, we must understand the trophic connections among organisms between these bodies of water and how these trophic connections might change under various management scenarios. The objective of this study is to determine how the biomass of drifting invertebrates from fishless habitats affects fish communities downstream. This experiment aims to quantify how cutthroat trout and rainbow trout densities and standing stocks vary relative to food delivery from headwater channels. We will electroshock to assess fish populations, and estimate prey abundance through drift net sampling, in up to 20 streams. We anticipate a positive relationship between biomass of drifting invertebrates from headwaters and biomass of fish. Data collection will begin in 2006. 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. This study will provide information on whether these upland aquatic habitats potentially require riparian buffer protection.

Effects of Intense Wildfire on Foodweb Subsidies in Headwater Streams

Student Investigator: Cassie Mellon, MS Fisheries
Advisors: Mark Wipfli and Judith Li
Funding Agency: Pacific Northwest Research Station/USDA Forest Service
In-Kind Support: Colville National Forest provided field housing and assistance

Forest fires play an important role in shaping ecosystems, and there has been much concern recently about increasing severity of fire and the impacts on forest and aquatic ecosystems. Due to their small size and connectivity to riparian forests, headwater streams may experience significant initial impacts from fire. Fish-bearing streams and riparian areas receive subsidies from headwater streams in the form of aquatic invertebrate drift and emergence. These subsidies may be impacted by intense wildfires through changes in allochthonous inputs to the stream. The Togo Fire was an intense, 5000-acre fire that occurred August 2003 in the Colville National Forest of northeastern Washington. This study examines the effects of this fire on the drift and emergence of invertebrates from fishless headwater streams and the composition of invertebrate communities within the stream. Benthic, emergent, and drift samples of macroinvertebrates were taken from five streams with burned watersheds and five streams with unburned watersheds once per month in summers 2004 and 2005. Invertebrates were identified to family, and length measured to the nearest millimeter. The composition of invertebrates drifting from burned sites shifted to a less diverse community dominated by chironomids. Abundance of drifting and emerging invertebrates was greater at burned sites during both summers. With climate change and fuels build up from past fire suppression efforts, many regions will likely experience more intense wildfires. Knowledge on how aquatic resources may be impacted by this change will provide an important tool in management of forests, fires, and fuels.

Marine-Derived Nutrients (MDN) in Riverine Ecosystems: Developing Monitoring Tools for Tracking MDN in Alaska Watersheds

Student Investigator: Daniel J. Rinella, PhD Biology
Advisor: Mark Wipfli
Funding Agency: EVOS Gulf Ecosystem Monitoring
In-Kind Support: Kachemak Bay Research Reserve and USDA Forest Service, Forest Health, for bunkhouse and lab space in Homer and Cooper Landing, respectively

Little is known about the watershed-scale distribution and effects of marine-derived nutrients and carbon (MDN) delivered to streams by spawning salmon. MDN can greatly increase stream productivity and the fitness of stream-rearing fishes, and understanding these effects at broad spatial scales is necessary for sound fisheries management. Our objective was to

track MDN and measure effects in stream and riparian environments at the watershed scale. Our approach was to link stream chemistry, stable isotope, and fatty acid measures along a longitudinal gradient from headwaters to mouth in nine streams (six with salmon and three without) in three regions of the Kenai Peninsula. Large fluxes of dissolved nutrients (nitrogen and phosphorus) coincided with salmon spawning and increased in a downstream direction. In salmon streams, macroinvertebrates and riparian plants generally (but not always) showed isotopic enrichment that increased in a downstream direction, but isotope ratios were highly variable and did not appear to be a reliable predictor of MDN inputs. Dolly Varden fatty acid signatures and lipid levels suggest that increased energy storage is associated with MDN consumption and that larger Dolly Varden disproportionately capitalized on MDN subsidies. Our data suggest that stream-resident fishes are the most reliable integrators and indicators of MDN at watershed scales. Forthcoming effort will focus on relationships between spawning salmon abundance and stream-resident fish growth and fitness as a tool for guiding ecologically-based salmon escapement goals.

Completed Wildlife Studies

Breeding Ecology of White-Winged Scoters on the Yukon Flats, Alaska

Student Investigator: David Safine, MS Wildlife Biology
Advisor: Mark Lindberg
Funding Agencies: Yukon Flats National Wildlife Refuge/USFWS (RWO 117); Sea Duck Joint Venture; and Department of Biology and Wildlife and Institute of Arctic Biology/UAF
In-Kind Support: Yukon Flats NWR provided air support for logistics and telemetry, and extensive equipment use during the field season. ADFG and Alaska Science Center/USGS provided mist and gill nets for bird capture.

Note: Dave Safine graduated from the University of Alaska Fairbanks in August 2005. The abstract of his thesis follows:

Breeding bird surveys indicate a long-term decline in the numbers of scoters (*Melanitta* sp.) in North America. My objectives were to estimate survival of nests, ducklings, and adult female White-winged Scoters (*Melanitta fusca*) breeding on the Yukon Flats National Wildlife Refuge, Alaska, 2002–2004, within their primary breeding range. I measured habitat variables at nest sites and random sites in the study area to characterize nest habitat selection, and investigated breeding incidence with a laboratory analysis of circulating concentrations of the plasma yolk precursors vitellogenin (VTG) and very-low density lipoprotein (VLDL). The low hen and nest survival rates I observed combined with the substantial proportion of non-breeders on the breeding ground (up to 28%) may be responsible for the observed declines in abundance if annual survival rates are not high enough to maintain stable populations. Scoters avoided nesting in graminoid habitat, but nested in all

other scrub or forested plant communities in proportion to their availability, selecting sites with more cover, higher variability of cover, and closer to edge and water than random sites. At the nest habitat scale, scoters are generalists, which may reduce the foraging efficiency of nest predators.

Factors Affecting Body Mass of Prefledging Emperor Geese

Student Investigator: Bryce Lake, MS Wildlife Biology
Advisors: Mark Lindberg
Funding Agencies: Yukon Delta National Wildlife Refuge/USFWS (RWO 121); Alaska Science Center/USGS; and UAF
In-Kind Support: Aircraft support, field equipment, and housing during field season

Note: Bryce Lake graduated from the University of Alaska Fairbanks in August 2005. The abstract of his thesis follows:

Body mass of prefledging geese has important implications for fitness and population dynamics. To address whether interspecific competition for forage was broadly relevant to prefledging emperor geese, I investigated the factors affecting body mass at three locations across the Yukon-Kuskokwim Delta, Alaska. From 1990–2004, densities of cackling geese more than doubled and were ~2–5x higher than densities of emperor geese, which were relatively constant over time. During 2003–2004, body mass of emperor geese increased with net above-ground primary productivity (NAPP) and grazing lawn extent and declined with interspecific densities of geese (combined density of emperor and cackling geese). Grazing by geese resulted in consumption of ≥90% of the NAPP that occurred during the brood rearing period, suggesting that interspecific competition was due to exploitation of common food resources. At six sampled locations, grazing lawn extent varied among- and within-locations, and was stable or declined slightly during 1999–2004, indicating reduced per capita availability. I conclude that negative effects of interspecific goose densities on body mass of prefledging geese are partially responsible for recent declines in the fall age ratio of emperor geese because of a positive correlation between body mass and survival to fall staging areas. Management to increase the population size of emperor geese should consider interspecific densities of geese and interactions between interspecific densities and forage.

Effects of Recreational Disturbance on Breeding Black Oystercatchers: Species Resilience and Conservation

Student Investigator: Julie Morse, MS Biology
Advisor: Abby Powell
Funding Agency: BRD/USGS, Seattle
In-Kind Support: Logistical support during field season provided by Kenai Fjords National Park

Note: Julie Morse graduated from the University of Alaska Fairbanks in December 2005. The abstract of her thesis follows:

The potential conflict between increasing recreational activities and nesting birds in coastal habitats has raised concerns about the conservation of the black oystercatcher (*Haemotopus bachmani*). To address these concerns, I studied the breeding ecology of black oystercatchers in Kenai Fjords National Park and examined the impact of recreational disturbance on breeding parameters. Most recreational disturbance of breeding territories was from kayak campers and occurred after June 13, the peak hatch of first clutches. Mean annual fledging success (24%) was low, but the results suggest that daily survival rates of nests and broods did not differ between territories with and without recreational disturbance. Nest survival varied annually and seasonally, and declined during periods of extreme high tides. Daily survival rate of broods was higher on island territories than mainland territories, presumably due to differences in predator communities. Most (95%) color-banded oystercatchers returned to their breeding territories in the subsequent year regardless of level of disturbance. On average, black oystercatchers decreased incubation constancy by 39% in response to experimental disturbance. However, I found no evidence that time off the nest was associated with probability of nest survival. Further, I found no evidence that oystercatchers habituated to recreational activity. The data suggest that black oystercatchers in Kenai Fjords National Park are resilient to the current low levels of recreational disturbance.

Migration Ecology and Distribution of King Eiders

Student Investigator: Laura Phillips, MS Biology
Advisor: Abby Powell
Funding Agencies: Minerals Management Service (MMS); Coastal Management Institute (CMI) and IAB/UAF; North Slope Borough (NSB); Sea Duck Joint Venture
In-Kind Support: Logistic support provided by ConocoPhillips, Alaska; equipment support provided by USFWS and AKCFWRU

Note: Laura Phillips graduated from the University of Alaska Fairbanks in August 2005. The abstract of her thesis follows:

Alaskan-breeding King Eiders (*Somateria spectabilis*) disperse from nesting areas on the Arctic Coastal Plain and move through the Beaufort Sea to wing molt and winter locations in remote areas of the Bering Sea. Knowledge of King Eider distribution outside the breeding period is critical to provide regulatory agencies with opportunities to minimize potential negative impacts of resource development. To characterize the nonbreeding distribution of King Eiders, we collected location data of 60 individuals over two years from satellite telemetry. During post-breeding migration, male King Eiders had much broader use areas in the Alaskan Beaufort Sea than females. Chronology of wing molt was earlier for males than females in all years. Throughout wing molt and winter, eider locations were closer to shore, in shallower water with lower salinity than randomly selected locations. Short residence time of King Eiders in deep water areas suggests the Alaskan Beaufort Sea may not be as critical a staging area for eiders during spring as it is during post-breeding. This study provides some of the first large-scale descriptions of King Eider migration, distribution, and habitat outside the breeding season.

Daily Heterogeneity in Habitat Selection by the Porcupine Caribou Herd during Calving

Student Investigator: Rachel Jones, MS Wildlife
Advisor: Brad Griffith
Funding Agencies: ADFG, USFWS, USGS

Note: Rachel Jones graduated from the University of Alaska Fairbanks in August 2005. Her thesis abstract follows:

Caribou exhibit scale-dependent habitat selection, but variance in daily habitat selection by the Porcupine Caribou Herd (PCH) has not been examined. Investigating temporal variance in habitat selection may clarify the time period when managers may accurately estimate calving-related habitat selection. Annually, 1992-1994, approximately 70 calves were radio-collared within 2 days of birth and relocated daily until departing the calving grounds. We used daily 99% fixed kernel utilization distributions (UD's) to estimate caribou distributions, then estimated daily habitat selection using logistic regression. Habitat variables included relative vegetation greenness, greening rate, landcover class, and elevation. Spatial scales of investigation included concentrated vs. peripheral use within daily UD's, daily use within the merged extent of all daily UD's, and daily use within the historical extent of calving, 1983-2001. We used linear regression of logistic regression parameter estimates on sequential sampling days to estimate temporal habitat selection trends during the 3 weeks following capture. Overall, caribou exhibited habitat selection at multiple scales, without temporal trends, suggesting that the 21-day period following capture constituted a single domain and that managers may accurately estimate calving-related habitat selection at any point during this period.

Population and Habitat Analyses for Dall's Sheep (*Ovis dalli*) in Wrangell-St. Elias National Park and Preserve

Student Investigator: Miranda Terwilliger, MS Wildlife
Advisor: Brad Griffith
Funding Agencies: U.S. National Park Foundation, Safari Club International, and Ted McHenry Scholarship
In-Kind Support: Wrangell-St. Elias National Park and Preserve/NPS

Note: Miranda Terwilliger graduated from the University of Alaska Fairbanks in August 2005. The abstract of her thesis follows:

We summarized and statistically analyzed historical fixed-wing aerial surveys (1949-2002) and harvest records (1983-2002) of Dall's sheep (Ovis dalli dalli) from Wrangell-St. Elias National Park and Preserve (WRST). Among survey units there were significant differences in observed densities, hunter-reported harvest, horn lengths of harvested rams, and horn length results from the regression of length on age. There was no consistent evidence of net change in WRST-wide sheep density, even though some survey units showed trends in density. Reported harvest in WRST declined linearly during 1973-2003 from 376 to 139 rams per year.

We estimated the relationships among population and habitat characteristics with multiple linear regression. We standardized all variables and evaluated all 1, 2, and 3 variable models using Akaike's Information Criterion for small sample sizes (AICc) for model selection. The best model for sheep density showed a positive correlation with median NDVI (relative vegetation greenness) and terrain ruggedness. The same model resulted from examining adult and lamb cohorts separately. Approximately 50% of horn length was explained by age. The habitat variables estimated did not explain a significant amount of the variance observed in reported harvests or horn length residuals from the regression of length on age.

Ongoing Wildlife Studies

Hen-Survival and Breeding Ecology of Waterfowl on Yukon Flats National Wildlife Refuge

Student Investigator: Kate Martin, MS Wildlife Biology
Advisor: Mark Lindberg
Funding Agency: Yukon Flats National Wildlife Refuge/USFWS (RWO 142)
In-Kind Support: Technical assistance and use of equipment provided by Yukon Flats NWR during field season

Information on the breeding ecology of waterfowl nesting in the boreal forest is lacking despite its relative importance to continental waterfowl production. Waterfowl management in North America is based on spring breeding pair surveys that assume equal potential productivity for breeding pairs across all regions; however, regional differences in population processes may exist. The objective of this study is to determine the factors limiting waterfowl

production in the boreal forest and provide estimates of breeding parameters for comparison with other regions. We will estimate hen survival, breeding probability, nest survival, and renesting probability of Lesser Scaup, American Wigeon and Northern Shovelers on the Yukon Flats National Wildlife Refuge 2005-2006. In 2005, we marked pre-nesting and nesting females with radio transmitters, monitored them throughout the breeding season, and gathered additional data on nest survival by locating and monitoring nests of unmarked females. Preliminary data suggest high female survival (0.95, n=57, all species); however, the high survival may be attributed to a high number of non-breeders at the study site. Only 23% of females marked pre-breeding (n=43, all species) were found on nests, which suggests one of the lowest rates of breeding recorded for ducks. In 2006, we will capture an additional 80 pre-nesting females and use physiological methods to evaluate the reproductive status of captured hens to better estimate breeding probability. The information provided by this study is pressing given the potential for resource development in the boreal forest, and the importance of the area to breeding Lesser Scaup, currently experiencing a population decline of concern to managers.

Population Dynamics of Tundra Swans Breeding on the Lower Alaska Peninsula

Student Investigator: Brandt Meixell, MS Biology
Advisor: Mark Lindberg
Funding Agencies: Izembek National Wildlife Refuge/USFWS (RWO 143); DBW and IAB/UAF
In-Kind Support: Izembek NWR/USFWS provided data management and logistics

The density of Tundra Swan breeding pairs at Izembek National Wildlife Refuge (NWR) on the Lower Alaska Peninsula has decreased by nearly 75% over the past 25 years. Swans breeding in this area are unique because they are the most southwesterly breeding population of Tundra Swans and the only known population of Tundra Swans to exhibit non-migratory behavior. Growing concerns about the status of swans breeding on the Alaska Peninsula, the unique behavior and characteristics of the Izembek population, and a potential increase in development and harvest pressure on or near Izembek NWR have prompted a demographic assessment of historic data collected between 1977 and 1996. The ultimate goal of this study is to identify which demographic parameters most affected the population in the past and which parameters should be targeted for future management. During the 19-year span of field studies, extensive aerial surveys of pairs and nests were conducted and nearly 500 active nests were monitored. Additionally, successfully hatched cygnets from those nests were monitored regularly to determine their fate, and 695 swans were captured and marked with neckbands. During subsequent summers and sporadically during the winter, observations of marked swans were made and a total of 5,565 resightings were recorded. Our specific objectives are to estimate nest

survival, egg survival, cygnet survival, annual age-specific apparent survival, and breeding probability of adult swans. As part of a larger collaborative project, we will construct a population model to provide managers with information about the most influential demographic parameters.

Population Ecology of Pacific Common Eiders on the Yukon-Kuskokwim Delta, Alaska

Student Investigator: Heather M. Wilson, PhD Biology
Advisor: Abby Powell
Funding Agencies: Yukon Delta NWR/USFWS, Alaska Science Center/USGS, Sea Duck Joint Venture, and Angus Gavin Memorial Bird Research Grant
In-Kind Support: Yukon Delta NWR and the Alaska Science Center provided equipment and logistical support during the field season

Populations of Pacific common eiders (*Somateria mollissima v-nigrum*) on the Yukon-Kuskokwim Delta (YKD) have declined dramatically over the last 50 years. Little is known of the ecology or demography of this declining subspecies, but other eider species on the YKD have been listed as "Threatened." We combined historical and current data to estimate spatio-temporal variability in survival and reproduction, and we used local estimates to develop a stochastic common eider population model. We collected data on survival and reproduction at three breeding sites (1991-2004) and built a stochastic population model using local vital rates. Adult survival was high and invariant, while reproduction was relatively low and variable. Contaminant burdens of lead were low and exposure infrequent, while selenium burdens were high. Our population model suggests that populations of YKD common eiders are stable to slightly increasing. Adult female survival appears the most influential parameter to prospective growth rate, and nest survival to variation in growth rates. To increase population growth rate we recommend managers focus on increasing mean adult survival and decreasing variability in annual nest success.

Should I Stay or Should I Go Now? Physiology and Behavior of Staging Shorebirds on Alaska's North Slope

Student Investigator: Audrey Taylor, PhD Biology
Advisor: Abby Powell
Funding Agencies: CMI, MMS, Angus Gavin Migratory Bird Research Fund, Migratory Bird Management and Arctic NWR/USFWS, Northern Field Office/BLM, BP Exploration, Inc. ConocoPhillips Alaska Inc., Manomet Center for Conservation Sciences, North Slope Borough (NSB) Department of Wildlife Management
In-Kind Support: Technical assistance and equipment use during the field season

Pre-migratory shorebirds depend on resources found in coastal areas on the North Slope of Alaska to acquire fuel for southward migration, yet little information exists on how shorebirds use these areas or what sites are most important in preparing birds for migration. Such information is critical for evaluating potential impacts of energy development along Alaska's North Slope. One relevant testable question is how shorebirds make decisions regarding site choice and timing of use while staging on the North Slope. We examined whether rate of mass gain (fattening rate) experienced by birds feeding at a particular staging site could explain patterns of length of stay (LOS) and movements among five sites, and whether these patterns matched published knowledge regarding each specie's migratory strategy. During July and August 2005 we captured shorebirds to collect blood samples and attach radio transmitters, and then followed the radio-equipped birds at and between the five sites to determine LOS and movement patterns. Analysis of blood plasma for triglyceride concentration showed species- and site-specific differences in fattening rates, indicating possible differences among the sites in their purpose for pre-migratory shorebirds. We also found that LOS and movements between sites differed by species and by site, and were to a degree predictable from known migratory patterns. Fattening rates provided a link between assumed migratory strategy and behavior patterns, although additional factors are likely to play a role in determining site choice and timing of use.

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

Student Investigator: Rebecca McGuire, PhD Biology
Advisor: Abby Powell
Funding Agencies: CMI; ConocoPhillips Alaska, Inc.; BLM; NSB; Minerals Management Service (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 western North American population declined by more than 50% between 1979 and 1996 for unknown reasons. The National Petroleum Reserve-Alaska (NPR-A) northeast planning area is 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 and the influence of nest site choice in both an undisturbed and disturbed area. Accessible areas around Teshekpuk Lake and Kuparuk were searched for nesting King Eiders in 2002, 2003, 2004, and 2005. Nests were located (~40/site/year) and monitored, and habitat evaluations were done. Nest success was slightly higher at Kuparuk in all years; however, very high nest success at Kuparuk in 2005 was likely the result of predator control. Preliminary analyses found no evidence for any effects of spatial covariates on nest survival. Incubation constancy is slightly higher at Kuparuk than at Teshekpuk. 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.

Migration Strategies and Winter Movements of King Eiders in the Bering Sea

Student Investigator: Steffen Oppel, PhD Biology
Advisor: Abby Powell
Funding Agencies: MMS and NSB

Little is known about the timing and distance of migratory and non-migratory movements of King Eiders (*Somateria spectabilis*) in the Chukchi and Bering Seas. Carryover effects of migration and wintering may affect reproductive performance and population development of migratory birds. Given recent declines in King Eider populations and ongoing climatic changes of their marine habitat, information is required how flexible King Eiders might be in response to new environmental challenges. The objective of this study was to develop definitions for King Eider seasons and describe patterns of movements during the nonbreeding period. Since 2002 a total of 80 King Eiders have been tracked via satellite transmitters for an average of 13 months. Based on movement rates we identified 5 distinct seasons during the nonbreeding period of King Eiders: molt migration, wing molt, fall migration, wintering, and spring migration. We identified three different migration strategies between breeding and wintering areas. More than one-third of the tracked birds did not show a fall migration and wintered in their molting areas. Length of the wintering period was highly variable, leading to different distances traveled by individuals during the winter period. Birds wintering at higher latitudes did not move more often than birds at lower latitudes. The average distance traveled in winter was 643.9 ± 452.8 km and did not differ between years, sexes, or latitude. Altogether, movements by King Eiders were highly variable, suggesting that the population could rapidly adapt to changing environmental conditions. Further research is required to determine factors that trigger midwinter movements.

The Common Raven (*Corvus corax*) on Alaska's Coastal Plain and its Relationship to Oil and Gas Development

Student Investigator: Stacia Backensto, PhD Biology
Advisor: Abby Powell
Funding Agency: Fairbanks BLM Office, BP Exploration AK Inc., Center for Global Change/UAF, CMI, ConocoPhillips, Fairbanks FWS Office, Regional Resilience and Adaptation Program
In-Kind Support: ConocoPhillips, BP Exploration AK Inc. and NSB Department of Wildlife Management provided accommodations, travel to field sites, and vehicle support in the field

A small portion of the common raven (*Corvus corax*) population on Alaska's North Slope uses infrastructure in Prudhoe Bay and Kuparuk oil fields for nesting. In 2005 we followed breeding adult ravens marked during 2004 in the oil fields, monitored breeding activities, documented foraging patterns, collected pellets from nest sites, and marked young from these nests. We continued trapping adults for satellite and radio telemetry in this area and initiated efforts along the Colville River and at Pt. Lonely. Sightings of marked ravens reported by oil field personnel and the general public across Alaska were collected during 2004–2005. Additionally, we interviewed oil field personnel in 2005 about ravens in the oil fields.

In 2005 we monitored 20 nests across Kuparuk and Prudhoe Bay, captured and marked one breeding adult, and marked 13 fledglings. Our preliminary findings suggest that breeding adults in the oil fields return to the same nest site annually and maintain 1-2 km territories around nest sites until late in the nestling stage. After fledgling, families make foraging movements >3 km from natal territory and remain together for a period of >5 weeks. Nest success was different for Kuparuk and Prudhoe Bay in both years. In 2004, 100% of nests initiated in Prudhoe Bay and 57% of nests in Kuparuk fledged at least one young. Nest success at both sites was lower in 2005; 81% of nests in Prudhoe Bay and 33% of nests in Kuparuk fledged at least one young. Sightings of marked ravens have been reported from the oil fields year round and from other locations throughout Alaska. The community of oil field personnel provided a body of knowledge that complements our research and generated new ideas regarding raven behavior and population demographics.

Development of a Bird Collision Risk Model

Principal Investigator: Falk Huettmann, DBW/IAB
Funding Agency: USFWS (RWO 148)

This project report summarizes interviews carried out during June-November 2005 in order to improve our knowledge regarding collisions of birds, e.g. endangered species, with power facilities (towers). We started with a list of approximately 143 contacts relevant for operating power facilities in coastal regions of Alaska. The first contact attempt was done by writing, and it included a letter and Excel sheet to be filled out. It resulted in a very low response rate. Throughout the project, addresses had to be updated or changed for various reasons. A second attempt was made in August/September involving email and telephone follow-ups. A slightly better response rate was achieved, but many requests were not answered or were still pending. A third and usually fourth attempt was made in October and November. All contacts and replies were documented. The main achievement of the interviews and contacts was better contact information and some details regarding facility structure and impacts. The low response rate has several reasons and likely relates to the lack of awareness of the facility operators and missing legal support for such work, e.g. the voluntary nature of responding to the requests.

Wildlife Habitat Modeling in the Toklat Basin Study Area, Denali National Park and Preserve

Student Investigator: Joy Ritter, MS Biology
Advisor: Eric Rexstad and Falk Huettmann
Funding Agency: Denali National Park/NPS (RWO 129)

Increasing visitor numbers in our national parks place a burden on existing facilities and thoroughfares. Park managers must decide if and where expansion can take place without damaging or destroying that which our park system was designed to preserve. A better understanding of landscape characteristics associated with the resources that organisms select can help managers make such decisions. The time and effort required to obtain data at a park-scale often make this type of study cost-prohibitive. However, the potential exists for the development of resource selection models using opportunistic data, or data that were collected for another use. The objective of this study is to explore the use of opportunistic data to model the habitat selection of four species common to Denali National Park: caribou, moose, grizzly bear, and wolf. Multiple years of radiolocation data for these species representing used habitat were obtained from park biologists. A geographic information system was used to obtain landscape characteristics associated with the animal locations and random locations placed in the same area. Several algorithms including logistic regression, classification trees, and ecological niche factor analysis were used to look for patterns of habitat selection. Models were evaluated by holding out a random partition of locations and calculating the percent correctly predicted. Classification tree models for caribou and grizzly bear were most successful at predicting animal occurrence but tended to predict presence in many areas where validation points did not occur. Maps were developed from the models illustrating the predicted occurrence of these species during different seasons. These maps can be used as a tool for land use decisions, and inference from underlying models can increase our understanding of how these animals choose the areas they inhabit.

Calving and Post-Calving Habitat Selection of the Teshekpuk Caribou Herd

Student Investigator: Lincoln Parrett, MS Wildlife
Advisor: Brad Griffith
Funding Agencies: Division of Wildlife Conservation/ADFG; North Slope Borough Department of Wildlife Management (NSBDWM)
In-Kind Support: Radio-tracking costs, field and office supplies, office space and internship in Barrow (ADFG); field supplies and lodging in Barrow (NSBDWM)

The majority of the Teshekpuk Caribou Herd (TCH) annual range is currently being considered for industrial development. Baseline information about this herd's distribution and habitat use is necessary for the interpretation of any

post-development distribution and habitat use studies, as well as for the development of any disturbance mitigation measures. The purpose of this study is to estimate the geographic areas, habitat features, and diet components that are selected by female caribou during the summer period. We radio-tracked marked female caribou every two weeks from mid-June until the rut in 2002–04. We estimated diet composition through microhistological analysis of fecal pellets. We analyzed habitat selection using logistic regression at two spatial scales, comparing used and available or unused habitat features such as air temperature, terrain ruggedness, remotely sensed vegetation class, and remotely sensed green-up patterns (NDVI). Post-calving distributions were similar in all three years. Little or no habitat selection was detected when we compared used locations to habitat available within bi-weekly utilization distributions. At the larger scale of analysis, there were dynamic temporal patterns in resource selection by caribou. Diet composition often appeared to contradict patterns in large scale resource selection; dominant plant species in the feces were often atypical of selected land cover classes. This herd consistently uses the area around Teshekpuk Lake intensively throughout the summer. Successful mitigation measures for petroleum development in NPR-A will need to be spatially and temporally tailored to observed dynamic patterns in caribou resource selection.

Assessing Population Status and Habitat Use in a Southeast Alaskan Moose Population

Student Investigator: Susan Oehlers, MS Biology
Advisor: Falk Huettmann
Funding Agencies: USDA Forest Service, Bureau of Indian Affairs
In-Kind Support: Technical assistance and field support provided by ADFG

Little is known about the moose population of the Yakutat forelands area of the Tongass National Forest. Dense forest cover obscures visibility of moose on the ground, decreasing the accuracy of aerial survey population estimates, while factors such as habitat use and sex and age composition remain un-studied. Moose are an important subsistence resource to the local community and appear to be at a low density. Precise and accurate information on population size and sex and age composition is critical for management and to provide subsistence hunting opportunities. We studied factors involving visibility of moose to improve population estimates from aerial surveys. Further, we evaluated habitat selection by moose by sex and season. We captured and radio-collared 58 adult moose and conducted 88 trials to determine the percentage of moose that are missed during aerial surveys. We examined variables that affect visibility of moose to develop a model for accurately estimating the population size from aerial survey data. Further, we described the differences in habitats selected between the sexes during different seasons and at four different spatial scales. Preliminary results indicate that observer experience, vegetation type, cover, and snow level are significant factors affecting the visibility of moose. Further, we

demonstrated differential habitat use with respect to such variables as gender, season, elevation, distance from water, and habitat class. Information on habitat use and implementation of the visibility model to future aerial surveys will generally improve population estimates and allow for more informed management decisions.

Forage and Nutritional Determinants of Moose Calf performance during Winter

Student Investigator: Shelly Szepanski, PhD Biology
Advisor: Brad Griffith
Funding Agency: NPS; USGS
In-Kind Support: Technical assistance and equipment provided by

Many moose populations in Alaska persist at low densities, and the management of sustained subsistence harvest of moose is becoming increasingly complex. Estimating causes of population limitation for moose would be improved by a regional assessment of density-dependent factors related to habitat capacity. The goal of this research is to develop and test a model that relates winter habitat capacity and calf weight dynamics across a wide range of moose densities and forage characteristics in Alaska. Forage production and utilization were estimated at Lake Clark National Park and Preserve, Koyukuk National Wildlife Refuge (KNWR), Alaska Peninsula/Becharof National Wildlife Refuge (APB), and Unit 20A using a stratified random sampling scheme based on moose density and vegetation landcover classes. Estimates of 5- and 10-month old calf weights, morphological measurements, and overwinter weight change in each study area will be completed by spring 2007. Preliminary analysis suggests significant 10-month-old calf weight differences among study areas (e.g, x=466 lbs, SD=54.6, n=34 at LCNPP versus x=361 lbs, SD=22.7, n=306 at Unit 20A), as well as substantial variability in overwinter weight change. Forage utilization at LCNPP appeared to be less than half that estimated in Unit 20A. Modeling the relationship between moose density, forage quality and quantity, and calf performance will generate comparable estimates of statewide variance in habitat capacity among regions in Alaska and will support subsistence and intensive management decisions for moose and predators.

Interrelationships between Brown Bears and Chum Salmon at McNeil River, Alaska

Student Investigator: Joshua Peirce, MS Wildlife
Co-Advisors: Mark Wipfli and Erich Follmann
Funding Agency: ADFG, GKW Foundation, NPS, the Wildlife Society
In-Kind Support: ADFG provided equipment, staff time, transportation, use of field camp facilities, and aerial surveys

Bear numbers have been in decline in the McNeil River State Game Sanctuary, southcentral Alaska, since 1997. Concurrently, chum salmon returns are low and escapement for McNeil River has been met only four times in the last 16 years. Chum are the principal food source for the bears that congregate annually at McNeil River falls. Few places in the world provide such a dramatic example of how direct the relationship between bears and salmon can be, with as many as 144 individual bears identified during a single year and 72 bears counted at one time. This study focuses on the impact bears have on chum production and the impact chum returns have on bear use at McNeil. Using radio-tagged fish I am evaluating the role bear predation has on adult chum stream life. Preliminary results show a stream life of 11 days, 36% below the current estimate. In 2005, 44% of the tagged fish were known to have been killed by bears. This study seeks to explicitly incorporate bear use of salmon into the McNeil River escapement goal, assuring a predictable food resource for bears. This project has the potential to serve as a model where escapement goals may not be adequately accounting for ecosystem needs.

Potential Effects of Military Overflights on Female Dall's Sheep Habitat Use and Selection, Tanana-Yukon Uplands, Alaska

Student Investigator: Brad Wendling, MS Wildlife
Advisor: Brad Griffith
Funding Agencies: Yukon-Charley River National Preserve/NPS; Division of Wildlife Conservation/ADFG
In-Kind Support: Yukon-Charley River National Preserve/NPS; Division of Wildlife Conservation/ADFG

Our objective was to assess the potential effects of varying intensity military overflights on female Dall's sheep (*Ovis dalli*) habitat use, habitat selection, home range size, and movement rates during 2-week sequential periods, April-July, 1999-2002. We examined sheep in 2 study areas, overlain with designated military training airspace, within the Tanana-Yukon uplands, Alaska. We estimated the effects of study area, year, and sequential time period on mean usage and selection ratios of elevation, slope, terrain ruggedness, aspect, and landcover class by sheep within sequential periods. Furthermore, we estimated effects of study area, year, and sequence on mean home range size and mean minimum hourly distance traveled by sheep within sequential periods. Mean number of daily military overflights

per sheep within sequential periods was used as a covariate in all analyses. Sheep movement rates, home range size, habitat use and selection differed among study area, years within study areas and sequential time period within years within study area, but did not vary in relation to military overflight intensity. We conclude that military training operations over the Tanana-Yukon uplands were an insignificant source of variance in activity and habitat use compared to the effects of seasons, years, and study areas.

Completed Ecological Studies

Carbon Exchange and Permafrost Collapse: Implications for a Changing Climate

Student Investigator: Isla Myers-Smith, MS Biology
Advisors: A. David McGuire and F. Stuart Chapin
Funding Agency: Geologic Division/USGS (RWO 97)

Note: Isla Myers-Smith graduated from the University of Alaska Fairbanks in May 2005. Her thesis abstract follows:

With a warmer climate, the wetlands of Interior Alaska may experience more frequent or extensive stand-replacing fires and permafrost degradation. This, in turn, may change the primary factors controlling carbon emissions. I measured carbon exchange along a moisture transect from the center of a *Sphagnum*-dominated bog into a burned forest (2001 Survey Line Fire) on the Tanana River Floodplain. Both the bog and the surrounding burn were sinks for CO_2, and the bog was a CH_4 source in the abnormally dry summer of 2004. Thermokarst and subsiding soils were observed on the margin of the bog in the three years since the fire, increasing the anaerobic portion of the soil landscape. I observed the greatest variation in carbon fluxes in this portion of the transect. I conclude that permafrost collapse is altering the pattern of emissions from this landscape. I tracked historical changes in vegetation, hydrology and fire at this site through macrofossil, charcoal and diatom analysis of peat cores. The paleoecological record suggests that fire mediates permafrost collapse in this system. This study indicates that future changes in temperature and precipitation will alter carbon cycling and vegetation patterns across this boreal landscape.

Forest Sector Outcomes with/without Climate Change and Carbon Sequestration Management (RWO 135, completed), Carbon Dynamics of the US Forest Sector with/without Climate Change and Carbon Sequestration Management (RWO 144, ongoing), and Impact of Climate Change on Vegetation and Water Supply (RWO 150, ongoing)

Student Investigator: Mike Balshi, PhD Biology (partial support for graduate student programmer)
Faculty: A. David McGuire
Funding Agency: USDA Forest Service

These three studies have objectives that are linked. The overall objectives of the first study were to (1) quantify the outcomes under no climate change and climate change in the forest sector under a business-as-usual scenario and a scenario with a future policy instrument focused on increasing carbon sequestration above the baseline for US forests and forest products; (2) analyze the impacts and their timing at local and regional scales in forest ecosystems and the forest sector; and (3) identify potential research issues involved in developing a more comprehensive approach to risk assessment

and management in the forest sector relative to climatic change. The second study adds another objective to the first study: to compare the results of US forest sector carbon dynamics simulated by two different models, one of which is the model implemented in Dr. McGuire's lab (the Terrestrial Ecosystem Model) and the other of which is a model implemented by the USDA Forest Service (FORCARB). The third study will analyze the estimates of leaf area index and water yield simulated by the model implemented in Dr. McGuire's lab. These studies are part of two USDA Forest RPA Special Studies that have been granted to Dr. Linda Joyce of the USDA Forest Service Rocky Mountain Forest and Range Experiment Station. In collaboration with Dr. Joyce, Dr. McGuire's lab has completed research on the first study, and the results have been incorporated into a Forest Service General Technical Report devoted to the RPA Special Studies. The simulations for the second and third studies are currently being designed and will be run in Dr. McGuire's lab this summer. The comparison of the carbon dynamics results of TEM with a Forest Service Model, FORCARB, will provide a measure of uncertainty relevant to policy decisions on carbon sequestration management. The analysis of water yield simulated by TEM will provide information relevant to policy discussions on water management in the face of climate change. This research will contribute to developing a more comprehensive approach to risk assessment and management in the forest sector relative to climatic change.

Quantifying the Relative Importance of Different Secondary Succession Processes in the Alaskan Boreal Forest

Student Investigator: Thomas A. Kurkowski, MS Natural Resource Management
Advisors: Scott Rupp and Daniel Mann
Funding Agency: Joint Fire Science Program/BLM (RWO 116)
In-Kind Support: Logistical support including helicopter and fixed-wing transportation from BLM and USFWS

Secondary succession after fires is arguably the most important ecological process occurring in the boreal forest. Post-fire forest succession in Interior Alaska occurs in two different ways, but their relative importance is unclear. Self-replacement (SR) occurs when pre-fire dominant tree species immediately replace themselves after fire as the canopy dominants. Species-dominance relay (SDR) involves the simultaneous establishment of deciduous and coniferous tree species after fire, followed by shifts in the dominant overstory species over time. The goal of this study is to quantify the relative importance of SR and SDR on a representative, hilly landscape near Fairbanks, Alaska. SR implies a relatively unchanging vegetation distribution that is equilibrated with environmental parameters, while SDR predicts stand composition is a function of time-since-last-fire. We tested these hypotheses by building a statistical model that relates stand type to environmental variables including solar insolation during the growing season, site altitude, and size of the hydrological catchment uphill. In addition, we tested the

relationship between stand age and species composition. Results show that in >85% of our study area, the extant forest is most likely the product of self-replacement. Stand distribution is controlled largely by the distribution of solar insolation. On similar boreal landscapes, self-replacement may be the general rule after fires.

Ongoing Ecological Studies

Ecosystem Management and Regional Dynamics in Response to Global Change: Three Case Studies from the Tongass National Forest and Southeastern Alaska

Student Investigator: Colin Beier, PhD Biology
Advisor: A. David McGuire
Funding Agencies: National Science Forest, USDA Forest Service, USDA New Crops, and IARC Center for Global Change/UAF

During the fourth year of study, significant progress has been made in case studies addressing (1) the role of climatic warming in widespread decline of Alaska yellow-cedar and its sustainability as a valuable timber resource; (2) the effects of Federal land-use policy on regional economic transition and provision of natural capital and services; and (3) an analysis of the institutional and political factors that maintain an economically unprofitable and inefficient Tongass timber sale program. Methods include dendroclimatology, spatial GIS applications, economic valuation of natural capital and services, and political science surveys and interviews. The role of Forest Service decision-making, institutional philosophy, and response to change will be the centralizing concept among the case studies and the focal point for describing and projecting the resilience of the timber management system in southeast Alaska to various drivers of change. Sampling and analysis has been completed for the cedar decline study, which has received additional support to expand our geographical coverage. GIS and remote sensing data providing coverage in the southeast Alaska region are being analyzed to determine natural capital and services provided by wilderness areas. Lastly, ongoing research on policy subsystems, institutional behavior, and networks of influence has dealt with both theoretical foundations and “policy monopolies” by the USDA Forest Service relating to timber management on US public lands.

Snow Cover and Biology in the Arctic

Postdoctoral Researcher: Eugénie Euskirchen
Faculty: A. David McGuire
Funding Agency: National Science Foundation (NSF)

In terrestrial high-latitude regions, observations indicate recent changes in snow cover, permafrost, and soil freeze-thaw transitions due to climate change. These modifications may result in temporal shifts in the growing

season and the associated rates of terrestrial productivity. Changes in productivity will influence the ability of these ecosystems to sequester atmospheric CO_2. We use the Terrestrial Ecosystem Model (TEM), which simulates the soil thermal regime, in addition to terrestrial carbon, nitrogen and water dynamics, to explore these issues over the years 1960-2100 in extratropical regions (30˚-90˚N). Our model simulations show decreases in snow cover and permafrost stability from 1960 to 2100. Decreases in snow cover agree well with NOAA satellite observations collected between the years 1972-2000, with Pearson rank correlation coefficients between 0.58-0.65. Model analyses also indicate a trend towards an earlier thaw date of frozen soils and the onset of the growing season in the spring by approximately 2-4 days from 1988-2000. Between 1988 and 2000, satellite records yield a slightly stronger trend in thaw and the onset of the growing season, averaging between 5-8 days earlier. In both the TEM simulations and satellite records, trends in day of freeze in the autumn are weaker, such that overall increases in growing season length are due primarily to earlier thaw. Although regions with the longest snow cover duration displayed the greatest increase in growing season length, these regions maintained smaller increases in productivity and heterotrophic respiration than those regions with shorter duration of snow cover and less of an increase in growing season length. Concurrent with increases in growing season length, we found a reduction in soil carbon and increases in vegetation carbon, with greatest losses of soil carbon occurring in those areas with more vegetation, but simulations also suggest that this trend could reverse in the future. Our results reveal noteworthy changes in snow, permafrost, growing season length, productivity, and net carbon uptake, indicating that prediction of terrestrial carbon dynamics from one decade to the next will require that large-scale models adequately take into account the corresponding changes in soil thermal regimes.

Modeling the Contribution of Belowground Carbon Allocation and Productivity to Net Carbon Storage in the Upper Great Lakes Region

Postdoctoral Researcher: Eugénie Euskirchen
Faculty: A. David McGuire
Funding Agency: USDA Forest Service

It is important to quantify carbon (C) pools and fluxes across different vegetation types and successional stages in order to gain a better understanding of the processes that control the uptake, storage, and release of CO_2 in forest ecosystems. However, one ambiguity in our understanding of the forest carbon cycle in managed landscapes is the partitioning of C between roots and stems and belowground productivity over successional stages and across forest types. Recent empirical studies of commercial and widespread tree species, including red pine, Scot's pine, aspen, and sugar maple, have found evidence to suggest that the root-to-shoot ratios in young coniferous stands are proportionally higher than those in older coniferous stands, with the ratio typically peaking around the time of canopy closure.

Furthermore, root-to-shoot ratios in aspen stands may be much higher than pine stands early in stand development after harvest or disturbance and for sugar maple, later in stand development. Consequently, maple and aspen may allocate more C to roots relative to pine, and therefore store more C in roots, when the landscape is considered. Process-based forest ecosystem models may not adequately account for these dynamics due to a previous lack of information on belowground allocation and productivity, and the fact that many models only consider mature forest ecosystems. Given our lack of knowledge about belowground allocation and productivity across managed forest landscapes, the objectives of this study will (1) incorporate empirical data pertaining to belowground allocation and productivity estimates from chronosequence studies in the Upper Great Lakes Region into a process-based model, the Terrestrial Ecosystem Model (TEM), and (2) examine how the incorporation of these data into TEM affects estimates of primary productivity and C uptake in the Upper Great Lakes Region. This research will provide basic knowledge of how the consideration of the successional patterns in belowground processes affects regional-scale estimates of C sequestration.

Fire-mediated Changes in the Arctic System: Interactions of Changing Climate and Human Activities

Postdoctoral Researcher: Monika P. Calef
Faculty: A. David McGuire
Funding Agency: NSF

The overall purpose of this study is to document the changing role of fire, particularly as affected by human activities, on the Arctic Climate System and its human residents. In Alaska, annual wildfires consume large tracts of boreal forest leading to an annual area burned that varies several magnitudes between years, depending on local weather and fuel conditions. Humans influence wildfires directly via fire starts and suppression, though once fires exceed a certain size suppression is nearly impossible. While the effectiveness of fire suppression is apparent on a local scale, implications on a regional scale are less clear. We are using a GIS-based approach to evaluate regional fire suppression over two decades with fire management zone as an indicator for suppression effort. We chose three study areas located in the Interior of the State where most of the fires occur which cover over 9 million hectares combined. Using GIS, we overlaid fire polygons from 1984 to 2004 in the Alaska Large Firescar database with their respective fire management zones and extracted annual area burned. Results show that most of the area burned over the 20 years can be attributed to a few large fire years which differ among study areas but include 1988, 1990, 1993, 2001, 2002, and 2004. When all years are combined, total area burned significantly depends on designated fire management zone (Chi square test with alpha = 0.05); however, this is not the case when years are analyzed individually. Our study investigates what happens during these anomalous years when suppression seems to fail, and thereby our study contributes

valuable insights to the current debate on effectiveness of fire suppression in the boreal forest.

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 will integrate data on carbon dioxide and methane dynamics of the Arctic System using a combination of prognostic and inverse approaches and 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 will bring together diverse regional data sets and understanding in the context of a linked set of numerical model studies. It will examine, and attempt to quantify, the fluxes and links between the terrestrial, atmospheric and oceanic components of the Arctic carbon and methane cycles. A postdoctoral researcher (Daniel Hayes) has been recruited and will start conducting research on this project in fall 2006.

Carbon Responses along Moisture Gradients in Alaskan Landscapes

Postdoctoral Researcher: Shuhua Yi
Faculty: A. David McGuire
Funding Agency: Geologic Division/USGS (RWO 149)

Recent changes in the climate of Alaska are being observed in air and ocean temperatures and in long-term temperature records. Consequences of this change are being observed in glacier retreat, sea surface ice, longer growing seasons, increased drought, and increased permafrost degradation. 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. The interaction of large wildfires with permafrost is of central concern because of longer growing seasons and increased drought. We hypothesize

that fire may act as a trigger to the rapid degradation of permafrost in Interior Alaska. How carbon responds to changing climate and fire will affect carbon dynamics and will likely depend on interactions with soil moisture, which is quite variable in Alaskan landscapes. In this project we are assessing carbon reserves and their interaction with fire and permafrost along soil moisture gradients in Alaskan landscapes. We are currently developing a new suite of ecosystem modeling tools which are capable of simulating the linkages between fire, permafrost degradation and ecosystem dynamics. These models require robust sets of data that can be used to parameterize these models as well as to test their limitations and utility. Our objective is to develop a set of physical (temperature, moisture, radiation) and biogeochemical (e.g. C flux and quality) data that will facilitate accurate models of C exchange in boreal landscapes. In this study, we are developing these data sets and are going to use them in modeling studies. A technician is currently developing and organizing these data sets. A postdoctoral researcher (Shuhua Yi) has been recruited and will start conducting the modeling studies in fall 2006.

Biocomplexity: Feedbacks between Ecosystems and the Climate System

Student Investigator: Michael Balshi, PhD Biology
Advisor: A. David McGuire
Funding Agency: NSF through the Marine Biological Laboratory

Wildfire has the potential to release substantial quantities of carbon dioxide to the atmosphere, the effects of which could have impacts for the climate system because of the ability of carbon dioxide to trap heat near the surface of the earth. Wildfire is not well represented in large-scale models of ecosystem function and structure. In order to predict future changes in fire regime, we must first understand how the temporal and spatial aspects of fire influence carbon dynamics over the historical fire data record. To evaluate the temporal and spatial changes of carbon dynamics in response to CO_2, climate, and fire disturbance, we developed a fire module for the Terrestrial Ecosystem Model (TEM) and simulated carbon dynamics for the pan-boreal region north of 45° N from 1950-2002. We conducted three simulations: CO_2 fertilization only, CO_2 and climate variability, and CO_2, climate, and fire disturbance. Simulation results for the pan-boreal region north of 45° N indicate that C storage increased in response to CO_2, climate, and fire at a rate of 694.84 Tg C yr^{-1} between 1996 and 2002. Partitioning the effects of CO_2, climate, and fire for North America indicates that from 1959-2002, atmospheric CO_2 was responsible for sequestering 41.47 Tg C yr^{-1} (3.85 g C m^{-2} yr^{-1}), climatic variation was responsible for sequestering 37.87 Tg C yr^{-1} (3.52 g C m^{-2} yr^{-1}), and fire was responsible for releasing 9.15 Tg C yr^{-1} (0.81 g C m^{-2} yr^{-1}). Across Eurasia from 1996-2002, atmospheric CO_2 was responsible for sequestering 207.75 Tg C yr^{-1} (8.16 g C m^{-2} yr^{-1}), climatic variation was responsible for sequestering 50.89 Tg C yr^{-1} (1.99 g C m^{-2} yr^{-1}), and fire was responsible for sequestering 323.04 Tg C yr^{-}

^{1} (12.67 g C m^{-2} yr^{-1}). Our analysis suggests that CO_2, climate, and fire each play important roles in carbon dynamics across the pan-boreal region. It also shows that it is important to incorporate fire in a temporally and spatially explicit manner when estimating the effects of fire on carbon dynamics for the boreal forest region. Our next step in this study is to develop a fire model that can be coupled to TEM to evaluate carbon dynamics across the boreal forest for future scenarios of climate change. We expect to extend the model framework to the conterminous U.S. and to the tropics. Successful development and coupling of a prognostic fire model to global biogeochemical models will allow climate assessments to consider the response of wildfire to projected climate change and to evaluate how that response will influence global terrestrial carbon storage.

Magnitude, Rate, and Heterogeneity of Lake Drying in Wetlands on National Wildlife Refuges in Alaska

Student Investigator: Jennifer Roach, PhD Biology
Advisor: Brad Griffith
Funding Agency: USFWS

The full extent, magnitude, and heterogeneity of climate-induced lake drying in Alaskan National Wildlife Refuges is not known. Wetlands are the dominant land-cover type on Alaskan refuges and provide critical habitat for waterfowl and moose which are important subsistence resources. Understanding the magnitude and mechanisms behind changes in surface water area will be essential to predicting the potential effects on the abundance and distribution of these species. The objectives of this study are to (1) fully characterize the magnitude and rate of lake drying in Alaskan Refuge wetlands, (2) identify potential mechanisms behind lake drying, and (3) estimate the effects of lake drying to waterfowl and moose populations. The above objectives will be addressed by (1) comparison of remotely sensed imagery from 1950s to present to estimate changes in number of water bodies and surface water area in a sample of study regions stratified on the basis of possible mechanisms, (2) a comparative field based analysis of lakes randomly selected and stratified based on differential rates of drying, and (3) spatial analysis of waterfowl and moose survey data with respect to rates of lake drying. Expected results will help to identify regions within Alaska that are most susceptible to lake drying and will identify potential positive or negative effects on moose and waterfowl populations. This project will provide baseline habitat data necessary to effectively design and implement further studies to assess the potential relationships between climate-induced lake drying and changes in wildlife populations.

List of Abbreviations

ADFG Alaska Department of Fish and Game

AKCFWRU Alaska Cooperative Fish and Wildlife Research Unit

ARCUS Arctic Research Consortium of the United States

BLM Bureau of Land Management

CMI Coastal Marine Institute, UAF

DBW Department of Biology and Wildlife, UAF

DOE Department of Energy

EVOS Exxon-Valdez Oil Spill

GIS Geographical Information System

GPS Global Positioning System

IAB Institute of Arctic Biology, UAF

IMS Institute of Marine Science, UAF

MMS Minerals Management Service

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