Alaska Cooperative Fish and Wildlife Research Unit

Annual Report—2004

May 2005

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
- Ed Morgan: Student Assistant

Unit Students

Current

- Corey Adler, MS Wildlife (Powell)
- Stacia Backensto, PhD Biology (Powell)
- Michael Balshi, PhD Biology (McGuire)
- Elizabeth Baney, MS Fisheries (Margraf)
- Colin Beier, PhD Biology (McGuire)
- Jeremy Carlson, MS Fisheries (Margraf)
- Catharine Copass Thompson, PhD Biology (McGuire)
- Dave Gregovich, MS Fisheries (Wipfli)
- Christie Hendrich, MS Fisheries (Margraf)
- Deena Jallen, MS Fisheries (Margraf)
- Rachel Jones, MS Wildlife (Griffith)
- 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)
- Julie Morse, MS Wildlife (Powell)
- Isla Myers-Smith, MS Biology (McGuire)
- Jenny Neyme Polloczek, MS Fisheries (Margraf)
- John O'Brien, MS Fisheries (Margraf)
- Lincoln Parrett, MS Biology (Griffith)
- Laura Phillips, MS Wildlife (Powell)
- Miranda Plumb, MS Fisheries (Margraf)
- Dan Rinella, PhD Biology (Wipfli)
- Kathy Smikrud, MS Fisheries (Margraf
- Shelly Szepanski, PhD Biology (Griffith)
- Theresa Tanner, MS Fisheries (Margraf)
- Audrey Taylor, PhD Biology (Powell)
- Miranda Terwilliger, MS Biology (Griffith)

- Jason Valliere, MS Fisheries (Margraf)
- Brad Wendling, MS Wildlife (Griffith)
- Heather Wilson, PhD Biology (Powell)

Graduated (during CY)

- Anthony Eskelin, MS Fisheries (Margraf)
- Michael Knoche, MS Wildlife (Powell)
- Daniel Young, MS Fisheries (Margraf)

Post-Doctoral Researchers

- Christopher Binckley
- Monika Calef
- Eugénie Euskirchen

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
- Bruce Finney, Marine Science and Limnology/Institute of Marine Science (IMS), UAF
- Erich Follmann, Institute of Arctic Biology (IAB), Department of Biology and Wildlife (DBW), UAF
- Anthony Gharrett, SFOS, UAF, Juneau
- Gordon Haas, SFOS and UA Museum, Fairbanks
- Nicholas Hughes, SFOS, UAF
- Mark Lindberg, DBW/IAB, UAF
- Daniel Mann, IAB, UAF
- C. Peter McRoy, IMS, UAF
- Edward Murphy, DBW/IAB, UAF
- Eric Rexstad, IAB/DBW, UAF
- 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)
- Bryce Lake, MS Wildlife (Lindberg)
- 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
- David Safine, MS Wildlife (Lindberg)

Graduated (during CY)

- Blair Flannery, MS Fisheries-Juneau (Gharrett)
- Joshua Schmidt, MS Wildlife (Rexstad)

Cooperators

- Brian Barnes–Director, Institute of Arctic Biology, University of Alaska Fairbanks
- Robert Davison–Northwest Representative, Wildlife Management Institute
- Kevin Duffy–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 2004. The Unit engages in research on living natural resources for a variety of State and Federal agencies. As an unbiased research organization, the Unit provides information requested and funded by these agencies. When studies are completed, the agencies use the information to assist in their natural resource management efforts. Most of the research is conducted by graduate students, many of whom go on to work for the agencies upon graduation.

The Alaska Unit was established in 1950, providing over half a century of research dedicated to helping conserve and enhance the living natural resources of the State and the Arctic Region. The Unit is part of a larger and even older program, the U.S. Department of the Interior's Cooperative Research Unit Program. Established in 1935, Cooperative Research Units were created to fill the vacuum of wildlife management information and the shortage of trained wildlife biologists. In 1960, the Unit Program was formally sanctioned by Congress with the enactment of the Cooperative Units Act. Each unit is a partnership among the Biological Research Division of the U.S. Geological Survey, a State fish and game agency, a host university, and the Wildlife Management Institute. Staffed by Federal personnel, Cooperative Research Units conduct research on renewable natural resource questions; participate in the education of graduate students destined to become natural resource managers and scientists; provide technical assistance and consultation to parties who have legitimate interests in natural resource issues; and provide continuing education for natural resource professionals. Presently, there are Cooperative Research Units in 38 states, conducting research on virtually every type of North American ecological community.

The Program is staffed by more than 110 PhD scientists who advise as many as 650 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: 5
Presentations: 30
Scientific and Technical Publications: 21

Graduate Committee Assignments

- Corey Adler, MS (Griffith)
- Richard Bernhardt, PhD (Margraf)
- Thomas Braille, PhD (Powell)
- Karen Clyde-Lien, MS (Griffith)
- Nathan Coutsoubos, PhD (Powell)
- Paul Duffy, PhD (McGuire)
- Greg Finstad, PhD (Griffith)
- Nancy Fresco, PhD (McGuire)
- Dave Gregovich, MS (Margraf)
- Ron Heintz, PhD (Wipfli)
- 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)
- Heidi Weigner, PhD (Margraf)
- Lijie Zhu -PhD (McGuire)

Courses Taught

- Contemporary Issues in Fisheries Science (Margraf, 1 credit hour, Spring 2004)
- Foraging Ecology (Griffith, 2 credit hours, Spring 2004)
- Freshwater Food Webs (Wipfli, 1 credit hour, Fall 2004)
- Integrative Modeling of Natural and Social Systems (McGuire, 4 credit hours, Fall 2004)
- Ornithology (Powell, 3 credit hours, Spring 2004)
- Quantitative Fisheries Science (Margraf, 3 credit hours, Spring 2004)

University Committees and Workgroups

- Chair, Faculty Search Committee (Margraf)
- Chair, Anthropology Program Review (2003-2004) (McGuire)
- Member, UAF/IAB Management and Budget Committee (Margraf)
- Member, UAF/IAB Space Utilization Committee (Margraf)
- Chair, Graduate Comprehensive Exam Committee (Griffith)
- Member, Executive Committee for the Regional Resilience and Adaptation Interdisciplinary Graduate Program, University of Alaska Fairbanks (McGuire)
- Member, Leadership Committee for Bonanza Creek Long-Term Ecological Research Program (McGuire)
- Member, Research Advisory Committee (Griffith)
- Space Committee, Coop Unit Representative, IAB (Powell)

Editorships

Auk—American Ornithologists' Union (Powell)

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,Committee to draft the Implementation Plan for the North American Carbon Program (NACP), a research activity supported through several federal agencies (McGuire)
- Member, Boreal Partners in Flight Task Force (Powell)
- Board Member, Scientific Advisory Committee Member Alaska Bird Observatory (Powell)
- 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, 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, 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, Committee to draft the Science Plan for the Northern Eurasian Earth System Partnership Initiative (NEESPI), an international research activity (McGuire)
- Member, Executive Committee, Alaska Shorebird Working Group (Powell)

Honors and Awards

- AOU Student Membership Award given by American Ornithologists Union to Julie Morse
- Angus Gavin Memorial Bird Research Grant given by University of Alaska Foundation to Heather Wilson
- Best Student Poster Award given by Pacific Seabird Group to Heather Wilson
- Graduate Research Fellowship given by UAF, Department of Biology and Wildlife to Audrey Taylor

- Sandpiper Technology Equipment Grant given by Sandpiper Technology to Rebecca McGuire.
- Sea Duck Joint Venture Grant given by Sea Duck Joint Venture to Heather Wilson
- Sigma Xi Grants-in-Aid-of-Research given by Sigma Xi to Audrey Taylor.

Outreach and Info Transfer

Alaska's Eiders. Presentation at Alaska Bird Observatory by Heather Wilson, Laura Phillips, Rebecca McGuire, and Mike Knoche. (Powell)

McGuire, R. L., L. Phillips, R. Suydam, and A. N. Powell. Breeding Biology and Habitat Use by King Eider (*Somateria spectabilis*) at Teshekpuk Lake and Kuparuk)Oilfields on the North Slope of Alaska. Oral paper presented at the Coastal Marine Institute Annual Research Review. (Powell)

Phillips, L., A. N. Powell, and E. Taylor. Migration Ecology of King Eiders. Oral paper presented at the Coastal Marine Institute Annual Research Review. (Powell)

Phillips. L. A., A. N. Powell, and E. Taylor. Migration Ecology of King Eiders. Alaska Forum on the Environment, Anchorage, AK. (Powell)

Powell, A. N. and Heather Wilson. Survival and Reproduction of Pacific Common Eiders (*Somateria mollissima v-nigrum*) on the Yukon Kuskokwim Delta, Alaska. Report to the Sea Duck Joint Venture, Endorsed Study No. 41. http://www.seaduckjv.org/ssna.html (Powell)

Powell, A. N., E. Taylor, E. Rexstad, and L. Phillips. Importance of the Alaskan Beaufort Sea to King Eiders. Report to the Sea Duck Joint Venture. http://www.seaduckjv.org/ssna.html (Powell)

Powell, A. N., R. Suydam, R. McGuire, and L. Phillips. Breeding biology and habitat use of King Eiders on the Coastal Plain of Northern Alaska. Report to the Sea Duck Joint Venture, Endorsed Study No. 25. http://www.seaduckjv.org/ssna.html (Powell)

Papers Presented

- Chapin, F. S. III, L. DeWilde, P. Duffy, T. S. Rupp, A. D. McGuire, E. Kasischke, D. Mann, T. Verbyla, S. Trainor, and M. Calef. May 2004. Scale-Dependency of Human-Fire Interactions in the Alaskan Boreal Forest. 12th Conference of the International Boreal Forest Research Association, Fairbanks, AK. Invited.
- Chapin, F. S. III, L. DeWilde, S. Trainor, M. Calef, A. D. McGuire, and T. S. Rupp. August 2004. Vulnerability and Resilience in a Directionally Changing World: Interactions of Social and Ecological Variables Governing the Fire Regime in Interior Alaska. Annual Meeting, Ecological Society of America, Portland, OR.
- Griffith, B., D. C. Douglas, R. G. White, D. E. Russell, and P. A. McNeil. September 2004. Differential Effects of Summer and Winter Warming on Caribou Habitats: Population Implications. 11th Annual Conference, The Wildlife Society, Calgary, Alberta.

- Griffith, B., D. C. Douglas, R. G. White, and D. E. Russell. 2004. Climate, Fall Forage Availability, and Parturition in Barren-Ground Caribou. 10th North American Caribou Workshop, Girdwood, Alaska.
- Kimbirauskas, R. K., R. W. Merritt, M. S. Wipfli, and P. E. Hennon. 2004. Macroinvertebrate Community Response to Riparian Red Alder in Forested Headwaters of Southeastern Alaska. Annual Meeting, North American Benthological Society, Vancouver, Canada.
- Knoche, M., A. N. Powell, P. Barboza, M. Wooller, and L. Quakenbush. August 2004. King Eider Wing Molt: Inferences from Stable Isotope Analyses. Annual Meeting, American Ornithologists Union, Quebec City, QC, Canada.
- McGuire, A. D. May 2004. Climate Disturbance Interactions in Boreal Forest Ecosystems. Opening presentation, 12th Conference of the International Boreal Forest Research Association, Fairbanks, AK.
- McGuire, A. D., L. A. Joyce, J. S. Clein, D. P. Coulson, and T. J. Burnside. August 2004. Historical Changes in Carbon Storage of the Eastern United States: Uncertainties Associated with Forest Harvest and Agricultural Activities. Annual Meeting, Ecological Society of America, Portland, OR.
- Morse, J. A., A. N. Powell and M. Tetreau. August 2004. Productivity of Black Oystercatchers at Kenai Fjords National Park: Assessing the Effects of Recreational Disturbance. Annual Meeting, American Ornithologists Union, Quebec City, QC, Canada.
- Phillips, L., A. N. Powell, and E. Taylor. August 2004. Molt Migration and Ecology of King Eiders. Annual Meeting, American Ornithologists Union, Quebec City, QC, Canada.
- Schmidt, J., A. N. Powell, E. Rexstad, and E. Taylor. March 2004. Incubation Rates and Patterns in a Nest-Box Population of Common Goldeneyes in Interior Alaska. Alaska Bird Conference, Anchorage.
- Wipfli, M. S. March 2004. Food Versus Habitat: Understanding the Significance of Food and Nutrient Subsidies in Salmonid Food Webs. Special Session, Food Webs and Fish Carrying Capacity. Annual Meeting, Western Division American Fisheries Society, Salt Lake City, UT.
- Wipfli, M. S. 2004. Prey and Detritus Subsidies in Riverine Ecosystems: A Watershed Perspective of Marine, Terrestrial, and Headwater Inputs for Fish-Bearing Food Webs in Coastal Alaska. Special Session, New Directions in Food Web Analysis. Annual Meeting, North American Benthological Society, Vancouver, Canada.
- Backensto, S., A. N. Powell, G. Kofinas, and C. Gerlach. March 2004. The Common Raven on the North Slope of Alaska: Wildlife Management and the Human Dimension. Alaska Bird Conference, Anchorage.
- Balshi, M., D. Verbyla, and A. D. McGuire. May 2004. Evaluating the Influence of Historical Wildlife Scars and Climate on Regional NDVI Changes in Alaska. 12th Conference of the International Boreal Forest Research Association, Fairbanks, AK.
- Beier, C. M., G. P. Juday, P. E. Hennon, D. D'Amore, A. D. McGuire, and F. S. Chapin III. May 2004. Dendroclimatology of Declining *Chamaecyparis nootkatensis* (Yellow Cedar) Forests in Southeast Alaska. 12th Conference of the International Boreal Forest Research Association, Fairbanks, AK.

- Calef, M. P., A. D. McGuire, and T. S. Rupp. May 2004. Human Impacts on Fire in the Western Arctic: A Statistical Assessment at the Regional Scale. 12th Conference of the International Boreal Forest Research Association, Fairbanks, AK.
- Eskelin, A. A., F. J. Margraf, and J. J. Hasbrouck. March 2004. Precision of Trap Efficiency Experiments to Estimate Coho Salmon Smolt Abundance in Small Streams. Annual Meeting, Western Division American Fisheries Society, Salt Lake City, UT.
- Jallen, D. M. and F. J. Margraf. March 2004. Developing a Method for Quantification of Chinook Salmon *Oncorhynchus tshawytscha* Spawning Habitat in the Yukon-Kuskokwim River Delta Using Stocks and Habitat in the Tuluksak River. Annual Meeting, Western Division American Fisheries Society, Salt Lake City, UT.
- Jallen, D. M., F. J. Margraf, and K. Harper. August 2004. Quantification of Chinook Salmon Spawning Habitat in the Kuskokwim River Basin. Annual Meeting, American Fisheries Society, Madison, WI.
- Knudsen, E. E., E. W. Symmes, and F. J. Margraf. May 2004. Advances in Alternative Modeling for Evaluation of Salmon Production Potential and Harvest Scenarios. Fourth World Fisheries Congress, Vancouver, BC, Canada.
- McGuire, R., L. Phillips, A. N. Powell, and R. Suydam. March 2004. Factors Influencing King Eider Nest Survival on Alaska's North Slope. Alaska Bird Conference, Anchorage.
- Meka, J. M. and F. J. Margraf. August 2004. Application of a Bioenergetics Model to Evaluate the Effects of Catch-and-Release Angling and Hooking Injury on Rainbow Trout Growth in Alaska. Annual Meeting, American Fisheries Society, Madison, WI.
- Morse, J. A., A. N. Powell, and M. Tetreau. March 2004. Assessing Effects of Recreational Activity on Productivity of Black Oystercatchers in Kenai Fjords National Park. Alaska Bird Conference, Anchorage.
- Neyme Polloczek, J., N. F. Hughes, and F. J. Margraf. March 2004. Environmental Processes Affecting Population Dynamics and Life History Traits of Arctic Grayling Populations in Western and Interior Alaska. Annual Meeting, Western Division American Fisheries Society, Salt Lake City, UT.
- O'Brien, J., F. J. Margraf, and K. Harper. August 2004. Understanding the Link between River Features and Habitat for Spawning Chum Salmon. Annual Meeting, American Fisheries Society, Madison, WI.
- Thompson, C., J. Beringer, A. D. McGuire, and F. S. Chapin III. August 2004. Carbon Exchange along a Gradient from Arctic Tundra to Boreal Treeline. Annual Meeting, Ecological Society of America, Portland, OR.
- Wilson, H. M. and A. N. Powell. March 2004. Selenium in Alaskan Eiders: Patterns and Consequences of Exposure. Alaska Bird Conference, Anchorage.
- Zhuang, Q., J. M. Melillo, D. W. Kicklighter, B. S. Felzer, A. D. McGuire, A. Sokolov, R. G. Prinn, P. A. Steudler, and S. Hu. August 2004. The Global Warming Potential Budget of Net Methane and Carbon Dioxide Exchanges

in Northern High Latitudes. Annual Meeting, Ecological Society of America, Portland, OR.

- Zhuang, Q., J. M. Melillo, D. W. Kicklighter, B. S. Felzer, A. Sokolov, R. G. Prinn, A. D. McGuire, P. A. Steudler, and S. Hu. May 2004. The Relationship of Global Warming Potentials to Methane and Carbon Dioxide Exchanges in Northern High Latitudes Estimated with a Process-Based Biogeochemistry Model. 12th Conference of the International Boreal Forest Research Association, Fairbanks, AK. Invited.

Scientific Publications

- Chaloner, D. T., G. A. Lamberti, R. W. Merritt, N. L. Mitchell, P. H. Ostrom, and M. S. Wipfli. 2004. Variation in responses to spawning Pacific salmon in three southeastern Alaska streams. Freshwater Biology 49:587-599.
- Csiszar, I., C. O. Justice, A. D. McGuire, M. A. Cochrane, D. P. Roy, F. Brown, S. G. Conard, P. G. H. Frost, L. Giglio, C. Elvidge, M. D. Flannigan, E. Kasischke, D. J. McRae, T. S. Rupp, B. J. Stocks, and D. L. Verbyla. 2004. Land use and fires. Chapter 19 (pp. 329-350) in G. Gutman, A. C. Janetos, C. O. Justice, E. F. Moran, J. F. Mustard, R. R. Rindfuss, D. Skole, B. L. Turner II, and M. A. Cochrane. 2004. Land Change Science: Observing, Monitoring, and Understanding Trajectories of Change on the Earth's Surface. Kluwer Academic Press, Dordrecht, Netherlands.
- Dion, C. A. and N. F. Hughes. 2004. Testing the ability of a temperature-based model to predict the growth of age-0 Arctic grayling. Transactions of the American Fisheries Society 133:1047-1050.
- Eckmayer, W. J., and F. J. Margraf. 2004. The influence of diet, consumption, and lipid use on recruitment of white bass. Lakes & Reservoirs: Research & Management 9:133-141.
- Epstein, H. E., J. Beringer, W. A. Gould, A. H. Lloyd, C. D. Thompson, F. S. Chapin III, G. J. Michaelson, C. L. Ping, T. S. Rupp, and D. A. Walker. 2004. The nature of spatial transitions in the Arctic. Journal of Biogeography 31:1917-1933.
- Eyler, S. M., L. E. Vogel, and F. J. Margraf. 2002. Effectiveness of a fish passage facility for anadromous river herring recruitment. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 56:55-64.
- Heintz, R. A., B. D. Nelson, J. P. Hudson., M. Larsen, L. Holland, and M. S. Wipfli. 2004. Marine subsidies in freshwater: Effects of salmon carcasses on the lipid class and fatty acid composition of juvenile coho salmon. Transactions of the American Fisheries Society 133:559-567.
- Kittel, T. G. F., N. A. Rosenbloom, J. A. Royle, C. Daly, W. P. Gibson, H. H. Fisher, P. Thornton, D. N. Yates, S. Aulenbach, C. Kaufman, R. McKeown, D. Bachelet, D. S. Schimel, and VEMAP2 Participants (including A. David McGuire). 2004. The VEMAP Phase 2 Bioclimatic Database I: A gridded historical (20th Century) climate dataset for modeling ecosystem dynamics across the conterminous United States. Climate Research 27:151-170.
- Kruse, J. A., R. G. White, H. E. Epstein, B. Archie, M. Berman, S. R. Braund, F. Stuart Chapin III, J. Charlie, Sr., C. J. Daniel, J. Eamer, N.

Flanders, B. Griffith, S. Haley, Lee Huskey, B. Joseph, D. R. Klein, et al. 2004. Modeling sustainability of arctic communities: An interdisciplinary collaboration of researchers and local knowledge holders. Ecosystems 7:1-14, DOI 10.1007/s10021-004-0008-z.

- Margraf, F. J. 2004. Book review: Sustaining North American Salmon: Perspectives Across Regions and Disciplines, edited by K. D. Lynch, M. L Jones, and W. W. Taylor, American Fisheries Society, Bethesda, MD, 2002. Fisheries 29(11):39.
- McGuire, A. D., M. Apps, F. S. Chapin III, R. Dargaville, M. D. Flannigan, E. S. Kasischke, D. Kicklighter, J. Kimball, W. Kurz, D. J. McRae, K. McDonald, J. Melillo, R. Myneni, B. J. Stocks, D. L. Verbyla, and Q. Zhuang. 2004. Land cover disturbances and feedback to the climate system in Canada and Alaska. Chapter 9 (pp. 139-161) in G. Gutman, A. C. Janetos, C. O. Justice, E. F. Moran, J. F. Mustard, R. R. Rindfuss, D. Skole, B. L. Turner II, and M. A. Cochrane, eds. Land Change Science: Observing, Monitoring, and Understanding Trajectories of Change on the Earth's Surface. Kluwer Academic Press, Dordrecht, The Netherlands.
- Orlikowska, E. H., R. L. Deal, P. H. Hennon, and M. S. Wipfli. 2004. Role of red alder in riparian forest structure along headwater streams in southeastern Alaska. Northwest Science 78:111-123.
- Reynolds, J. B. and F. M. Holliman. 2004. Injury of American eels captured by electrofishing and trap-netting. North American Journal of Fisheries Management 24:686-689.
- Stow, D., A. Hope, A. D. McGuire, D. Verbyla, J. Gamon, K. Huemmrich, S. Houston, C. Racine, M. Sturm, K. Tape, K. Yoshikawa, L. Hinzman, C. Tweedie, B. Noyle, C. Silapaswan, D. Douglas, B. Griffith, G. Jia, H. Epstein, D. Walker, S. Daeschner, A. Petersen, L. Zhou, and R. Myneni. 2004. Remote sensing of vegetation and land-cover changes in Arctic tundra ecosystems. Remote Sensing of Environment 89:281-283.
- Thompson, C. D., J. Beringer, F. S. Chapin III, and A. D. McGuire. 2004. Structural complexity and land-surface energy exchange along a gradient from arctic tundra to boreal forest. Journal of Vegetation Science 15:397-406.
- Wipfli, M. S. and J. Musslewhite. 2004. Density of red alder (*Alnus rubra*) in headwaters influences invertebrate and organic matter subsidies to downstream fish habitats in Alaska. Hydrobiologia 520:153-163.
- Zhuang, Q., J. M. Melillo, D. W. Kicklighter, R. G. Prinn, A. D. McGuire, P. A. Steudler, B. S. Felzer, and S. Hu. 2004. Methane fluxes between terrestrial ecosystems and the atmosphere at northern high latitudes during the past century: A retrospective analysis with a process-based biogeochemistry model. Global Biogeochemical Cycles 18:GB3010, doi:10.1029/2004GB002239.

Technical Publications of Federal Staff

- Griffith, B. and S. Szepanski. 2004. Lake Clark National Park and Preserve moose habitat and condition study. Annual Progress Report, RWO 133, to USGS/BRD. 2 pp.

- Morse, J. A. and A. N. Powell. 2003. Nesting habitat and breeding distribution of Marbled Godwits on the Alaska Peninsula: A preliminary assessment using GIS land cover data. Final Report. USGS Alaska Biological Science Center, Anchorage, AK. 21 pp.
- Musslewhite, J. and M. S. Wipfli. 2004. Effects of alternatives to clearcutting on invertebrate and detritus transport from headwaters in southeastern Alaska. General Technical Report PNW-GTR-602, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.
- Wipfli, M. S. and R. L. Deal. 2004. Ecological payoffs from red alder in southeastern Alaska. Pacific Northwest Research Station Report—Science Findings. Issue 63.

Theses and Dissertations of Unit Graduate Students

- Eskelin, A. A. 2004. An assessment of trap efficiency to estimate coho salmon smolt abundance in a small Alaskan stream. MS Thesis, University of Alaska Fairbanks. 65 pp.
- Knoche, M. J. 2004. King eider molt: Inferences from stable isotope analyses. MS Thesis, University of Alaska Fairbanks. 79 pp.
- Young, D. B. 2004. The migration and spawning distribution of sockeye salmon within Lake Clark, Alaska. MS Thesis, University of Alaska Fairbanks. 72 pp.

Theses and Dissertations of Affiliated Graduate Students

- Flannery, B. G. 2004. Application of molecular markers to mixed-stock analysis of Yukon River fall chum salmon. MS Thesis, University of Alaska Fairbanks. 89 pp.
- Schmidt, J. H. 2004. Duckling survival and incubation behaviors in common goldeneyes in Interior Alaska. MS Thesis, University of Alaska Fairbanks. 170 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

An Assessment of Trap Efficiency to Estimate Coho Salmon Smolt Abundance in a Small Alaskan Stream

Student Investigator: Anthony Eskelin, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: ADFG
In-Kind Support: Sport Fish Division/ADFG, Region II

Note: Tony Eskelin graduated from UAF in August 2004. His thesis abstract follows:

Abstract—Smolt abundance is commonly estimated using trap efficiency-based methods; however, few studies have investigated the accuracy of trap efficiency estimates. The objectives of this study were to (1) test the hypotheses that (i) trap efficiency is not affected by release timing nor release distance, (ii) trap efficiency-based estimates of smolt abundance are concordant with smolt-adult mark-recapture estimates, and (2) evaluate if water level and turbidity influence trap efficiency. In Deep Creek, Alaska, during 2001 and 2002, coho salmon *Oncorhynchus kisutch* smolt abundance was estimated using trap efficiency-based methods and compared to independent smolt-adult mark-recapture estimates. Marked smolts were released at two times of day (1200 hours and 0000 hours) and two release distances upstream of the trap (400 m and 1500 m) every 2 to 4 d throughout each year. Trap efficiency estimates were highly variable (range 0%-55%) and trap efficiency-based estimates of abundance were not concordant with smolt-adult mark-recapture estimates. Release timing and turbidity significantly influenced trap efficiency, whereas release distance did not. Several assumptions of the trap efficiency approach were not met, which produced biased estimates and conflicting results among years when comparing estimation techniques. These results suggest that assumptions of the trap efficiency-based methods be fully assessed to accurately estimate smolt abundance.

Application of Molecular Markers to Mixed-Stock Analysis of Yukon River Fall Chum Salmon

Student Investigator: Blair Flannery, MS Fisheries
Principal Investigator: Anthony Gharrett
Funding Agencies: USFWS (RWO 92)

Note: Blair Flannery graduated from UAF in May 2004. His thesis abstract follows:

Abstract—Country of origin provides the basis for allocating harvests of Yukon River chum salmon. The genetic divergence among Yukon River chum salmon populations adjacent to the international border as revealed by allozyme and microsatellite variation is insufficient to determine the country of origin of returning fish using mixed-stock analysis (MSA). Consequently, we investigated the resolution provided by alternative genetic markers in an attempt to detect levels of divergence that would be sufficient for MSA. We analyzed 10 Yukon River chum salmon populations for variation at 30 variable amplified fragment length polymorphism (AFLP) loci and for mitochondrial DNA (mtDNA) restriction site variation. We assessed these markers for their utility in MSA and, for mtDNA, phylogeographic analysis. The AFLP results show that MSA was most successful when mixtures were allocated to regions. The AFLP data were able to provide improved country of origin MSA estimates for the border populations with a 6.5% improvement for the Canadian populations over microsatellite analysis. No divergence in mtDNA haplotype frequency distributions was detected ($P>0.05$) within the Yukon River. Lack of mtDNA convergence likely resulted from a Pleistocene bottleneck that led to panmixia of the mtDNA genome.

The Migration and Spawning Distribution of Sockeye Salmon within Lake Clark, Alaska

Student Investigator: Daniel Young, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: None
In-Kind Support: Fully supported by Alaska Science Center/USGS. Logistic support furnished by Lake Clark National Park and Preserve, NPS.

Note: Dan Young graduated from UAF in August 2004. His thesis abstract follows:

Abstract—Recent declines in the number of sockeye salmon *Oncorhynchus nerka* returning to Lake Clark, Alaska have caused economic hardship in the region and raised resource concerns among local subsistence users and Federal managers. A lack of information regarding the distribution of spawning habitats in the glacially turbid Lake Clark watershed instigated this research. Radio telemetry was used to (1) determine the in-lake movement patterns of adult sockeye salmon and (2) identify sockeye salmon spawning

locations. Sockeye salmon were radio tagged as they entered Lake Clark and tracked to spawning locations. After entering Lake Clark, sockeye salmon usually migrated to a region of the lake that was within 15 km of their spawning location. Tagged fish migrated faster and more directly to spawning locations in tributary rivers and lakes than to Lake Clark beaches. Thirty-three spawning locations were identified in the Lake Clark watershed including 18 new spawning locations compared to previous scientific research and 10 compared to traditional local knowledge. Most radio tagged sockeye salmon (65%) returned to spawning locations in glacially turbid waters and most spawning locations (75%) were adjacent to privately owned lands. Protective measures should be taken to conserve both migration corridors and spawning habitats.

Ongoing Aquatic Studies

Distribution of Non-*Oncorhynchus* Salmonids in the Ugashik Lakes in Southwestern Alaska

Student Investigator: Miranda Plumb, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: USFWS (RWO 111)
In-Kind Support: Boat, technical assistance and equipment provided by King Salmon Fish and Wildlife Field Office/FWS during field season

Few studies have investigated resident salmonids in Southwestern Alaska. Basic biological information is needed to accurately document the current status of resident fish. The Ugashik Lakes are warm thereimictic, meaning that they typically lack thermal structure. Normally, in deep lakes fish are distributed according to the temperature structure of the lake, but due to the lack of a thermocline, distributions should be influenced by other factors, such as depth, physical habitat features, or food availability. The object of our study was to determine if resident salmonids (Arctic char, lake trout, round whitefish, pygmy whitefish, Arctic grayling, Dolly Varden) were distributed according to depth, substrate particle size, or other physical habitat features. The lakes were divided into four areas or zones, each with three different depth strata. Random sample sites were chosen within each zone and depth strata, and a gill net was set at each site. Depth, water temperature at depth, substrate particle size, and other environmental factors were recorded. Dominant substrate particle size was recorded with the use of an underwater camera. Based on preliminary analysis, depth appears to be the principal determinant of distribution, but other factors such as substrate particle size and food availability may also play a role.

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)
In-Kind Support: Technical assistance and equipment provided by USFWS

A study of chum salmon (*Oncorhynchus keta*) spawning habitat was conducted from June 2002 to January 2005 on the Tuluksak River in Southwestern Alaska. Chum salmon are reported to favor riverine spawning sites that are influenced by both hyporheic upwelling water and groundwater upwelling. Landscape topography and channel morphology constitute hydraulic controls that create these preferred spawning conditions. Large-scale river features were identified by aerial photographs, satellite images (LANDSAT-7), and synthetic aperture radar images (SAR). These large-scale features, including sinuosity, abandoned channels and the size and density of adjacent lakes, were measured and mapped using a GIS system. 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 and among small-scale variables, large-scale variables and spawning areas. The results were compared with known habitat preferences and tolerance ranges for chum salmon found in the literature and used to develop a conceptual model and a habitat-based biological escapement goal for the Tuluksak River.

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

A disparity of growth and life history characteristics in Arctic grayling (*Thymallus arcticus*) species has been observed between Western and Interior Alaska. Arctic grayling are considered to be one of the top three freshwater sport fish by anglers in the state of Alaska (Armstrong 1986). However, the regional differences found in Western and Interior grayling populations remain poorly documented in the existing literature. By studying population response to environmental conditions we hope to expand our understanding of grayling to other regions in Alaska and throughout the range of this species. The primary objectives of this study were to identify regional differences in growth and maximum size of Arctic grayling in Western and Interior Alaska and determine what environmental factors may be responsible for the disparity. The life history traits that form the basis for our comparison include growth, maximum size, annual survival, maximum

age, age at maturity, and reproductive investment. We gathered data on physical and biological aspects of the habitat and applied several foraging models to the data to understand regional differences in forage potential. We also conducted prey and diet sampling to understand prey preference. Estimated maximum size for Western grayling was at least 20% longer than interior grayling in each of the study years. Annual survival was also higher in Western region adult populations. We found that traditional and Net Rate of Energy Intake modeling methods of evaluating forage potential for Arctic grayling were inadequate to explain the differences found in growth and maximum size for Western and Interior populations. However, new information gained from this study on alternative prey sources and temperature regimes indicates that Western habitat is more favorable for increased growth. With this project we intend to provide a tool for managers and researchers interested in understanding regional diversity of this highly popular sport fish. We feel that a firm understanding of regional diversity is important for the proper management and enhancement of this species.

Assessment of Habitat Variables on Fish Condition for Four Arctic Species

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 condition factors for Arctic cod, Arctic flounder, Arctic cisco and Dolly Varden to simple habitat parameters. The study will also provide an opportunity to ground-truth habitat conditions identified by remote sensing. Fish will be captured in various types of nets. Condition of targeted species will be assessed using bioelectrical impedance analysis. Habitat data will be gathered and compared to fish condition information. It is expected that bioelectrical impedance analysis will contribute to the creation of a model that explains the relationship between fish condition and habitat variables. This project is part of a larger project that will try to incorporate remote sensing into the estimation of fish condition by looking at habitat variables such as sea surface temperature, salinity, and turbidity. The use of remote sensing tools could eliminate or reduce the need for time-consuming ground measurements.

Inconnu (*Stenodus leucichthys*) Spawning Habitat Selection: A Remote Sensing-based Predictive Model

Student Investigator: Theresa Tanner, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: USFWS (RWO 127)
In-Kind Support: Technical assistance and equipment from Fairbanks Fish and Wildlife Field Office, USFWS during field season

The purpose of this study is to build a GIS-based habitat model that can be used to effectively direct search efforts for the spawning habitats of inconnu (*Stenodus leucichthys*) in freshwater systems. This filtering technique will be useful because of the difficulty in identifying spawning habitat due to large survey areas, limited access in remote areas, short detection intervals for spawning habitat (<4 weeks), and challenging environmental conditions (i.e., freezing temperatures, remote areas). A two-stage, multi-resolution procedure will be implemented to create the predictive model. The first step will allow users to evaluate a watershed with widely available course resolution data to determine if appropriate spawning habitat is likely, and if so, approximately where within the drainage might it occur. This first step allows the user to justify the acquisition of finer resolution images that may not be readily available and/or are expensive to obtain. Images with a fine resolution are necessary due to the scale and linearity of river systems, but are not available for most of Alaska. The second step will allow the user to closer identify the stream reaches in question for habitat suitability. GIS software will analyze the spatial coincidence of input data layers (e.g., stream feature variables, such as substrate) to identify areas of habitat preference for the predictive model. Ground truthing will allow for a measure of confidence in the accuracy of the remotely gathered data. Lastly, the predictive model, based on the Selawik River spawning grounds, will be tested against other Alaska rivers with known inconnu spawning areas.

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, harvest rates and escapement goals for Chinook salmon historically have been based on spawner-recruit relationships derived from intensive stock assessments that require many years of data. The intent of our study was to explore habitat-based approaches to setting escapement goals for Chinook salmon on the Unuk River in Southeast Alaska. The Alaska Department of Fish and Game has monitored these runs since the mid-1970s. Sufficient data now exist to establish escapement goals using

relationships of large spawners to smolt production, large spawners to adult production, and large spawners to adult production, with an index of marine survival as a covariate. An alternative to traditional methods is being explored, guided by the assumption that smolt production is constrained by freshwater habitat capacity. In 2000, we began to collect spatially referenced habitat information including spawning stream surveys and an inventory of rearing areas. Surveys of adult spawners have been conducted since 2003. These surveys provide information needed to estimate spawning area and spawner-densities to be evaluated in the context of available habitat information. Relationships between spawning habitat and fish densities will be evaluated for potential application toward a habitat-based escapement goal.

A Remote Sensing Approach to Analyzing Spatial and Temporal Habitat Variables to Detect Potential Salmon Rearing Habitat in the Unuk River, 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

On-site sampling of large, glacial rivers is difficult given their size and typically complex habitat. Managers need alternative methods to effectively document and monitor changes in fish habitat within these large rivers. New methods will aid managers in determining if watersheds are spawning or rearing limited for salmon production. The objective of this study is to determine if habitat and geomorphic variables can be derived from high-resolution digital images and satellite imagery and used to model for potential salmon rearing habitat in the Unuk River, Southeast Alaska. Commercial image processing software and a geographic information system (GIS) were used to process and analyze the digital aerial and satellite images. Results relate spatial and temporal data on large wood dynamics (quantity and distribution), surface water temperature, geomorphic variables, and locations of juvenile salmon. The final output map remotely characterizes probability of occurrence for salmon rearing habitat. 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.

The Eelgrass Ecosystem of Izembek Lagoon: Retrospective Analysis and Development of a Protocol for Future Monitoring

Principal Investigator: C Peter McRoy
Funding Agency: USFWS (RWO 124)
Other Support: ARCUS, Sea Grant

The overall goal of this project is to transfer data collected by numerous studies carried out since 1963 on the eelgrass community and environment of Izembek Lagoon to electronic media, to analyze the data for long-term changes with a focus on response to the impact of climate change, and eventually to develop a plan for a monitoring program of the health of the eelgrass community. The major objective of the project is to create a publicly available database that will allow comparisons of the eelgrass population in Izembek Lagoon between sites and years to evaluate the impact of climate change. A secondary objective is to use the historical data in combination with recently acquired data to design a monitoring program that can be used by USFWS to assess the health of the eelgrass populations. First I developed a standardized format and procedure for entering data from old field notebooks into electronic media. Wherever possible I used original field notes and data forms. While it seems a straightforward task, the interpretation of field notes, verifications of sample identification and location information collected by many individuals over many years is fraught with ambiguities. The initial effort in data transfer was to resolve these problems. Data are entered into an Excel spread sheet format and eventually a CD-ROM will be produced that can be widely distributed. With support from ARCUS, I have been able to return to Izembek Lagoon each fall since 2002 in conjunction with the USFWS Eider Journey program. Eider Journey sponsors a few high school students from Barrow along with their science teacher to participate in the banding of Stellers Eiders in Izembek Lagoon. With their support I have resampled using a traditional quadrant technique some of the eelgrass habitat transects that were established in the 1970s. Data collected include eelgrass biomass, shoot density and leaf size. The data set includes eelgrass biomass, shoot density, leaf area index, associated biota, sediment characteristics and nutrients and water column temperature, salinity and inorganic nutrients. A stable carbon isotope inventory of eelgrass and the associated faunal community is also available. Not all data are available for all years; the most consistent data are the quantitative descriptions of the eelgrass population. To date, I have entered data from 1964, 1969, 1970, 1977, 1978, 1979, 1980 and 1981. I have also added the data from 2002, 2003 and 2004. The recently collected data provide a basis for comparison with the eelgrass populations of 30 years ago and indicate that the plants in Izembek Lagoon are indeed responding to a changing climate. A first analysis suggests little change in shoot density and eelgrass leaf biomass since 1978 but a remarkable decline in leaf size. Smaller leaves could well affect patterns of waterfowl grazing by their smaller size and through a change in the epibiota community. Connections between the eelgrass population data and environmental conditions are being explored.

Assessing Past Sockeye Salmon Population Trends in Katmai National Park using Paleolimnological Techniques

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

This project uses paleolimnological techniques to better understand long-term environmental trends and processes in a suite of different lake types in the Katmai National Park Unit of the Southwestern Alaska Network (SWAN). Lakes and lake types included in this study are Brooks (clearwater, salmon); Naknek (glacial, salmon); JoJo (clearwater, formerly anadromous); and Klosterman (clearwater, control). 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 5,000 years. A comparison of past sockeye abundance trends along with the role salmon-derived nutrients (SDN) play in lake productivity among the various lake types will be inferred using stable nitrogen isotope analysis ($\delta^{15}N$) and algal diatom proxies. The study of a control lake (Klosterman) 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.

Headwater Stream Spatial Subsidies across Climatic and Disturbance Gradients in the Pacific Northwest

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

How energy and nutrient subsidies link different habitat types is an increasingly important question in ecology. Information regarding how these subsides vary across diverse landscapes, however, is largely lacking. Salmonid populations in the Pacific Northwest have been the focus of intense management and conservation efforts. Although these species receive energy and nutrient subsidies from numerous headwater streams, how larger scale climatic and disturbance regimes affect these subsidies is unknown. The objectives of this study are to quantify how headwater stream subsidies are influenced by different climatic ecoregions (e.g. wet/dry) and land use histories (e.g. logging), and how these further affect downstream salmonid populations. Drift samples of invertebrates, organic, and inorganic material are being collected from 60 streams located in the Cascade Mountains of

Washington state. Of these, 30 located are located within each of two ecoregions, of which 15 have been recently logged while 15 remain relatively undisturbed. The abundance of fish will be measured downstream to determine relationships between headwater subsides and salmonid population parameters. Although we expect large variation in the amount of headwater subsidy delivered to salmonid populations, we hypothesize that headwater streams will cluster into four groups based on ecoregion and land use. These data will provide critical information regarding the magnitude of energy and nutrient subsidies originating from a diverse sample of headwater streams and how these further affect salmonid populations.

Influence of Landscape-Level Physical Characteristics on Non-Game Fish Species Distribution in Southeastern Alaska Lakes

Student Investigator: Dave Gregovich, MS Fisheries
Advisor: Mark Wipfli
Funding Agency: Sport Fish Division/ADFG (RSA Base Supplement)
In-Kind Support: The Nature Conservancy

The distributions of non-game fish species distributions in Southeast Alaska are not well known. Identification of important habitats for these fishes is lacking and is needed in order to properly manage their habitats. An assessment of the landscape-level variables that may influence non-game fish species presence is being undertaken based on existing data. Analyses are being conducted on fish data from 60 lakes sampled in 1979-1981 in relation to lake elevation, size, riparian slope, outlet stream gradient, and riparian wetlands composition. Influential variables identified will be used as stratification factors in a region-wide study of sculpin and stickleback presence in lakes of varying gross physical characteristics. Preliminary results suggest that riparian slope, outlet stream gradient, and elevation are major determinants of fish species presence. Field investigations will test hypotheses generated from this initial data set. This research will result in a species-presence likelihood model based on lake geographic attributes that can be used by managers to assess the risk of management actions on non-game fish species and their habitats.

Freshwater Community Development in Response to Nutrient Supplementation within Newly Restored Fish Habitat on the Northern Kenai Peninsula, Alaska

Student Investigator: Aaron Martin, MS Fisheries
Advisor: Mark S. Wipfli
Funding Agency: Chugach National Forest/USDA

Little is known about the effects of nutrient supplementation on freshwater community development at the microhabitat level in artificially created salmonid rearing habitats in Alaska. Due to a century of intense placer

mining, fish rearing habitat has been lost throughout a mile-long reach of Resurrection Creek on the northern Kenai Peninsula. These habitats need to be restored and fish populations reestablished. Constructing off-channel habitats and artificially enriching them with nutrients may help achieve these habitat restoration goals. The three main objectives of this study are to measure aquatic community development in newly formed fish habitat (alcoves) along Resurrection Creek, determine if additions of marine derived nutrients (MDNs) to these alcoves increases community development and productivity, and monitor the movement of juvenile and resident salmonids between alcove treatments. This study is part of a broader stream restoration project on a placer-mined reach of Resurrection Creek where off-channel habitats (alcoves) will be created and used as experimental units. Half of the alcoves will be enriched with salmon carcasses and the other half left as controls. Biofilm, invertebrates, and juvenile salmonids will be sampled over a two-year period beginning immediately after the creation of the new rearing habitat and nutrient enrichment, spring 2005 through fall 2006. Alcoves that receive MDN supplements are expected to have more rapid community development, higher levels of productivity and greater numbers of fish than alcoves with no nutrient additions.

Logging-Induced Changes to Headwater Invertebrate Communities in Moist and Dry Ecoregions of the North Cascade Range

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

How logging and subsequent riparian forest regeneration affect headwater stream productivity and invertebrate assemblages in the North Cascade Range has not been documented. Invertebrates transported from headwater streams are often prey to downstream fish, amphibians, and birds. Forest management practices likely alter headwater invertebrate assemblages and productivity, subsequently affecting the quality and quantity of food (invertebrates) delivered from these habitats to consumers in habitats further downstream. The objectives of this study are to (1) determine the community composition and abundance of invertebrates in headwater streams within moist and dry ecoregions of the Wenatchee River watershed, (2) document how commercial timber harvesting influences these communities, and (3) establish how timber harvesting influences invertebrate drift assemblages. Twenty headwater streams in the Wenatchee River drainage of the North Cascades will be investigated for two years beginning April 2005 where both benthic and drifting communities will be sampled. Invertebrate transport will be collected with 250 μm mesh drift nets placed in stream reaches for 48 hr, and associated benthic samples with be taken immediately upstream of drift nets with modified 250 μm surber samplers. We expect there will be lower diversity but higher biomass present in logged

sites, as indicated by both drift and benthic data. We also expect invertebrate communities to differ between ecoregions, possibly as a function of rainfall and vegetation cover. These results are expected to have important management implications for headwater and riparian forests throughout the Pacific Northwest as resource managers look for ways to harvest timber in headwater forests while protecting aquatic ecosystems and fisheries resources.

Wildfires and Headwater Stream Productivity: Effects of an Intense, Stand-Replacing Fire on Energy Subsidies to Downstream and Riparian Habitats in Eastern Washington

Student Investigator: Cassie Mellon, MS Fisheries
Advisors: Mark Wipfli and Judith Li
Funding Agency: Pacific Northwest Research Station/USDA

There is concern over a shift in fire regime to more intense wildfires throughout the West. The effects of wildfire on food subsidies from headwater streams to downstream and adjacent riparian habitats are not well understood. Fish-bearing streams and riparian areas receive food subsidies from headwater streams. These subsidies may be impacted by intense wildfires. The first objective for this study is to examine the effects of forest fire on drift and emergence of invertebrates from headwater streams within burned forests. The second objective is to quantify the effects of forest fire on the abundance and diversity of macroinvertebrate communities and the structure of the functional feeding groups. Benthic, emergent, and drift samples of macroinvertebrates were taken from five burned streams and five similar unburned streams once per month in June, July, and August 2004 and will be taken again in summer 2005. Invertebrates will be identified to family and measured to the nearest millimeter to determine biomass. Expected results are that burned streams will have a higher biomass of drifting and emerging invertebrates, but the community composition will be less diverse. This research will provide timely information for riparian forest management in fire-prone regions of North America and may impact how fires are potentially managed in riparian areas. Wildfires may be very beneficial to aquatic habitats both in creating diverse habitat and conditions that support an abundance and diversity of invertebrates and other organisms.

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

Student Investigator: Dan Rinella, PhD Biology
Advisor: Mark Wipfli
Funding Agency: EVOS Gulf Ecosystem Monitoring

Spawning salmon deliver massive quantities of marine-derived nutrients and carbon (MDN) to streams in the Pacific Northwest and Alaska, and considerable research has shown that that these nutrients can be locally important. However, little is known about the magnitude and effects of MDN at the watershed scale, and tools for monitoring MDN in watersheds do not currently exist. Additionally, current methods for estimating salmon escapement to streams are labor intensive and expensive. This project addresses MDN effects in streams over large spatial scales and economically estimating salmon escapement. The first objective of this study is to develop tools for tracking and measuring MDN effects in stream, riparian and nearshore environments on the southern Kenai Peninsula. The second objective is to determine if a water chemistry proxy can be developed to estimate salmon escapement based on changes in dissolved nutrient levels. Our approach in year 1 of this 3-year effort was to link stream chemistry, marine stable isotope signatures, and lipid and fatty acid measures along a gradient from headwaters to river mouth in watersheds with and without spawning salmon (North Fork Anchor River and Happy Valley Creek, respectively). In years 2 and 3, we will expand the study to replicate across several watersheds with and without salmon runs. We are investigating the potential for a salmon biomass proxy by correlating salmon escapement data with measures of dissolved nutrient concentrations released by returning and decomposing salmon. Year 1 analyses are ongoing, but some preliminary results are available. Year 1 spawning runs delivered 13,000 kg of chinook (*Oncorhynchus tshawytscha*) biomass and 2000 kg of coho (*O. kisutch*) biomass to the North Fork Anchor River. Dolly Varden char (*Salvelinus malma*), horsetail (*Equisetum* sp.), and several macroinvertebrate taxa collected in spawning reaches of the North Fork Anchor River prior to seasonal salmon runs showed enriched δ^{15}N values relative to Happy Valley Creek, suggesting that MDN was incorporated into biota and sequestered for extended periods of time. Aquatic macroinvertebrates also showed a general trend toward δ^{15}N enrichment along a gradient from mouth to headwaters for both streams, suggesting that trophic complexity increased with stream size regardless of spawning salmon presence. The ongoing analysis of lipids and fatty acids and N, C, and S stable isotopes from peak salmon spawning periods will give additional information into temporal and spatial patterns of MDN uptake and the utility of stable isotope and fatty acid analysis as tools for tracking MDN in riverine food webs. This project will provide tools to monitor long-term variation in the input and effects of MDN in streams. This is an important step in understanding MDN effects over spatially extensive scales and may prove useful in applications like salmon recovery efforts.

Additionally, it may provide a cost effective method for estimating salmon escapement to streams.

Completed Wildlife Studies

King Eider Wing Molt: Inferences from Stable Isotope Analysis

Student Investigator: Michael Knoche, MS Wildlife
Advisor: Abby Powell
Funding Agency: Coastal Management Institute (CMI)

Note: Mike Knoche graduated from UAF in December 2004. His thesis abstract follows.

Abstract—The western North American population of the King Eider is thought to have declined by over 50% between 1974 and 1996 without an apparent cause. The nonbreeding period of King Eiders consists of 80-100% of their annual cycle. I used stable carbon and nitrogen isotope values of feathers and muscles to examine the wing molt and migration ecology of King Eiders in 2003. Eider primary feathers were isotopically homogenous along the length of the feather, implying invariable diets during wing molt. Captive eiders in their hatch-year did not fractionate nitrogen isotopes, potentially indicating preferential protein allocation associated with growth. Six percent of female eiders sampled molted primary feathers on their breeding grounds, which had not been previously substantiated. Tissue samples from both genders corroborated dietary shifts inherent in switching from a marine to terrestrial diet. Carbon isotopes of feathers from satellite-transmittered males were correlated with longitude of their known wing molt locations indicating that the gradient of carbon isotopes can be used to draw inferences about molt location of eiders.

Duckling Survival and Incubation Behaviors in Common Goldeneyes in Interior Alaska

Student Investigator: Joshua Schmidt, MS Wildlife
Advisor: Eric Rexstad
Funding Agency: USFWS (RWO 136)

Note: Josh Schmidt graduated from UAF in August 2004. His thesis abstract follows.

Abstract—The lack of research on the Common Goldeneye (*Bucephela clangula*) in Interior Alaska prompted this study. My objectives were to estimate duckling survival relative to several explanatory variables and to characterize incubation behaviors in a subset of females nesting in the Chena River State Recreation Area. My estimates of duckling survival were higher than previously reported for this species: 0.65 (95% CI 0.49 to 0.82) and 0.68 (95% CI 0.58 to 0.79) for 2002 and 2003, respectively. Seasonally,

duckling survival increased linearly throughout 2002, remained nearly constant in 2003, and was negatively related to daily precipitation in both years. Nest attendance patterns and incubation behaviors were not related to weather, female experience, clutch size, or day of incubation. Average number of recesses per day (2.9 ± 0.05), length of recesses (100.7 ± 1.5 min), and incubation constancy (79.8 ± 0.3%) were similar to values previously reported for this species (mean ± SE). I observed nocturnal recesses in this population. Although not previously reported for this species, these recesses may occur due to extended daylight hours during the incubation period.

Ongoing Wildlife Studies

Breeding Ecology of White-Winged Scoters on the Yukon Flats National Wildlife Refuge, 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.

Breeding bird surveys indicate a long-term decline in the numbers of scoters breeding in North America. This study provides critical management information on the breeding ecology and habitat requirements of White-winged Scoter in their primary breeding range. We estimated nest, duckling, and adult female survival of White-winged Scoters breeding on the Yukon Flats NWR by tracking marked hens and their broods. In addition, we characterized the nest habitats selected by breeding females. We used transmitters, color markers, and brood surveys to locate nests of scoters and monitor hen, nest, and duckling survival at the Scoter Lake Complex. We measured habitat variables at nest sites as well as random sites in the study area to characterize nest habitat preferences. We observed relatively high rates of female mortality during the nesting season, ~20%, and low nest and apparent duckling survival, ~10% and ~28% respectively, on the study area from 2002 to 2004 due to predation. Scoters avoided nesting in meadows, but nested in all other shrub or forested habitat types in proportion to their availability, selecting sites with more and variable cover, which were closer to edge and water than random sites on the study area. The low recruitment rates that we observed may be a reason for the observed declines in abundance if annual survival rates are not high enough to maintain growing populations. Habitat development activities must consider the diversity of habitats used by breeding scoters.

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

The breeding ecology of waterfowl nesting in the boreal forest is not well documented despite the relative importance of this area to 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, such as hen and nest survival and renesting probability, may exist. In addition, the information needs for breeding waterfowl in boreal forest habitats are pressing given the potential for future resource development in the area and the importance of the area to breeding lesser scaup, currently experiencing a population decline of concern to managers. The object of this study is to determine the factors limiting waterfowl production in the boreal forest and to provide information for comparison with other regions. We will measure the hen mortality rate, the nest survival rate, and the renesting probability of lesser scaup, American wigeon, and Northern shovelers on Yukon Flats National Wildlife Refuge. During spring/summer 2005 and 2006, we will capture a minimum of 20 pre-nesting hens of each species, implant radio-transmitters on each hen, and monitor their nesting activities throughout the breeding season.

Factors Affecting Body Mass of Prefledging Emperor Geese

Student Investigator: Bryce Lake, MS Wildlife Biology
Advisors: Mark Lindberg and Joel Schmutz
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

The abundance of emperor geese has changed little since 1985 and remains at levels well below management goals. Estimates of adult survival obtained during this period show little variation, but estimates of recruitment have declined over the last eight years compared to the previous 11. Previous research has shown that survival and subsequent recruitment of prefledging geese are strongly correlated with body mass prior to fledging. Body mass of goslings is most sensitive to variation in forage quality and quantity, and we hypothesized that an increase in the numbers of sympatrically nesting goose species (cackling geese and black brant) and subsequent competition for grazing lawn habitat negatively affected body mass of prefledging emperor geese. Such a decline could explain observed reductions in recruitment.

Broods of emperor geese forage in grazing lawns of *Carex subspathacea* vegetation, and we estimated aerial extent (1999, 2003, 2004), and apparent offtake in these lawns (2003, 2004) at six locations across the Yukon-Kuskokwim Delta. At three of these same locations, we captured prefledging emperor geese during 1990–2004 and recorded body mass. We estimated local densities of nesting geese using the grazing lawn community from 1990–2004. Our results suggest that the extent of grazing lawns has not changed over time but varies substantially among locations. Despite increased susceptibility to predation, broods of emperor geese most strongly select pond, not river, habitat, and our results suggest there is 4% more grazing lawn around ponds. During 1990–2004, body mass was highest in years of low overall nesting success. Overall densities of goose broods were reduced in years of low nest success, and this result implied that density-dependent effects on body mass occurred. During 2003–2004, body mass varied among locations by years. Body mass was highest in a location with lowest densities of nesting geese and higher among all locations in a year with reduced nest success. Similar to previous studies of colonially nesting geese, we detected a negative relationship between body mass and an individual's hatch date relative to peak of hatch. Management to increase the population size of emperor geese should consider total densities of geese on the Yukon-Kuskokwim Delta.

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); Department of Biology and Wildlife and Institute of Arctic Biology/UAF
In-Kind Support: Izembek NWR/USFWS

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 are 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 an increase in development and harvest pressure on or near Izembek NWR have prompted an assessment of past data. Using data collected between 1977 and 1996, we will analyze the population dynamics of this population with the ultimate goal of identifying which population parameters most affected dynamics of 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 approximately 700 swans were captured and

marked with neckbands. During subsequent summers and sporadically during the winter, observations of marked swans were made and an estimated total of nearly 10,000 resightings were recorded. Our specific objectives are to estimate nest survival and cygnet survival and annual, age-specific apparent survival, and breeding probability of adult swans. As part of a larger collaborative project, a population model will be constructed from these estimates to provide managers with information about which parameters had the greatest effect on the population.

Using Fat Metabolites to Infer Staging Site Quality for Post-breeding Shorebirds on Alaska's North Slope

Student Investigator: Audrey Taylor, PhD Biology
Advisor: Abby Powell
Funding Agencies: CMI, USFWS, UA Foundation, USGS (Quick Response Program)
In-Kind Support: BP Exploration, Inc.; North Slope Borough (NSB)

In Alaska, post-breeding shorebirds depend on resources found in coastal areas to acquire fat necessary for southward migration, yet little is known about shorebird use of littoral zones along the Arctic Coastal Plain (ACP) during the pre-migratory period. Future energy development along the ACP may have negative impacts on shorebird staging behavior and staging site quality, and thus may affect the birds' ability to accumulate the fat resources necessary for successful migration to wintering areas. To be able to predict how and where oil and gas development may impact staging shorebirds, we need to better understand how pre-migratory shorebirds are distributed across the ACP prior to fall migration, what sites are particularly valuable during this period, how long birds stay at ACP staging sites, and the degree to which they move between sites. The objective of this study is to determine abundance, distribution, and movements of shorebirds staging across the ACP prior to fall migration. An additional aim is to investigate physiological factors that may influence site choice, duration of site use, and movements among sites. In 2004 we tested methods appropriate to our objectives at one study site on the North Slope (Barrow, AK). We captured 200 shorebirds of four species, marked or radio-tagged each individual, and collected a 200-300 microliter blood sample from each to estimate fattening rates (a surrogate for site quality) at staging locations within the Barrow vicinity. We found inter-specific differences in fattening rates (smaller shorebirds gained mass more rapidly than the larger species). Marked or radio-tagged shorebirds moved widely between our four banding locations (leading us to predict few inter-site differences in fattening rates), yet birds gained mass at one banding location more quickly than at the other three. Staging shorebirds on the ACP may be particularly susceptible to the effects of human activity and development because they are concentrated in coastal areas during a critical period in their life cycles. The ability to determine staging site use and quality (using radiotelemetry and physiology data) has the potential to inform future management and development decisions.

Effects of Recreational Disturbance on the Productivity of Black Oystercatchers in Kenai Fjords National Park

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

In Alaska, national parks are generally assumed to provide high-quality undisturbed wildlife habitats. However, these parks also attract recreational users, whose presence may in turn reduce the suitability of key habitats for nesting shorebirds. In Kenai Fjords National Park, popular campsites are often also nesting habitats of the Black Oystercatcher (*Haematopus bachmani*). This study was initiated in response to increasing recreational activity in coastal Alaska. The primary objective of this study is to acquire baseline data on the breeding ecology of Black Oystercatchers needed for prescribing appropriate management and conservation efforts. Survival of Black Oystercatcher nests and chicks has been monitored since 2001 and will continue through 2005. Productivity has been measured in areas of both high and low recreational disturbance within the park. Beginning in 2003, breeding birds have been captured and banded with unique color bands in order to determine individual reproductive characteristics and adult survival rates. We monitored the survival of nests and chicks on 33 to 39 breeding territories annually from 2001-2004. Most recreational disturbance on nesting territories was from kayak campers and occurred after the peak hatch of first clutches. Annual fledging success (24%) was low, but our best models suggest daily survival rates of nests and chicks did not differ between disturbed and undisturbed territories. Most (96%) of the color banded oystercatchers returned to their breeding territory in the subsequent year irregardless of level of disturbance. Our data suggest Black Oystercatchers are resilient to recreational disturbance at the low levels observed; a threshold may exist below which productivity is not affected or effects are not detectable. Due to the high levels of depredation observed, we suggest conservation efforts must focus on examining the influence of recreational disturbance on predator movements.

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 of King Eiders declined by

more than 50% between 1979 and 1996 for unknown reasons. The National Petroleum Reserve-Alaska (NPR-A) is being leased for oil and gas exploration and may potentially be developed. Within the northeast planning area of NPR-A is the highest known density of nesting King Eiders on the north slope of Alaska. The primary objective of this study is to provide information on eider nest survival and how it is influenced by nest site choice in both an undisturbed and disturbed area. Accessible areas around Teshekpuk Lake and Kuparuk were searched for pre-nesting and nesting King Eider in June and July 2002, 2003, and 2004. Nests were located (~40/site/year) and monitored, and habitat evaluations were done. Nest success was not different between years and sites; however, daily nest success was higher on islands than mainland sites. Our preliminary analyses found no evidence for any effects of spatial covariates on daily nest survival. Incubation constancy is higher at Kuparuk than at Teshekpuk and higher on island sites than mainland sites. Field work will continue in 2005. 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 Eider in both an undisturbed and a disturbed area.

The Common Raven in Alaska's North Slope Oil Fields

Student Investigator: Stacia Backensto, PhD Biology
Advisor: Abby Powell
Funding Agency: CMI; Regional Resilience and Adaptation Program, MMS; BLM; USFWS; Center for Global Change/UAF
In-Kind Support: ConocoPhillips, BP Exploration, North Slope Borough

Common ravens in Alaska's North Slope Oil Fields use anthropogenic resources and infrastructure for foraging and breeding. The oil field population appears to be increasing, potentially as a result of infrastructure and human activity. Common ravens are foraging generalists and prey on the eggs and chicks of tundra-nesting birds on Alaska's Coastal Plain. Ravens may inflate predation pressure on local breeding bird communities in areas of high human activity and where infrastructure is present. The objective of this study is to describe raven breeding activities and evaluate how ravens use anthropogenic resources in areas where human activity is spread over a large area (e.g. Kuparuk and Prudhoe Bay oil fields), moderate area (e.g. villages of Barrow and Nuiqsut) and low (NPR-A Colville River Unit, Pt. Lonely). During spring and summer 2004, ravens breeding in the oil fields were captured and marked with wing markers and VHF or satellite transmitters. Ravens with VHF transmitters were tracked during a portion of their breeding season. Juvenile ravens were also captured and marked with wing markers. Regurgitated pellets and prey remains were collected from nest sites in the oil fields. Ravens nest on major facilities, drill site pads, and under bridges. Nests are constructed primarily of industrial materials. Raven fledgling success during 2004 in the oil fields was high. Breeding ravens used an area of 500 m to 1 km around their nest site during the early stages of their

nesting cycle. This area increased during the latter period of the nesting cycle and into the fledgling period. If human infrastructure and food sources are benefiting raven populations in the oil fields, then productivity for many tundra-nesting species may be reduced in portions of this area.

Large-scale Movements and Migration Ecology of King Eiders (*Somateria spectabilis*) throughout the Non-breeding Period

Student Investigator: Laura Phillips, MS Biology
Advisor: Abby Powell
Funding Agencies: MMS; CMI and Institute of Arctic Biology/UAF; NSB; Sea Duck Joint Venture
In-Kind Support: Logistic support provided by ConocoPhillips, Alaska; equipment support provided by USFWS and AKCFWRU

King Eiders (*Somateria spectabilis*) molt wing feathers and overwinter in remote areas of the Bering Sea, precluding direct observation of the birds at this time. To characterize timing of migration and habitat used by King Eiders during the non-breeding period, we derived the location data of 60 individuals (27 females and 33 males) from satellite telemetry and oceanographic information from remotely sensed data. Male King Eiders dispersed from breeding areas, arrived at wing molt sites, and dispersed from wing molt sites earlier than females in all years. Males that arrived at molt sites earlier molted at higher latitudes. Female King Eiders that wintered further south returned to breeding areas earlier the following summer. Distributions of molt and winter locations did not differ by sex or among years. General linear models suggest that the variables distance to shore, water depth, and salinity best describe King Eider habitat throughout the non-breeding period. During the winter, lower ice concentrations were also associated with King Eider locations. This study provides some of the first large-scale descriptions of King Eider migration and habitat outside the breeding season.

Body Condition of Glaucous-Winged Gulls throughout the Reproductive Period

Student investigator: Brook Gamble, MS Wildlife
Advisors: Loren Buck and Edward Murphy
Funding Agency: USFWS (RWO 119)

Availability of food resources has a significant impact on the reproductive performance of seabirds, both directly due to the amount of energy allocated to offspring and indirectly through parental body condition. Body condition reflects the physiological state of an animal and influences its present and future fitness. Because body condition of adult seabirds is closely coupled to marine conditions, it may be a useful indicator of resource availability. Thus, a thorough understanding of body condition in long-lived seabirds may prove

to be a valuable tool to monitor seabird populations and understand complex marine ecosystems. The glaucous-winged gull (*Larus glaucescens*) is an abundant, colony-nesting seabird in Kodiak, Alaska. We analyzed body condition of glaucous-winged gulls throughout their reproductive stages using four different measures: circulating corticosterone levels, plasma lipid metabolites, proximate analysis, and body condition index based on morphological characteristics. Lipid reserves of adult glaucous-winged gulls tended to decrease through the reproductive period as shown by both their body condition index and total proximate composition. Baseline levels of corticosterone and plasma sterols tended to increase as the reproductive period progressed, peaking in the chick rearing stage. Our results demonstrate that there was also a rise in levels of free fatty acids with a loss of lipid. While proximate compositional analysis may be the ideal and definitive measure of body condition, corticosterone, plasma sterols and free fatty acids, as well as body condition indices appear to predict body condition in the glaucous-winged gull. These measures provide a minimally invasive way to study free-living glaucous-winged gulls, and may assist with future predictions of prey abundance and ecosystem health.

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 places 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 was 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. Three years of radiolocation data for these species representing used habitat were obtained from park biologists. Random locations placed on the landscape surrounding the animal locations represent available habitat. A geographic information system (GIS) was used to obtain landscape characteristics associated with the locations representing used and available habitat. Several algorithms including logistic regression, classification trees, and neural networks were used to look for patterns of habitat selection. Caribou spatial distribution differed seasonally and among years and was strongly influenced by elevation, terrain ruggedness, and vegetation type. AICc and prediction accuracy assessment was used to select models used in mapping the likelihood of occurrence for each species in the

Toklat Basin area of Denali National Park. 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, lodging in Barrow (NSBDWM)

The majority of the Teshekpuk Caribou Herd (TCH) annual range is currently being considered for industrial development. Habitat selection and distribution of the TCH has not been studied beyond the calving period. The TCH comprises a significant subsistence resource for several North Slope villages. 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. This 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. During the course of the study, 35-50 active radio-collars were deployed. Female caribou were radio-tracked every other day in early June and every two weeks from mid-June until the rut, weather permitting, in 2002, 2003 and 2004. Fecal samples were collected following each survey period whenever possible. In 2004, 9 weather stations were deployed to supplement meteorological data from permanent stations within the NPR-A. A GIS will be used to analyze patterns of selection in habitat features such as snow cover, terrain ruggedness, potential for insect harassment, remotely sensed vegetation class, and remotely sensed green-up patterns (NDVI). In 2002, 23 calving locations were estimated, and in 2003, 20 calving locations were estimated. The 16 calving locations estimated in 2004 were spread across the North Slope, following an unprecedented winter movement into eastern Alaska (ANWR). An additional 3 post-calving habitat use surveys were conducted in 2002, with 4 post-calving habitat use surveys conducted in 2003, and 6 in 2004. Eight composite fecal samples were collected in 2002, 6 in 2003, and 7 in 2004. Concentrated calving areas were to the northeast and southeast of Teshekpuk Lake in 2002 and to the northeast, southeast, and west of Teshekpuk Lake in 2003. There was no concentrated calving area in 2004. Following calving in 2002, the majority of female caribou moved to the southwest of Teshekpuk Lake before aggregating along the coast between Barrow and Harrison Bay in mid-July. By late August 2002, caribou were spread out across the central coastal plain. Following calving in 2003, female caribou moved to the southeast of Teshekpuk Lake before aggregating along

the coast between Admiralty and Harrison Bays in mid-July, again achieving wide distribution by mid-August. Calving distribution in 2004 was much different from the previous 2 years, but post-calving distributions were similar in all 3 years. Fecal samples were analyzed for diet composition. Lichen was the dominant plant fragment in the fecal samples during calving, with sedges and deciduous shrubs becoming prevalent as the summer progressed, with sedges becoming dominant in July, and willows dominant in late June and early August. An increase in the prevalence of lichen was evident by mid-August, potentially indicating a return to winter diets. This herd consistently uses the area around Teshekpuk Lake intensively throughout the summer. Although the reasons for fidelity to this area are not clear at this time, their intensive use of this area needs to be taken into consideration when planning for industrial development in the Teshekpuk area. Results from analysis of habitat use and diet patterns may help managers determine the availability of suitable alternative habitats, and inform future studies on habitat quality in the area.

A Habitat Suitability Analysis for Dall's Sheep 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

The relationship between large-scale habitat attributes and population characteristics has not been estimated for Dall's sheep. The purpose of this study was to model habitat using geographic information systems against Dall's sheep characteristics. We estimated the linear relationship between escape terrain, two estimations of terrain ruggedness, percentage south- and west-facing slopes, percentage vegetated/non-forested, and relative non-forest greenness (normalized differential vegetation index), and population characteristics (density and horn length) for aerial sheep units in Wrangell-St. Elias National Park and Preserve. Lamb:ewe ratios did not vary among survey units and were not further analyzed. We standardized all variables, classified them into quarter standard deviations above and below their mean, and evaluated all 1, 2, and 3 variable models using AICc (Akaike's Information Criterion, Akaike 1973) for model selection. For all estimates of density (adult, lamb, and total) the top model included a positive correlation with median NDVI and terrain ruggedness. The model was strongest for adult density (AICc = 65.15, w_i = 0.82) and least strong for lamb density (AICc = 62.19, w_i = 0.22). Escape terrain, while in the top 10 models, was not significant. This is the first large-scale sheep habitat assessment that clearly identifies forage characteristics as a density predictor. Harvest was best predicted by adult density and percentage south-facing slopes (AICc = 51.86, w_i = 0.95). Horn length (cm) was best predicted by trends in adult density and perimeter:area of escape terrain (AICc = 61.47, w_i = 0.38). This is the only population characteristic that had escape terrain in the top model

and it quantitatively corroborates Geist's (1971) hypothesis that increasing populations would have larger horn sizes.

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 furnished by ADFG

Moose in Lake Clark National Park and Preserve (LCNPP), like in many Interior Alaska populations, exist at low densities and limiting factors are not well understood. While calf predation clearly can be a limiting factor, juvenile mortality also can be associated with malnutrition and an inability of calves to meet their nutritional demands. Estimating causes of population limitation for moose, therefore, would be incomplete without an assessment of density-dependent factors related to winter habitat, when habitat capacity may be most limiting. The goal of our research is to estimate the relationship between winter habitat capacity and moose calf weight dynamics at LCNPP and at other study areas to put our results in a broader context. Our objectives are to (1) estimate moose winter diets; (2) assess moose calf growth and mass change during winter; (3) model winter habitat capacity for moose using estimates of forage species composition, nutritional characteristics, availability, use, and amount remaining at the landscape scale; and (4) develop predictive surface models of forage intake by integrating estimates of bite size, stem density, and digestible energy/protein concentrations. Composition of moose winter diets was estimated using fecal analyses. Forage production and utilization were estimated using a stratified random sampling scheme based on moose density and vegetation landcover classes. Weights of 10-month old calves were obtained during spring 2004, and fall-to-spring weight change will be estimated when calves caught at 4-months (fall 2004) are re-captured as 10-month olds during spring 2005. Geostatistical analysis techniques will be used to create a statistically valid surface of the distribution of digestible energy and protein on the landscape. Relative to moose calf weights obtained in other parts of Alaska, our preliminary results indicated that 10-month old moose calves in LCNPP (mean = 453 lbs., n = 15) were heavier than same-age calves weighed in Denali (mean = 430 lbs.), McGrath (mean = 408 lbs.), and Unit 20A near Fairbanks (mean = 366 lbs.). Additionally, forage utilization at LCNPP appeared to be less than half that estimated in Unit 20A. Moose are an important subsistence and sport-hunting resource, and their management requires an understanding of factors that limit their numbers. Development of a statewide model of the relationship among moose density, forage characteristics, and calf performance may clarify upper and lower thresholds for winter range capacity and may support moose and predator management decisions in Alaska.

Sightability, Habitat Use, and Sexual Segregation in Moose: Implications for Population Management

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

Few data are available on the health, sex and age composition, and size of the moose population on the Yakutat forelands. Moose are an important subsistence resource in Yakutat, Alaska, a community of approximately 800 people. Dense vegetation, unknown habitat use, and sexual segregation may lead to biases in our current population estimates obtained from aerial surveys. More information on this recently established moose population is needed for state and federal agencies to effectively manage this important subsistence resource. The objectives of this study are to develop a reliable method of population and sex and age composition estimation and to quantify male and female habitat use and distribution throughout the year. Bull and cow moose were captured and fitted with standard VHF and GPS radio-collars. Sightability trials were conducted from November 2003-March 2004 to determine percentage of collared moose seen during surveys and obtain a detection probability function. GPS collars collect locations 4 times daily to be used to determine habitat use. Initial results show that males were sighted in 25 of 33 trials (76% visibility) and females were sighted in 37 of 55 trials (66% visibility). GPS collar data has been collected but not yet analyzed for habitat use. Little is known about the population dynamics of this recently established moose population. This relatively isolated population appears to be at a low density and is apparently affected by wolf and brown bear predation as well as human harvest. Improved population estimates and knowledge of habitat use will help managers to maintain sufficient numbers and sex ratio to sustain the population and provide a subsistence resource for the local community.

Ongoing Ecological Studies

Biocomplexity: Feedbacks between Ecosystems and the Climate System

Student Investigator: Michael Balshi, PhD Biology
Advisor: A. David McGuire
Funding Agency: National Science Foundation (NSF) through 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. To address this issue, we are developing a prognostic model that can be applied at large spatial scales to simulate the

effects of wildfire on the global carbon cycle. The initial focus has been on developing the model for Alaska and Canada due to the extensive historical fire record documenting the timing and location of fires since the 1950s. Progress in explaining inter-annual variability of fire with climatic variables at 5^{o} latitude by 5^{o} longitude resolution has been made over the last year. The next stage is to couple the fire model to the terrestrial ecosystem model (TEM) to simulate carbon dynamics of Alaska and Canada for the period 1860-2000. We expect to find that carbon dynamics simulated for Alaska and Canada will be similar to a simulation driven by observed fire history from 1959-2000. We will then use the coupled model to evaluate carbon dynamics for future scenarios of climate change. After developing and testing the model over the Alaska and Canada domain, the model will be evaluated for its ability to simulate the fire regime in boreal Eurasia. It is anticipated that coupled model simulations for the pan-boreal region north of 45°N will be completed during summer 2005. The model framework will then be extended to the temperate zone through application to the conterminous U.S. and to the tropics through evaluation in the Amazon Basin. Successful development of a prognostic fire capability in global carbon cycle 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.

Forest Sector Outcomes with/without Climate Change and Carbon Sequestration Management

and

Carbon Dynamics of the US Forest Sector with/without Climate Change and Carbon Sequestration Management

Students: Gregg Christopher and Michael Balshi (partial support for graduate student programmers)
Faculty: A. David McGuire
Funding Agency: USDA Forest Service (RWOs 135 and 144)

These two studies have objectives that are linked. The overall objectives of the first study are 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) to analyze the impacts and their timing at local and regional scales in forest ecosystems and the forest sector; and (3) to 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: compare the results of US forest sector carbon dynamics simulated by two different models. These studies are part of two USDA Forest RPA Special Studies, which 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 prepared the output of the Terrestrial Ecosystem Model (TEM) so that it is summarized by forest type regionally and at the county scale. We have developed a draft methods paper to describe the computations for climate change deltas so that TEM output can be converted for use by a timber assessment market model used at the national level by the USDA Forest Service. This study will examine the impact of climate change on the forest sector by estimating the variability of growth parameter modifications in the timber assessment market model. 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. This research will contribute to developing a more comprehensive approach to risk assessment and management in the forest sector relative to climatic change.

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: NSF, USDA Forest Service, USDA New Crops, and Center for Global Change, International Arctic Research Center/UAF

During the third 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 are ongoing 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. Methods of sampling for this final case study are still being developed.

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

Post-Doctoral Researcher: Monika 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. The effects of human activities on the fire regime of high latitude ecosystems have the potential to influence water, energy, and carbon dioxide exchange with the atmosphere by influencing land cover and ecosystem dynamics. In this project, we assess the potential footprint of human activities on fire regime in the Western Arctic. The first strategy in the project is to evaluate the human footprint on fire with distance from settlements, roads, and rivers in Interior Alaska using Geographic Information Systems (GIS). Currently, humans are responsible for high fire frequency near settlements, roads, and to a lesser degree, rivers. Human impact on fire regime is a function of population size and access to remote areas. In general, human-caused fires are smaller than lightning-ignited fires, and humans suppress large fires near their structures. Surprisingly, some degree of human influence on fire can be noted throughout all of sparsely populated Interior Alaska. The second strategy consists of a quantification of this human footprint on natural wildfires in Interior Alaska through the development of an empirical fire prediction model. The model will predict monthly burn probability for 1990 to 2000 based on local air mass lightning strikes, climate, topography, vegetation type, and distance from towns, roads, and rivers. Model results will provide a measure of the human effect on fire over the natural fire patterns at 1 km resolution. A future step will be the simulation of the carbon dynamics in the Western Arctic using the Terrestrial Ecosystem Model (TEM) constrained by the historic fire regime from 1950 to 2000. This will provide valuable information on past and potential future carbon emissions in the boreal forest.

Snow Cover and Biology in the Arctic

Post-Doctoral Researcher: Eugénie Euskirchen
Faculty: A. David McGuire
Funding Agency: NSF

The overall purpose of this study is to examine recent regional changes in snow cover extent and soil freeze-thaw transitions due to climate. These modifications may result in temporal shifts in the growing season and the associated rates of terrestrial productivity. Our methodology involves the use of a large-scale terrestrial ecosystem model (TEM) and the comparison of model output with datasets of soil freeze-thaw and snow cover dynamics based on satellite observations. We are also coupling our results of TEM simulations to an atmospheric transport model to evaluate how well the

results agree with data on atmospheric carbon dioxide concentrations. The TEM simulations indicate snow cover duration has decreased by approximately 6-8 days between the years 1972-2000. This result is generally consistent with NOAA satellite observations, which show a decrease between 3-6 days per decade since 1972. This modeled decrease in snow cover is associated with a trend toward an earlier thaw date of frozen soils and the onset of the growing season in the spring by approximately 1-2 days between 1960 and 1980 and 3-5 days from 1980-2000. Between 1988 and 2000, satellite records show a slightly stronger trend in thaw and the onset of the growing season, averaging between 5-8 days earlier. However, we have also found that there is as much a difference in recent trends of freeze-thaw dynamics between the data sets based on satellite data as there are between TEM and the satellite data. Finally, although the 1960s-1980s showed a less pronounced trend in earlier thaw dates and increased growing season length, our model analyses indicate increasing net carbon uptake at the decadal scale. Future research will involve the implementation of a dynamic vegetation model (DVM) within TEM (DVM-TEM). DVM-TEM will then be implemented in two separate studies. One of these will entail coupling DVM-TEM to a global climate model (CCSM) to examine permafrost, vegetation, and atmospheric dynamics. The other will involve applying DVM-TEM to examine productivity across chronosequences of ecologically and economically important tree species in North America.

Fate of Carbon in Alaskan Landscapes

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

The purpose of this study is to model how soil drainage influences carbon dynamics in Alaskan landscapes. This study is part of a larger global change study funded by the USGS Geologic Division, which has been granted to Dr. Jennifer Harden of USGS Geologic Division in Menlo Park. Dr. Harden is conducting field work in Alaska to determine soil drainage controls on (1) decomposition rates and fuel storage, (2) fire severity, (3) permafrost degradation and recovery after fire, and (4) successional responses after fire. The understanding from these field studies will be transferred into a successional version of the terrestrial ecosystem model (TEM), which is being enhanced to consider interactions between fire severity, the soil thermal regime, and carbon dynamics. Model development is represented in three manuscripts that have been published (Zhuang et al. 2001. *Journal of Geophysical Research* 106:33,649-33,670; Zhuang et al. 2002. *Journal of Geophysical Research* 107, 8147, doi:10.1029/2001JD001244 [printed 108(D1), 2003]; Zhuang et al. 2003. *Tellus* 55B:751-776; and Zhuang et al. 2004. *Global Biogeochemical Cycles* 18, GB3010, doi:10.1029/2004GB002239). The first manuscript reports on a study that indicates that the soil thermal regime in Alaskan landscapes appears to be most sensitive to moss and snow thermal properties. The second manuscript

reports on a study that uses the model to evaluate how fire influences soil thermal and ecosystem dynamics during forest stand development after fire disturbance. The third manuscript reports on a study with the coupled soil thermal-ecosystem model to evaluate the potential importance of freeze/thaw dynamics in simulating carbon dynamics of the Northern Hemisphere. The fourth manuscript reports on a study that developed a model that simulates methane dynamics in uplands and wetlands of northern ecosystems. These developments have allowed the incorporation of interactions among fire, permafrost dynamics, and soil drainage into a framework that is being used to model carbon dynamics at large spatial scales in Alaska. The graduate student on the project has conducted field studies of carbon dioxide and methane dynamics along a soil moisture gradient on the Tanana River Floodplain in an ecosystem that burned in 2001. The student has measured carbon dioxide and methane emissions at this site and has tracked historical changes in vegetation, hydrology and fire through macrofossil, charcoal and diatom analysis of peat cores. The paleoecological record reveals a pattern of expansion of this permafrost collapse after fire. Since 2001, the submerged area of the bog has expanded 6 meters, increasing the submerged portion of the moisture gradient. The entire transect was found to be a sink for carbon dioxide; however, the submerged region was also a significant source of methane. Methane emissions were found to be negligible during dry periods of the growing season. If Interior Alaska experiences more abnormally warm and dry summers like that of 2004, future methane production may be suppressed by the changing climate. Information from this study will be used to refine the modeling framework.

Determining Successional Pathways Following Fire Using Stand Initiation Ages and Topographic Variables near Fairbanks, Alaska

Student Investigator: Thomas Kurkowski, MS Natural Resource Management
Advisors: Scott Rupp and Daniel Mann
Funding Agency: Joint Fire Science Program/BLM (RWO 116)
In-Kind Support: UAF Forest Soils Lab, equipment use during field season

Researchers are uncertain and unable to predict the relative occurrence of dominant successional pathways in Interior Alaska. Past research has documented the occurrence of both species dominance relay and self-replacement successional pathways in Interior Alaska. Landscape-scale fire modeling efforts are unable to accurately predict post-fire vegetation trajectories without knowing which successional pathway will be followed. This investigation aims to quantify the occurrence of species dominance relay succession relative to self-replacement following fire in a topographically complex region. Our study area is the north side of Ester Dome near Fairbanks, Alaska. The general pattern of species dominance relay in our study area was determined at two sites from stand growth reconstructions. Using the resulting patterns observed from the stand reconstructions, we

tested additional stands and stand boundaries using stand initiation ages to determine if the same patterns exist. Statistical models were developed to predict vegetation types and successional pathway based on solar insolation, hydrology, and other topographic variables. The stand reconstructions of species dominance relay revealed that all species that occur on a site are present immediately following fire. Deciduous trees dominate the canopy for the first 40 years following fire. There is a transitional co-dominance of deciduous and coniferous species for an additional 40 to 50 years. Spruce dominance did not occur until 100 to 140 years following fire. Six of 16 stands tested concluded to have gone through species dominance relay succession, 8/16 stands concluded to have self-replaced, and 2/16 stands were inconclusive. Preliminary results of the modeling effort identified summer insolation, elevation, and slope as significant variables in predicting vegetation type. The management of the Interior boreal forest is becoming increasingly important for wildfire mitigation, forest harvesting activities, wildlife habitat, and recreational and economic development. These management activities can alter vegetation patterns across the landscape and impact successional trajectories. This research focuses on understanding patterns of succession and the mechanisms that influence them at the landscape scale in order to inform a fire management model.

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

LTER Taiga Long Term Ecological Research Program

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
USFS U.S. Forest Service

USFWS U.S. Fish and Wildlife Service

USGS U.S. Geological Survey
BRD Biological Resources Discipline