Alaska Cooperative Fish and Wildlife Research Unit

Annual Report—2006

March 2007

Alaska Cooperative Fish and Wildlife Research Unit
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Contents

Unit Roster

Federal Scientists

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

University Staff

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

Unit Students

Current

- Chrissy Apodaca, PhD Biology (Wipfli)
- Stacia Backensto, PhD Biology (Powell)
- Michael Balshi, PhD Biology (McGuire)
- Colin Beier, PhD Biology (McGuire)
- Elizabeth (Baney) Benolkin, MS Fisheries (Margraf)
- Rebecca (McGuire) Bentzen, PhD Biology (Powell)
- Meagan Boltwood, PhD Biology (Wipfli)
- Jeremy Carlson, MS Fisheries (Margraf)
- Samantha Decker, MS Fisheries (Margraf)
- Jon Gerken, MS Fisheries (Margraf)
- Elizabeth Green, MS Biology (Wipfli)
- Dave Gregovich, MS Fisheries (Wipfli)
- Christie Hendrich, MS Fisheries (Margraf)
- Christopher Latty, MS Wildlife (Powell)
- Andra Love, PhD Fisheries (Margraf)
- Aaron Martin, MS Fisheries (Wipfli)
- Bruce Medhurst, MS Biology (Wipfli)
- Steffen Oppel, PhD Biology (Powell)
- Lincoln Parrett, MS Biology (Griffith)
- Josh Peirce, MS Wildlife (Wipfli/Follmann)
- Jeff Perschbacher, MS Fisheries (Margraf)
- Dan Rinella, PhD Biology (Wipfli)
- Jennifer Roach, MS Biology (Griffith)
- Kathy Smikrud, MS Fisheries (Margraf
- Shelly Szepanski, PhD Biology (Griffith)
- Theresa Tanner, MS Fisheries (Margraf)
- Audrey Taylor, PhD Biology (Powell)
- Jason Valliere, MS Fisheries (Margraf)
- Brad Wendling, MS Wildlife (Griffith)
- Heather Wilson, PhD Biology (Powell)

Graduated (during CY)

- Cassie Mellon, MS Fisheries (Wipfli)
- John O'Brien, MS Fisheries (Margraf)
- Miranda Plumb, MS Fisheries (Margraf)

Post-Doctoral Researchers

- Christopher Binckley (Wipfli)
- Daniel Hayes (McGuire)
- Shuhua Yi (McGuire)

Research Associates

- Eugénie Euskirchen, Institute of Arctic Biology (IAB)

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
- Monica Calef, Assistant Professor, State University of New York Albany
- F. Stuart Chapin III, Department of Biology and Wildlife (DBW)/IAB, UAF
- Bruce Finney, Marine Science and Limnology/Institute of Marine Science (IMS), UAF
- Erich Follmann, IAB/DBW, UAF
- Falk Huettmann, DBW/IAB, UAF
- Nicholas Hughes, SFOS, UAF
- Gordon Kruse, SFOS, UAF
- Mark Lindberg, DBW/IAB, UAF
- C. Peter McRoy, IMS, UAF
- Edward Murphy, DBW/IAB, UAF
- Eric Rexstad, University of Edinburgh, Scotland
- James Reynolds, Emeritus UAF

Affiliated Students

Current

- Todd Brinkman, PhD Biology (Chapin)
- Nathan Coutsoubos, MS Natural Resource Management (Huettmann)
- Blair French, MS Wildlife (Follmann)
- Brook Gamble, MS Wildlife (Buck/Murphy)
- Thomas Kurkowski, MS Natural Resource Management (Rupp/Mann)
- Kate Martin, MS Wildlife (Lindberg)
- Brandt Meixell, MS Biology (Lindberg)
- Susan Oehlers, MS Wildlife (Bowyer/Huettmann)
- Morgan Peterson, MS Biological Oceanography (Finney)
- Joy Ritter, MS Wildlife (Rexstad/Huettmann)

Cooperators

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

- McKie Campbell–Commissioner, Alaska Department of Fish and Game
- Rowan Gould–Director, Region 7, US Fish and Wildlife Service
  Tom Melius–Director, Region 7, US Fish and Wildlife Service (effective May 2006)
- 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 2006. The Unit engages in research on living natural resources for a variety of State and Federal agencies. As an unbiased research organization, the Unit provides information requested and funded by these agencies. When studies are completed, the agencies use the information to assist in their natural resource management efforts. Most of the research is conducted by graduate students, many of whom go on to work for the agencies upon graduation.

The Alaska Unit was established in 1950, providing over half a century of research dedicated to helping conserve and enhance the living natural resources of the State and the Arctic Region. The Unit is part of a larger and even older program, the U.S. Department of the Interior's Cooperative Research Unit Program. Established in 1935, Cooperative Research Units were created to fill the vacuum of wildlife management information and the shortage of trained wildlife biologists. In 1960, the Unit Program was formally sanctioned by Congress with the enactment of the Cooperative Units Act. Each unit is a partnership among the Biological Research Division of the U.S. Geological Survey, a State fish and game agency, a host university, and the Wildlife Management Institute. Staffed by Federal personnel, Cooperative Research Units conduct research on renewable natural resource questions; participate in the education of graduate students destined to become natural resource managers and scientists; provide technical assistance and consultation to parties who have legitimate interests in natural resource issues; and provide continuing education for natural resource professionals. Presently, there are 40 Cooperative Research Units in 38 states, conducting research on virtually every type of North American ecological community. The Program is staffed by more than 100 PhD scientists who advise as many as 675 graduate student researchers per year.

Statement of Direction

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

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

Unit Cost-Benefit Statements

In-Kind Support

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

Benefits

Students Graduated: 3
Presentations: 76
Scientific and Technical Publications: 22

Courses Taught

- Quantitative Fisheries Science (Margraf, 3 credit hours, Spring 2006)
- Integrative Modeling of Natural and Social Systems (McGuire, 1 credit hour, Fall 2006)
- Freshwater Seminar Series (Wipfli, 1 credit hour, Spring 2006)

Honors and Awards

- Fulbright Grant awarded to Meagan Boltwood to conduct research at the Universidad Austral in Valdivia, Chile, March-December 2006
- 2006 Angus Gavin Memorial Migratory Bird Research Mini-Grant awarded to Kate Martin
- 2006 IAB Graduate Research Summer Fellowship awarded to Brandt Meixell
- UAF Graduate School Travel Grant awarded to John O'Brien to give a presentation at the American Fisheries Society 2006 Western Division Annual Meeting, Bozeman, MT, May 2006
- UAF Graduate School Travel Grant awarded to Kathy Smikrud to give a presentation at the ASRAS 2006 Annual Conference in Reno, NV, May 2006
- UAF College of Natural Sciences and Mathematics Travel Grant awarded to Bruce Medhurst to give presentations at the Annual Meeting, North American Benthological Society, Anchorage, AK, June 2006.

Outreach and Info Transfer

Backensto, S., A. Powell, G. Kofinas, C. Gerlach, and E. Follmann. February 2006. The common raven (*Corvus corax*) on the North Slope of Alaska. Annual Research Review, Coastal Marine Institute, University of Alaska Fairbanks, Fairbanks, AK.

Balshi, M. S., A. D. McGuire, et al. 2006. The role of fire disturbance in the response of historical carbon dynamics in the boreal forest. International Arctic Research Center/Japan Aerospace Exploration Agency Terrestrial Team Workshop (IARC/JAXA), International Arctic Research Center, Fairbanks, AK. (Oral Presentation and Poster)

Balshi, M. S., A. D. McGuire, et al. 2006. The role of fire disturbance in the response of historical carbon dynamics in the boreal forest from 1950-2002. LTER Symposium, Princess Hotel, Fairbanks, AK. Poster.

Web Site developed for research on the migration and breedingof king eiders nesting on the North Slope of Alaska: http://mercury.bio.uaf.edu/kingeider

Wipfli, M. S. February 2006. Marine-derived nutrients in river ecology in Alaska. Presented at an international workshop sponsored by the Moore Foundation and The Wild Salmon Center, at Flathead Lake Biological Station, University of Montana, Polson, MT.

Papers Presented

Backensto, S. A., G. Kofinas, and A. N. Powell, C. Gerlachm, and E. Follman. February 2006. The common raven through the eyes of oil field workers: Local knowledge in Alaska's North Slope oil fields. Eleventh Annual Alaska Bird Conference, Juneau, AK.

Balshi, M. S. and A. D. McGuire. April 2006. The role of fire disturbance in the response of historical carbon dynamics in the boreal forest from 1950-2002. Annual Meeting, European Geophysical Union, Vienna, Austria.

Balshi, M. S. and A. D. McGuire. December 2006. The role of historical fire disturbance in the carbon dynamics of the pan-boreal region: A process-based analysis. Fall Meeting, American Geophysical Union, San Francisco, CA.

Balshi, M. S. and A. D. McGuire. October 2006. The role of historical fire disturbance in the carbon dynamics of the pan-boreal region: A process based analysis. AAAS Arctic Science Conference, Fairbanks, AK. (Poster)

Balshi, M. S., A. D. McGuire, Q. Zhuang, J. M. Melillo, D. W. Kicklighter, E. S. Kasischke, C. Wirth, M. Flannigan, J. Harden, J. S. Clein, T. Burnside, J. McAllister, W. Kurz, M. Apps, and A. Shvidenko. October 2006. The role of fire disturbance in the carbon dynamics of the pan-boreal region: A process-based analysis. AAAS Arctic Division Meeting, Fairbanks, AK.

Balshi, M. S., A. D. McGuire, Q. Zhuang, J. M. Melillo, D. W. Kicklighter, E. S. Kasischke, C. Wirth, M. Flannigan, J. Harden, J. S. Clein, T. Burnside, J. McAllister, W. Kurz, M. Apps, and A. Shvidenko. December 2006. The role of fire disturbance in the carbon dynamics of the pan-boreal region: A process-based analysis. Fall Meeting, American Geophysical Union, San Francisco, CA.

Bentzen, R. L., A. N. Powell, and R. Suydam. October 2006. Factors influencing nest success of king eiders breeding on the coastal plain of northern Alaska. Fourth North American Ornithological Conference, Veracruz, Mexico. (Poster)

Binckley, C. A., J. Y. Kill, R. B. Medhurst, M. S. Wipfli, and K. Polivka. June 2006. Spatial subsidies from headwater streams to fish bearing habitats across climatic and disturbance gradients in the North Cascade Mountains. Annual Meeting, North American Benthological Society, Anchorage, AK.

Calef, M. P., A. D. McGuire, and F. S. Chapin III. August 2006. When fire suppression fails: A GIS-based analysis. Ninety-first Annual Meeting, Ecological Society of America, Memphis, TN.

Calef, M., A. D. McGuire, F. S. Chapin III, and L. DeWilde. October 2006. Human influence on fire at the regional scale in Alaska. Fourteenth International Conference of the Society for Human Ecology, Bar Harbor, ME.

Chapin, F. S., III, S. F. Trainor, A. Lovecraft, A. D. McGuire, T. S. Rupp, N. Fresco, H. Huntington, and D. C. Natcher. October 2006. Impacts of global and national processes on local human-fire interactions in interior Alaska: Constraints on future options. Fourteenth International Conference of the Society for Human Ecology, Bar Harbor, ME.

Chapin, F.S., III, S. F. Trainor, A. Lovecraft, P. Baer, L. DeWilde, H. Huntington, O. Huntington, A. D. McGuire, D. Natcher, J. Nelson, T. S. Rupp, and E. Zavaleta.

November 2006. Fire-mediated changes in the Alaska boreal forest: Interactions of changing climate and human activities. Third International Fire Congress, San Diego, CA.

Conlin, M. R., M. R. Turetsky, J. W. Harden, and A. D. McGuire. December 2006. Moisture controls on CO_2 fluxes from boreal wetlands: Integration of experimental and gradient-based measurements at the Bonanza Creek LTER, Interior Alaska. Fall Meeting, American Geophysical Union, San Francisco, CA.

Conlin, M. R., M. R. Turetsky, J. W. Harden, and A. D. McGuire. June 2006. Moisture controls on CO2 fluxes from boreal wetlands: Integration of experimental and gradient-based measurements at the Bonanza Creek LTER, interior Alaska. BIOGEOMON 2006 5th International Symposium on Ecosystem Behavior, Santa Cruz, CA.

Cox, M. K., K. J. Hartman, and F. J. Margraf. November 2006. Bioelectrical Impedance Analysis: A non-lethal tool to measure composition/energy density in fish. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Decker, S. K., F. J. Margraf, M. Evenson, and N. F. Hughes. November 2006. Temperature as a spatial and temporal limit of Chinook salmon spawning habitat. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Decker, S. K., F. J. Margraf, M. Evenson, and N. F. Hughes. September 2006. Predicting Chinook salmon spawner density using habitat preference. Annual Meeting, American Fisheries Society, Lake Placid, NY.

Euskirchen, E. S., A. D. McGuire, and F. S. Chapin III. April 2006. The relative influences of the responses of albedo and the exchange with the atmosphere of carbon storage in high latitude terrestrial ecosystems on the climate system. Annual Meeting, European Geophysical Union, Vienna, Austria.

Euskirchen, S. E., A. D. McGuire, and F. S. Chapin III. December 2006. Energy feedbacks to the climate system due to reduced high latitude snow cover during 20th Century warming. Fall Meeting, American Geophysical Union, San Francisco, CA.

Euskirchen, S. E., A. D. McGuire, and F. S. Chapin III. November 2006. Energy feedbacks to the climate system due to reduced high latitude snow cover during 20th Century warming. Earth System Science Partnership Open Science Conference, Beijing, China.

Euskirchen, S. E., A. D. McGuire, and F. S. Chapin III. October 2006. Energy feedbacks to the climate system due to reduced high latitude snow cover during 20th Century warming. AAAS Arctic Division Meeting, Fairbanks, AK.

Finney, B. P. and I. Gregory-Eaves. June 2006. Multi-proxy approaches for understanding long-term ecosystem dynamics in Pacific salmon lakes. Tenth International Paleolimnology Symposium, Duluth, MN.

Griffith, B. November 2006. Heterogeneity in climate warming effects on fish and wildlife habitats and populations. Plenary Session, Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Harden, J., K. Manies, and A. D. McGuire. April 2006. Resilience of Alaskan boreal systems: The mechanistic role of soil temperature in fractal geometry of fire scars. Annual Meeting, European Geophysical Union, Vienna, Austria.

Kasischke, E. S., J. Allen, N. H. F. French, E. Hoy, R. Jandt, A. D. McGuire, K. A. Murphy, T. S. Rupp, M. R. Turetsky, and D. L. Verbyla. November 2006. Satellite assessment of fire severity in Alaska's boreal forest. Third International Fire Congress, San Diego, CA.

Kicklighter, D. W., J. M. Melillo, R. G. Prinn, A. D. McGuire, B. S. Felzer, and Q. Zhuang. May 2006. Relative importance of multiple stresses on terrestrial carbon sequestration. Spring Meeting, American Geophysical Union, Baltimore, MD.

Kicklighter, D. W., J. M. Melillo, R. G. Prinn, A. D. McGuire, B. S. Felzer, and Q. Zhuang. August 2006. Importance of DOC exports on estimates of terrestrial carbon sequestration. Ninety-first Annual Meeting, Ecological Society of America, Memphis, TN.

Knoche, M., L. Phillips, A. Powell, and L. Quakenbush. February 2006. Isotopes, feathers, and transmitters, or what can be learned about waterbirds during nonbreeding by combining marking methods. Pacific Seabird Group, Girdwood, AK.

Latty, C. J., T. E. Hollmen, M. R. Petersen, A. N. Powell, and R. D. Andrews. February 2006. Effects of implanted satellite transmitters on captive common eiders. Pacific Seabird Group, Girdwood, AK.

Latty, C. J., T. E. Hollmen, M. R. Petersen, A. N. Powell, and R. D. Andrews. September 2006. Effects of implanted satellite transmitters on captive common eiders foraging at a depth of 4.5 m. Thirteenth Annual Conference of The Wildlife Society, Anchorage, AK.

Margraf, F. J., K. J. Hartman, and M. K. Cox. May 2006. Non-lethal estimation of energy content of Yukon River salmon. Annual Meeting, Western Division, American Fisheries Society, Bozeman, MT.

Margraf, F. J., K. J. Hartman, and M. K. Cox. November 2006. Nondestructive field estimation of fat content of Yukon River salmon. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Margraf, F. J., K. J. Hartman, and M. K. Cox. September 2006. Non-lethal estimation of energy content of Yukon River salmon. Annual Meeting, American Fisheries Society, Lake Placid, NY.

Martin, A. E., M. S. Wipfli, and R. Spangler. November 2006. Aquatic community development in response to habitat restoration: Effects of wood and salmon analog addition. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Martin, A. E., M. S. Wipfli, and R. Spangler. June 2006. Freshwater community development in response to salmon carcass additions to newly created fish habitats in Alaska. Annual Meeting, North American Benthological Society, Anchorage, AK.

McGuire, A. D. April-May 2006. Integrated regional changes in boreal forests: Implications for the global climate system. International Institute for Applied Systems Analysis, Laxenburg, Austria. Invited.

McGuire, A. D., E. Euskirchen, F. S. Chapin III, M. Balshi, Q. Zhuang, J. Melillo, D. Kicklighter, J. Walsh, and C. Wirth. June 2006. Integrated regional changes in boreal forest climate feedbacks: Implications for the global climate system. USGS Global Change Workshop, Denver, CO.

McGuire, A. D., E. Euskirchen, F. S. Chapin III, M. Balshi, Q. Zhuang, J. Melillo, D. Kicklighter, J. Walsh, and C. Wirth. August 2006. Integrated regional changes in boreal forest climate feedbacks: Implications for the global climate system. Thirteenth International Boreal Forest Research Association, Umea, Sweden.

McGuire, R., A. Powell, and R. Suydam. February 2006. Eider one problem of another: Identifying egg predators through digital photography. Pacific Seabird Group, Girdwood, AK.

Medhurst, R. B., C. A. Binckley, J. Y. Kill, M. S. Wipfli, and K. Polivka. June 2006. Aquatic invertebrate community structure across climatic and disturbance gradients in the Northern Cascade Range, Washington. Annual Meeting, North American Benthological Society, Anchorage, AK. (NABS abstract)

Medhurst, R. B., M. S. Wipfli, C. A. Binckley, and J. Y. Kill. June 2006. Headwater invertebrate communities in logged and unlogged sub-basins in wet and dry

ecoregions of the North Cascade Mountains. Annual Meeting, North American Benthological Society, Anchorage, AK.
Mellon, C. D., M. S. Wipfli, and J. L. Li. June 2006. Headwater streams and wildfire: Short-term disturbance effects following a stand-replacing fire in northeastern Washington. Annual Meeting, North American Benthological Society, Anchorage, AK.
Morse, J. A. and A. N. Powell. February 2006. The effects of recreational disturbance on black oystercatchers at Kenai Fjords National Park. Shorebird Science in the Western Hemisphere, Boulder, CO.
Morse, J. A. and A. N. Powell. February 2006. The effects of recreational disturbance on breeding black oystercatchers: management implications. Eleventh Annual Alaska Bird Conference, Juneau, AK.
O'Brien, J. P. and F. J. Margraf. May 2006. River characteristics associated with chum salmon spawning habitat in southwestern Alaska. Annual Meeting, Western Division, American Fisheries Society, Bozeman, MT.
Oehlers, S., R. T. Bowyer, F. Huettmann, D. Person, N. Barten, and W. Kessler. June 2006. Sexual segregation and sightability of moose in Yakutat, Alaska. Forty-second Annual North American Moose Conference, Baddeck, Nova Scotia.
Oppel, S. and A. N. Powell. February 2006. Migration strategies and winter movements of king eiders wintering in the Bering Sea. Eleventh Annual Alaska Bird Conference, Juneau, AK.
Oppel, S., L. Dickson, and A. Powell. October 2006. Migratory patterns and winter movements of king eiders in the Bering Sea. Fourth North American Ornithological Conference, Veracruz, Mexico.
Peirce, J. M. and K. N. Peirce. September 2006. Use of electric fences in a high brown bear density area, McNeil River, Alaska. Thirteenth Annual Conference, The Wildlife Society, Anchorage, AK. (Poster)
Peirce, J. M., T. Otis, M. S. Wipfli, and E. H. Follmann. November 2006. Salmon escapement goals for wildlife: A case study at McNeil River Alaska. Invited speaker, Joint Session of the Annual Meetings of the Alaska Chapter, American Fisheries Society and the Alaska Chapter, Wildlife Society, Fairbanks, AK.
Perschbacher, J. and F. J. Margraf. November 2006. Habitat assessment of juvenile salmonids with aerial imagery of a southcentral Alaskan stream. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.
Phillips, L. M., S. Oppel, and A. N. Powell. August 2006. Movements of King Eider (*Somateria spectabilis*) during the non-breeding period in the Bering Sea. International Ornithological Congress, Hamburg, Germany.
Plumb, M. and F. J. Margraf. May 2006. Ecological factors influencing fish distribution in a large subarctic lake system. Annual Meeting, Western Division, American Fisheries Society, Bozeman, MT.
Plumb, M. and F. J. Margraf. September 2006. Ecological factors influencing fish distribution in a large subarctic lake system. Annual Meeting, American Fisheries Society, Lake Placid, NY.
Rinella, D. J., M. S. Wipfli, C. Walker, C. Stricker, R. Heintz. January 2006. Marine derived nutrients (MDN) in riverine ecosystems: Developing monitoring tools for tracking MDN in Alaska watersheds. Marine Science Symposium for Alaska, Anchorage, AK.
Rinella, D.J., M.S. Wipfli, C. Walker, C. Stricker, R. Heintz. June 2006. Marine derived nutrients (MDN) in riverine ecosystems: Developing monitoring tools for tracking MDN in Alaska watersheds. Annual Meeting, North American Benthological Society, Anchorage, AK.
Smikrud, K. M., F. J. Margraf, A. Prakash, and B. Frenette. November 2006. A remote sensing/GIS based approach to predicting and estimating juvenile

Chinook salmon rearing habitat within a transboundary river floodplain in Southeast Alaska. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Smikrud, K. M., F. J. Margraf, A. Prakash, F. Huettmann, and B. Frenette. September 2006. A remote sensing/GIS based approach to predicting and estimating juvenile Chinook salmon rearing habitat in Southeast Alaska. Annual Meeting, American Fisheries Society, Lake Placid, NY.

Tanner, T. L. and F. J. Margraf. September 2006. Geomorphology and selection of spawning habitat by inconnu: A heuristic model. Annual Meeting, American Fisheries Society, Lake Placid, NY.

Tanner, T. L., and F. J. Margraf. November 2006. Geomorphology and selection of spawning habitat by inconnu: A heuristic model. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Taylor, A. R. and F. Huettmann. March 2006. Facilitation of global predictive modeling for shorebirds. Shorebird Science in the Western Hemisphere Conference., Boulder, CO.

Taylor, A. R. and A. S. Kitaysky. December 2006. Corticosterone in post-breeding dunlin: Regulating molt or pre-migratory fattening? Tenth Western Sandpiper Group Meeting, Simon Fraser University, Vancouver, British Columbia.

Taylor, A., R. Lanctot, A. Powell, and T. Williams. February 2006. Should I stay or should I go now: The importance of staging sites to shorebirds on Alaska's North Slope. Shorebird Science in the Western Hemisphere, Boulder, CO.

Taylor, A. R., R. B. Lanctot, and A. N. Powell. December 2006. North Slope Staging Shorebird Project: Version 2006 update. 2006 Alaska Shorebird Group Meeting, Anchorage, AK.

Taylor, A. R., R. B. Lanctot, A. N. Powell, and T. D. Williams. March 2006. The importance of shorebird staging sites on Alaska’s North Slope. Shorebird Science in the Western Hemisphere Conference, Boulder, CO.

Taylor, A. R. and F. Huettmann. March 2006. Facilitation of global predictive modeling for shorebirds. Shorebird Science in the Western Hemisphere Conference., Boulder, CO.

Trainor, S. F., F. S. Chapin III, M. Bifelt, M. Calef, L. DeWilde, N. Fresco, A. D. McGuire, H. Huntington, O. Huntington, A. Lovecraft, D. C. Natcher, J. Nelson, T. S. Rupp, A. Starfield, and E. Zavaleta. October 2006. Human-fire interactions in the boreal forest of Alaska. AAAS Arctic Division Meeting, Fairbanks, AK.

Treat, C., M. R. Turetsky, J. W. Harden, and A. D. McGuire. December 2006. Soil climate controls on methane fluxes in boreal peatlands: Experimental manipulation of soil temperature and water table position in an Alaskan rich fen. Fall Meeting, American Geophysical Union, San Francisco, CA.

Turetsky, M. R., B. Amiro, M. Flannigan, J. Harden, E. Kasischke, and A. D. McGuire. August 2006. Peatlands and wildfire regimes in the North American boreal forest region: Implications for pyrogenic emissions. Wetlands 2006 Symposium, Traverse City, MI. Invited.

Turetsky, M. R., B. Amiro, M. Flannigan, J. Harden, E. Kasischke, and A. D. McGuire. November 2006. Peatlands and wildfire regimes in the North American boreal forest region: Implications for pyrogenic emissions. Third International Fire Congress, San Diego, CA.

Wilson, H. M., P. L. Flint, C. L. Moran, and A. N. Powell. October 2006. Ecological effects of trace elements: Spatio-temporal variability and demographic implications for Pacific common eiders. Fourth North American Ornithological Conference, Veracruz, Mexico.

Wilson, H. M., P. L. Flint, C. L. Moran, and A. N. Powell. September 2006. Survival of breeding Pacific common eiders. Thirteenth Annual Conference of The Wildlife Society, Anchorage, AK.

Wilson, H., P. L. Flint, and A. N. Powell. February 2006. Lead and selenium in breeding Pacific common eiders on the Yukon-Kuskokwim Delta, Alaska. Pacific Seabird Group, Girdwood, AK.

Wipfli, M. S. 2006. Predicting climate change effects on freshwater foodwebs. Special Session, Climate Change and Alaska Fisheries. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Wipfli, M. S. 2006. Marine-derived nutrients in stream ecosystems: The value of setting ecological escapement goals. Special Session, Marine-Derived Nutrients in Alaskan Ecosystems. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Zhuang, Q., J. M. Melillo, B. S. Felzer, D. W. Kicklighter, A. D. McGuire, and R. G. Prinn. August 2006. A modelling analysis of impact of fire disturbances on net carbon exchanges in boreal terrestrial ecosystems. Ninety-first Annual Meeting, Ecological Society of America, Memphis, TN.

Scientific Publications

Chapin, F.S. III, A. D. McGuire, R. W. Ruess, M. W. Walker, R. D. Boone, M. E. Edwards, B. P. Finney, L. D. Hinzman, J. B. Jones, G. P. Juday, E. S. Kasischke, K. Kielland, A. H. Lloyd, M. W. Oswood, C. L. Ping, E. Rexstad, V. E. Romanovsky, J. P. Schimel, E. B. Sparrow, B. Sveinbjornsson, D. W. Valentine, K. Van Cleve, D. L. Verbyla, L. A. Viereck, R. A. Werner, T. L. Wurtz, and J. Yarie. 2006. Summary and synthesis: Past and future changes in the Alaskan boreal forest. Pages 332-338 322 *in* F. S. Chapin III, M. W. Oswood, K. Van Cleve, L. A. Viereck, and D. L. Verbyla, eds. Alaska's Changing Boreal Forest. Oxford University Press, New York.

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Mellon, C. D. 2006. The effects of intense fire on headwater streams of the Colville National Forest, WA. MS Thesis, University of Alaska Fairbanks. 65 pp.

O'Brien, J. P. 2006. River features associated with chum salmon spawning areas: A method to estimate habitat capacity. MS Thesis, University of Alaska Fairbanks. 72 pp.

Plumb, M. P. 2006. Ecological factors influencing fish distribution in a large subarctic lake system. MS Thesis, University of Alaska Fairbanks. 74 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

The Effects of Intense Fire on Headwater Streams of the Colville National Forest, WA

Student Investigator: Cassie Mellon, MS Fisheries
Advisor: Mark S. Wipfli
Funding Agency: Pacific Northwest Research Station/USDA Forest Service

Note: Cassie Mellon graduated from the University of Alaska Fairbanks in December 2006. Her thesis abstract follows:

Forest fires play an important part in shaping ecosystems, and there has been growing concern on the effects of high intensity fires on forest and aquatic ecosystems. Headwater streams are highly connected to riparian and surrounding terrestrial systems, and to downstream aquatic systems, partly through prey nad organic matter transfers via aquatic invertebrate drift and emergence. Because of their small size, headwater streams may experience the greatest initial impact from forest fire, but may also return to pre-fire conditions quicker than larger streams.

In this study, headwater streams from replicated burned and control watesheds were sampled in the two years following an intense forest fire in northeastern Washington. Benthic, drift and emergence samples of aquatic invertebrates were taken and analyzed for differences in density, biomass and community composition between watershed types. There was significantly higher density of invertebrates in burned sites, but no difference in biomass except in invertebrate emergence which was greater at burned sites. There was lower diversity in the burned watersheds, and the invertebrate community was dominated by chironomids. These changes in invertebrate density and community composition could influence the food resources available to aquatic and riparian consumers.

River Features Associated with Chum Salmon Spawning Areas: A Method to Estimate habitat capacity

Student Investigator: John O'Brien, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: U.S. Fish and Wildlife Service (USFWS) (RWO 112)

Note: John O'Brien graduated from the University of Alaska Fairbanks in May 2006. His thesis abstract follows:

Diminishing returns of salmon and years of poor commercial and subsistence fishing in western Alaska are a cause for concern. Management tools which recognize the intricate life histories of salmon and incorporate environmental conditions at each particular life stage are needed. Toward that goal a study of spawning habitat for chum salmon *Oncorhynchus keta* was conducted from 2002 to 2005 on the Tuluksak River in western Alaska. Small-scale river features were measured during two summers of field work. Large-scale river features were identified using remote

sensing. Principal components analysis (PCA) denoted an association between spawning sites and channel intersections, gravel bars, islands, and areas of accelerated channel change, forming the basis for a predictive habitat model. Two models were developed that combined the habitat assessment with chum salmon redd size and spatial requirements at three spawning densities. The first model, based on field observations in 2002 and 2003, estimated a greater spawning capacity than the second model, based on large-scale river features. Spawning capacity estimates from both models were consistent with historic escapement data and should be used as a starting point for further research. This study represents progress toward a management strategy that is sensitive to habitat-dependent production potential.

Ecological Factors Influencing Fish Distribution in a Large Subarctic Lake System

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

Note: Miranda Plumb graduated from the University of Alaska Fairbanks in May 2006. Her thesis abstract follows:

The coastal climate and frequent wind storms in southwest Alaska create an atypical thermal environment (non-stratified in summer) in the remote Ugashik lakes. This study documents the distribution of lake trout *Salvelinus namaycush*, Arctic char *S. alpinus*, Dolly Varden *S. malma,* Arctic grayling *Thymallus arcticus,* round whitefish *Prosopium cylindraceum,* and pygmy whitefish *P. coulterii* relative to depth, substrate particle size, food habits, length, and age in the absence of strong thermal structure. Sample sites were randomly chosen within sampling strata and gill nets were set at each site. Lake trout and round whitefish were most abundant and had the oldest individuals in the catch. In more typical thermally stratified lake systems lake trout and Arctic char usually move to colder, deeper water in summer. In the Ugashik lakes, however, both species were abundant in shallow water all summer. Prior to this study pygmy whitefish were undocumented in this system. The fish examined in the Ugashik lakes were opportunistic feeders, consuming organisms such as isopods and amphipods. Fish in the Ugashik lakes were found in locations different from what one would expect from predominant literature. Fishery managers may need to take this into account in their fisheries management.

Ongoing Aquatic Studies

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

Student Investigator: Libby Benolkin, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: U.S. Geological Survey (USGS)
Other Support: National Park Service (NPS), University of Washington

Average sockeye salmon escapement to the Kvichak River, AK has declined since 1996. Sockeye salmon are the most important subsistence resource for Alaska Natives in the Kvichak drainage and the Newhalen River/Lake Clark area. This study focuses on determining life history characteristics, population structure, and mortality rates of the Lake Clark component and comparing these characteristics to those of the overall Kvichak River return. We will also examine possible trends in age and size at maturity of sockeye salmon from the Newhalen River over time (1973-2006) and test relationships between size at age and environmental variables. We collected sockeye salmon age and size data from Newhalen River subsistence gill nets from June 30 to July 24, 2001-2006, which will be compared to sockeye salmon age and size data from the Kvichak River collected by the Alaska Department of Fish and Game during 2001-2006. The University of Washington, Fisheries Research Institute, collected and shared age and size data from the Newhalen River subsistence fishery for the years 1973-1999 for use in correlation analyses. Trends in age distribution were similar in both rivers from 2001-2006; however, composition of age classes of adult sockeye salmon escapement differed each year between Newhalen and Kvichak rivers. In general, Newhalen River sockeye salmon were larger at age of maturity than Kvichak River salmon. A better understanding of the life history characteristics, population structure, and the environmental processes affecting this fishery could provide better scientific information to aid managers in the conservation and perpetuation of sockeye salmon originating in the Newhalen River/Lake Clark area.

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

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 objects of this study are to evaluate and calibrate the use of Bioelectrical Impedance Analysis (BIA) for determining fat content of fish as means of accurately measuring fish condition in the field. Fish examined include immature and mature Arctic cisco, Arctic cod, Arctic flounder and Dolly Varden. Fish were captured in nets set in Jago and Kaktovik lagoons in summer 2005. BIA measurements were taken on sampled fish. These fish were then euthanized, homogenized, and sent to a laboratory to determine fat, protein, water, and ash composition. Lab results will be used to calibrate the BIA measurements. It is

expected that BIA will provide researchers with a quick, minimally invasive technique to evaluate fish condition in the field. The prospect of oil development and the increase in arctic temperatures may cause problems for fish species that use nearshore waters for feeding and growth. Reduction in the ability of fish to forage efficiently may directly affect subsistence users and the many arctic species that utilize them.

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

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

Little is known about inconnu (*Stenodus leucichthys*) critical habitat needs. Current studies of inconnu spawning behavior suggest a high level of habitat selectivity, implying there are specific habitat characteristics that these fish require for spawning. The purpose of this study is to build a heuristic habitat model that can be used to better understand inconnu spawning site selection within Alaskan watersheds. Using readily available, low, or no-cost remote sensing data layers, geographical information systems (GIS) are used in conjunction with multivariate statistics to elucidate relationships between geomorphologic features and spawning site selection. Landscape variables such as stream gradient and local geology are expected to be significantly correlated to habitat selection. Drainage basin morphology influences finer-scale habitat attributes, which in turn, influence biologic communities. Understanding the relationship between macro-habitat characteristics and inconnu critical habitat requirements will drive further research efforts.

Temperature as a Spatial and Temporal Limiter of Chinook Salmon Spawning Habitat on the Chena River

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

Habitat limitations to spawning areas of Chinook salmon are largely unexplored in the northern regions where the runs remain strong and the habitats are generally in a natural state. Understanding the mechanism behind habitat selection will allow for critical habitat to be identified and estimation of the effects of climate changes on carrying capacity for Chinook salmon in the Chena River. Much research has occurred on upper thermal limits of Chinook salmon on highly modified rivers in California, Oregon, Washington and British Columbia, but little work has been done on cold, northern rivers with healthy stocks. The object of this study is to use accumulated thermal units to determine the upstream and downstream extents of the Chinook salmon spawning habitat. Temperature loggers were placed at intervals along the Chena River. Accumulated thermal units will be compiled and thermal zones mapped with GIS. If possible, arrival timing and habitat use will be measured with weekly aerial surveys. We predict the results will show a length of the Chena River that reliably achieves the required thermal units for Chinook salmon egg development with marginal areas upstream and downstream that may or may not be suitable

habitat on any given year. Although moderately urbanized in its lower reaches, the Chena River has many qualities that make it a typical interior Alaska stream. If the habitat use by Chinook salmon can be better understood here, then this information may be transferable to other more remote systems.

Habitat Assessment of Juvenile Salmonid Populations with the Aid of Aerial Imagery of a Southcentral Alaskan Stream

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

Summer rearing habitat and population distributions of juvenile salmonids have not been identified on the southern Kenai Peninsula. Access to upper sections of watersheds can be logistically difficult and costly. Steelhead trout are a valuable sport fish resource, while Chinook and coho salmon are important to subsistence, sport, and commercial fisheries for the southern Kenai Peninsula. Little is known about the freshwater habitat quality and quantity essential to sustain healthy populations in areas of increasing recreation, residential, and commercial development. The object of this study is to determine the summer distribution and freshwater habitat use of juvenile salmonids in the Chakok River and North and South forks of the Anchor River. Habitat field measurements from 15 sites throughout the watershed were collected July-September 2006 following EPA's (EMAP): *Western Pilot Study Operations Manual for Wadeable Streams.* Available aerial imagery will be used to assess the accuracy of measuring in-stream habitat characteristics with Erdas Imagine software. Snorkel surveys will be conducted summer 2007 at these same sites to estimate juvenile salmonid population densities. Juvenile coho salmon population densities should be highest in tributaries located in the middle and upper sections of the watershed. Juvenile Chinook densities should be highest in the main river channel of the middle sections of the watershed, while rainbow/steelhead should be distributed evenly throughout the entire watershed. The use of aerial imagery to assess habitat characteristics in areas without significant overhanging vegetation, shade, or sun glare should be accurate for general presence/absence identification. Traditional habitat assessment of juvenile salmonids is logistically challenging and can be costly. The alternative approach of using aerial imagery offers an affordable way to assess habitat characteristics that can be easily repeatable to monitor change. Identification of juvenile salmonid population densities and distribution can be combined with habitat characteristics in a GIS framework to be used by fisheries and land use managers to help sustain healthy salmonid populations.

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

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

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

A Remote Sensing/GIS-based Approach for Assessment of Chinook Salmon Rearing Habitat in the Unuk River Floodplain: Capabilities, Limitations, and Implications for Future Research

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

Remote sensing offers an alternative method to researchers and managers in monitoring large rivers and the aquatic habitat within. Large rivers are not accommodating for traditional (on the ground) fish habitat surveys due to their size and typically complex habitat. This study investigates the capabilities and limitations of using high spatial resolution digital aerial photography and thermal infrared images to spatially map and quantify potential juvenile Chinook salmon habitat in the Unuk River. Airborne digital images acquired in spring 2003, 2004, and 2005 were processed and analyzed using commercial image processing software and a geographic information system (GIS). Classification of the images provided spatial layers for the following landscape elements: large wood (LWD), water, sand/gravel, and vegetation, at an overall accuracy of ~85%. LWD dynamics (e.g., quantity and distribution) were assessed over the 3-year time period for annual changes. Chinook salmon indicator layers and metrics derived from the classified imagery were weighted and integrated to produce a potential rearing habitat map for a continuous 12-Rkm section of the Unuk River floodplain. Remote sensing techniques developed

in this project provide a successful method for monitoring and evaluating change in LWD dynamics mapping habitat. Thermal infrared imagery shows great potential for mapping and delineating river channels, particularly in areas obstructed by forest canopy and shadows. Results from this study provide a promising foundation towards an alternative methodology for predicting and monitoring salmon habitat that will assist managers toward the ultimate goal of linking habitat conditions with salmon production.

Reconstructing Salmon Runs Using Marine Derived Nutrients in Freshwater Mussels

Student Investigator: Andra Love, PhD Fisheries
Advisor: F. Joseph Margraf
Funding Agency: National Park Service to HDR Inc.
In-Kind Support: Field and office equipment provided by HDR Inc.

Alaska's Bristol Bay region supports a world-class salmon fishery that has recently experienced variable returns. An understanding of historical salmon presence in the Bristol Bay drainages would be beneficial in efforts to create responsive management plans to variability in fish returns. In addition, a gold mining project is proposed in a portion of the fishery's headwaters, creating a need to research baseline conditions in the region. Freshwater mussels are an effective tool for water quality monitoring and are being used for several studies in the area. The objectives of this study were to establish a nutrient baseline in the tissue of the mussels and to explore the use of nitrogen and sulfur ($\delta^{34}S$) isotopes (marine derived nutrient indicators) in the annual rings of the mussel shells for reconstruction of historical fluctuations in Bristol Bay salmon escapement. *Anodonta beringiana* mussels were collected from Katmai National Park in 2005 and from Iliamna Lake in 2005 and 2006. Katmai National Park mussel tissues were examined in 2005 to determine whether there are differences in $\delta^{15}N$ ratios between systems that receive MDN and systems that do not. Freshwater mussel shells were examined in 2006 for $\delta^{34}S$. Sample processing is ongoing. There was a statistically significant difference in $\delta^{15}N$ ratios between the systems that receive MDN and ones that do not in Katmai National Park. Samples from sites where salmon were present were generally more enriched in nitrogen isotopes. Sulfur isotope enrichment was detected in the freshwater mussel shells. The next step in the process is to test for individual rings and compare data to anadromous fish stream records. If it is proven that freshwater mussel annuli can be used as a proxy for historical salmon run abundance in a system, a low-cost method of establishing escapement data can be developed where such information does not currently exist. Freshwater mussels can be used as a tool for this purpose when sediment cores and other methods are not appropriate or are not cost effective.

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

Investigator: Bruce Finney
Funding Agency: Southwest Alaska Network/NPS
In-Kind Support: Vehicle, technical assistance, and equipment provided by NPS during field season

Long-term data are needed to better understand long-term population trends in Pacific salmon, relationships to climatic change, and the effects of salmon-derived

nutrients on freshwater productivity in the Southwest Alaska Network of the National Park Service. Because salmon play an important role in the ecology and economy of this region, this study focuses on reconstructing sockeye salmon abundance over the past 500 to 10,000 years. This project uses paleolimnological techniques to develop long-term records for a suite of 15 lakes. Lake types included in this study include clearwater, glacial, anadromous, formerly anadromous, and non-anadromous. A comparison of past sockeye abundance trends along with the role salmon-derived nutrients play in lake productivity among the various lake types will be inferred using stable nitrogen isotope analysis ($\delta^{15}N$) and primary productivity proxies. Studies of non-anadromous, control lakes will help assess what other factors, such as climate, natural disturbances, and human impact, influence freshwater systems in the absence of salmon. Variations in salmon abundance will be compared to climate and environmental histories documented from other studies. Overall, the data generated will be useful in designing viable monitoring programs by defining natural sockeye salmon variability and its relationship to past changes in climate, landscape processes, oceanic condition, and commercial fishing. The last phase of fieldwork was completed during 2006, and project completion and synthesis is in progress.

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

Investigator: Christopher Binckley, Postdoctoral Fellow
Principal Investigator: Mark Wipfli
Funding Agency: Bonneville Power Administration/DOE
In-Kind Support: Technical assistance and equipment provided by the USDA Forest Service

Headwater streams provide energy and nutrients for downstream consumers (e.g. fish), yet how regional climate and local land-use interact to influence the magnitude of these subsidies is poorly understood. Quantifying how timber harvest surrounding headwater streams differs among larger scale ecological sub-regions is needed to predict how headwater streams might affect fish populations. The objective of this study was to determine how timber harvest and ecological sub-region impact the downstream transport of invertebrate, organic, and inorganic material. We measured the amount of invertebrate, organic, and inorganic material transported to fish habitats from 60 fishless headwater streams in the Wenatchee River Basin of the North Cascade Range. Streams were categorized into four groups based on ecological sub-region (wet or dry), and extent of past timber harvest (high or low). The magnitude of headwater stream resources transported downstream reflects both the smaller scale land-use surrounding headwater streams and the larger scale climatic region in which they occur. Significantly more invertebrates were transported from dry ecoregion streams, while organic and inorganic material transport was significantly higher in high timber harvest sites. Headwater streams dominate the total stream number, channel length, and catchment area of larger drainage networks. Predicting the magnitude of downstream transport from these sites, and the consequences this may have on consumer populations, requires an understanding of how both local land-use and regional climate influence these subsidies.

Landscape Modeling of Threespine Stickleback Occurrence in Small Lakes of Northern Southeast Alaska

Student Investigator: Dave Gregovich, MS Fisheries
Advisor: Mark Wipfli
Funding Agency: Sport Fish Division/ADFG (RSA Base Supplement)
In-Kind Support: Field logistics and equipment provided by ADFG during field season

The distribution of threespine stickleback is largely unknown in lakes of Southeast Alaska. Threespine stickleback are an important prey resource for many vertebrate and invertebrate consumers. Isolated stickleback populations are also of potential scientific and conservation concern, due to their unique genetic status. The object of this study was to determine relationships between landscape-level variables and the occurrence of stickleback in small lakes and to better understand what factors limit their distribution. Stickleback occurrence was assessed via minnow trapping and snorkeling at 54 lakes divided between northern and southern study areas within southeast Alaska. Fourteen environmental factors, largely derived from GIS analysis, were analyzed against stickleback occurrence. Factors associated with stickleback ability to colonize a lake—lake elevation, distance from saltwater, and steepness of the lake outlet stream—had greater influence on stickleback occurrence than factors related to habitat suitability. Stickleback were largely confined to low-lying areas near the coast. Human development also tends to occur in this landscape position, so land-use and recreational practices should take into account the high probability of stickleback occurrence here.

Aquatic Community Development in Response to Stream Habitat Restoration: Effects of Wood and Salmon Analog Additions

Student Investigator: Aaron Martin, MS Fisheries
Advisor: Mark S. Wipfli
Funding Agency: Chugach National Forest/USDA
In-Kind Support: Forest Service vehicle, technical assistance and equipment use during field season

Off-channel stream habitats can be important rearing environments for juvenile coho salmon. These habitats were destroyed throughout 1.5 km of Resurrection Creek, on the Kenai Peninsula, Alaska, from placer mining over the past century. Based on recent surveys and historical data from nearby unmined stream reaches, these habitats were abundant and heavily used by rearing coho in the mined reach before mining. Restoring these off-channel habitats, including their productivity, is important for managing fisheries resources in Resurrection Creek. Our primary objective was to test the effectiveness of adding woody debris bundles and marine-derived nutrients (MDN), via salmon analog pellets, to newly created alcoves for accelerating aquatic community development and productivity. During summer 2006, 12 alcoves were constructed during the restoration and four treatments applied: wood bundles, nutrients, wood bundles and nutrients, and control (no bundles or nutrients added). Dissolved nutrients, biofilm mass, invertebrate abundance, and juvenile salmonid condition and density were sampled every 3 weeks from late May to early September to follow recovery under the four treatment regimes. Colonization of alcoves was rapid, with substantial invertebrate and fish colonization occurring in less than a week in most alcoves. Results also showed that the nutrient enrichment significantly increased most measured responses, while the wood

addition provided no detectable significant effects. Ultimately, these results will provide insight into the viability of using the addition of MDN and woody debris bundles as tools to augment stream restoration efforts in freshwater systems.

Headwater Invertebrate Communities across a Gradient of Logging Disturbance in Wet and Dry Ecoregions of the Wenatchee River Sub-basin, Washington

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

Little is known about the effects of timber harvest and subsequent riparian forest regeneration on headwater stream biota in the North Cascade Range. Invertebrates transported from headwater streams are often prey for downstream fish, amphibians, and birds. Forest management practices likely alter headwater invertebrate assemblages, subsequently affecting the quality and quantity of food (invertebrates) delivered from these habitats to consumers in habitats farther downstream. The objective of this study was to determine if timber harvest influences aquatic invertebrate community structure (density, and taxa richness) in wet and dry ecoregions within the eastern slope of the North Cascade Range, Washington. Benthic and drifting invertebrate assemblages were examined from 24 headwater streams spanning a wet and dry ecoregion of the Wenatchee River sub-basin in 2005 and 2006. Invertebrate drift was sampled for 24 hours using 250-um mesh drift nets, and associated benthic samples taken immediately after, using modified 250-um Surber samplers. All benthic invertebrates were identified to genus and drift invertebrates identified to family for benthic-drift comparisons. Preliminary results suggest that within the dry ecoregion, streams exposed to recent timber harvest have reduced taxa richness and reduced numeric abundance relative to unharvested sites. In contrast, streams exposed to recent timber harvest in the wet ecoregion have higher numeric abundances and little change in taxa richness relative to unharvested watersheds. These data suggest that ecoregional conditions may govern how headwater stream invertebrate communities respond to timber harvest. Understanding these relationships may help guide management decisions associated with forest and aquatic resources.

Headwater Food Subsidies Downstream: Drifting Invertebrates from Fishless Areas as Food for Downstream Fish in the Wenatchee River Basin

Student Investigator: Elizabeth Green, MS Biology
Advisor: Mark Wipfli
Funding Agency: Bonneville Power Administration/DOE
In-Kind Support: Technician and equipment provided by the USDA Forest Service, Forestry Science Research Station, Wenatchee, WA during field season

The importance of headwater streams for delivering invertebrates from upslope aquatic habitats to fish communities downstream is not understood. Often legal protection from activities such as timber harvest applies only to streams bearing fish. The influence of small, fishless streams on fish in areas fed by those small streams is not clear, but the potential for forest management to impact this food resource for

fishes is great. Understanding the strength of the trophic connections between these two habitats will then allow us to begin to understand how impacts from resource management in headwater forests will affect fish communities downstream. The objective of this study is to determine how the biomass of drifting invertebrates from fishless reaches affects the biomass of fish downstream. The biomass of drifting invertebrates at the uppermost barrier to fish within a stream was compared to fish biomass and growth downstream. Invertebrate biomass was further manipulated to measure the effect of altered food supply on fish feeding and growth. Data are still being collected, but a positive correlation between biomass of drifting invertebrates and biomass of fish is expected. If fishless headwater streams are important food sources for fish downstream, the fish-bearing criterion qualifying a stream for buffer protection may not be sufficient to protect fish.

Tracking the Presence and Effects of Marine-Derived Nutrients in Southcentral Alaska Watersheds

Student Investigator: Daniel J. Rinella, PhD Biology
Advisor: Mark Wipfli
Funding Agency: Gulf Ecosystem Monitoring Program/EVOS
In-Kind Support: Bunkhouse and lab space in Homer and Cooper Landing, respectively, provided by Kachemak Bay Research Reserve and USDA Forest Service; thesis preparation support provided by Environment and Natural Resources Institute/UAA

Little is known about the watershed-scale distribution and effects of marine-derived nutrients and carbon (MDN) delivered to streams by spawning salmon. MDN can greatly increase stream productivity and the fitness of stream-rearing fishes, and understanding these effects at broad spatial scales is necessary for sound fisheries management. Our objectives were to track MDN and measure effects in stream and riparian environments at the watershed scale and to understand the relationship between spawner abundance and the fitness of rearing fishes. During 2004 and 2005 our approach was to link stream chemistry, stable isotope, and fatty acid measures along a gradient from headwaters to mouth in nine watershed (six with salmon, three without) in three regions of the Kenai Peninsula. During 2006 we measured juvenile coho salmon and Dolly Varden fitness parameters during spring and fall in 12 salmon streams representing a large range of spawner densities. Large fluxes of dissolved nutrients (nitrogen and phosphorus) coincided with salmon spawning and increased in a downstream direction. Macroinvertebrates and riparian plants generally showed isotopic enrichment that increased in a downstream direction, but isotope ratios were highly variable and did not appear to be a reliable predictor of MDN inputs. Dolly Varden fatty acids signatures and lipid levels suggest that increased energy storage is associated with MDN consumption and that larger Dolly Varden disproportionately capitalized on MDN. Our data suggest that stream-resident fishes are the most reliable integrators and indicators of MDN at watershed scales. Current effort is focusing on the relationship between spawning salmon abundance and stream-resident fish growth and fitness as a tool for guiding ecologically based salmon escapement goals.

The Role of Marine-Derived Nutrients in the Health and Sustainability of Resident and Anadromous Fishes of the Yukon River Drainage

Student Investigator: Chrissy Apodaca, PhD Biology
Advisor: Mark Wipfli
Funding Agency: Science Support Program/USGS
In-Kind Support: Logistical and equipment support provided by USFWS

Little is known about the presence and role of marine-derived nutrients (MDN) in the Yukon River watershed. MDN from adult salmon may influence the health and sustainability of fish that occur in and near salmon spawning areas. Yukon River salmon support important subsistence and commercial fisheries in both Alaska and Canada. Multi-species and ecosystem-level effects of marine subsidies remain poorly understood, particularly in large, complex river systems like the Yukon drainage. The objectives of this study are to determine: (1) the biological extent of MDN in riverine ecosystems (e.g., measure how much MDN are assimilated by resident and anadromous fish), (2) the magnitude of MDN influence across broad geographic scales (Yukon Delta, Yukon Flats, Yukon River headwaters in Canada), (3) if certain fishes benefit from the spawning runs of others (e.g., do Chinook juveniles and resident fishes benefit from chum runs?), and (4) the role and significance of MDN in fish health. Stable isotopes (carbon, nitrogen, and sulfur) and fatty acid analyses were used to track the presence of MDN in fishes. Tissue samples were collected from one anadromous species (Chinook salmon) and two resident species (Arctic grayling and slimy sculpin) at sites representative of geographically distinct regions of the Yukon drainage (Yukon Delta NWR, Yukon Flats NWR, and Yukon Territory, Canada). Samples for the first year of study (2006) have been collected and are currently being processed and analyzed. Incorporating nutrient information into salmon escapement management may enhance current management techniques. Research focused on MDN can provide managers with information about how the magnitude of salmon runs may be linked with habitat quality for fish that rear in freshwater environments.

Ongoing Wildlife Studies

Hen-Survival and Breeding Probability of Lesser Scaup on the 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 equipment provided by Yukon Flats NWR during field season

Little attention has been given to waterfowl breeding parameters in the boreal forest, an important region to lesser scaup, whose continental population is currently 48% below the population goal set by the North American Waterfowl Management Plan. The objective of this study is to estimate hen breeding season survival and breeding probability of lesser scaup on the Yukon Flats National Wildlife Refuge in interior Alaska. Ninety-three female scaup were radio marked both pre-nesting and during nesting in 2005 and 2006, and blood samples were taken from the pre-nesting females to determine their reproductive state through measuring yolk precursor levels in the blood plasma. Female survival and reproductive status was monitored daily throughout the breeding season via aerial and ground radio telemetry. Apparent survival was 0.90 (SE = 0.03) over both years, higher than estimates from previous studies. Using radio tracking data only (blood tests are currently being analyzed), breeding probability for paired females marked pre-nesting over both years is 0.19 (SE = 0.05). A previous study has shown that using radio telemetry alone can underestimate breeding probability by up to 25%, but even when incorporating this bias, our estimate is still lower than any known breeding probability for ducks. Waterfowl management in North America, largely based on annual spring breeding pair surveys, assumes that all paired ducks attempt to breed and that there are no regional differences in the potential productivity of breeding pairs. Our results suggest that boreal scaup have low breeding probability, even when paired during the breeding season, which may have important implications for their population ecology and management.

Population Dynamics of Tundra Swans Breeding on the Lower Alaska Peninsula

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

The density of tundra swan breeding pairs on and adjacent to Izembek National Wildlife Refuge on the lower Alaska Peninsula (Izembek population) 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. We are conducting a demographic assessment of historic data collected between 1977 and 1996 to investigate the underlying processes affecting the reproductive productivity and annual survival of tundra swans breeding on the lower Alaska Peninsula. Our ultimate goal is to identify which demographic parameters most affected the population in the past and which parameters should be targeted for

future management. We used state-of-the-art methods and Program MARK to produce maximum likelihood estimates of nest, egg, and cygnet survival rates and assess the effects of weather, bear densities, cygnet age, and season date on survival. We will use Cormack-Jolly-Seber models, program MARK, and resightings and recaptures of marked birds to obtain seasonal estimates of age-specific adult survival probability, breeding probability, and neckband retention rates. Tundra swan productivity on the lower Alaska Peninsula was lower and more variable than elsewhere in Alaska, and high estimates of productivity on a portion of our study area with low bear densities suggest that depredation of nests by brown bears had considerable effects on variation in tundra swan reproductive success. Preliminary results indicate that population growth of the Izembek population may be limited by reproductive success, and therefore management to improve tundra swan reproductive success may positively influence population growth rates.

Aleutian Canada (Cackling) Geese: An Assessment of Abundance and Monitoring Designs

Student Investigator: Joshua Schmidt, PhD Biology
Advisor: Mark Lindberg
Funding Agency: USFWS (RWO 154)

Aleutian Canada geese were listed as an endangered species in 1967 and a recovery program began in 1974. Since that time the population has increased dramatically and an accurate measure of abundance was needed before considering management actions. The approach that was used for estimating the abundance of Aleutian geese in the past (Lincoln-Peterson) may not be accurate enough for sound management. There were also questions about the adequacy of the resighting effort and number of marked individuals that were monitored. The objectives of this study were to estimate the abundance of Aleutian Canada geese based on neck collar resighting data and provide guidelines for the number of geese to collar in the future and the amount of resighting effort that would be necessary to accurately estimate abundance. We used Jolly-Seber models in program MARK to estimate the abundance of Aleutian Canada geese using resightings of collared geese and flock sizes from 1995-2005. These models allow emigration of geese from the population and are less biased than the Lincoln-Peterson estimator that was previously used. We estimated that the winter 2004 abundance of Aleutian Canada geese was 106,872 (SE=5,024). To provide future accurate estimates, we recommended that resightings effort should maintain a detection probability of at least 0.4, and approximately 1 in every 500 geese should be collared annually. Based on this analysis, future management decisions can be based on unbiased abundance estimates. Our recommendations for resighting and marking effort will allow managers to produce accurate and unbiased estimates of the abundance of Aleutian Canada geese in the future.

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

Student Investigator: Heather M. Wilson, PhD Biology
Advisor: Abby Powell
Funding Agencies: Yukon Delta NWR/USFWS, Alaska Science Center/USGS, Sea Duck Joint Venture, and Angus Gavin Memorial Bird Research Grant

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

Ecology of Staging Shorebirds on Alaska's North Slope

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

Post-breeding shorebirds on the North Slope of Alaska commonly stage on the coast prior to fall migration and likely depend on resources found in coastal areas to acquire fuel for southward migration. Little information exists on the large-scale distribution of staging shorebirds across the North Slope, how long they stay after breeding, movement patterns from breeding sites to the coast and among staging areas, and what sites are most important in preparing birds for migration. Such information is critical for evaluating potential impacts of energy development and climate change along Alaska's North Slope. Briefly, our study objectives are to (1) estimate the abundance and distribution of post-breeding shorebirds along the coast, (2) document tenure times and movement patterns of common species at several sites across the North Slope, and (3) characterize the physiological condition of staging shorebirds at those same sites to evaluate site quality. During July–September 2006 we conducted aerial surveys along the coast and deployed three-person field camps at six locations across the North Slope. Personnel in the camps conducted daily transect and telemetry surveys, captured, radio-marked and collected blood samples from shorebirds, and sampled invertebrate food availability at shorebird feeding locations. Abundance and distribution of staging shorebirds

varied across space and time during the aerial surveys. The largest numbers of shorebirds were found along the western Beaufort coast, and the peak of staging occurred between August 4-8. Thus, human activity and energy development in this area during late summer may affect a disproportionate number of staging shorebirds. Radio-marked shorebirds moved widely across the North Slope in species-specific patterns, indicating that individual birds may use more than one staging site to prepare for southbound migration. This finding has implications for the scale of effects from energy development: Shorebird species that move widely across the North Slope and use more than one staging area may be impacted by development at a variety of locations. The potential for cumulative effects on post-breeding shorebirds should be evaluated on a species- and site-level basis. Fattening rates (as measured by blood plasma triglycerides) and corticosterone concentrations (a surrogate for a bird's migration "preparedness") are still being analyzed but appear to vary with molt and migration strategy. Thus these parameters need to be factored into assessments of staging site quality.

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

Student Investigator: Rebecca McGuire Bentzen, 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 National Petroleum Reserve-Alaska (NPR-A) northeast planning area has the highest known density of nesting king eiders in Alaska and is being leased for oil and gas exploration. Our objectives were to estimate nest survival and the influence of nest site choice in both an undisturbed and disturbed area. Additionally, we evaluated incubation behavior and the nutritional and physiological state of incubating females at both sites. Accessible areas around Teshekpuk Lake and Kuparuk were searched for nesting king eiders from 2002 through 2005. We located and monitored nests (~40/site/year), measured habitat characteristics of nest and random sites, placed data loggers in nests to monitor incubation constancy, and trapped females to take blood samples. Preliminary analyses found no evidence for effects of spatial covariates on nest survival, but nest success was higher at Kuparuk and when nests were undisturbed by observers. Incubation constancy was slightly higher at Kuparuk than at Teshekpuk. Plasma concentrations of variables associated with lipid metabolism, protein metabolism, and baseline corticosterone indicated that female king eiders feed during incubation but that feeding rates differ between sites. The NPR-A is the center of the breeding distribution and the area of greatest nest density of king eiders in Alaska, and it is being leased for development, so it is important to have information on the reproductive parameters of king eiders in both an undisturbed and a disturbed area.

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

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

Current climatic changes can have profound effects on migratory birds if the timing and extent of migration are closely adjusted to past environmental conditions. Understanding the variability in timing and extent of migratory patterns is therefore crucial to predict potential influences of climatic changes on the populations of migratory birds. King eiders *Somateria spectabilis* wintering in the Bering Sea have declined substantially since the 1970s, but causes for the declines are poorly understood. Warming trends have caused several changes to the Bering Sea ecosystem in recent years, and these changes may affect king eider populations. In this study we used satellite telemetry of more than100 individual king eiders from western North America to describe the timing and extent of migration and wintering patterns in the Bering Sea. We found generally very high variability in the timing of migration events. The arrival on breeding grounds and the onset of molt migration were the least variable events. Fall migration was extremely flexible, spanning over several months, and we found that more than a third of king eiders omitted fall migration and wintered on or near molting areas. There was very diffuse connectivity between breeding and wintering areas, and very low intra-year fidelity to wintering sites. More than half of the tracked king eiders used several wintering sites, and winter movement ranges were considerably larger than for other sea-duck species. We identified three distinct wintering regions in the Bering Sea between which no movements occurred from late December until April. We conclude that the high phenotypic plasticity in the timing and extent of migration may render King Eiders more likely to adapt to environmental shifts than other sea ducks with a higher degree of migratory connectivity.

Sub-lethal Effects of Implantable Satellite Transmitters on Common Eiders

Student Investigator: Christopher Latty, MS Biology
Advisor: Abby Powell
Funding Agencies: Alaska Science Center/USGS and Alaska SeaLife
In-Kind Support: Alaska SeaLife Center

Small surgically implanted satellite transmitters have been used to delineate populations and identify movement patterns of sea ducks. However, little is known about how transmitters may affect their carriers. For migration studies, anything that would negatively affect a marked individual's ability to successfully forage or move with the rest of the population would violate the assumption that the marker or marking process does not affect the animal. The objective of our study is to test this assumption and determine what, if any, physiological and/or behavioral factors are influenced by the implantation process or the subsequent carrying of the transmitter. We trained six captive common eiders to dive to the bottom of a 5-m column for their food, then surgically implanted these birds with satellite transmitters. We collected biological samples from each bird and video footage of foraging dives prior to surgery and at staggered intervals post-surgery. Preliminary analysis of biological samples suggests that eiders implanted with transmitters have both short- and long-term biochemical changes. Further biological sample analysis, as well as analysis of video data, is ongoing. Much of our knowledge of sea duck movement patterns and

phenology (including that of threatened species) is based on satellite telemetry data. If birds marked with satellite transmitters are not as successful in foraging as are untagged birds, or if they are plagued by health problems only seen in individuals with implanted transmitters, then the movement information gathered from these individuals may not be representative of the rest of the population.

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

Student Investigator: Stacia Backensto, PhD Biology
Advisor: Abby Powell
Funding Agency: Fairbanks BLM Office, Center for Global Change/UAF, CMI, Regional Resilience and Adaptation Program/UAF, and MMS
In-Kind Support: ConocoPhillips, BP Exploration AK Inc., USFWS, NSB

Little is known about the breeding ecology of the common raven on the North Slope of Alaska and how human development affects raven survival and productivity. Ravens appear to be increasing their numbers across the North Slope in response to human development. Ravens are nest predators of tundra-nesting birds, and the extent to which they negatively influence these species is unknown. The objectives of this study are to describe raven breeding and foraging ecology and document their current and historical abundance and distribution in the oil fields. In 2006 we trapped adults for satellite telemetry, monitored breeding activities, and documented foraging patterns of adults and juveniles after fledging. Regurgitated pellets collected in 2004 and 2005 were separated, and small mammal remains identified to species. Additionally, we distributed short surveys to oil field personnel to obtain additional information about how ravens use the oil fields. Nest success across the oil fields was higher in 2006 (85-87%) than in 2004 and 2005. Breeding adults exhibited high nest site fidelity and maintained 1-2 km territories during the nestling stage and territories >3 km past fledging. Juveniles marked in 2004, located previously in other areas of Alaska in the winter, returned to Prudhoe Bay in 2005/2006. Future oil development on the North Slope of Alaska is imminent, and industrial infrastructure and associated human activities provide food, shelter, and breeding sites for ravens. Ravens are abundant in the oil fields and their impact as predators on tundra-nesting birds may be heightened in this area.

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

Student Investigator: Nathan Coutsoubos, MS Biology
Advisor: Falk Huettmann
Funding Agency: BLM (RWO 155)
In-Kind Support: USFWS

The local-scale effects on tundra-nesting shorebirds of landfill development and climate change on Alaska's Arctic Coastal Plain near Barrow are largely unknown. Many shorebird species worldwide are in decline or are otherwise of management concern. The town of Barrow has just built a new landfill south of town. Barrow also has shorebird survey transects first used in the late 1970s. Objectives of this study are twofold: (1) to determine the effect of a new landfill on local-scale shorebird distribution, abundance, and nesting success; and (2) to re-survey the transects from the 1970s and determine if the local shorebird fauna has changed in 30 years.

Field methods include distance sampling surveys in and around the new landfill and surveys along the 1970s transects. Data from the 1970s transects are collected with modern techniques but can be truncated to compare directly with 1970s methods. Preliminary results suggest the new landfill provides an important early-season feeding habitat for many birds. Nesting chronology seems to be advanced compared to nearby, undisturbed locations. Data from the 1970s transects are under analysis. As the Arctic continues to develop and urbanize, these local-scale results on management-important species will be vital in forging a planning paradigm that is responsible both ecologically and socially.

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 national parks place a burden on existing facilities and thoroughfares. Decisions concerning expansion impacts can be facilitated by increasing our knowledge of the relationships between animals and their environments. The objective of this study is to explore the use of existing data to model the distribution of four species in Denali National Park: caribou, moose, grizzly bear, and wolf. Radiolocation data consisting of 1,331 locations collected over 3 years for female caribou, 1,329 locations collected over 3 years for female moose, 6,579 locations collected over 10 years for grizzly bears, and 2,686 locations collected over 3 years for wolves were obtained from park biologists. A geographic information system was used to derive landscape characteristics associated with the animal locations and random locations placed in the same area. Model testing based on the percent of randomly withheld animal locations correctly classified showed a high prediction success (75-94%) using classification trees. Fall models for female caribou had the poorest prediction ability, while summer models for female grizzly bears performed best. Topographic landscape characteristics such as elevation and terrain ruggedness were important classifiers for most of our prediction models. Distribution maps were developed for individual and multiple species during different seasons. Areas of moderate elevation along the north side of the Alaska Range are important for all our study animals. These maps can be used as a tool for land use decisions, and inference from underlying models increases our understanding of how these animals choose the areas they inhabit.

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

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

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

any disturbance mitigation measures. The purpose of this study is to estimate the geographic areas, habitat features, and diet components that are selected by female caribou during the summer period. Distribution and habitat selection were studied with the aid of radio-marked animals, 2002-2004. Fecal microhistology was used to estimate diet composition. An index of diet quality was estimated using fecal neutral detergent fiber nitrogen (NDF-N). Post-calving distributions were similar in all three years. Little or no habitat selection was detected when we compared used locations to habitat available within biweekly utilization distributions. At the larger scale of analysis, there were dynamic temporal patterns in resource selection by caribou, particularly air temperature, and the three major landcover types. Diet quality and composition showed strong seasonal patterns that correlated well with remotely sensed patterns in vegetation greenness. This herd consistently uses the area around Teshekpuk Lake intensively throughout the summer. Successful mitigation measures for petroleum development in NPR-A will need to be spatially and temporally tailored to observed dynamic patterns in caribou resource selection. NDF-N may prove to be a useful tool to measure seasonal and interannual differences in diet quality.

Developing a Method for Estimating Deer Abundance in Southeast Alaska

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

In recent years, subsistence users on Prince of Wales Island (POW) have expressed concern about the difficulty in harvesting sufficient numbers of deer to meet their needs. Lack of information about Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) populations has hindered attempts to address subsistence hunting concerns and evaluate management practices. In particular, no reliable estimates of population abundance exist. Abundance is one of the most important population parameters because it serves as the currency by which success of management programs can be judged. Further, a reliable estimate of abundance leads to a better understanding of other variables (e.g., landscape change, cause-specific mortality) influencing the species of interest. Our primary objective is to develop a method to estimate density and population trends for deer in southeast Alaska. We are using pellet-group surveys along transects located on POW to count fecal pellets and collect pellets for DNA extraction. We will use DNA extracted from fecal pellets to identify individual deer. After individual deer can be linked back to a specific place and time, mark and recapture techniques will be used to estimate abundance. Our first of three field seasons was completed in May 2006. We collected samples from 1,408 pellet groups and counted 3,620 individual pellet groups. DNA extraction has begun and we anticipate that an estimate of deer abundance at a watershed scale will be determined by February. It is important to monitor deer population levels and trends in southeast Alaska to help resolve subsistence harvest issues, manage sustainable harvests, and evaluate the effects of habitat change on population.

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

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

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, AK, a community of about 800 people. Dense vegetation, unknown habitat use, and sexual segregation may lead to biases in the 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 were to develop a reliable method of population and sex and age composition estimation and 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 obtain a detection probability function. GPS collars collected locations four times daily to be used to determine habitat use. There was no significant difference in sightability between sexes; overall sightability was 70%. Males and females selected habitats differently during all seasons except during the fall breeding period when moose are aggregated in rutting groups. Little is known about the population dynamics of this recently established moose population. The relatively isolated population appears to be at a low density and is 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 ratios to sustain the population and provide a subsistence resource for the local community.

Forage and Nutritional Determinants of Moose Calf Performance during Winter

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

Many moose populations in Alaska persist at low densities, and the management of sustained subsistence harvest of moose is becoming increasingly complex. Increasing demand, improved hunter access, and factors related to climate change may significantly influence moose populations and subsistence opportunity. Estimating causes of population limitation for moose would be improved by a regional assessment of density-dependent factors related to habitat capacity. Existing datasets for a high-density moose population in Game Management Unit 20A near Fairbanks and a relatively low-density population at Lake Clark National Park and Preserve (LCNPP) suggest that indices of body condition are a practical method of evaluating relative resource limitation for moose. The goal of this research is to develop and test a model that relates winter habitat capacity and calf weight dynamics across a wide range of moose densities and forage characteristics in Alaska. Calf weights and estimates of forage production and utilization—using a stratified random sampling scheme based on moose density and vegetation

landcover classes—were obtained at LCNPP, Koyukuk National Wildlife Refuge (KNWR), Alaska Peninsula/Becharof National Wildlife Refuge (APB), and Unit 20A. Additional habitat sampling and calf weight estimation will be completed in Unit 20A during spring 2007. For the study year 2005-2006, over-winter weight change of calves averaged -12.9 kg at KNWR (SE=2.1 kg, n=26), -2.0 kg at APNWR (SE=3.2 kg, n=10), and 8.1 kg at LCNPP (SE=2.2 kg, n=20) with statistically significant differences ($P \leq 0.0135$) among all areas. Analyses of forage characteristics from LCNPP, KNWR, APB, and 20A will be used to estimate habitat capacity and to interpret calf weight differences among study areas. Modeling the relationship between moose density, forage quality and quantity, and calf performance will generate comparable estimates of statewide variance in habitat capacity among regions in Alaska and will support subsistence and intensive management decisions for moose and predators.

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

Student Investigator: Joshua Peirce, MS Wildlife
Co-Advisors: Mark Wipfli and Erich Follmann
Funding Agency: Wildlife Conservation and Commercial Fisheries Divisions/ADFG
In-Kind Support: Equipment, field camp logistics, and aerial surveys provided by ADFG

Since 1988, McNeil River has experienced consistently low chum salmon escapements leading to annual closures of the commercial fishery. Concurrently, brown bear densities at McNeil Falls have fallen below the minimum identified threshold. McNeil River State Game Sanctuary is an important brown bear feeding area. Bears at McNeil River are dependent upon a reliable food resource which requires sound management of the chum salmon fishery. Our primary objective in this study was to establish an escapement goal for McNeil River that explicitly incorporates bear use of salmon and adequately sustains both salmon and bear populations. This objective was accomplished using radio-tagged chum salmon and daily monitoring of chum salmon capture rates by bears at McNeil Falls. Bears were found to capture a significant number of pre-spawning chums, and the stream-life factor currently used to calculate annual escapement indices was found to be too high. These data will allow us to recommend changes to the escapement goal that will both assure a predictable food resource for McNeil bears and benefit the commercial fishery.

Completed Ecological Studies

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

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

These two studies have objectives that are linked. The overall objective of the first study is to compare the results of US forest sector carbon dynamics simulated by two different models, one of which is the model implemented in Dr. McGuire's lab (the Terrestrial Ecosystem Model) and the other of which is a model implemented by the USDA Forest Service (FORCARB). The second study will analyze the estimates of leaf area index and water yield simulated by the model implemented in Dr. McGuire's lab. These studies are part of two USDA Forest RPA Special Studies that have been granted to Dr. Linda Joyce of the USDA Forest Service Rocky Mountain Forest and Range Experiment Station. In collaboration with Dr. Joyce, Dr. McGuire's lab has provided the results of simulations to his USDA Forest Service collaborators for purposes of conducting the comparison of the two models. The comparison of the carbon dynamics results of TEM with FORCARB will provide a measure of certainty relevant to policy decisions on carbon sequestration management. The output variables for the second study are currently being analyzed. The analysis of water yield simulated by TEM will provide information relevant to policy discussions on water management in the face of climate change. This research will contribute to developing a more comprehensive approach to risk assessment and management in the forest sector relative to climatic change.

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 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. In order to predict future changes in fire regime, we must first understand how the temporal and spatial aspects of fire influence carbon dynamics over the historical fire data record. To improve our understanding of how wildfire influences carbon dynamics of the pan-boreal region, we used a process-based model to estimate spatially explicit fire emissions and changes in carbon storage in the region and evaluated the role of historically recorded fire (1959-2002 for North America and 1999-2002 for the pan-boreal region) in the carbon dynamics of the region within the context of ecosystem responses to changes in atmospheric CO_2 concentration and climate. To evaluate the temporal and spatial changes of carbon dynamics in response to changes in CO_2, climate, and fire disturbance, we developed a fire module for the Terrestrial Ecosystem Model (TEM) and simulated carbon dynamics for the pan-boreal region north of 45° N from 1901-2002.

Simulated annual emissions from wildfire were not sensitive to the consideration of CO_2 fertilization. Fire emissions for boreal North America were estimated to be approximately 40 Tg C yr^{-1} over the period 1959-2002, and for North America, Eurasia, and the pan-boreal region were estimated to be approximately 45 Tg C yr^{-1}, 215 Tg C yr^{-1}, and 260 Tg C yr^{-1}, respectively, over the period 1996-2002. Simulations for boreal North America over the period 1959-2002 estimate that the response of terrestrial ecosystems to the combination of variability in atmospheric CO_2, climate, and fire resulted in the sequestration of 81.7 Tg C yr^{-1}. The isolation of individual effects for North America from 1959-2002 identified that CO_2 fertilization sequestered 50.4 Tg C yr^{-1}, climatic variation sequestered 46.9 Tg C yr^{-1}, and fire released 15.6 Tg C yr^{-1}. In simulations that excluded CO_2 fertilization, estimated sequestration was reduced by approximately 50 Tg C yr^{-1}. Simulation results for the pan-boreal region for the time period from 1996 and 2002 indicate that carbon storage increased in response to changes in CO_2, climate, and fire disturbance by 405.6 Tg C yr^{-1}. In contrast, the region is estimated to act as a source of approximately 5 Tg C yr^{-1} if CO_2 fertilization is not considered. For the case of CO_2 fertilization, the isolation of individual effects identified that CO_2 fertilization sequestered 284.6 Tg C yr^{-1}, climate variability sequestered 136.9 Tg C yr^{-1}, and fire released 15.9 Tg C yr^{-1}.

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

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

During the fifth 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 is 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. The cedar decline study has been written up by the graduate student and submitted to a peer review journal. GIS and remote sensing data providing coverage in the southeast Alaska region have been analyzed, and a manuscript describing what these analyses reveal about natural capital and services provided by wilderness areas has been developed. Lastly, a manuscript is being developed on policy subsystems, institutional behavior, and networks of influence concerning timber management on US public lands in southeast Alaska.

Snow Cover and Biology in the Arctic

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

In terrestrial high-latitude regions, observations indicate recent changes in snow cover, permafrost, and soil freeze-thaw transitions due to climate change. In a previous paper funded by this project (*Euskirchen et al., Global Change Biology, 2006*), we successfully simulated these changes and related them to changes in growing season length, productivity, and net carbon uptake in extratropical regions (30°–90°N) for the period 1960–2100. In the past year, we have expanded on this work, with an emphasis on energy feedbacks of northern high latitude ecosystems to the climate system due to reduced snow cover during two warming periods of the 20th Century, 1910–1940 and 1970–2000. We found that increases in snow cover-climate feedbacks during 1970–2000 were nearly three times larger than during 1910–1940 because the recent snow-cover change occurred in spring, when radiation load is highest, rather than in autumn. Based on linear regression analysis, we also detected a greater sensitivity of snow cover-climate feedbacks to temperature trends during the more recent time period. Pan-arctic vegetation types differed substantially in snow cover-climate feedbacks.Those with a high seasonal contrast in albedo, such as tundra, showed much larger changes in atmospheric heating than did those with a low seasonal contrast in albedo, such as forests, even if the changes in snow-cover duration were similar across the vegetation types. These changes in energy exchange warrant careful consideration in studies of climate

change, particularly with respect to associated shifts in vegetation between forests, grasslands, and tundra.

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

Researcher: Eugénie Euskirchen (Research Associate, IAB)
Faculty: A. David McGuire
Funding Agency: USDA Forest Service

It is important to quantify carbon (C) pools and fluxes across different vegetation types and successional stages in order to gain a better understanding of the processes that control the uptake, storage, and release of CO_2 in forest ecosystems. However, one ambiguity in our understanding of the forest carbon cycle in managed landscapes is the partitioning of C between roots and stems and belowground productivity over successional stages and across forest types. Recent empirical studies of commercial and widespread tree species, including red pine, scotch pine, aspen, and sugar maple, have found evidence to suggest that the root-to-shoot ratios in young coniferous stands are proportionally higher than those in older coniferous stands, with the ratio typically peaking around the time of canopy closure. Furthermore, root-to-shoot ratios in aspen stands may be much higher than pine stands early in stand development after harvest or disturbance and for sugar maple, later in stand development. Consequently, maple and aspen may allocate more C to roots relative to pine, and therefore store more C in roots, when the landscape is considered. Process-based forest ecosystem models may not adequately account for these dynamics due to a previous lack of information on belowground allocation and productivity, and the fact that many models only consider mature forest ecosystems. In the first phase of this project, we have been compiling empirical data from chronosequence studies of red pine, scotch pine, aspen, and sugar maple ecosystems in the Upper Great Lakes Region. These data pertain to ecosystem-specific variables, such as (1) net primary productivity, (2) leaf, wood, and root carbon and nitrogen, (3) carbon and nitrogen in the soils, and (4) root-to-shoot ratios. These data will be used in conjunction with climate data (precipitation, solar radiation, and air temperature) from the Upper Great Lakes Region and a process-based model, the Terrestrial Ecosystem Model, to simulate successional patterns of carbon and nitrogen dynamics in these ecosystems. This research will provide a basic knowledge of how the consideration of successional patterns of carbon and nitrogen belowground affects regional-scale estimates of C sequestration.

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

Researcher: Monika P. Calef (former postdoctoral researcher, now Assistant Professor at SUNY Albany)
Faculty: A. David McGuire
Funding Agency: NSF

The overall purpose of this study is to document the changing role of fire, particularly as affected by human activities, on the Arctic Climate System and its human residents. In Alaska, annual wildfires consume large tracts of boreal forest leading to an annual area burned that varies several magnitudes between years, depending on local weather and fuel conditions. Humans influence wildfires directly via fire starts

and suppression, though once fires escape initial attack, suppression is nearly impossible. We evaluated human fire ignitions and suppression in interior Alaska by analyzing historic fire records, fire management zones as indicators for suppression efforts, and distances from settlements, roads, and rivers in a Geographic Information System (GIS). Currently, humans are responsible for high frequency of fire ignitions near settlements and roads while simultaneously suppressing large fires near structures. This impact is directly related to human access and population size. Some degree of human influence on fire can be noted throughout all of sparsely populated interior Alaska. Most of the area burned over the past decades can be attributed to a few large fire years which differ among locations. When all years are combined, total area burned significantly depends on designated fire management zone; however, this is not the case when years are analyzed individually. We have developed a manuscript from this study that focuses on the importance of human influence on the regional fire regime in the Alaska region. An important conclusion from this study is that human impacts on natural wildfires have implications for long-term stand composition and age distribution, carbon storage, and future fire behavior.

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

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

A large release of carbon dioxide and methane from high latitude terrestrial and marine systems to the atmosphere has the potential to affect the climate system in a way that may accelerate global warming. To improve our ability to predict the dynamics of carbon in high latitudes, this project will comprehensively analyze the carbon cycle of the arctic system, guided by the following two general questions: (1) What are the geographic patterns of fluxes of carbon dioxide and methane over the Pan-Arctic region and how is the balance changing over time; and (2) What processes control the sources and sinks of carbon dioxide and methane over the Pan-Arctic region and how do the controls change with time? To address these general questions, the project will integrate data on carbon dioxide and methane dynamics of the Arctic System using a combination of prognostic and inverse approaches and provide an integrative approach to estimating and understanding the exchanges of carbon dioxide and methane from terrestrial and marine components of the system. This study will bring together diverse regional data sets and understanding in the context of a linked set of numerical model studies. It will examine, and attempt to quantify, the fluxes and links between the terrestrial, atmospheric, and oceanic components of the arctic carbon and methane cycles. A postdoctoral researcher (Daniel Hayes) arrived in November 2006 to start conducting research on this project. In preparation for the research by the postdoctoral researcher study, McGuire is conducting an international assessment of the current understanding of the carbon cycle in the Arctic.

Carbon Responses along Moisture Gradients in Alaskan Landscapes

Student Investigator: Jon O'Donnell, PhD Biology (effective January 2007)
Advisor: A. David McGuire
Funding Agency: Geologic Division/USGS (RWO 149)

The Alaskan interior contains enormous carbon reserves in vegetation and soils. As a result of changing temperatures, we anticipate enhanced releases of carbon dioxide, methane, and dissolved organics to streams and ocean waters. How carbon responds to changing climate will affect carbon dynamics and will likely depend on interactions with soil moisture and permafrost extent, which is quite variable in Alaskan landscapes. In this project, we are examining physical and biological controls on carbon exchange along soil moisture gradients in the boreal forest of interior Alaska. Our objective is to develop a set of physical (temperature, moisture, radiation) and biogeochemical (e.g. C flux and quality) data that will facilitate accurate models of C exchange in boreal landscapes. In 2005, study plots were established along a moisture gradient near the Bonanza Creek Experimental Forest, 20 km southwest of Fairbanks, AK. A boardwalk was constructed spanning the entire moisture gradient (approximately 400 m) to minimize trampling of the site. We installed Campbell CR10X dataloggers along the moisture gradient at five locations that varied according to vegetation type and drainage class. Beginning in May 2005, soil temperature, soil moisture, photosynthetically active radiation, and water table height were logged hourly at each site. During of 2006, we began monitoring electrical conductivity and redox potential at the three wettest sites along the moisture gradient. Data from dataloggers were manually downloaded once a week during the summer field seasons and once per month during the winter. We have also measured a suite of biogeochemical factors in conjunction with the physical parameters at each of the sites along the moisture gradient. These include total C and total N stocks for each organic layer, CO_2 and CH_4 fluxes from the soil to the atmosphere, groundwater solutes, and dissolved gases. Both the physical and biogeochemical data are currently being maintained in databases at UAF and at the USGS in Menlo Park, CA. Data from the moisture gradient are being analyzed and have been presented at the 2006 American Geophysical Union Fall Meeting in San Francisco, CA. Preliminary findings from the groundwater sampling indicate that dissolved organic carbon concentration is typically greater at the wetter sites than the dry sites along the moisture gradient, reflecting stronger leaching potential at wetter sites. Other analyses suggest that both vegetation type and moisture are both important controls on the chemical composition of DOC. Nitrate and sulfate concentrations decreased with increasing moisture content, which reflects the importance of anaerobic microbial processing (e.g. denitrification, sulfate reduction) under wetter conditions. Additionally, the ratio of dissolved CH_4:CO_2, which functioned as an index of anaerobic activity, increased with depth from the soil surface. The insights from these studies have the potential to inform models of C exchange in boreal landscapes.

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

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

One of the greatest uncertainties in modeling carbon cycling in boreal forests is the level of surface fuel consumption (SFC) that occurs during fires. The deep ground-layer of organic matter present in many boreal forests (consisting of litter, lichen, mosses, dead woody debris, and organic soil) frequently burns during fire. The amount of carbon released directly to the atmosphere from SFC ranges between 5 and >60 t C ha^{-1}. The spatial and temporal factors controlling variations in SFC require additional research. Researchers at the University of Maryland and Michigan State University are conducting field studies to evaluate the role of landscape characteristics (topography, soil texture, and presence/absence of permafrost) and climatic processes (seasonal weather patterns controlling fuel moisture and fire behavior and inter- and intra-annual climate patterns controlling seasonal permafrost thaw and drought) in controlling surface fuel consumption during individual fire events. We will incorporate the improved understanding from the field studies into the Terrestrial Ecosystem Model (TEM) to address the following objectives: (1) generate a set of trace gas emissions estimates from North American boreal fires for the years 1995 to 2006 that can be used by the atmospheric science community interested in studying the effects of fire emissions; (2) determine the relative impacts of intra- and inter-annual variations of North American boreal fire emissions on atmospheric CO, CH_4, and CO_2; and (3) examine how recent increases in fire activity in the North American boreal region are influencing the terrestrial carbon budget based on variations in assumptions concerning seasonal variations in area burned and surface fuel consumption. A postdoctoral researcher (Shuhua Yi) arrived in October 2006 to start conducting research on this project.

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

Student Investigator: Jennifer Roach, MS Biology
Advisor: Brad Griffith
Funding Agency: USGS/SSP (RWO 152)

Recent studies have identified substantial losses in surface water area in sub-Arctic boreal regions since 1950, and this trend has been coincident with climate warming in these regions. However, the magnitude, heterogeneity, and mechanisms behind climate-induced lake drying in interior Alaskan National Wildlife Refuges are not known. Changes in the amount of surface water in National Wildlife Refuges could alter critical summer breeding and nesting habitats for migratory waterfowl. The objectives of this study are to (1) identify potential mechanisms behind lake drying and (2) fully characterize the magnitude and rate of lake drying in interior Alaskan National Wildlife Refuges. Possible mechanisms will be identified by comparing field characteristics at lake sites with differential rates of drying in National Wildlife Refuges. The magnitude of surface water changes in interior National Wildlife Refuges will be estimated by comparing imagery from different time periods. More extensive floating mats at dried lakes compared to lakes with stable water levels at study sites in Yukon Flats National Wildlife Refuge indicate that terrestrialization is

the primary mechanism behind observed rates of drying in this study region. Greater surface area to volume ratios at dried lakes indicate that lakes with a shallow basin morphometry may be more susceptible to the effects of terrestrialization. Changes in the amount of surface water in National Wildlife Refuges could impact waterfowl breeding and nesting habitats. In addition, the processes of terrestrialization and peatland formation could result in an increase in carbon storage on the landscape.

List of Abbreviations

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