Alaska Cooperative Fish and Wildlife Research Unit

Annual Research Report—2009

October 14, 2011

Alaska Cooperative Fish and Wildlife Research Unit
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In memory of Nick Hughes, 1962–2009

Unit Roster

Federal Scientists

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

University Staff

- Karen Enochs: Fiscal Technician
- Jennifer Miller: Travel Coordinator
- Holly Neumeyer: Travel Coordinator (effective November 16)
- Kathy Pearse: Administrative Assistant

Unit Students

Current

- Matthew Albert, MS Fisheries (Margraf)
- Emily Benson, MS Biology (Wipfli)
- Jeremy Carlson, MS Fisheries (Margraf)
- Amy Churchill, MS Biology (McGuire)
- Roy Churchwell, PhD Biological Sciences (Powell)
- Samantha Decker, MS Fisheries (Margraf)
- David Esse, MS Fisheries (Margraf)
- Heather "River" Gates, MS Wildlife Biology (Powell)
- Laura Gutierrez, MS Biology (Wipfli)
- Christie Hendrich, MS Fisheries (Margraf)
- Nicole McConnell, MS Biology (McGuire)
- Jamie McKellar, MS Fisheries (Margraf)
- Jason Neuswanger, PhD Biological Sciences (Wipfli)
- Jonathan O'Donnell, PhD Biological Sciences (McGuire)
- Megan Perry, MS Biology (Wipfli)
- Jeff Perschbacher, MS Fisheries (Margraf)
- Dan Rinella, PhD Biological Sciences (Wipfli)
- Jennifer Roach, MS Biology (Griffith)
- David Roon, MS Biology (Wipfli)
- Heather Scannell, MS Fisheries (Margraf)
- Matt Sexson, PhD Biological Sciences (Powell)
- Lisa South, MS Fisheries (Margraf and Rosenberger)
- Valerie Steen, MS Wildlife Biology (Powell)
- Jason Stolarski, PhD Fisheries (Margraf)
- Lila Tauzer, MS Interdisciplinary (Powell and Prakash)
- Audrey Taylor, PhD Biological Sciences (Powell)
- Jason Valliere, MS Fisheries (Margraf)
- Emily Weiser, MS Wildlife Biology (Powell)
- Teri McMillan Wild, MS Wildlife Biology (Powell)

Graduated in CY 2009

- Elizabeth Benolkin, MS Fisheries (Margraf)

- Rebecca Bentzen, PhD Biological Sciences (Powell)
- Jonathon Gerken, MS Fisheries (Margraf)
- Bessie Green, MS Biology (Wipfli)
- Deena Jallen, MS Fisheries (Margraf)
- Meagan Krupa, PhD Biological Sciences (Wipfli and Chapin)

Post-Doctoral Researchers

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

University Cooperators

- Perry Barboza, Department of Biology and Wildlife(DBW)/Institute of Arctic Biology (IAB)-UAF
- F. Stuart Chapin, III, DBW/IAB
- Eugénie Euskirchen, IAB
- Kris Hundertmark, DBW/IAB
- Christine Hunter, DBW/IAB
- Glenn Juday, Forest Sciences Department-UAF
- Gordon Kruse, School of Fisheries and Ocean Sciences (SFOS)-UAF
- Mark Lindberg, DBW/IAB
- Anupma Prakash, Geophysical Institute-UAF
- James Reynolds, Emeritus UAF
- Amanda Rosenberger, SFOS
- Roger Ruess, DBW/IAB
- Trent Sutton, SFOS
- Amy Tidwell, Institute of Northern Engineering-UAF

Affiliated Students

Current

- David Gustine, PhD Biology (Barboza)
- Kevin Foley, MS Fisheries (Rosenberger)
- Sophie Gilbert, PhD Biology (Hundertmark)
- Tyler Lewis, MS Wildlife (Lindberg)
- Aleya Nelson, MS Wildlife (Lindberg)
- Ken Tape, PhD Biology (Ruess)
- Joe Welch, MS Wildlife (Barboza)

Graduated in CY 2009

- Todd Brinkman, PhD Biology (Chapin and Hundertmark)

Cooperators

- Brian Barnes–Director, Institute of Arctic Biology, University of Alaska Fairbanks
- Denby Lloyd–Commissioner, Alaska Department of Fish and Game
- Geoff Haskett–Director, Region 7, US Fish and Wildlife Service
- Michael Tome–Unit Supervisor, Cooperative Research Units, US Geological Survey

This is the Annual Report for the Alaska Cooperative Fish and Wildlife Research Unit, highlighting activities for calendar year 2009. The Unit engages in research on living natural resources for a variety of State and Federal agencies. As an unbiased research organization, the Unit provides information requested and funded by these agencies. When studies are completed, the agencies use the information to assist in their natural resource management efforts. Most of the research is conducted by graduate students, many of whom go on to work for the agencies upon graduation.

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

Statement of Direction

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

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

Unit Cost-Benefit Statements

In-Kind Support

In-kind support, usually operational support of field activities, is critical to the success of the Alaska Cooperative Fish and Wildlife Research Unit. Although the

monetary value of this support is not known, a listing of the assistance is provided for each project in this report.

Benefits

Students Graduated: 7
Presentations: 46
Scientific and Technical Publications: 27

Courses Taught

- Dave McGuire: Special Topics in IGERT Program in Regional Resilience and Adaptation, BIOL F693 [1 credit hour, Fall 2009, Hybrid (Part Classroom/Part On-Line)]
- Abby Powell: Readings in Conservation Biology, BIOL F622 (3 credit hours, Spring 2009)
- Abby Powell: Readings in Avian Ecology, BIOL F693 (1 credit hour, Fall 2009)
- Mark Wipfli: Freshwater Ecosystems Seminar, BIOL F492/692 and FISH 492/692 (1 credit hour, Spring 2009)
- Mark Wipfli: Climate Change Seminar, BIOL F492/692 and FISH F492/692 (1 credit hour, Fall 2009)

Honors and Awards

- Jon Gerken: Best Student Paper at the Western Division Annual Meeting, American Fisheries Society, Albuquerque, NM, May 2009.
- F. Joseph Margraf: Meritorious Service Award, American Fisheries Society, International, August 2009.
- Jason Neuswanger, Best Student Paper at the Alaska Chapter 36th Annual Conference, American Fisheries Society, Fairbanks, AK, November 2009.
- David Roon, Best Student Poster at the Alaska Chapter 36th Annual Conference, American Fisheries Society, Fairbanks, AK, November 2009.
- Lisa South, Thesis Completion Scholarship for Fall 2009 from the Graduate School, UAF.

Outreach and Info Transfer

- Brinkman, T. J. 2009. Estimating deer populations using DNA. Article in Alaska Department of Fish and Game Newsletter *Deer Trails.* Issue 1.
- Brinkman, T. J. 2009. Landscape changes may challenge strategies for hunting deer. Article in Alaska Department of Fish and Game Newsletter *Deer Trails.* Issue 1.
- Gutierrez, Laura. Video of research on UAF website: http://www.uaf.edu/news/news/20091021161413.html
- McGuire, A. D., H. P. Huntington, and S. Wilson. 2009. Sensitivity of arctic carbon in a changing climate. Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS) Newsletter 8:12-14.
- Wipfli, M. S. 2009. Rainforest-River-Ocean Connections: Nutrient and Energy Pathways that Fuel Riverine Food Webs. Seminar for the UAS Sitka Campus Natural History Seminar Series, Sitka, AK.
- Wipfli, M. S. 2009. Climate Change and Freshwater Ecosystems. Training seminar for an environmental specialists training workshop sponsored by the Alaska Sea Grant Marine Advisory Program, Fairbanks, AK.

- Wipfli, M. S. 2009. Rainforest-River-Ocean Connections: Nutrient and Energy Pathways that Fuel Riverine Food Webs. Plenary address for a workshop sponsored by the Alaska Sea Grant Marine Advisory Program, Petersburg, AK.
- Wipfli, M. S. 2009. River Ecology and Salmon. Training seminar for a teacher training workshop sponsored by COSEE (Centers for Ocean Sciences and Educational Excellence), Fairbanks, AK.

Papers Presented

Benson, E. R., M. S. Wipfli, and N. F. Hughes. May 2009. Environmental variation, whole stream metabolism, and benthic macroinvertebrates in a subdrainage of the Yukon River, subarctic Alaska. Annual Meeting, North American Benthological Society, Grand Rapids, MI.

Benson, E. R., M. S. Wipfli, and N. F. Hughes. November 2009. Environmental variation and whole stream metabolism in the Chena River, interior Alaska. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Churchill, A., A. D. McGuire, and M. R. Turetsky. September 2009. Plant physiological and environmental controls on primary production in Alaskan peatlands. International Conference on the Role and Importance of Peatlands in the Global Carbon Cycle: Past, Present, and Future, Prague, The Czech Republic.

Collins, S. F., C. V. Baxter, A. Marcarelli, and M. S. Wipfli. May 2009. Adult riparian insect response to experimental in-stream salmon nutrient additions in Idaho. Annual Meeting, North American Benthological Society, Grand Rapids, MI.

Davis, K., S. Alin, A. Barr, P. Coble, R. Cook, S. Denning, P. Griffith, D. Hayes, L. Heath, D. Huntzinger, A. Jacobson, A. King, W. Kurz, A. D. McGuire, S. Ogle, W. Post, B. Raczka, D. Ricciuto, A. Richardson, K. Schaefer, P. Thornton, S. Wofsy, and many data contributors. September 2009. Towards well-constrained continental flux estimates: Progress in the North American Carbon Program. Eighth International Carbon Dioxide Conference, Jena, Germany.

Gerken, J., F. J. Margraf, and R. Brown. May 2009. Identification and characterization of inconnu spawning habitat in the Sulukna River, Alaska. Annual Meeting, Western Division, American Fisheries Society, Albuquerque, NM. (Best Student Paper)

Green, E. C., E. R. Benson, L. Gutierrez, J. R. Neuswanger, M. T. Perry, M.S. Wipfli, N.F. Hughes, and M.J. Evenson. September 2009. Ecology of juvenile Chinook salmon in the Chena River, interior Alaska. International Polar Year Conference, Whitehorse, YT, Canada.

Green, E. C., M. T. Perry, J. Neuswanger, E. R. Benson, L. Gutierrez, M. S. Wipfli, M. Evenson, and N. F. Hughes. September 2009. The ecology of juvenile Chinook salmon in the Chena River, Interior Alaska. Student Conference, Association of Canadian Universities for Northern Studies (ACUNS), Whitehorse, YT, Canada.

Green, E. C., M. T. Perry, J. R. Neuswanger, E. R. Benson, L. Gutierrez, M. S. Wipfli, N. F. Hughes, and M. J. Evenson. November 2009. The ecology of juvenile Chinook salmon in the Chena River, interior Alaska. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Green, E. C., M. S. Wipfli, and K. M. Polivka. June 2009. Logging effects on salmonids in headwater streams vary with ecoregion in the east Cascade Range, Washington, USA. Annual Meeting, North American Benthological Society, Grand Rapids, MI.

Green, E. C., M. S. Wipfli, and K. M. Polivka. August 2009. Falling forest flies, downstream-drifting delicacies, benthic breakfast bugs: What are headwater

stream fish really eating? Annual Meeting, American Fisheries Society, Nashville, TN.
Gutierrez, L., M. S. Wipfli, N. F. Hughes, and E. C. Green. May 2009. Temporal patterns of terrestrial and aquatic invertebrate prey abundance for juvenile Chinook salmon in a subdrainage of the Yukon River, Alaska. Annual Meeting, North American Benthological Society, Grand Rapids, MI.
Gutierrez, L., M. S. Wipfli, N. F. Hughes, and E. C. Green. November 2009. Patterns of prey abundance for juvenile Chinook salmon in the Chena River, interior Alaska. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.
Harden, J. W., M. R. Turetsky, M. Conlin, E. Kane, A. D. McGuire, and K. L. Manies. May 2009. The influence of seasonal thaw and water table dynamics on soil carbon and trace gas flux in an ecosystem grandient in Interior Alaska. Spring Meeting, American Geophysical Union, Toronto, Canada.
Kane, E., M. Turetsky, M. Waddington, J. Harden, and A. D. McGuire. May 2009. Seasonal ice and drainage controls over solute chemistry in a rich boreal fen: A field water table manipulation study in Interior Alaska. Spring Meeting, American Geophysical Union, Toronto, Canada.
Kasischke, E. S., S. J. Goetz, A. D. McGuire, and D. J. Hayes. December 2009. An overview of the role of disturbance in the terrestrial carbon budget. Fall Meeting, American Geophysical Union, San Francisco, CA. Invited.
Kilinc, M., J. Beringer, L. Hutley, N. Tapper, A. D. McGuire, K. Kurioka, S. Wood, and N. D'Argent. December 2009. Biophysical controls of carbon exchange in old growth Mountain Ash stands. Fall Meeting, American Geophysical Union, San Francisco, CA.
Macheel, C. A., R. Daanen, D. Misra, A. D. McGuire, M. Turetsky, M. Waddington, and E. Kane. September 2009. Numerical simulations of variably saturated flow with energy and water phase change in northern latitude peatlands. Annual Meeting, Association of Engineering and Environmental Geologists, Reno, NV.
Marcarelli, A. M., C. V. Baxter, S. F. Collins, and M. S. Wipfli. August 2009. Short-term ecosystem responses to experimental salmon carcass and analog additions in headwater streams. Annual Meeting, Ecological Society of America, Albuquerque, NM, 2-7 August.
Margraf, F. J., K. J. Hartman, and M. K. Cox. September 2009. Evaluation of Biological Impedance Analysis using a robust data set. Annual Meeting, American Fisheries Society, Nashville, TN.
Martin, R., A. Marcarelli, C. V. Baxter, S. Collins, and M. S. Wipfli. May 2009. Nutrient limitation and uptake response to experimental salmon additions in Idaho headwater streams. Annual Meeting, North American Benthological Society, Grand Rapids, MI.
McGuire, A. D. August 2009. The contemporary carbon cycle of the pan-Arctic: Data, models and spatial-temporal dynamics. Annual Meeting, Ecological Society of America, Albuquerque, NM. Invited.
McGuire, A. D., D. J. Hayes, D. W. Kicklighter, M. Manizza, Q. Zhuang, M. Chen, M. J. Follows, K. R. Gurney, J. W. McClelland, J. M. Melillo, B. J. Peterson, and R. G. Prinn. September 2009. An analysis of the carbon balance of the Arctic Basin from 1997-2006. Eighth International Carbon Dioxide Conference, Jena, Germany.
McGuire, A. D., J. W. Harden, S. Yi, D. A. Hayes, E. Euskirchen, D. W. Kicklighter, Q. Zhuang, K. Manies, and M. Turetsky. September 2009. Meeting challenges in modeling carbon-climate feedbacks of northern high latitude ecosystems. International Conference on the Role and Importance of Peatlands in the Global Carbon Cycle: Past, Present, and Future, Prague, The Czech Republic. Invited.

Neuswanger, J. R., N. F. Hughes, M. S. Wipfli, and L. H. Kelly. September 2009. Accessible 3-D video methods for in situ fish measurement and behavioral analysis. Annual Meeting, American Fisheries Society, Nashville, TN.

Neuswanger, J. R., N. F. Hughes, M. S. Wipfli, and L. H. Kelly. November 2009. Improved 3-D analysis for underwater video, with applications to wild juvenile Chinook salmon foraging behavior. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Perry, M. T., N. F. Hughes, M. S. Wipfli, J. R. Neuswanger, and M. J. Evenson. September 2009. Growth of juvenile Chinook salmon in an interior Alaska river: responses to food abundance and temperature. Annual Meeting, American Fisheries Society, Nashville, TN.

Perry, M. T., N. F. Hughes, M. S. Wipfli, J. R. Neuswanger, and M. J. Evenson. November 2009. Growth responses of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) to food abundance and temperature in the Chena River, interior Alaska. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Powell, A. N. and S. Oppel. September 2009. Movements and survival of first- and second-year king eiders in the Bering and Chukchi seas. 16th Wildlife Society Conference, Monterey, CA.

Rinella, D. J., M. S. Wipfli, C. Stricker, and R. Heintz. May 2009. Relationship between spawning salmon abundance and fitness of stream-dwelling fishes, Kenai Peninsula, Alaska. Annual Meeting, Western Division, American Fisheries Society, Albuquerque, NM.

Rinella, D. J., M. S. Wipfli, C. Stricker, and R. Heintz. November 2009. Relationships between spawning salmon abundance and the fitness of stream-dwelling fishes, Kenai Peninsula, Alaska. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Roon, D. A., M. S. Wipfli, and T. L. Wurtz. November 2009. Ecological effects of introduced European bird cherry on salmonid food webs in Anchorage streams. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK.

Steen, V. A. and A. N. Powell. November 2009. Habitat selection by black terns in the Prairie Pothole Region. 33rd Annual Meeting, The Waterbirds Society, Cape May, NJ.

Steen, V. A. and A. N. Powell. September 2009. A comparison of habitat models for black terns. 16th Annual Conference, The Wildlife Society, Monterey, CA.

Steen, V.A. and A. N. Powell. April 2009. A comparison of multiscale habitat models for black terns. 79th Annual Meeting, Cooper Ornithological Society, Tucson, AZ.

Turetsky, M. R., M. R. Chivers, J. M. Waddington, J. W. Harden, and A. D. McGuire. May 2009. Climatic and vegetation controls on peatland CO2 fluxes in Alaska: Early response to ecosystem-scale drought and soil warming manipulations. Spring Meeting, American Geophysical Union, Toronto, Canada.

Weiser, E. and A. Powell. April 2009. Does garbage make more glaucous gulls? (preliminary results). 79th Annual Meeting, Cooper Ornithological Society, Tucson, AZ.

Weiser, E. and A. Powell. April 2009. Does garbage make more glaucous gulls? (preliminary results). Annual Meeting, Alaska Chapter, The Wildlife Society, Fairbanks, AK.

Weiser, E. and A. Powell. October 2009. Effects of changes in garbage management on glaucous gull diet at Barrow, Alaska. Student Conference, Association of Canadian Universities for Northern Studies (ACUNS), Whitehorse, YT, Canada.

Weiser, E. and A. N. Powell. November 2009. Garbage makes more glaucous gulls. Annual Meeting, Waterbird Society, Cape May, NJ.

Wild, T. L., S. Kendall, F. Huettmann, C. Villa, and A. N. Powell. September 2009. Smith's longspur density and distribution in Alaska's Brooks Range. 16th Wildlife Society Conference, Monterey, CA.

Wipfli, M. S., and C. V. Baxter. May 2009. Food supplies that drive fish productivity: Modeling prey flux in riverine networks. Annual Meeting, North American Benthological Society, Grand Rapids, MI.

Wipfli, M. S., E. Green, C. Binckley, R. Medhurst, and C. Mellon. September 2009. Headwater stream productivity: Why does it range so broadly? Special symposium on headwater streams. Annual Meeting, American Fisheries Society, Nashville, TN. (invited)

Zhuang, Q., J. Melillo, J. Reilly, A. D. McGuire, R. Prinn, A. Shvikdenko, N. Tchebakova, A. Sirin, S. Maksyutov, A. Peregon, D. Kicklighter, E. Parfenova, and G. Zhou. April 2009. Changes of land cover and land use and greenhouse gas emissions in Northern Eurasia. Annual Meeting, European Geophysical Union.

Zhuang, Q., J. Tang, J. Melillo, M. Chen, Y. Jiang, D. Kicklighter, R. Prinn, and A.D. McGuire. September 2009. Constraining the uncertainty of carbon dynamics in North America using eddy flux measurements and satellite-based net primary production data. Eighth International Carbon Dioxide Conference, Jena, Germany.

Zhuang, Q., J. Tang, Y. Lu, K. Xu, X. Xiong, J. Melillo, R. Prinn, and A.D. McGuire. May 2009. Evaluating contributions of wetland and lake emissions of methane to atmospheric methane concentrations with a process-based biogeochemistry model and an atmospheric chemistry transport model and satellite retrieval data in northern high latitudes. Spring Meeting, American Geophysical Union, Toronto, Canada.

Scientific Publications

Balshi, M. S., A. D. McGuire, P. Duffy, M. Flannigan, D. W. Kicklighter, and J. Melillo. 2009. Vulnerability of carbon storage in North American boreal forests to wildfires during the 21st century. Global Change Biology 15:1491-1510, doi:10.1111/j.1365-2486.2009.01877.x

Balshi, M. S., A. D. McGuire, P. Duffy, M. Flannigan, J. Walsh, and J. Melillo. 2009. Assessing the response of area burned to changing climate in western boreal North America using a Multivariate Adaptive Regression Splines (MARS) approach. Global Change Biology 15:578-600, doi:10.1111/j.1365-2486.2008.01679.x.

Belant, J. R., B. Griffith, Y. Zhang, E. H. Follmann, and L. G. Adams. 2009. Population-level resource selection by sympatric brown and American black bears in Alaska. Polar Biology. DOI 10.1007/s00300-009-0682-6.

Bentzen, R., A. Powell, and R. Suydam. 2009. Strategies for nest site selection by king eiders. Journal of Wildlife Management 73(6):932-938. DOI: 10.2193/2008-411.

Bentzen, R. L., A. N. Powell, T. D. Williams, and A. S. Kitaysky. 2009. Characterizing the nutritional strategy of incubating king eiders *Somateria spectabilis* in northern Alaska. Journal of Avian Biology 39:683-690. doi: 10.1111/j.1600-048X.2008.0442.x.

Birdsey, R., N. Bates, M. Behrenfeld, K. Davis, S. Doney, R. Feely, D. Hansell, L. Heath, E. Kasischke, H. Kheshgi, B. Law, C. Lee, A.D. McGuire, P. Raymond, and C.J. Tucker. 2009. Carbon cycle observations: Gaps threaten climate mitigation policies. Eos 90(34):292-293.

Brinkman, T. J., M. K. Schwartz, D. K. Person, K. L. Pilgrim, and K. Hundertmark. 2009. Effects of time and rainfall on PCR success using DNA extracted from deer fecal pellets. Conservation Genetics (DOI 10.1007/s10592-009-9928-7)

Chapin, F. S. III, J. McFarland, A. D. McGuire, E. S. Euskirchen, R. W. Ruess, and K. Kielland. 2009. The changing global carbon cycle: Linking plant-soil carbon dynamics to global consequences. Journal of Ecology 97:840-850.

Chivers, M. R., M. R. Turetsky, J. M. Waddington, J. W. Harden, and A. D. McGuire. 2009. Effects of experimental water table and temperature manipulations on ecosystem CO2 fluxes in an Alaskan rich fen. Ecosystems 12:1329-1342.

Euskirchen, E. S., A. D. McGuire, F. S. Chapin, III, S. Yi, and C. C. Thompson. 2009. Changes in vegetation in northern Alaska under scenarios of climate change, 2003-2100: implications for climate feedback. Ecological Applications 19(4):1022-1043.

Fagre, D. B., C. W. Charles, C. D. Allen, C. Birkeland, F. S. Chapin III, P. M. Groffman, G. R. Gunternspergen, A. K. Knapp, A. D. McGuire, P. J. Mulholland, D.P.C. Peters, D.D. Roby, and G. Sugihara. 2009. Thresholds of climate change in ecosystems. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Geological Survey, Reston VA, USA. 170 pages.

Griffith, B., J. M Scott, R. Adamcik, D. Ashe, B. Czech, R. Fischman, P. Gonzalez, J. Lawler, A. D. McGuire, and A. Pidgorna. 2009. Climate change adaptation for the U.S. National Wildlife Refuge System. Environmental Management 44:1043-1052 (DOI 10.1007/s00267-009-9323-7)

Karl, T. R., J. M. Melillo, T. C. Peterson, D. M. Anderson, D. F. Boesch, V. Burkett, L. M. Carter, S. J. Cohen, N. B. Grimm, J. L. Hatfield, K. Hayhoe, A. Janetos, J. A. Kaye, J. Lawrimore, J. McCarthy, A. D. McGuire, E. Miles, E. Mills, J. T. Overpeck, J. Patz, R. Pulwarthy, B. Santer, M. J. Savonis, H. G. Schwartz, E. Shea, J. Stone, B. H. Udall, J. Walsh, M. F. Wehner, T. J. Wilbanks, and D. Wuebbles. 2009. Global Climate Change Impacts in the United States: A State of Knowledge Report from the U.S. Global Change Research Program. Cambridge University Press. New York. 188 pages.

McGuire, A. D., L. G. Anderson, T. R. Christensen, S. Dallimore, L. Guo, D. J. Hayes, M. Heimann, T. D. Lorenson, R. W. Macdonald, and N. Roulet. 2009. Sensitivity of the carbon cycle in the Arctic to climate change. Ecological Monographs 79(4):523-555.

O'Donnell, J. A., V. E. Romanovsky, J. W. Harden, and A. D. McGuire. 2009. The effect of moisture content on the thermal conductivity of moss and organic soil horizons from black spruce ecosystems in interior Alaska. Soil Science 174(12):646-651.

Oppel, S., D. L. Dickson, and A.N. Powell. 2009. International importance of the eastern Chukchi Sea as a staging area for migrating king eiders. Polar Biology 32:775-783.

Oppel, S. and A. N. Powell. 2009. Carbon isotope turnover in blood as a measure of arrival time in migratory birds using isotopically distinct environments. Journal of Ornithology. DOI 10.1007/s10336-009-0434-y.

Oppel, S. and A. N. Powell. 2009. Does winter region affect nest survival of king eiders in northern Alaska? Polar Biology 32:1203-1209. DOI 10.1007/s00300-009-0618-1.

Oppel, S., A. N. Powell, and D. L. Dickson. 2009. Using an algorithmic model to reveal individually variable movement decisions in a wintering sea duck. Journal of Animal Ecology 78:524-531. doi: 10.1111/j.1365-2656.2008.01513.x.

Oppel, S., A. N. Powell, and D. M. O'Brien. 2009. Using eggshell membranes as a non-invasive tool to investigate the source of nutrients in avian eggs. Journal of Ornithology 150:190-215.

Overton, A. S., F. J. Margraf, and E. B. May. 2009. Spatial and temporal patterns in diet of striped bass Morone saxatilis in Chesapeake Bay. Transactions of the American Fisheries Society 138:915-926.

Phillips, L. M. and A. N. Powell. 2009. Brood rearing ecology of King Eiders on the North Slope of Alaska. The Wilson Journal of Ornithology 121(2):430-434.

Post, E., M. C. Forchhammer, M. S. Bret-Harte, T. V. Callaghan, T. R. Christensen, B. Elberling, A. D. Fox, O. Gilg, D. S. Hik, T. T. Hoye, R. A. Ims, E. Jeppesen, D. R. Klein, J. Madsen, A. D. McGuire, et al. 2009. Ecological dynamics across the Arctic associated with recent climate change. Science 325:1355-1358.

Stolarski, J. T. and K. J. Hartman. 2010. Comparisons of growth and condition of fluvial and resident brook trout within partially migratory populations. Fisheries Management and Ecology 17:33-39.

Trainor, S. F., M. Calef, D. Natcher, F. S. Chapin III, A. D. McGuire, O. Huntington, P. Duffy, T. S. Rupp, L. DeWilde, M. Kwart, N. Fresco, and A. L. Lovecraft. 2009. Vulnerability and adaptation to climate-related fire impacts in rural and urban interior Alaska. Polar Research 28:100-118.

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Theses and Dissertations of Unit-Sponsored Graduate Students

Benolkin, Elizabeth B. 2009. Variation in age and size at maturity of Lake Clark, Alaska sockeye salmon. MS thesis, University of Alaska Fairbanks. 84 pp.

Bentzen, Rebecca. 2009. Reproductive patterns in king eiders. PhD thesis, University of Alaska Fairbanks. 161 pp.

Brinkman, Todd J. 2009. Resilience of a deer hunting system in southeast Alaska: Integrating social, ecological, and genetic dimensions. PhD thesis, University of Alaska Fairbanks. 215 pp.

Gerken, Jonathon. 2009. Identification and characterization of inconnu spawning habitat in the Sulukna River, Alaska. MS thesis, University of Alaska Fairbanks. 74 pp.

Green, Elizabeth C. 2009. Ecological linkages between headwater streams and riparian and downstream habitats in the Eastern Cascade Range, Washington, USA. MS thesis, University of Alaska Fairbanks. 30 pp.

Jallen, Deena M. 2009. River features associated with chinook salmon spawning habitat in southwest Alaska. MS thesis, University of Alaska Fairbanks. 91 pp.

Krupa, Meagan B. 2009. Urban stream management: Interdisciplinary assessment of an Alaskan salmon fishery. PhD thesis, University of Alaska Fairbanks. 196 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

Variation in Age and Size at Maturity of Lake Clark, Alaska Sockeye Salmon

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

Note: Libby Benolkin graduated from the University of Alaska Fairbanks in December 2009. Her thesis abstract follows:

Salmon returning to Lake Clark, Alaska are a valuable subsistence, commercial and ecological resource, and are an important component of the larger Kvichak River escapement. Average escapement to the Kvichak River declined sharply during 1996-2005, prompting studies to investigate age and size at maturity, key life history traits of salmon linked to reproductive success and survival. We examined potential factors which may influence sockeye salmon *Oncorhynchus nerka* age and size at maturity: spawning habitat and ocean environment, and examined variation in both traits over time. Sockeye salmon age and length at maturity differed among spawning locations and between brood years, but no consistent patterns were observed among habitat types. Age and length at maturity differed over time; the proportion of older marine age 3 fish was larger in recent brood years, while fish were smaller during 1997-2001 compared to 1976-1980. Sea surface temperatures and coastal upwelling appeared to be important indicators of fish length, highlighting the importance of the ocean environment in salmon growth. These results demonstrate the complexity and importance of both the freshwater and ocean ecosystems in variation in age and size at maturity, and indicate that trends may not necessarily be similar among systems or years.

Identification and Characterization of Inconnu Spawning Habitat in the Sulukna River, Alaska

Student Investigator: Jonathon Gerken, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Koyukuk/Nowitna National Wildlife Refuge/USFWS

Note: Jon Gerken graduated from the University of Alaska Fairbanks in December 2009. His thesis abstract follows:

Inconnu *Stenodus leucichthys* are present throughout much of the Yukon River drainage in Alaska, but only five spawning areas have been identified. Spawning habitat requirements are therefore thought to be very specific; however, the physical qualities of these habitats have only been characterized in general terms. The Sulukna River is one of five identified inconnu spawning areas within the Yukon River drainage. A systematic sampling design was used in September and October of 2007-2008 to define Sulukna River spawning locations. Presence of inconnu was identified using hook and line sampling methods and spawning was verified by

catching broadcast eggs in plankton nets. Small-scale, large-scale, and chemical habitat variables were sampled at transects located every 1.8 river kilometer (rkm). Project results indicate that spawning habitat was confined to a narrow reach of approximately 20 rkm. Spawning habitat occurred significantly more often in transects characterized with substrate between 6 and 12 cm, a width to depth ratio between 15 – 36, and water conductivity between 266 – 298 μS/cm. Similar studies on other known spawning habitats would reveal whether these qualities are common to all inconnu spawning populations or unique to the Sulukna River.

Ecological Linkages between Headwater Streams and Riparian and Downstream Habitats in the Eastern Cascade Range, Washington, USA

Student Investigator: Elizabeth C. Green, MS Biology
Advisor: Mark Wipfli
Funding Agency: Bonneville Power Authority/DOE

Note: Bessie Green graduated from the University of Alaska Fairbanks in December 2009. Her thesis abstract follows:

I examined how headwater streams are ecologically linked with the terrestrial environment and upstream waters. I examined relationships between fish (rainbow and cutthroat trout), invertebrates, and habitat in 15 headwater streams in two ecoregions (wet, dry) and timber harvest scenarios (logged, unlogged) in the Wenatchee River sub-basin in the eastern Cascade Mountain Range, Washington state, USA. Fish biomass, density, and size were not related to ecoregion nor to logging history. Invertebrate drift manipulations in 13 streams influenced fish movement (fish moved downstream in sites that were not supplemented with food) and diet (fish consumed less prey when drifting invertebrates were removed), but not fish growth or abundance. This study demonstrated that fish utilize drifting prey originating from upstream fishless waters, and that they are not able to compensate for the loss of this food. Headwater forest management may affect fish populations by altering prey resources where fish are food-limited.

River Features Associated with Chinook Salmon Spawning Habitat in Southwest Alaska

Student Investigator: Deena M. Jallen, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: USFWS (RWO 112)

Note: Deena Jallen graduated from the University of Alaska Fairbanks in August 2009. Her thesis abstract follows:

Chinook salmon *Oncorhynchus tshawytscha* are a highly valued traditional, subsistence, and commercial resource in Southwest Alaska. Stream habitat availability is a major component influencing salmon productivity. The objective of this study is to identify river features associated with spawning habitat, and describe upper and lower boundaries of Chinook salmon spawning on the Tuluksak River. River distances, elevation, salmon locations, spawning sites, and habitat

observations were collected along 75 rkm (river kilometers) of the Tuluksak River primarily within the Yukon Delta National Wildlife Refuge. Habitat and salmon observations were grouped into strata along the length of the river for comparison and analysis. Chinook salmon were observed spawning in the upper 45 rkm of the study area. Map-based observations of elevation and channel sinuosity correlate better with Chinook salmon spawning than in stream habitat measurements along the Tuluksak River. The upper boundary of Chinook salmon spawning in the Tuluksak River was outside of our study area. The lower boundary for Chinook salmon spawning habitat on similar rivers might be determined by examining elevation, sinuosity, and channel features from remote images or maps prior to conducting field studies.

Urban Stream Management: Interdisciplinary Assessment of an Alaskan Salmon Fishery

Student Investigator: Megan B. Krupa, PhD Biology
Co-Advisors: Mark Wipfli and F. Stuart Chapin III
Funding Agencies: National Science Foundation Integrated Graduate Education and Research Traineeship (IGERT), UAF Resilience and Adaptation Program (RAP)

Note: Megan Krupa graduated from the University of Alaska Fairbanks in May 2009. Her dissertation abstract follows:

The Lower Ship Creek Fishery in the city of Anchorage, Alaska is one of the state's most popular sport fisheries. After years of channelization and development, this social-ecological system (SES) continues to experience the effects of urbanization and is struggling to achieve robustness. I applied a robustness framework to the management of this fishery because of its semi-engineered nature. This framework uses interdisciplinary methods to study the interrelationships between the fishery's socio-economic and ecological components. Robustness is more appropriate than resilience as an analytical framework because of the relative insensitivity of the engineered components to ecological feedbacks. On Lower Ship Creek, the engineered hatchery fish continue to thrive despite declining stream conditions. The robustness of this fishery contributes to the resilience of the city by increasing local food and recreation options and supporting a diverse set of businesses. To study the robustness of this SES in the context of the resilience of Anchorage, I first combined historical photos and existing Ship Creek data with research conducted on other streams to create an environmental history of the creek. This history then was used to describe how eras of urban development have altered the creek's ecosystem processes and created new ecological constraints related to 1) loss of wetlands and riparian vegetation; 2) erosion, pollution, and channelization; 3) loss of fish species; and 4) flow alteration and habitat loss. Using Lovecraft's (2008) typology, I proposed four plausible management scenarios that highlight the trade-offs associated with management of this fishery: 1) Ship Creek Redesign, 2) Mitigation, Construction, and Maintenance, 3) KAPP Dam Removal, and 4) Business as Usual. The second of these scenarios is most consistent with the current ecological constraints, the characteristics preferred by most stakeholders, and current socio-economic trends. Since Scenario 2 will require a large monetary investment, I examined this SES's cost structure and compared it with previously published analyses of the economic benefits of the fishery. By quantifying the costs borne by each agency, I showed how externalities produce intra- and inter-agency tension. These data were used to construct a new cost-sharing framework that provides decision makers with an

economic incentive to work more cooperatively in the future. I then explored the interrelationship of the SES's socio-economic and ecological subsystems, using Anderies et al.'s (2004) framework. I applied Ostrom's design principles (1990) to sport fisheries to explore the reasons why agencies have not cooperated to produce a more robust fishery. This SES fails to meet three of the design principles: it lacks 1) an equal proportion of benefits and costs, 2) collective-choice arrangements, and 3) user and biophysical monitoring. I then suggest how to improve the design and increase the robustness of this SES. This study proposes that the maintenance of semi-engineered systems is important both for local users and for the resilience of states and countries. In the context of global trends toward increasing urbanization, this study provides an interdisciplinary approach to increasing the robustness of urban streams and building resilience within states and countries.

Ongoing Aquatic Studies

Spawning Stock Characteristics of Inconnu in the Sulukna River, Alaska

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

Abundance and characteristics such as genetic structure, migratory movements, and age composition for spawning inconnu stocks within the Yukon River watershed are largely unknown. Inconnu are an important subsistence, commercial, and sport fish within Alaska. With the lack of information on abundance and characteristics of inconnu stocks within the Yukon River drainage, fisheries managers lack the tools necessary for informed harvest management decisions. The objectives of this study are to (1) determine the abundance and out-migration timing of Sulukna River inconnu; (2) determine if any individuals of this stock migrate to saltwater areas; and (3) determine the age structure of out-migrating inconnu. In 2008 and 2009, Dual-frequency Identification Sonar was used to document abundance of inconnu leaving the spawning grounds as well as the timing of out-migration. In 2008, from September 17 to October 10, 2,079 inconnu out-migrated past the sonar site. In 2009, from September 18 to October 8, 3,571 inconnu out-migrated. In both years 96% of out-migrants moved past the sonar site between 8 p.m and 9 a.m. Sagittal otoliths were collected and are being analyzed to determine age and amphidromy. With known inconnu spawning areas limited to five locations within the Yukon River drainage, these stocks and associated spawning habitats are extremely susceptible to exploitation and detrimental land use activities. Land and fisheries managers must be conservative when it comes to harvest and land use decisions associated with inconnu and inconnu spawning habitat until a comprehensive population assessment can be completed.

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

Student Investigator: Lisa South, MS Fisheries
Co-Advisors: F. Joseph Margraf and Amanda Rosenberger
Funding Agency: Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYKSSP), Commercial Fisheries Division/ADFG

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

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

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

Northern pike are an important sport and subsistence fish in interior Alaska. Detailed study of seasonal movements of northern pike in Minto Flats is lacking. These movements need to be better understood to improve management of the fisheries that occur in Minto Flats. Additionally, little is known regarding environmental factors that affect northern pike movements in Alaska. The study objective are to (1) describe seasonal movements of northern pike in the Minto Lakes portion of Minto Flats and how these movements may be related to certain environmental factors and (2) evaluate assumptions of population closure and mixing of marked and unmarked individuals used for the mark-recapture experiment conducted by ADFG in 2008 in the Minto Lakes study area. In March 2008 and 2009, ADFG implanted 80 and 40 (respectively) northern pike with radio-telemetry tags (in addition to tagged fish that remained from a previous pilot study). These tagged fish were tracked with a boat daily for two 8-day periods each month from May–August. Aerial and snowmachine telemetry surveys were conducted during winter/spring 2008-09. Water level and

temperature loggers were deployed for both the 2008 and 2009 field seasons. A portable weather station was deployed for the duration of field work. In late April, northern pike located in over-wintering areas in the Chatanika River made an en-mass movement into the study area that coincided with ice-out in the Chatanika River and Goldstream Creek. Post-spawn (late May/early June) fish dispersed to summer locations, primarily within the study area. Water temperatures varied widely by location and time of day. Mixing rates of fish appear to be highest during early summer. Tagged fish began out-migration to the Chatanika River in late September and continued into December. A better understanding of northern pike movements and what causes those movements will allow fishery managers to identify key areas and times when they are more vulnerable to harvest and to identify optimum times for stock assessment experiments.

Dolly Varden Energetics: Temporal trends, Environmental Correlates and Bioelectrical Impedance Modeling

Student Investigator: Jason Stolarski, PhD Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Arctic National Wildlife Refuge/USFWS (RWO 160)
In-Kind Support: Logistics provided by the Fairbanks Field Office/FWS

Very little is known regarding how a changing Arctic climate will affect Dolly Varden char populations. Dolly Varden char support one of the largest subsistence fisheries on the North Slope. Data suggesting how changes in climate might affect this resource will allow proactive management and aid in the long-term sustainability of populations and local fisheries. The primary objective is to determine how temporal changes in North Slope climate are affecting growth rates of Dolly Varden char. Secondary objectives include characterizing annual lipid fluctuations and refining bioelectrical impedance models for Dolly Varden. Dolly Varden will be sampled twice annually during spring and fall. Statistical models will be developed to correlate environmental variables to back-calculated estimates of Dolly Varden growth obtained from otoliths. Otoliths from previous projects will be obtained as relevancy permits. Seasonal fluctuations in lipids will be examined using proximate analysis, and measures of electrical resistance and reactance (taken at the time of capture) will be fitted to estimates of lipid content to create predictive models. This research will yield statistical models capable of estimating Dolly Varden lipid content non-lethally. Furthermore, we will, for the first time have an understanding of seasonal fluctuations in Dolly Varden lipid content and how environmental factors influence Dolly Varden growth. Bioelectrical impedance models will be used to access fish condition in the field. Relationships among growth and environmental data will be used to proactively manage Dolly Varden populations in the face of a constantly changing Arctic.

Spawning and Recruitment of Razor Clams (*Siliqua patula*) in East Cook Inlet

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

The East Cook Inlet razor clam fishery, located between the Kasilof and Anchor Rivers on the Kenai Peninsula, is the only major recreational razor clam fishery in Alaska. Sampling by ADFG indicates that populations at Ninilchik grow faster than those at Clam Gulch and successful recruitment events were less frequent and/or less abundant in recent years. Productivity in the area may be declining. The purpose of this study is to enhance our knowledge of life history patterns of the razor clam on east Cook Inlet beaches and improve management of the resource. We will sample juvenile and adult razor clams monthly (March–October) to examine growth rates and sexual maturity. An absence of juvenile razor clams and low numbers of sexually mature adult razor clams seem to indicate that recruitment in the 2009 season was not as successful at Clam Gulch as at Ninilchik. Fisheries managers need to respond appropriately to population changes in order to protect the sustainability of this stock.

Using Archival Tags to Determine Vertical Movements and Thermal Habitat of Burbot in Copper and Tanada Lakes, Alaska

Student Investigator: Heather L. Scannell, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agencies: Sport Fish Division/ADFG (Base funding) and NPS
In-Kind Support: Personnel, vehicles, and equipment provided by ADFG

In the late 1970s and early 1980s burbot stocks started to decline throughout southcentral Alaska in response to intense sportfishing pressure. Many lakes in the Upper Copper Upper Susitina Management Area (UCUSMA) started to experience depleted local stocks that forced the Alaska Department of Fish and Game (ADFG) to initiate an aggressive stock assessment program aimed at monitoring burbot abundance and determining sustainabiltiy. Several lakes were included in this monitoring program, but lakes located within the Wrangell St. Elias National Park (WRST) were excluded. In 2007 the potential for subsistence fishing within WRST forced both WRST and ADFG to conduct stock assessments on Copper and Tanada Lakes. Both these lakes have extreme bathymetry, and the current sampling protocol for burbot restricts the sampling of burbot at depths >15 m. The purpose of this study is to use surgically implanted archival tags to determine the vertical movements and thermal habitat occupied by burbot. Various sized burbot from both deep and shallow categories will be captured, tagged, and released for one year, after which they will be recaptured. Upon recapture the tags will be removed, downloaded, and analyzed. Findings from this study will be used to evaluate the assumptions of a two-event mark recapture event. We will use mixing tests and transition probabilities to determine if current burbot abundance estimates are biased due to the depth restrictions on sampling.

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

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

Although numerous studies have shown positive effects of marine-derived nutrients (MDN) from Pacific salmon on freshwater fishes, the amount of MDN required to maximize the growth and nutritional status of freshwater fishes is unknown. Identifying salmon spawner levels above which stream-dwelling fish cease to gain physiological benefits may be a direct and appropriate measure of the capacity of fish populations to utilize MDN. The objectives of this study were to determine (1) if growth rates and energy density in coho salmon parr and juvenile Dolly Varden reach an asymptote (i.e., saturate) with increasing MDN abundance and (2) what level of MDN abundance is required to elicit any saturation responses. We collected coho salmon (*Oncorhynchus kisutch*) parr and juvenile Dolly Varden (*Salvelinus malma*) during spring and fall from 11 streams on the Kenai Peninsula, southcentral Alaska, that varied widely in salmon spawner densities (0.1 to 4.8 kg/m^2). From these samples we measured RNA-DNA ratios (an index of recent growth rates) and energy density (kJ/g dry mass). RNA-DNA ratios and energy density indicated a saturation response where values increased rapidly with spawner abundance up to approximately 1 kg/m^2 and then leveled off somewhat (except for Dolly Varden during fall, which were not successfully sampled at sites with high spawner abundance). This study shows strong linkages between MDN availability and fitness responses in juvenile salmonids and that fitness-based saturation points can indicate target spawner densities that balance salmon harvest with the ecological benefits of MDN in stream ecosystems.

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

Student Investigator: Emily Benson, MS Biology
Advisor: Mark Wipfli
Funding Agency: AYKSSP/ADFG
In-Kind Support: Boat, vehicle, and technical assistance during field season provided by Sport Fish Division/ADFG

How stream flow and other environmental variables relate to whole stream metabolism and aquatic macroinvertebrate communities is not well understood. Understanding how environmental drivers affect stream metabolism, and in turn aquatic macroinvertebrates—an important food resource for fish—will help clarify which physical and biological drivers affect food abundance for juvenile salmon and potentially their productivity. The goals of this work were to determine (1) how changes in ecosystem metabolism (primary production and community respiration) relate to changes in light intensity, nutrient concentration, and stream flow, and (2) how changes in benthic macroinvertebrate communities relate to changes in primary production and stream flow in the Chena River. This research was accomplished by monitoring whole stream metabolism, light intensity, stream flow, nutrient concentrations, and benthic macroinvertebrate communities at four sites in the Chena River during summers 2008 and 2009. Primary production rates increased

with increasing light intensity under some conditions; in addition, primary production rates were highest at intermediate stream flows, and community respiration rates were lowest at intermediate stream flows. Benthic macroinvertebrate densities were lowest at highest stream flows. Data from this study will contribute to the long-term goal of understanding the environmental factors that affect river food webs in interior Alaska that support juvenile Chinook salmon.

Patterns of Prey Abundance for Juvenile Chinook Salmon in the Chena River, Interior Alaska

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

Both aquatic and terrestrial invertebrates are important prey for juvenile salmonids, but their seasonal abundance, relative importance, and potential role in limiting juvenile Chinook salmon production are not known—particularly in subarctic streams. Documenting the seasonal availability of prey and the environmental factors that affect prey abundance for juvenile Chinook salmon will contribute a better understanding of how food resources may control Chinook salmon population dynamics and productivity. The objectives of this study were to determine through time and in response to stream flow (1) the seasonal influx of terrestrial invertebrates into the Chena River, (2) the proportion of aquatic and terrestrial prey in the drift, and (3) the predation on aquatic- and terrestrial-born prey by 0+ juvenile Chinook salmon. Data indicate that juvenile Chinook predominantly preyed upon chironomid midges, chloroperlid stoneflies, heptageniid mayflies and a small percentage of terrestrial invertebrates. Seasonally, the importance of terrestrial invertebrates seemed to increase in late summer. Total food consumption by juvenile Chinook salmon declined after high water events. It appears that both aquatic and terrestrial food sources are important for stream-rearing Chinook salmon in the Chena system, but that prey abundance is highly variable over time. This variation in food supplies likely influences juvenile Chinook salmon growth and production on the Chena River.

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

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

Water temperature and food availability are among the most important variables affecting fish growth, yet these and other environmental variables are not taken into account in salmon stock-recruitment models. Competition further affects fish growth and abundance, but current literature lacks data demonstrating competition in juvenile Chinook salmon. Factors that regulate growth and the abundance of juvenile Chinook salmon need to be identified to improve the reliability of stock-recruitment models. The objectives of this work were to (1) determine whether food or

temperature limits juvenile Chinook salmon growth, (2) investigate if seasonal patterns of fish growth or changes in fish abundance give evidence of competitive bottlenecks that cause density dependent mortality, (3) develop a model capable of predicting the effect of stream temperature on juvenile growth, (4) test whether the growth model can be used to predict annual growth and annual variation in smolt size, and (5) determine whether there is a positive correlation between smolt size and the productivity of a brood year in terms of recruits per spawner. To accomplish these objectives we monitored individual growth of juvenile Chinook salmon along the natural temperature gradient in the Chena River using stereo-videogrammetry and conducted a mark-recapture study to estimate population abundance. To determine effects of food limitation on juvenile Chinook growth we supplemented food to half of the study sites and are using a growth model to see how temperature and food intake interact to influence fish growth. This work is being supplemented with a retrospective analysis of the relationship between water temperature and growth to determine how fish productivity is related to growth in fresh water. At research sites where fish were fed we observed local aggregations of juvenile Chinook salmon and other fish species, but we observed no significant effects of food supplementation on individual fish growth during summer 2009. We are in the process of analyzing mark-recapture data to consider the effect of food supplementation on local abundance and are currently incorporating temperature data into growth models. We anticipate the growth model may be used to predict temperature effects on Chinook salmon smolt size. The ability to forecast estimates of smolt growth from an easily measurable environmental variable such as temperature would increase the rigor of models used to forecast future returns.

Process-based Modeling of the Behavior, Growth, and Survival of Juvenile Chinook Salmon at the Micro- and Mesohabitat Scales in the Chena River

Student Investigator: Jason Neuswanger, PhD Biological Sciences
Co-Advisors: Mark Wipfli and Amanda Rosenberger
Funding Agency: AYKSSP/ADFG

Stock-recruitment analyses suggest that the Chena River Chinook salmon population is strongly affected by river flow and temperature during each generation's first summer, but these effects are poorly understood. Current ecological models are so narrowly focused that several models must be integrated before they provide useful information on the processes driving a population this complex. Study objectives are to (1) develop a highly efficient, 3D-video-based process for measuring fine-scale behavior; (2) characterize the mechanisms of intra-school competition, in order to model the distribution of resources among individuals in a school; (3) develop a 3D model of the flow velocity and invertebrate drift density throughout a pool; and (4) predict the impact of novel seasonal scenarios of flow, temperature, and invertebrate drift on the growth and survival of juvenile Chinook salmon. Methods are to (1) write computer programs to measure 3D points from video footage, and to extract and visualize patterns in those data; (2) use video data to quantify the feeding territories and related behaviors of individual juvenile Chinook salmon as they grow through the 30-80 mm range; (3) create a fine-scale 3D model of the velocity field and density of drifting invertebrates in one surveyed pool at any flow level; and (4) use an individual-based model to link the behaviors seen in video analysis with the physical model of the pool to predict the growth and survival of its inhabitants. Behavioral analyses suggest that flow velocity, cover, and water temperature determine juvenile Chinook distribution. Intra-specific competition for food affects fine-scale distribution

and individual growth. Knowledge of environmental influences on juvenile survivorship will help managers predict the strength of each year class before the adults return to spawn.

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

Student Investigator: David Roon, MS Biology
Advisor: Mark Wipfli
Funding Agencies: USFS and USFWS
In-Kind Support: Anchorage Parks Foundation, UAA Environment and Natural Resource Institute, UAF Cooperative Extension Service, Municipality of Anchorage Parks and Recreation

Introduced species are a concern worldwide as they can displace native species and disrupt ecological processes. European Bird Cherry (*Prunus padus* L.) (EBC) is an introduced, ornamental tree that is quickly spreading and possibly displacing the native riparian vegetation along streams in some urban areas of Alaska. Riparian vegetation indirectly influences stream salmonids by supporting aquatic and terrestrial invertebrate prey communities—key food resources for these fishes. The spread of EBC and possible displacement of native plants in riparian zones could affect invertebrate communities, potentially affecting salmon production in streams. The objectives of this study were to (1) map the distribution of EBC in two Anchorage streams, Campbell and Chester Creeks, and (2) determine the effects of EBC on selected ecological processes linked to salmonid food webs. We systematically surveyed riparian vegetation, deployed leaf packs to compare in-stream decomposition rates of leaf litter and aquatic invertebrate communities, clipped branches to compare terrestrial invertebrate communities, and collected diet samples from juvenile salmonids. Data from the 2009 field season showed EBC was widely distributed along Chester Creek, EBC leaf litter decomposed at different rates than native species, and that EBC supported different species of terrestrial invertebrates than native plants. This study provides information on how introduced plant species can affect native species and ecological processes in riparian habitats of Alaska. These findings will ultimately help guide management of EBC by city, state and federal agencies involved in managing urban watersheds and controlling introduced species.

Completed Wildlife Studies

Reproductive Patterns in King Eiders

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

Note: Rebecca Bentzen graduated from the University of Alaska Fairbanks in December 2009. Her dissertation abstract follows:

Mammalian predation, avian predation, female body condition and food availability on the breeding ground are likely the main factors influencing nesting success in tundra-nesting waterfowl. These driving factors are mediated by the primary life history characteristics; incubation behavior, female body size, nesting associations, and nest site selection. I created a conceptual model illustrating how these factors are inter-related and how they impact nest success through a variety of pathways to better understand the evolution of a species' nesting strategy and patterns observed in the field. The importance of the driving factors likely varies between sites and with the species nesting strategy. Given the conceptual model, I predicted the difference in life history characteristics and nesting success at two sites that vary in any of the four driving factors. I tested the model and associated predictions using King Eider females (*Somateria spectabilis*) breeding on Alaska's coastal plain by comparing selective forces influencing nesting strategies at two sites, Teshekpuk and Kuparuk, between 2002 and 2006. King Eiders fit the model with some modifications to the mediating pathways. Site differences were found in many of the reproductive parameters which matched the prediction of more available forage at Kuparuk than at Teshekpuk. No differences in either avian or mammalian predation pressure were evident between sites. Eiders at Kuparuk had higher nest survival and incubation constancy than at Teshekpuk. Body mass and nest selection were similar between sites. Although questions concerning the nesting strategies of King Eider remain, I feel that this was a valid approach to identifying selective forces impacting nesting strategies and applicable to tundra nesting waterfowl in general.

Resilience of a Deer Hunting System in Southeast Alaska: Integrating Social, Ecological, and Genetic Dimensions

Student Investigator: Todd J. Brinkman, PhD Biological Sciences
Co-Advisors: F. Stuart Chapin III and Kris Hundertmark
Funding Agency: Wildlife Conservation Division/ADFG (RSA Base Supplement)

Note: Todd Brinkman graduated from the University of Alaska Fairbanks in August 2009. His dissertation abstract follows:

I examined the interactions of key components of a hunting system of Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) on Prince of Wales Island, Alaska to address concerns of subsistence hunters and to provide a new tool to more effectively monitor deer populations. To address hunter concerns, I documented local knowledge and perceptions of changes in harvest opportunities of deer over the last 50 years as a result of landscape change (e.g., logging, roads). To improve deer monitoring, I designed an efficient method to sample and survey deer pellets, tested

the feasibility of identifying individual deer from fecal DNA, and used DNA-based mark and recapture techniques to estimate population trends of deer. I determined that intensive logging from 1950 into the 1990s provided better hunter access to deer and habitat that facilitated deer hunting. However, recent declines in logging activity and successional changes in logged forests have reduced access to deer and increased undesirable habitat for deer hunting. My findings suggested that using DNA from fecal pellets is an effective method for monitoring deer in southeast Alaska. My sampling protocol optimized encounter rates with pellet groups allowing feasible and efficient estimates of deer abundance. I estimated deer abundance with precision (±20%) each year in 3 distinct watersheds, and identified a 30% decline in the deer population between 2006-2008. My data suggested that 3 consecutive severe winters caused the decline. Further, I determined that managed forest harvested >30 years ago supported fewer deer relative to young-managed forest and unmanaged forest. I provided empirical data to support both the theory that changes in plant composition because of succession of logged forest may reduce habitat carrying capacity of deer over the long-term (i.e., decades), and that severity of winter weather may be the most significant force behind annual changes in deer population size in southeast Alaska. Adaptation at an individual and institutional level may be needed to build resilience into the hunting system as most (>90%) of logged forest in southeast Alaska transitions over the next couple decades into a successional stage that sustains fewer deer and deer hunting opportunities.

Ongoing Wildlife Studies

Multi-scale Habitat Requirements of Black Terns in the Prairie Pothole Region

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

Black Terns are a species of concern due to habitat loss on the breeding grounds and population declines. They nest in freshwater wetlands and forage in a larger area that includes neighboring wetlands. This indicates that Black Terns select habitat at two spatial scales—one at the local scale for suitable nesting habitat and one at the landscape-scale for suitable foraging habitat. Because Black Terns commonly nest in areas where land is subject to intense agricultural pressure, knowledge of the limiting habitat requirements at both scales can help guide management decisions to mitigate against further population declines. The objective of this study is to develop models of Black Tern breeding and foraging based on local and landscape-scale habitat features. We surveyed 598 wetlands in 2008 and 2009 in North Dakota and South Dakota, and found Black Terns breeding at 5% and foraging at 17% of wetlands. Multivariate analyses indicate that Black Terns select for breeding and foraging habitat differently, and that landscape-scale features may only influence breeding habitat selection. The breeding habitat model indicated that Black Terns were selecting primarily for wetlands with more floating matted vegetation (a common nest substrate), and also for a larger amount of wetland in the landscape and larger wetlands. The foraging habitat model indicated that Black Terns were selecting primarily for larger wetlands and also for wetlands with more floating mat and more open water. The results of this multi-scale habitat analysis will be useful in guiding regional conservation planning for Black Terns.

Diet of Glaucous Gulls on Alaska's North Slope

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

Glaucous Gulls are major predators on the North Slope and may benefit from human development. Currently, their diet and their population response to development are unknown. Glaucous Gulls may be feeding on birds that are of conservation concern and/or species hunted for subsistence by Native Alaskans. If gull population growth results from future development on the North Slope, increased gull predation could cause or exacerbate population declines for those prey species. This study describes Glaucous Gull diet and reproductive output on the North Slope, including how gulls use prey species of concern and garbage, and the effect garbage may have on reproductive success. We studied 10 breeding colonies in residential, industrial, and undeveloped areas of the North Slope. At each colony, we collected regurgitated pellets to describe gull diet and monitored gull reproductive output. Glaucous Gulls in our study areas fed primarily on microtine rodents, birds (especially shorebirds and waterfowl), fish, and garbage. Diet included at least 12 bird species of conservation concern. The amount of garbage in diet had a significant positive effect on productivity. If more garbage becomes available to gulls with future development, gulls may see improved reproductive output and regional populations may increase. Managers and developers may be able to limit gull population growth by preventing gulls from accessing garbage, e.g. through incinerating or covering food waste.

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

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

The breeding ecology of Smith's Longspurs in the Brooks Range is largely unknown. Smith's Longspurs are a species of conservation concern that breeds in the Brooks Range. To develop effective conservation measures information is needed on population abundance, distribution, and habitat requirements. The object of this study is to measure Smith's Longspur abundance and distribution, identify habitat associations, and develop a predictive species distribution model. Bird and habitat surveys were conducted on nine study sites in June 2008 and 2009. This data was combined with agency survey data to determine abundance estimates, analyze habitat associations, and model distribution. Smith's Longspurs are associated with dwarf shrub and sedge herbaceous tundra vegetation communities, with patchy distribution along the Brooks Range foothills (predictive accuracy: 68.5%, AUC 0.77). Density estimates ranged from 0.06 - 0.5 birds/ha. Understanding breeding

Smith's Longspur distribution and abundance is the critical first step in developing a conservation plan. Changes in the distribution and condition of breeding habitat due to climate change will be difficult to predict without an understanding of current habitat associations.

Renesting Ecology of Arctic-breeding Dunlin on Alaska's North Slope

Student Investigator: Heather "River" Gates, MS Wildlife Biology
Advisor: Abby Powell
Funding Agency: Migratory Bird Program/USFWS
In-Kind Support: Vehicle, technical assistance, and equipment provided by USFWS during field season; purchase of VHF radios/IAB

Renesting rates in arctic-breeding shorebirds are largely unknown and are presumed to be low due to females' physiological constraints, short nesting season, and limited food resources. Dunlin are a common arctic-breeder across the North Slope with populations that are reportedly declining. A better understanding of this demographic rate will increase the accuracy of reproductive productivity estimates. In 2007-09, we conducted a study to evaluate how arctic-breeding Dunlin responded to experimental clutch removal. We measured renesting propensity, mate and territory fidelity, and the interval between clutch removal and replacement clutch laying. We captured, radio- and color-marked approximately 20 adult Dunlin pairs and removed approximately 20 clutches during early incubation (2007-2009) and late incubation (2008 and 2009). Eighty-seven percent of the females laid replacement clutches after early removal, while only 43% replaced clutches after late removal with an average renesting interval of six days for both removal treatments. Divorce rate was low in all years (8%), and in all cases, males remained on their original territory while females moved (>5 km) to renest. Our study revealed an unexpectedly high rate of clutch replacement, suggesting that a female's propensity to lay a replacement clutch is not likely due to physiological constraints but more strongly related to timing of nest loss. Results indicate that reproductive productivity estimates are biased-low due to lack of including renesting as a frequent response to high predation rates.

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

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

There is little knowledge of shorebird biology in the Arctic and what draws these birds to littoral delta mudflats during the post-breeding period, although shorebird biologists suspect food resources may influence shorebird behavior at this time. The Arctic National Wildlife Refuge is investigating these questions to manage and preserve shorebird species and habitat along the refuge's coast. Interest in this question grows as potential negative impacts to the coast have developed through offshore oil development and climate change. This study will determine shorebird distribution in relation to invertebrate food resources spatially and temporally and investigate how resource differences between study sites influence length of stay and

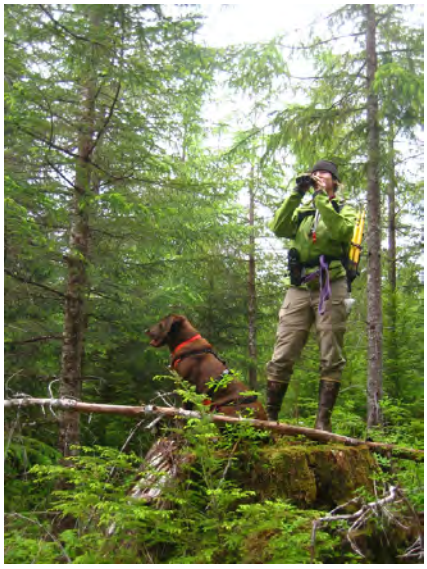
shorebird physiological parameters. We will conduct shorebird surveys regularly in conjunction with collecting invertebrate core samples on delta mudflats during the post-breeding season. We will measure physiological parameters using blood samples from captured birds. This project is in the beginning stages of development as we analyze data from our first pilot season. During a pilot study (fall 2009) we found invertebrate diversity was low on the mudflat and patchily distributed. Some patches had high abundance though, and shorebirds seemed to key into these areas. Several shorebird populations using this habitat are declining, and some are listed as species of concern in the US Shorebird Conservation Plan and by the US Fish and Wildlife Service. With augmented climate change impacts along Alaska's northern coast, this research will give insight into how climate change influences shorebird habitat.

Spatiotemporal Variation in the Non-breeding Distribution and Annual Survival of Spectacled Eiders

Student Investigator: Matt Sexson, PhD Biological Sciences
Advisor: Abby Powell
Funding Agencies: MMS, USGS, USFWS, BLM, NFWF
In-kind Support: ConocoPhillips Alaska, Inc.; BLM; Columbus Zoo (Ohio), Mesker Park Zoo (Indiana)

Spectacled Eiders are threatened sea ducks that spend 9 to 12 months of the year at sea. Little is known about non-breeding survival and distribution, making it difficult to predict how populations will respond to ecosystem change resulting from climate warming, development of offshore natural resources in Arctic, and expansion of the Bering Sea fishery. Development of offshore natural resources in the Arctic and the northward expansion of the Bering Sea fishery might affect Spectacled Eider critical habitat. Climate change might rapidly alter marine habitat and food sources. The primary objective of our study is to assess non-breeding survival and habitat use by Spectacled Eiders. We are marking Spectacled Eiders with implantable satellite transmitters to collect location and survival data over a period of two years each. Data will be incorporated into models of individual home range and habitat use, stable isotope analysis, and an analysis of site fidelity. Survival data will be used to model annual and seasonal survival. We expect the satellite telemetry data to provide location and survival information over the course of four years (2008–2012). We expect to detect significant relationships between environmental variables, survival, and individual home ranges. These data will contribute to Spectacled Eider conservation and recovery efforts in areas where rapid development and environmental change are expected in the future

Survival of Prince of Wales Spruce Grouse in Southeast Alaska



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

Prince of Wales spruce grouse (*Falcipennis canadensis isleibi)* are of conservation concern in Southeast Alaska because they inhabit temperate rainforest where large-scale landscape alteration due to timber harvest has occurred and these birds may receive subspecies classification. During 2007-2008, we radio-marked 38 grouse to investigate how timber practices affected their mortality risk. We also examined how season, gender, and breeding status affect survival probability. Breeding status caused the most variation in survival probability. The annual survival of non-breeding birds was 0.72±0.082 ($\hat{S}$±SE_S) while for breeding birds it was 0.08±0.099. Survival for non-breeding birds was highest during the period spanning winter and spring, 0.93±0.089, compared to equivalent rates for summer and fall, 0.88±0.058. Effects of breeding lasted throughout the year, with non-breeding birds being about twice as likely to survive each season as breeding birds. Timber harvest was not as important in predicting survival as breeding status, with no differences detected between habitat types. Road-related mortality (hunter harvest and vehicle strike) was the largest (42%) known source of death for spruce grouse, with predation (25%) and unknown causes (25%) following. Our results show that the time when birds are breeding is the most critical period of survival, and this investment in reproduction can have long-term implications. If survival of Prince of Wales spruce grouse is of concern and hunting has an additive effect on survival, it may be beneficial to allow broods to utilize the road network safely through temporary and limited closure of logging roads.

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

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

How does the body condition of caribou affect population dynamics? We are developing and refining a non-invasive technique to assess average body protein loss that will assist management agencies to ascertain mechanisms of population dynamics in caribou herds. We will examine how diet, demographic (age and reproductive status), and environmental parameters (winter severity and terrain variables) in late winter vary with body protein loss. Protein loss was evaluated with isotopic measures of nitrogen metabolites in urine and feces collected from snow. In addition, we will use blood fractions collected from caribou during late winter. We are using blood samples from 160 adult female caribou of known reproductive status and age in the Denali herd across 12 years (1993-2005) to assess relationships between

protein status and demographic or environmental parameters. These analyses will set the context for estimates of protein status using excreta collected from four Alaskan caribou herds from 2006-2008. To date, we have collected 1060 excreta samples (feces and snow urine) from the winter ranges of the Western Arctic, Central Arctic, Denali, and Chisana caribou herds. All aspects of field work were completed for this project in April 2008. We predict that variation in all factors (diet, demography, and environment) will affect the protein status of female caribou in the Denali herd. Specifically, we predict that severe winters will limit the body protein available for reproduction and this limitation will be evident in our isotopic measure of protein status; the results and implications from this work are pending. Regarding the population-level comparisons using excreta, the Central Arctic and Chisana herds had poorer estimates of protein status than the Western Arctic and Denali herds. The amount of shrubs in the winter diets of caribou had a positive effect on protein status across herds and years. Climate changes in arctic and subarctic systems may increase the likelihood of more severe winters and limit the availability of preferred winter forages for caribou. Unfortunately, assessing population-level impacts using excreta may be difficult as caribou exhibit a diversity of physiological adaptations to deal with spatial and temporal variance in environmental conditions. In addition, variation in forage selection may also alter the estimation of protein status from isotopes. Selection of forages that are high in N such as shrubs may enable caribou to minimize losses of body protein in late winter.

Effects of Habitat Selection on Fitness and Population Growth for Deer in Human-altered Landscapes

Student Investigator: Sophie L. Gilbert, PhD Biological Sciences
Advisor: Kris Hundertmark
Funding Agency: Wildlife Conservation Division/ADFG (Base Funding Supplement)
In-Kind Support: Field season personnel, logistics, and equipment provided by ADFG

Sitka black-tailed deer are the most economically important and abundant ungulate in southeast Alaska and play a major ecological role as a forest herbivore and as prey for Alexander Archipelago wolves, black bears, and brown bears. While much is known about energetics, ecology, and habitat preference in adult Sitka black-tailed deer, there is a gap in knowledge concerning reproduction and recruitment. This project will identify factors influencing fawn mortality of Sitka black-tailed deer on Prince of Wales Island. Sitka black-tailed deer are a management priority for the Tongass National Forest. Prince of Wales Island is a significant harvest area and highly representative of habitats in southeast Alaska. To ensure continuing health of deer populations for the Tongass and Prince of Wales, understanding fawn mortality is key. Our primary objective in this study is to identify factors influencing fawn survival and recruitment. Then, we will use fawn demographic data to better understand population dynamics for the deer population and inform management strategies. We will radio collar adult female and fawn deer and monitor their habitat use and mortality. We will characterize habitat by vegetation, predator activity levels (using scat abundance surveys), and other geographic features. The first field season will occur April-August 2010.

Completed Ecological Studies

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 comprehensively analyzed 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 integrated data on carbon dioxide and methane dynamics of the Arctic System using a combination of prognostic and inverse approaches to provide an integrative approach to estimating and understanding the exchanges of carbon dioxide and methane from terrestrial and marine components of the system. This study brought together diverse regional data sets and understanding in the context of a linked set of numerical model studies, and has quantified the fluxes and links between the terrestrial, atmospheric and oceanic components of the Arctic carbon and methane cycles between 1997 and 2006. A postdoctoral researcher, Dr. Daniel Hayes, conducted a series of historical simulations with the Terrestrial Ecosystem Model (TEM) for diagnosis and attribution of the response of arctic system C dynamics to recent changes in atmospheric chemistry, climate and disturbance regime. The overall results of the project indicated that terrestrial areas of the Arctic Basin lost 62.9 Tg C yr^{-1} and that the Arctic Ocean gained 94.1 Tg C yr^{-1}. Arctic lands and oceans were a net CO_2 sink of 108.9 Tg C yr^{-1}, which is within the range of uncertainty in estimates from atmospheric inversions. Although both lands and oceans of the Arctic were estimated to be CO_2 sinks, the land sink diminished in strength because of increased fire disturbance compared to previous decades, while the ocean sink increased in strength because of increased biological pump activity associated with reduced sea ice cover. Terrestrial areas of the Arctic were a net source of 41.5 Tg CH_4 yr^{-1} that increased by 0.5 Tg CH_4 yr^{-1} during the decade of analysis, a magnitude that is comparable with an atmospheric inversion of CH_4. Because the radiative forcing of the estimated CH_4 emissions is much greater than the CO_2 sink, the analysis suggests that the Arctic Basin is a substantial net source of green house gas forcing to the climate system.

Ongoing Ecological Studies

Soil Climate and Its Control on Wetland Carbon Balance in Interior Boreal Alaska: Experimental Manipulation of Thermal and Moisture Regimes

Student Investigator: Amy Churchill, MS Biology
Faculty: A. David McGuire
Funding Agency: NSF

Boreal ecosystems contain about 30% of the world's soil carbon (C), largely in peatlands. Recent studies indicate strong climatic controls on northern peatland C balance and show that water bodies in some wetland regions in Alaska are drying, while other regions are becoming wetter. Central to peatland C balance is the role and fate of soil hydrology, which controls both vegetation and belowground C processes. This project addresses hydrology-warming-carbon cycle interactions by manipulating water tables and environmental temperatures in peatlands. Net primary production and net C fluxes (CO_2, CH_4, dissolved organic carbon or DOC) are being measured regularly. Annual isotopic and laboratory experiments are being conducted to complement field measurements and are focusing on linking vegetation composition, nutrient availability, and substrate use. Based on the field studies, we will use models as tools to understand controls over CO_2 and CH_4 fluxes and DOC production at the ecosystem scale, and we will incorporate insights gained from our research into a regional modeling effort to evaluate how changing hydrological and climate conditions in interior Alaska are influencing regional C dynamics. Amy Churchill is a graduate student on the project who started in January 2009 to study vegetation responses to the manipulations. We have recruited a postdoctoral researcher who will start in May 2010 to conduct the modeling studies.

Snow Cover and Biology in the Arctic

Research Personnel: Eugénie Euskirchen (Research Assistant Professor)
Faculty: A. David McGuire
Funding Agency: NSF

In terrestrial high-latitude regions, observations indicate recent changes in snow cover, permafrost, soil freeze-thaw transitions, and fire due to climate change. The responses of high latitude ecosystems to these changes may have consequences for the climate system. In the first study funded by this project (*Euskirchen et al., Global Change Biology, 2006*), we successfully simulated these changes and related them to changes in growing season length, productivity and net carbon uptake in extratropical regions (30°-90° N) for the period 1960-2100. We have conducted three follow-up studies. In the first follow-up study (*Euskirchen et al., Global Change Biology, 2007*) we found that increases in snow cover-climate feedbacks during 1970-2000 were nearly three times larger than during 1910-1940 because the recent snow-cover change occurred in spring, when radiation load is highest, rather than in autumn. These changes in energy exchange warrant careful consideration in studies of climate change, particularly with respect to associated changes in vegetation cover. In the second follow-up study (*Euskirchen et al., Ecological Appliations, 2009a*), we developed a new version of the Terrestrial Ecosystem Model (TEM, version 7.0) to include a dynamic vegetation component with competition among plant functional types for nitrogen and light. We performed model simulations for the years 2002–2100 under nine future climate scenarios for a region in northern Alaska extending from the ecotonal boreal forest to the Arctic Ocean. Our analysis

indicates that the net primary productivity of the dominant plant functional types will increase to cause a decrease in summer albedo, leading to an overall atmospheric heating effect. However, this heating effect was smaller than that due to changes in the snow season, including both the melting of snow in the spring and the return of snow in the autumn. In the third follow-up study (*Euskirchen et al., Journal of Geophysical Research – Biogeosciences, 2009b*) we examined how climate change effects on both fire regimes and snow cover duration will influence atmospheric heating effects of high latitude terrestrial ecosystems. Changes in summer heating due to changes in vegetation associated with fire showed a slight cooling effect due to increases in summer albedo. Over this same time period, decreases in snow cover caused a reduction in albedo, and result in a heating effect when holding the vegetation map from 2003 constant. Adding both the summer negative change in atmospheric heating due to changes in fire regimes to the positive changes in atmospheric heating due to changes in the length of the snow season resulted in a 3.4 W m^{-2} $decade^{-1}$ increase in atmospheric heating. These findings highlight the importance of gaining a better understanding of the relative influences of changes in surface albedo on atmospheric heating due to both changes in vegetation and changes in snow cover duration. These studies are generally relevant to climate change policy as they consider multiple ways in which terrestrial ecosystem responses to climate change can influence the climate system.

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

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

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

include collaborations with CFS scientists working on modeling of the carbon cycle, as well as scientists from the USGS and USFS who have expertise and field observations of fuel consumption during fires. It will aid in the implementation of the Joint North American Carbon Program through the continuation of existing joint research activities between U.S. and Canadian scientists, and reduce terrestrial carbon cycle uncertainties in a significant region of the Northern Hemisphere. Dr. Fengming Yuan is the postdoctoral researcher conducting the research with TEM in this project.

Carbon Responses along Moisture Gradients in Alaskan Landscapes

Student Investigator: Jonathan O'Donnell, PhD Biology
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 are quite variable in Alaskan landscapes. To better understand these interactions, PhD student Jon O'Donnell is studying the implications of permafrost degradation on soil carbon (C) accumulation and loss from boreal ecosystems. The primary questions of his research are (1) How does water influence the stability of permafrost in upland and wetland ecosystems, (2) What is the net effect of permafrost degradation on C storage across a range of boreal ecosystems, and (3) What controls C loss from ecosystems where permafrost has degraded? In summer 2007, Jon examined permafrost conditions and C storage across an upland fire chronosequence at Hess Creek and characterized soil samples for bulk density, moisture/ice content, C and nitrogen concentration, and radioisotopes. During fall 2007, he conducted a laboratory experiment to evaluate the effect of soil moisture on thermal conductivity in different organic horizons. Findings from both the field and laboratory studies were presented at the Ninth International Conference on Permafrost held in summer 2008. In summer 2008, Jon examined permafrost conditions and C storage across a bog and fen thaw chronosequence at Koyukuk Flats National Wildlife Refuge and a second upland thaw chronosequence off the Taylor Highway. In fall 2008, Jon used the Terrestrial Ecosystem Model (TEM) to evaluate the potential effects of fire severity and frequency on permafrost and soil C dynamics at the Hess Creek study site. In late February and early March 2009, Jon completed and passed his comprehensive exam, successfully advancing to candidacy. During the summer, Jon wrote his first chapter entitled, "The effect of moisture content on the thermal conductivity of moss and organic soil horizons from black spruce ecosystems in interior Alaska," which was submitted to, accepted, and published in the journal *Soil Science*. Also during summer 2009, Jon conducted fieldwork at Innoko Flats National Wildlife Refuge to examine soil C dynamics across a collapse-scar bog chronosequence. Jon also returned to Koyukuk Flats and Hess Creek to download data and extract soil instrumentation from these sites. At the 2009 Fall Meeting of the American Geophysical Union, Jon presented a poster entitled "Permafrost controls on soil C storage and turnover in upland black spruce ecosystems of interior Alaska." Findings from these field-based, laboratory and modeling studies will help refine conceptual models about the vulnerability of permafrost to thaw in response to a warming climate in interior Alaska and the fate of carbon upon thaw of permafrost. The

insights from this research have the potential to inform models of C exchange in boreal landscapes.

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

Postdoctoral Researcher: Kristofer Johnson
Faculty: A. David McGuire
Funding Agency: Geologic Division/USGS (RWO 163)

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

Partitioning of Soil Respiration along Moisture Gradients in Alaskan Landscapes

Student Investigator: Nicole McConnell, MS Biology
Faculty: A. David McGuire
Funding Agency: Geologic Division/USGS (RWO 178)

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, which is quite variable in Alaskan landscapes. One of the challenges of modeling carbon responses to a changing climate is the proper representation of the response of decomposition to changes in soil climate. Because measurements of soil respiration include both decomposition (heterotrophic respiration) and plant respiration (autotrophic respiration), it is important to separate out these components to properly interpret how decomposition is responding to changes in soil climate. In this study we will conduct a study that measures soil respiration along a moisture gradient in interior Alaska and collects ancillary data that will allow us to separate out the decomposition and plant respiration components of soil respiration. We will use this understanding to inform models how to represent this partitioning. Nicole McConnell is a new graduate student who began in September 2009 and will conduct the partitioning research in this study.

2010 Yukon River Basin Studies—Yukon Flats Tree Ring Data Bases For NDVI Comparison.

Principal Investigator: Glenn P. Juday
Funding Agency: USGS (RWO 181)
In-Kind Support: UAF

Temperatures have increased across interior Alaska for much of the past century, and especially since the mid-1970s. The Yukon Flats has the highest summer temperatures in Alaska and low precipitation, resulting in high risk of temperature-caused moisture stress for current tree species. The Yukon Flats National Wildlife Refuge supports important forest and early succession habitats for migratory birds and moose. The effect of recent warming on the health and growth of trees on the Yukon Flats has not been studied. As part of the USGS Yukon River Basin project, this study is designed to determine the long-term growth history of white and black spruce on the Yukon Flats, the factors of climate that control their growth, recent trends in growth related to satellite NDVI estimates of landscape-scale photosynthesis, and the recent history of insect disturbance affecting the forest. Tree ring core samples and disks were collected from 9 stands and 102 trees along the Yukon River and lower Birch Creek. Annual ring width growth of the trees was compared to climate data at Fairbanks and Bettles. Black spruce trees in the sample originated about 1800, the mid-1800s, 1915, and 1923. White spruce originated in the early 1700s and mid-1800s. Growth was negatively related to high spring and summer temperatures (May and July). High temperatures since 1974 are associated with the lowest growth in the overall record. A number of insect outbreaks have been particularly severe over the past 35 years. Additional temperature increases equal to the past century would almost certainly result in the death of these trees. The combination of cumulative stress from summer temperatures remaining at recent high levels (as indicated by very low recent growth rates) and insect attacks would likely result in widespread tree death over the next few decades.

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

Student Investigator: Jennifer Roach, MS Biological Sciences
Advisor: Brad Griffith
Funding Agencies: USFWS; USGS

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

Ecosystem Shifts in Response to Climate Change at Creamer's Refuge, Fairbanks, AK

Student Investigator: Lila Tauzer, Interdisciplinary MS (Ecology, Remote Sensing)
Co-Advisors: Abby Powell and Anupma Prakash
Funding Agency: Alaska Space Grant/NASA

Worldwide, there is growing evidence that plant and animal communities are being profoundly affected by recent changes in climate-particularly in the Arctic and sub-Arctic regions. Our understanding of the extent and consequences of ecosystem change in northern boreal forest is mostly insufficient and/ or limited to computer generated models. Land stewards are finding it increasingly difficult to effectively manage with the limited data available. My specific objectives are twofold: (1) to quantify habitat change in the last 30 years at Creamer's Refuge, and (2) to examine local bird data from the same time period to look for trends. First, I will quantify change in landcover class using archived vegetation field data from the 1970s and remote sensing data. Second, I will compile and analyze a relatively rich dataset available on local birds to qualitatively explore relationships of avian distribution to changes in habitat. I predict that change has occurred during this 30-year time period. Habitat maps will be developed to accurately assess the amount and direction of landcover change; avian data collected will increase understanding of local bird dynamics. This study will give an indication of the spatial and temporal scale needed to accurately document environmental change in this ecosystem. Information gathered may provide information about which habitat types are most

susceptible to change and about the ecological impacts of this change, potentially allowing for more accurate climate change projections.

List of Abbreviations

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