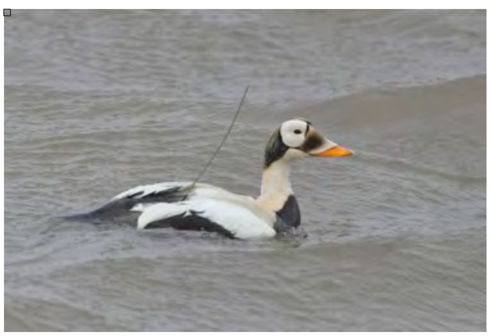

Alaska Cooperative Fish and Wildlife Research Unit

Annual Research Report—2010
October 14, 2011

Alaska Cooperative Fish and Wildlife Research Unit
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Unit Roster

Federal Scientists

- Brad Griffith: Assistant Leader-Wildlife
- A. David McGuire: Assistant Leader-Ecology and Acting Leader
- Abby Powell: Assistant Leader-Wildlife
- Mark Wipfli: Assistant Leader-Fisheries

University Staff

- Karen Enochs: Fiscal Officer
- Holly Neumeyer: Travel Coordinator
- Kathy Pearse: Administrative Assistant

Unit Students

Current

- Jeremy Carlson, MS Fisheries (Margraf)
- Amy Churchill, MS Biology (McGuire)
- Roy Churchwell, PhD Biological Sciences (Powell)
- David Esse, MS Fisheries (Margraf)
- Heather "River" Gates, MS Wildlife Biology (Powell)
- Laura Gutierrez, MS Biology (Wipfli)
- Christopher Harwood, MS Biology (Powell)
- Nicole McConnell, MS Biology (McGuire)
- Jason McFarland, MS Biology (Wipfli)
- Jason Neuswanger, PhD Biological Sciences (Wipfli and Rosenberger)
- Vijay Patil, PhD Biological Sciences (Griffith and Euskirchen)
- Megan Perry, MS Biology (Wipfli)
- Jeff Perschbacher, MS Fisheries (Margraf)
- Jennifer Roach, MS Biology (Griffith and Verbyla)
- David Roon, MS Biology (Wipfli)
- Matt Sexson, PhD Biological Sciences (Powell and Peterson)
- Lila Tauzer, MS Interdisciplinary (Powell and Prakash)
- Audrey Taylor, PhD Biological Sciences (Powell)
- Jason Valliere, MS Fisheries (Margraf)
- Teri McMillan Wild, MS Wildlife Biology (Powell)
- James Willacker Jr., PhD Biology (Wipfli and von Hippel)

Graduated in CY 2010

- Stacia Backensto, MS Interdisciplinary (Powell)
- Emily Benson, MS Biology (Wipfli)
- Samantha Decker, MS Fisheries (Margraf)
- Jonathan O'Donnell, PhD Biological Sciences (McGuire)
- Dan Rinella, PhD Biological Sciences (Wipfli)
- Lisa South, MS Fisheries (Margraf and Rosenberger)
- Valerie Steen, MS Wildlife Biology (Powell)
- Emily Weiser, MS Wildlife Biology (Powell)

Post-Doctoral Researchers

- Kirsten Barrett (USGS Mendenhall Postdoctoral Fellow, co-sponsored with Carl Markon, USGS Alaska Science Center) (McGuire)
- Rebecca Bentzen (Powell)
- Daniel Hayes (McGuire)
- Kristofer Johnson (McGuire)
- Caroline Lundmark (Griffith and Euskirchen)
- Samuel Nicol (Griffith and Hunter)
- 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
- Courtney Carothers, School of Fisheries and Ocean Sciences (SFOS)-UAF
- Eugénie Euskirchen, IAB
- Teresa Hollingsworth, Boreal Ecology Cooperative Research Unit (BECRU)-UAF
- Kris Hundertmark, DBW/IAB
- Christine Hunter, DBW/IAB
- Katrin Iken, SFOS
- Glenn Juday, Forest Sciences Department-UAF
- Gordon Kruse, 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
- Dave Verbyla, SALRM
- Frank von Hippel, UAA
- Donald Walker, IAB

Affiliated Students

Current

- Matthew Albert, MS Fisheries (Sutton)
- Brittany Blain, MS Fisheries (Sutton)
- Kevin Foley, MS Fisheries (Rosenberger)
- Sophie Gilbert, PhD Biology (Hundertmark)
- Christie Hendrich, MS Fisheries (Kruse)
- Tyler Lewis, MS Wildlife (Lindberg)
- Jamie McKellar, MS Fisheries (Iken and Sutton)
- Katie Moerlein, MS Fisheries (Carothers)
- Heather Scannell (Sutton and Margraf)
- Nicholas Smith (Sutton)
- Jason Stolarski (Sutton and Prakash)
- Ken Tape, PhD Biology (Ruess)
- Mark Winterstein, MS Biology (Walker and Hollingsworth)

Graduated in CY 2010

- David Gustine, PhD Biology (Barboza)
- Aleya Nelson, MS Wildlife (Lindberg and Rabe)

Cooperators

- Brian Barnes–Director, Institute of Arctic Biology, University of Alaska Fairbanks
- Denby Lloyd–Commissioner, Alaska Department of Fish and Game (retired December 1, 2010) and Cora Campbell–Commissioner, Alaska Department of Fish and Game (appointed December 22, 2010).
- Geoff Haskett–Director, Region 7, US Fish and Wildlife Service
- F. Joseph Margraf–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 2010. 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: 10
Presentations: 46
Scientific and Technical Publications: 26

Courses Taught

- Brad Griffith: Foraging Ecology (2 credit hours, Fall 2010)
- Dave McGuire: Interdisciplinary Modeling of High Latitude Global Change (4 credit hours, Fall 2010)
- Abby Powell: Scientific Writing, Editing, and Reviewing (3 credit hours, Spring 2010)
- Mark Wipfli: Freshwater Ecosystems Seminar (1 credit hour, Spring 2010)
- Mark Wipfli: Aquatic Entomology (2 credit hours, Fall 2010)
- Mark Wipfli: Global Change Seminar, BIOL F492/692 and FISH F492/692 (1 credit hour, Fall 2010)

Honors and Awards

- Dave McGuire: 2010 Performance Award awarded by US Geological Survey/ Cooperative Research Units
- Jamie McKellar, Best Student Poster at the Alaska Chapter Annual Conference, American Fisheries Society, Juneau, AK, November 2010.
- Jason Neuswanger, Best Student Paper at the Alaska Chapter Annual Conference, American Fisheries Society, Juneau, AK, November 2010.
- Abby Powell: 2010 Performance Award awarded by US Geological Survey/.Cooperative Research Units

Outreach and Info Transfer

- Science in Short, The Wildlife Society, "Garbage for Gulls." Feature about a publication in *Condor* (Weiser and Powell 2010).
- Abby Powell: Judge at Barnette School Science Fair.
- Mark Wipfli: Bioblitz 2010. In collaboration with ADFG, NOAA, USGS, and USFWS, organized and led a public education session on freshwater ecosystems, Juneau, AK.
- Mark Wipfli: "Nutrient and prey fluxes across ecosystem boundaries sustain freshwater fishes." Article in *Oncorhynchus*, the newsletter of the Alaska Chapter, American Fisheries Society 30(2):1-4.

Papers Presented

Barman, R., A. Jain, M. Liang, and A.D. McGuire. December 2010. Investigating the interactions between biogeophysical and biogeochemical processes in the northern high latitudes using a land surface model: feedbacks and climatic impacts. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Oral)

Bentzen, R., A.N. Powell, and R. Suydam. November 2010. Strategies for nest site selection by king eiders. 14th Alaska Bird Conference, Anchorage, AK. (Contributed Oral)

Churchill, A.C., A.D. McGuire, and M.R. Turetsky. August 2010. Responses of primary productivity and annual biomass in Alaskan boreal peatlands to changing hydrology and permafrost. Annual Meeting of the Ecological Society of America, Pittsburgh, PA. (Contributed Poster)

Churchill, A.C., T.N. Hollingsworth, A.D. McGuire, and M.R. Turetsky. December 2010. Response of vegetation structure and function to experimental drought and flooding in an Alaskan fen. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Poster)

Churchwell, R., S. Kendall, S. Brown, and A. Powell. November 2010. Shorebird use of Arctic Refuge coastal mudflats. 14th Alaska Bird Conference, Anchorage, AK. (Contributed Oral)

Collins, S.F., C.V. Baxter, A. Marcarelli, and M.S. Wipfli. June 2010. Responses of riparian insects and spiders to experimental additions of salmon carcasses. Joint American Society of Limnology and Oceanography & North American Benthological Society annual meetings, Santa Fe, NM. (ASLO/NABS abstract) (Contributed Oral)

Gates, H.R., Lanctot, R.B., and A.N. Powell. February 2010. Replacement clutch laying in an arctic-breeding shorebird in response to experimental removal. COS/AOU/SCO Joint Annual Meeting, San Diego, CA. (Invited Oral)

Griffith, B. January 2010. Caribou in the dynamic Arctic. "Why the Arctic Matters" Symposium, Western Oregon University, Monmouth, OR. Invited. (Invited Oral)

Griffith, B., C. Cuyler, R.G. White, L.G. Adams, D.E. Russell, D.C. Douglas, A. Gunn, and R.D. Cameron. February 2010. Implications of a greener north for Arctic caribou: Is trophic mismatch likely? Plenary Session, Alaska Chapter of The Wildlife Society Annual Meeting, Anchorage, AK. (Invited Oral)

Griffith, B., D.C. Douglas, and N.G. Platonov. March 2010. Heterogeneity in habitat trends among circumpolar Rangifer herds. Paper presented at Special Session 3.4, Heterogeneity and Resilience of Human-Rangifer Systems: A Circumpolar Social-Ecological Synthesis. ARCSS, State of the Arctic, Miami, FL. (Invited Oral)

Griffith, B., J.M. Scott, D. Ashe, and J. Baron. March 2010. Climate change adaptation options for public.lands and resources. USGS Global Change Conference, Denver, CO. (Contributed Oral)

Harden, J.W., K.D. Johnson, C.R. Lawrence, K.L. Manies, A.D. McGuire, J.A. O'Donnell, and M.P. Waldrop. March 2010. Carbon in terrestrial landscapes: Is the past the key to the future? U.S. Geological Survey Global Change Conference, Denver, CO. (Contributed Oral)

Hoy, E., E.S. Kasischke, M.R. Turetsky, E.S. Kane, K.M. Barrett, and A.D. McGuire. December 2010. Drivers of vulnerability of carbon stocks to variations in the fire regime in Alaskan boreal forests. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Oral)

Johnson, K.D., J.W. Harden, A.D. McGuire, J. Bockheim, M. Clark, J. O'Donnell, C. Ping, and E.A. Schuur. December 2010. Soil carbon storage in Alaska: Results from a new database and a multi-regional landscape approach to spatial distribution assessment. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Oral)

Kicklighter, D.W., D.J. Hayes, J.W. McClelland, B.J. Peterson, A.D. McGuire, and J.M. Melillo. December 2010. Relative importance of multiple factors on terrestrial loading of DOC to Arctic river networks. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Oral)

McConnell, N.A., A.D. McGuire, J.W. Harden, E.S. Kane, and M.R. Turetsky. December 2010. Controls on ecosystem and root respiration in an Alaskan peatland. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Poster)

McGuire, A.D. and T.R. Christensen. October 2010. Regional Carbon Cycle Assessment and Processes: Arctic Tundra. Regional Carbon Cycle Assessment on Lands and Oceans Workshop, Viterbo, Italy. Invited. (Invited Oral)

McGuire, A.D. April 2010. Keynote: Sensitivity of the carbon cycle in the Arctic to climate change. Symposium on Spatio-Temporal Patterns in the Carbon Balance of Northern High Latitude Regions. Stockholm University. Stockholm, Sweden. (Invited Oral)

McGuire, A.D. August 2010. Recent impacts of climate change in Alaska and other boreal regions. XXIII IUFRO World Congress, Seoul, South Korea. (Invited Oral)

McGuire, A.D. October 2010. Feedbacks of northern high-latitude terrestrial ecosystems to the climate system. Department of Energy Climate Change Workshop on Experiments in High Latitude Ecosystems, Fairbanks, AK. Invited. (Invited Oral)

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, and B.J. Peterson. March 2010. The changing carbon cycle of the Arctic. State of the Arctic Conference, Miami, FL. (Contributed Oral)

McGuire, A.D., D.J. Hayes, D.W. Kicklighter, Q. Zhuang, M. Chen, K.R. Gurney, J.W. McClelland, J.M. Melillo, B.J.Peterson, and R.G. Prinn. July 2010. Analysis of the carbon balance of boreal Asia from 1997–2006. International Conference on Environmental Observations, Modeling and Information Systems, Tomsk, Russia. (Invited Oral)

Neuswanger, J.C., N.F. Hughes, M.S. Wipfli, and L.H. Kelly. May 2010. Improved 3-D video analysis methods, with applications to wild juvenile Chinook salmon foraging video. International Symposium: Advances in the Population Ecology of Stream Salmonids, Luarca, Asturias, Spain. (APESS abstract) (Invited Poster)

Neuswanger, J.C., N.F. Hughes, M.S. Wipfli, L.H. Kelly, and A.E. Rosenberger. November 2010. The roles of territoriality and detritus in wild juvenile Chinook salmon drift-feeding behavior. Annual Meeting, Alaska Chapter, American Fisheries Society, Juneau, AK. (Contributed Oral)

Neuswanger, J.C., N.F. Hughes, M.S. Wipfli, L.H. Kelly, and A.E. Rosenberger. May 2010. Intra-school competition and drift-feeding behavior in wild juvenile Chinook salmon. International Symposium: Advances in the Population Ecology of Stream Salmonids, Luarca, Asturias, Spain. (APESS abstract) (Contributed Oral)

O'Donnell, J.A., J.W. Harden, A.D. McGuire, V.E. Romanovsky, M.Z. Kanevskiy, and T. Jorgenson. December 2010. Soil carbon accumulation and loss in Alaska's boreal forest: Exploring the interactive effects of wildfire and permafrost thaw. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Oral)

Otis, E.O., J.M. Peirce, M.S. Wipfli, and E.H. Follmann. November 2010. Radio telemetry to estimate chum salmon streamlife in McNeil River, Alaska. Annual Meeting, Alaska Chapter, American Fisheries Society, Juneau, AK. (Contributed Oral)

Perry, M.T., N.F. Hughes, M.S. Wipfli, J.R. Neuswanger, and M.J. Evenson. April 2010. Summer growth of juvenile Chinook salmon (Oncorhynchus tshawytscha) in an Interior Alaskan River. American Fisheries Society Western Division meeting, Salt Lake City, UT. (AFS abstract) (Contributed Oral)

Powell, A.N. and S. Backensto. October 2010. Nesting ecology of Common Ravens in an Arctic industrial landscape. The Wildlife Society, 17th Annual Conference, Snowbird, UT. (Contributed Oral)

Rinella, D.J., M.S. Wipfli, and C. Stricker. August 2010. Relationships among spawning salmon abundance, stable isotope measures of marine-derived nutrient assimilation, and the fitness of stream-dwelling fishes. 7th International Conference on Application of Stable Isotope Techniques to Ecological Studies, Fairbanks, AK. (ISOECOL abstract) (Contributed Oral)

Roon, D.A., M.S. Wipfli, T.L. Wurtz, and A. Prakash. June 2010. Invasive European bird cherry affects ecological processes within Alaska streams and riparian forests. Joint American Society of Limnology and Oceanography & North American Benthological Society annual meetings, Santa Fe, NM. (ASLO/NABS abstract) (Contributed Poster)

Roon, D.A., M.S. Wipfli, T.L.Wurtz, and A. Prakash. November 2010. Invasive European bird cherry affects prey resources for juvenile coho salmon in Anchorage streams. Annual Meeting, Alaska Chapter, American Fisheries Society, Juneau, AK. (Contributed Oral)

Rover, J., B.K. Wylie, K.P. Wickland, B. Griffith, D. Dahal, and B. Granneman. March 2010. Quantifying surface water in the Yukon River Basin. USGS Global Change Conference, Denver, CO. (Contributed Poster)

Sexson, M., M. Petersen, and A.N. Powell. January 2010. Preliminary results from ongoing spectacled eider satellite telemetry. Alaska Marine Science Symposium, Anchorage, AK. (Contributed Oral)

Sexson, M., M.R. Petersen, and A.N. Powell. November 2010. Spatiotemporal distribution of spectacled eiders during nonbreeding seasons. 14th Alaska Bird Conference, Anchorage, AK. (Contributed Oral)

Steen V.A. and A.N. Powell. February 2010. Nest site and foraging habitat selection by black terns in the Prairie Pothole region. AOU/COS/SCO Joint Annual Meeting, San Diego, CA. (Contributed Oral)

Taylor, A.R. February 2010. Lessons learned from three summers of postbreeding shorebird research in Arctic Alaska. In Advances in Shorebird Research Symposium. AOU/COS/SCO Joint Annual Meeting, San Diego, CA. (Contributed Oral)

Waldrop, M.P., J.W. Harden, M.R. Turetsky, D.G. Peterson, A.D. McGuire, M.J. Briones, A.C. Churchill, D.H. Doctor, and L.E. Pruett. December 2010. Relationships between soil microbial communities and soil carbon turnover along a vegetation and moisture gradient in interior Alaska. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Oral)

Walvoord, M., R. Striegl, G. Aiken, M. Dornblaser, S. Ewing, B. Griffith, J. Koch, J. Schmutz, P. Schuster, R. L. Smith, C. Voss, and K. Wickland. March 2010. Climate change and water in interior Alaska: An overview of hydrologic, aquatic biogeochemical, and biodiversity studies in the Yukon River Basin. USGS Global Change Conference, Denver, CO. (Contributed Oral)

Weiser, E. and A.N. Powell. February 2010. Garbage makes more glaucous gulls. AOU/COS/SCO Joint Annual Meeting, San Diego, CA. (Contributed Poster)

Weiser, E. and A.N. Powell. February 2010. Using stable isotope analysis to evaluate biases in conventional diet samples. AOU/COS/SCO Joint Annual Meeting, San Diego, CA. (Contributed Poster)

Wipfli, M.S., A.M. Marcarelli, K.L. Kavanagh, G. Servheen, S.F. Collins, L.A. Felicetti, S.T. Florin, C.V. Baxter, and T. Wheeler. August 2010. Mitigating for the loss of marine nutrients from salmon: Ecological effects of salmon carcass and analog additions to headwater aquatic and terrestrial systems. Ecological Society of America annual meeting, Pittsburg, PA. (ESA abstract) (Contributed Oral)

Wipfli, M.S., and C.V. Baxter. May 2010. Managing salmon returns and riparian forests to benefit salmonids and their riverine habitats: Seeing the unseen. International Symposium: Advances in the Population Ecology of Stream Salmonids, Luarca, Asturias, Spain. (APESS abstract) (Contributed Oral)

Wipfli, M.S., N.F. Hughes, M.J. Evenson, E.R. Benson, E.C. Green, L. Gutierrez, J.R. Neuswanger, and M.T. Perry. November 2010. Environmental processes affecting juvenile Chinook salmon in the Chena River, interior Alaska. Annual Meeting, Alaska Chapter, American Fisheries Society, Juneau, AK. (Contributed Oral)

Wipfli, M.S., N.F. Hughes, M.J. Evenson, E.R. Benson, E.C. Green, L. Gutierrez, J.R. Neuswanger, and M.T. Perry. May 2010. Environmental processes affecting juvenile Chinook salmon in an interior Alaska river. International Symposium: Advances in the Population Ecology of Stream Salmonids, Luarca, Asturias, Spain. (APESS abstract) (Invited Poster)

Wullschleger, S.D., L.D. Hinzman, A.D. McGuire, S.F. Oberbauer, W.C. Oechel, R.J. Norby, P.E. Thornton, E.A. Schuur, H.H. Shugart, J.E. Walsh, and C.J. Wilson. December 2010. Climate change experiments in Arctic ecosystems: Scientific strategy and design criteria. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Oral)

Scientific Publications

Belant, J.R., B. Griffith, Y. Zhang, E.H. Follmann, and L.G. Adams. 2010. Population-level resource selection by sympatric brown and American black bears in Alaska. Polar Biology 33:31-40. DOI 10.1007/s00300-009-0682-6.

Bentzen, R.L., A.N. Powell, L.M. Phillips, and R.S. Suydam. 2010. Incubation behavior of king eiders on the coastal plain of northern Alaska. Polar Biology 33(8): 1075-1082, DOI: 10.1007/s00300-010-0787-y.

Binckley, C., M.S. Wipfli, R.B. Medhurst, K. Polivka, P. Hessburg, B. Salter, and J.Y. Kill. 2010. Ecoregion and land-use influence invertebrate and detritus transport from headwater streams. Freshwater Biology 55:1205-1218.

Chapin, F.S. III, A.D. McGuire, R.W. Ruess, T.N. Hollingsworth, M.C. Mack, J.F. Johnstone, E. Kasischke, E.S. Euskirchen, J.B. Jones, M.T. Jorgenson, K. Kielland, G.P. Kofinas, M.R. Turetsky, J. Yarie, A.H. Lloyd, and D.L. Taylor. 2010. Resilience to climate change in Alaska's boreal forest. Canadian Journal of Forest Research 40:1360-1370. doi:10.1139/X10-074.

Euskirchen, E.S., A.D. McGuire, F.S. Chapin, and T.S. Rupp. 2010. The changing effects of Alaska boreal forests on the climate system. Canadian Journal of Forest Research 40:1336-1346. doi:10.1139/X09-209.

Griffith, B., C. Cuyler, R.G. White, L.G. Adams, D.E. Russell, D.C. Douglas, A. Gunn, and R.D. Cameron. 2010. No evidence of trophic mismatch for caribou in Greenland. Science. http://www.sciencemag.org/cgi/eletters/325/5946/1355

Gustine, D.D., P.S. Barboza, and J.P. Lawler. 2010. Dynamics of body protein and the implications for reproduction in captive muskoxen (Ovibos moschatus) during winter. Physiological and Biochemical Zoology 83(4):687-697.

Heintz, R.A., M.S. Wipfli, and J.P. Hudson. 2010. Identification of marine-derived lipids in juvenile coho salmon and aquatic insects through fatty acid analysis. Transactions of the American Fisheries Society 139:840-854.

Kane, E.S., M.R. Turetsky, J.W. Harden, A.D. McGuire, and J.M. Waddington. 2010. Seasonal ice and hydrologic controls on dissolved organic carbon and nitrogen concentrations in a boreal-rich fen. Journal of Geophysical Research – Biogeosciences 115, G04012, 15 pages, doi:10.1029/2010JG001366.

Kasischke, E.S., D. Verbyla, T.S. Rupp, A.D. McGuire, K.A. Murphy, J.L. Allen, E.E. Hoy, R. Jandt, P. Duffy, M. Calef, and M.R. Turetsky. 2010. Alaska's changing fire regime – Implications for the vulnerability of its boreal forests. Canadian Journal of Forest Research 40:1313-1324. doi:10.1139/X10-098.

Latty. C.J., T.E. Hollmén, M.R. Petersen, A.N. Powell, and R.D. Andrews. 2010. Abdominally implanted transmitters with percutaneous antennas affect the dive performance of common eiders. Condor 122(2):314-322.

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. Prinn. 2010. An analysis of the carbon balance of the Arctic Basin from 1997 to 2006. Tellus 62B:455-474. doi:10.1111/j.1600-0889.2010.00497.x

McGuire, A.D., F.S. Chapin III, and R.W. Ruess, Special Editors. 2010. The Dynamics of Change in Alaska's Boreal Forests: Resilience and Vulnerability in Response to Climate Warming. Foreword. Canadian Journal of Forest Research 40:1195-1196.

McGuire, A.D., R.W. Macdonald, E.A.G. Schuur, J.W. Harden, P. Kuhry, D.J. Hayes, T.R. Christensen, and M. Heimann. 2010. The carbon budget of the northern cryosphere region. Current Opinion in Environmental Sustainability 2:231-236. doi:10.1016/j.cosust.2010.05.003

McGuire, A.D., R.W. Ruess, A. Lloyd, J. Yarie, J.S. Clein, and G. Juday. 2010. Vulnerability of white spruce tree growth in interior Alaska in response to climate variability: Dendrochronological, demographic, and experimental perspectives. Canadian Journal of Forest Research 40:1197-1209. doi:10.1139/X09-206.

Medhurst, R.B., M.S. Wipfli, K. Polivka, C. Binckley, P. Hessburg, and B. Salter. 2010. Headwater streams and forest management: Does ecoregional context influence logging effects on benthic communities? Hydrobiologia 641:71-83.

Oppel, S. and A.N. Powell. 2010. Age-specific survival estimates for king eiders derived from satellite telemetry. Condor 112(2):323-330.

Oppel, S., A.N. Powell, and D. O'Brien. 2010. King eiders use an income strategy for egg production: a case study for incorporating individual dietary variation into nutrient allocation research. Oecologia 164:1-12, DOI 10.1007/s00442-010-1619-z

Oppel, S., R. Federer, D. O'Brien, A. Powell, and T. Hollmen. 2010. Effects of lipid extraction on stable isotope ratios in avian egg yolk – is arithmetic correction an alternative? Auk 157:72-78.

Schambler, J.L., P.L. Flint, and A.N. Powell. 2010. Patterns of use and distribution of king eiders and black scoters during the annual cycle in northeastern Bristol Bay, Alaska. Marine Biology 157:2169-2176, DOI 10.1007/s00227-010-1481-x

Scott, C.A., J.A.K. Mazet, and A.N. Powell. 2010. Health evaluation of western arctic king eiders (Somateria spectabilis). Journal of Wildlife Diseases 46(4):1290-1294.

Weiser, E.L. and A.N. Powell. 2010. Does garbage in diet improve reproductive output in Glaucous Gulls? Condor 112(3):530-538.

Wipfli, M.S. and C.V. Baxter. 2010. Linking ecosystems, food webs, and fish production: Subsidies in salmonid watersheds. Fisheries 35(8):373-387.

Wipfli, M.S., J.P. Hudson, J.P. Caouette, N.L. Mitchell, J.L. Lessard, R.A. Heintz, and D.T. Chaloner. 2010. Salmon carcasses increase stream productivity more than inorganic fertilizer pellets: A test on multiple trophic levels in streamside experimental channels. Transactions of the American Fisheries Society 139:824-839.

Technical Publications

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Theses and Dissertations of Unit-Sponsored Graduate Students

Backensto, Stacia A. 2010. Common ravens in Alaska's North Slope oil fields: An integrated study using local knowledge and science. MS thesis, University of Alaska Fairbanks. 162 pp.

Benson, Emily R. 2010. Relationships between ecosystem metabolism, benthic macroinvertebrate densities, and environmental variables in a sub-arctic Alaskan river. MS thesis, University of Alaska Fairbanks. 55 pp.

Decker, Samantha K. S. 2010. Thermal limitations on Chinook salmon spawning habitat in the northern extent of their range. MS thesis, University of Alaska Fairbanks. 41 pp.

Gustine, David D. 2010. Protein status of muskoxen and caribou in late winter. PhD thesis, University of Alaska Fairbanks.

Nelson, Aleya R. 2010. Ecology of Prince of Wales spruce grouse. MS thesis, University of Alaska Fairbanks. 85 pp.

O'Donnell, Jonathan A. 2010. The effects of permafrost degradation on soil carbon dynamics in Alaska's boreal region. PhD thesis, University of Alaska Fairbanks. 214 pp.

Rinella, Daniel J. 2010. Marine-derived nutrients in riverine ecosystems: Developing tools for tracking movement and assessing effects in food webs on the Kenai Peninsula, Alaska. PhD thesis, University of Alaska Fairbanks. 167 pp.

South, Lisa. 2010. A remote sensing-GIS based approach to identify and model spawning habitat for fall chum salmon in a sub-arctic, glacially-fed river. MS thesis, University of Alaska Fairbanks. 76 pp.

Steen, Valerie. 2010. Waterbird distribution and habitat in the Prairie Pothole Region, U.S.A. MS thesis, University of Alaska Fairbanks. 67 pp.

Weiser, Emily L. 2010. Use of anthropogenic foods by glaucous gulls (*Larus hyperboreus*) in northern Alaska. MS thesis, University of Alaska Fairbanks. 71 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

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

Student Investigator: Samantha Decker, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Sport Fish Division, Alaska Department of Fish and Game

Note: Sam Decker graduated from the University of Alaska Fairbanks in May 2010. Her thesis abstract follows:

Pacific salmon (*Oncorhynchus*) habitat models attempt to balance research efficiency with management effectiveness, however, model transferability between regions remains elusive. To develop efficient habitat models, we must understand the critical elements that limit habitat. At the northern edge of the geographic range for Chinook salmon, *O. tschawytscha*, water temperature is a probably a limiting habitat factor. This study investigated the spatial and temporal correspondence between water temperature and Chinook salmon spawning on the Chena River, Alaska. Water temperatures were monitored at 21 stations across 220 river kilometers during the 2006 and 2007 spawning seasons and compared to known thermal requirements for egg development. While an absolute upstream thermal boundary to spawning was not discovered, we describe potential temporal limitations in thermal conditions over the spawning season. Our results show that 98.5% of Chinook salmon selected spawning habitat in which their eggs have a 90% probability of accumulating 450 ATUs before freeze up. This suggests not only temperature conditions limit salmon spawning habitat, but also, as expected, water temperatures temporally limit accessible Chinook salmon spawning habitat at the northern edge of their range. This project documents new spawning habitat for the Anadromous Waters Catalog and broadens the geographical range of Chinook salmon thermal habitat research. It also contributes to the understanding of the processes that define salmon habitat, while providing a baseline for further investigations into water temperature in other thermal regimes.

A Remote Sensing-GIS Based Approach to Identify and Model Spawning Habitat for Fall Chum Salmon in a Sub-Arctic, Glacially-Fed River

Student Investigator: Lisa South, MS Fisheries
Co-Advisors: F. Joseph Margraf and Amanda Rosenberger
Funding Agencies: AYKSSI, Commercial Fish Division, ADFG; and Tanana Chiefs Conference

Note: Lisa South graduated from the University of Alaska Fairbanks in August 2010. Her thesis abstract follows:

At northern extremes, fish habitat requirements are often linked to thermal preferences and the presence of overwintering habitat. The goal of this study was to

identify spawning habitat for fall chum salmon *Oncorhynchus keta* and model habitat selection from spatial distributions of tagged individuals in the mainstem Tanana River, Alaska. I hypothesized that the presence of groundwater, which provides thermal refugia for overwinter incubation, would be most important for fall chum salmon. Models included braiding, sinuosity, open water surface area (indicating significant groundwater influence), and open water persistence (consistent presence of open water for a 12 year period according to satellite imagery). Candidate models containing open water persistence were selected as most likely. Persistent open water areas were further examined using forward-looking infrared (FLIR) imagery; marked differences between sites were observed in the extent of thermal influence by groundwater. Persistent open water sites with strong groundwater influence appear to serve as core areas for spawning salmon; the importance of stability through time suggests the legacy of successful reproductive effort in these areas for this homing species. This study indicates that not only the presence of groundwater is important for spawning chum, but its persistence and extent of groundwater influence.

Relationships between Ecosystem Metabolism, Benthic Macroinvertebrate Densities, and Environmental Variables in a Sub-Arctic Alaskan River

Student Investigator: Emily Benson, MS Biology
Advisor: Mark Wipfli
Funding Agency: AYKSSI, ADFG

Note: Emily Benson graduated from the University of Alaska Fairbanks in August 2010. Her thesis abstract follows:

The aim of this study was to investigate the environmental drivers of river ecosystem metabolism and macroinvertebrate density in a sub-arctic river. Ecosystem metabolism is the combination of gross primary production and ecosystem respiration within a river. Aquatic macroinvertebrates link primary producers at the base of the food web with secondary consumers. The extent to which photosynthetically active radiation, discharge, and nutrients influence metabolism rates and how primary production and river discharge rates influence benthic macroinvertebrate densities in sub-arctic rivers is not clear. These processes ultimately help regulate prey resources available for upper level consumers such as juvenile salmon. I employed Random Forests model analyses to identify important predictor variables for primary production and respiration rates (estimated using the single-station diel oxygen method) at four sites in the Chena River, sub-arctic Alaska, throughout the summers of 2008 and 2009. I calculated Spearman correlations between nutrient levels and metabolism rates. I used Random Forests models to identify the variables important for predicting benthic macroinvertebrate density and biomass at the study sites. The models indicated that discharge and length of time between high water events were the most important variables measured for predicting metabolism rates. Discharge was identified as the most important variable for predicting benthic macroinvertebrate density and biomass. Phosphorus concentration was low (at times below the detection limit), while nitrogen concentration was more variable; the ratio of nitrogen to phosphorus was above the threshold for phosphorus limitation, suggesting that phosphorus may have been limiting primary production.

Marine-Derived Nutrients in Riverine Ecosystems: Developing Tools for Tracking Movement and Assessing Effects in Food Webs on the Kenai Peninsula, Alaska

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

Note: Dan Rinella graduated from the University of Alaska Fairbanks in May 2010. His dissertation abstract follows:

Marine-derived nutrients (MDN) delivered by spawning Pacific salmon (*Oncorhynchus* spp.) contribute to the productivity of riverine ecosystems. Optimizing methods for measuring MDN assimilation in food webs will foster the development of ecologically based resource management approaches. This dissertation aims to better understand relationships among spawning salmon abundance, biochemical measures of MDN assimilation, and the fitness of stream-dwelling fishes. The goals of my first research chapter were (1) to understand the factors that influence stable isotope ($\delta 13C$, $\delta 15N$, and $\delta 34S$) and fatty acid measures of MDN assimilation in stream and riparian biota, and (2) to examine the ability of these measures to differentiate among sites that vary in spawning salmon biomass. For all biota studied, stable isotopes and fatty acids indicated that MDN assimilation increased with spawner abundance. Among Dolly Varden (*Salvelinus malma*), larger individuals assimilated proportionately more MDN. Seasonal effects were detected for aquatic macroinvertebrates and riparian horsetail (*Equisetum fluviatile*), but not for Dolly Varden. Of all dependent variables, Dolly Varden $\delta 15N$ had the clearest relationship with spawner abundance, making this a good measure for monitoring MDN assimilation. Expanding on these results, two chapters examined potential fisheries management applications. The first sought to identify spawner levels above which stream-dwelling Dolly Varden and coho salmon (*O. kisutch*) parr cease to gain physiological benefits associated with MDN. RNA-DNA ratios (an index of recent growth rate) and energy density indicated saturation responses where values increased rapidly with spawner abundance up to approximately 1 kg/m2 and then leveled off. In coho salmon parr, energy density and RNA-DNA ratios correlated significantly with $\delta 15N$. These results show strong linkages between MDN and fish fitness responses, while the saturation points may indicate spawner densities that balance salmon harvest with the ecological benefits of MDN. The second application tested a quick and inexpensive method for estimating spawning salmon abundance based on $\delta 15N$ in stream-dwelling fishes. Estimates made with coho salmon parr were unbiased, tightly correlated with observed values, and had a mean absolute deviation of 1.4 MT spawner biomass/km. Application of this method would allow estimates of annual escapement to be made on a potentially large number of streams.

Ongoing Aquatic Studies

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: Trent Sutton
Funding Agency: Sport Fish Division, ADFG (Base Funding)
In-Kind Support: Personnel, vehicles, boats, and field equipment provided by ADFG

Northern pike are an important sport and subsistence fish in interior Alaska. Detailed study of seasonal movements of northern pike in Minto Flats is lacking. These movements need to be better understood to improve management of the fisheries that occur in Minto Flats. 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 northern pike, respectively, with radio-telemetry tags (in addition to 83 radio-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
Advisors: Trent Sutton and Anupma Prakash
Funding Agency: Fairbanks Fisheries Resource Office and Arctic National Wildlife Refuge, U.S. Fish and Wildlife Service (RWO 160)

Arctic environments are warming at accelerated rates yet little is known regarding the potential effect of this change on stenothermic fishes such as Dolly Varden. Dolly Varden are a primary species captured in subsistence fisheries throughout the Alaskan Arctic. Little data is available for managers to use to develop management strategies. Our objectives in this study are to (1) describe seasonal fluctuations in Dolly Varden energy content; (2) correlate archived growth data to broad-scale environmental variables; and (3) create bioelectrical impedance models (BIA) capable of estimating Dolly Varden proximate composition non-lethally Objectives will be accomplished through a combination of field work on the Ivishak River and lab analyses. Data collected in the field (length, weight, and BIA data) will complement lab procedures (proximate analysis, increment analysis, and remote sensing techniques). Biological impedance analysis produces superior estimates of proximate content in Dolly Varden relative to traditional weight-length approaches. These data will characterize seasonal fluctuations in energy content, elucidate the effect of broad-scale habitat on long-term trends in growth, and develop non-lethal means of collecting high quality condition data. Together this information can aid resource professionals in developing proactive management strategies for Dolly Varden populations during a time of sustained change.

Population Structure and Reproductive Status of Razor Clams (*Siliqua patula*) in Eastern Cook Inlet

Student Investigator: Jamie McKellar, MS Fisheries
Co-Advisors: Katrin Iken and Trent Sutton
Funding Agency: Sport Fish Division, ADFG (Base funding)
In-Kind Support: Personnel, vehicles, and equipment provided by ADFG

Growth, survival and recruitment rates may be changing in the important razor clam *Siliqua patula* stock targeted by sport and personal use diggers on the east side of Cook Inlet. A basic population assessment, the ability to track year classes as they age and to measure annual growth, is compromised by lack of life history information that enables accurate age determination. This project will estimate duration and timing of adult spawning, size of clams at settlement, juvenile clam growth by month, and improve the recognition of sequential annular growth and the identification of newly recruited and juvenile clams. 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. The purpose of this study is to enhance our knowledge of life history patterns of the razor clam on eastern Cook Inlet beaches. Quantification of life history traits will result in more accurate age determination, which can lead to the development of better stock-recruitment models. Objectives will be accomplished with monthly (March–October) sampling of juvenile and adult razor clams to examine growth rates and sexual maturity. Additionally, sediment samples will be taken between March and October to detect the presence of newly settled clams. Spawning occurs primarily in July and August at Clam Gulch and Ninilchik. An absence of newly settled razor clams and low numbers of sexually mature adult razor clams seem to indicate that recruitment in 2009 and 2010 was not as successful at Clam Gulch as at Ninilchik. Fisheries managers need to respond appropriately to population changes, especially at Clam Gulch, in order to protect the sustainability of this stock.

Vertical Movements and Thermal Habitat Utilized by Burbot in Copper and Tanada Lakes, Alaska

Student Investigator: Heather L. Scannell, MS Fisheries
Co-Advisors: Trent Sutton and F. Joseph Margraf
Funding Agency: Wrangell-St. Elias National Park, National Park Service
In-Kind Support: Sport Fish Division, 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 sustainable exploitation levels. The UCUSMA supports the largest burbot sport fishery within the state with up to 30% of the total statewide harvest coming from this region. Several lakes were included in the 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 of which have extreme bathymetry. 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. We will use mixing tests and transition probabilities to determine if current burbot abundance estimates are biased due to the depth restrictions on sampling. This determination was accomplished by tagging 140 burbot (70 from each lake) with archival tags. These tags were surgically implanted into selected fish and are programmed to take a depth and temperature reading every 15 minutes for up to 469 days. To date, Tanada Lake data collection is complete. Out of the 70 fish tagged in summer 2009, 15 fish were recaptured this last summer. In Copper Lake the other 70 tags were deployed and an aggressive recapture event will take place in fall 2010. The data from this study will aid managers in determining the adequacy of burbot abundance estimates in lakes that have bathymetry which excludes a proportion of the lake from sampling.

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: AYKSSI, 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

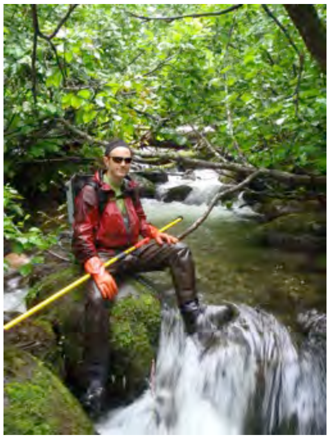
Chinook distribution. Intra-specific competition for food affects fine-scale distribution and individual growth. Knowledge of environmental influences on juvenile survivorship will help managers predict the strength of each year class before the adults return to spawn.

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: USDA Forest Service and U.S. Fish and Wildlife Service
In-Kind Support: Anchorage Parks Foundation, Municipality of Anchorage Parks and Recreation, UAA Environment and Natural Resource Institute, UAF Cooperative Extension Service, Alaska Natural Heritage Program

Introduced species are a concern worldwide as they can displace native species and disrupt ecological processes. European Bird Cherry (*Prunus padus* L.) (EBC) is a non-native, ornamental tree that is rapidly spreading and possibly displacing the native trees in riparian forests in some parts of urban Alaska. Because riparian zones link terrestrial and aquatic ecosystems, the spread of EBC in riparian zones could affect stream organisms and food webs, including juvenile salmon who rear in these streams. The objectives of this study were to (1) map the distribution of EBC in two Anchorage streams, Campbell Creek and Chester Creek, 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 leaf litter processing and aquatic invertebrate shredder colonization; and sampled terrestrial invertebrate communities on riparian tree branches, their infall into streams, and consumption by juvenile coho salmon. Data from the 2009 and 2010 field seasons showed EBC was widely distributed along Campbell Creek and Chester Creek; EBC leaf litter broke down faster and supported similar shredder communities compared to native trees; and EBC supported a lower biomass of terrestrial invertebrates on riparian tree branches, contributed a lower biomass of terrestrial invertebrates to streams, but did not appear to affect the mass of terrestrial invertebrates consumed by juvenile coho salmon relative to native trees. Although ecological processes in this study did not seem to be dramatically affected by EBC presence, lowered prey abundance as measured in this study may have long-term consequences for stream-rearing fishes as EBC continues to spread. These findings will help guide management of EBC by municipal, state and federal agencies involved in managing urban watersheds and controlling invasive species.

Longitudinal Distribution Patterns and Habitat Associations of Juvenile Coho Salmon in High Gradient Headwater Tributaries of the Little Susitna River, Alaska



Student Investigator: Kevin Foley, MS Fisheries
Advisor: Amanda Rosenberger
Funding Agency: Anchorage Field Office, USFWS (RWO 174)
In-Kind Support: Technical assistance and equipment provided by USFWS

The upper Little Susitna River provides habitat for Pacific salmon runs faced with increased watershed development and fishing pressure. We lack a full understanding of juvenile rearing habitat and factors that limit the distribution and production of Pacific salmon within the region. Restoration and conservation practices in the form of culvert pipe replacement are currently underway within the upper Little Susitna River watershed. These efforts are prioritized with little consideration to the differential capacity of these areas to bear and support salmon populations. My primary objective was to determine the upstream limit and distribution of juvenile coho salmon by size and age class and to associate spatial patterns in juvenile fish distributions and abundance with habitat features. I used backpack electrofishers to sample juvenile coho salmon to their upper distribution limit within two headwater streams, measured all fish captured, and collected scale and otolith samples for aid with aging. Habitat assessed in a stream-wide manner included a suite of common variables of known importance to rearing juvenile salmon. Preliminary results suggests multiple age classes of juvenile coho are using these areas for rearing and are contiguously present throughout the stream to their upper distribution limit, with older juveniles more dominant in middle to lower stream areas. Results from this project will allow for a more strategic and informed management of these populations. For example, prioritizing replacement of culvert pipes will take place in systems with the largest area used by older, upstream moving age classes of juvenile salmon.

Winter Movement Patterns and Habitat Use of Kotzebue Region Inconnu

Student Investigator: Nicholas Smith, MS Fisheries
Advisor: Trent Sutton
Funding Agency: Office of Subsistence Management, USFWS (RWO 177)
In-Kind Support: Fairbanks Fish and Wildlife Field Office and Selawik National Wildlife Refuge: field camp logistics and equipment use during field season; ADF&G: equipment use during field season

Inconnu of the Selawik and Kobuk river drainages are considered separate stocks. However, the two stocks over-winter as a mixed stock within Hotham Inlet and Selawik Lake and to date no evaluation of inconnu migration and distribution during the wintering period relative to physico-chemical attributes within these drainages have been conducted. Inconnu provide an important subsistence food resource for this region of Alaska. In order to effectively manage the inconnu of this region, winter movement and habitat use needs to be identified. The primary objectives of this study are to examine the distribution patterns of inconnu in the Selawik and Kobuk river drainages during the wintering period and determine whether water depth, temperature, or salinity influence winter habitat selection. These objectives were accomplished using acoustically tagged inconnu and automated submersible receivers affixed with archival tags. The expected results are that inconnu will be uniformly distributed throughout the drainages during the late fall and winter months and will show no stock-related preferences for particular water depths, temperature profiles, or salinity gradients. These data will allow managers to determine the appropriateness of winter stock specific harvest guidelines in the region.

The Effects of Barotrauma and Deepwater-release Devices on the Reproductive Viability of Yelloweye Rockfish *Sebastes ruberrimus* in Prince William Sound, Alaska

Student Investigator: Brittany Blain, MS Fisheries
Advisor: Dr. Trent Sutton
Funding Agency: Sport Fish Division, ADFG
In-Kind Support: Boat, crew, field camp logistics and equipment provided by ADFG

Rockfish suffer barotrauma when subjected to catch-and-release fishing, and barotrauma-induced mortality is thought to be as high as 90% for some species of demersal rockfish. Recent studies by the Alaska Department of Fish and Game (ADFG) Division of Sport Fish have determined that yelloweye rockfish have high survival when released with a deepwater-released device (DRM), but no other effects have been examined. The use of DRMs has gained popularity and more sport anglers are utilizing these devices, but managers lack data of the effects to long-lived, deep-dwelling species such as rockfish. Once a rockfish is released back down to depth versus onto the surface, the question is whether after survival they remain a viable member of the population and reproduce in subsequent years. Our primary objective in this study was to determine if after recompression with a DRM, one or two years later, will a yelloweye rockfish continue to reproduce and could there be effects to offspring quality. Hook and line sampling was conducted in Port Gravina, Prince William Sound. Blood and gonads were collected from yelloweye rockfish, and lab analysis was conducted. Each of the female yelloweye rockfish tagged in 2008 and 2009 and recaptured in 2010 was reproducing. Effects on embryos are still being investigated to determine if there are differences in embryo quality. The data collected from this project will give managers insight on some of the possible long-term effects of DRMs on long-lived, deep-dwelling species such as rockfish.

Completed Wildlife Studies

Waterbird Distribution and Habitat in the Prairie Pothole Region, U.S.A.

Student Investigator: Valerie Steen, MS Biology
Advisor: Abby Powell
Funding Agency: Region 6, USFWS (RWO 156)

Note: Valerie Steen graduated from the University of Alaska Fairbanks in December 2010. Her thesis abstract follows:

The Prairie Pothole Region (PPR) of north-central North America provides some of the most critical wetland habitat continent-wide to waterbirds. Agricultural conversion has resulted in widespread wetland drainage. Furthermore, climate change projections indicate a drier future, which will alter remaining wetland habitats. I evaluated Black Tern (*Chlidonias niger*) habitat selection and the potential impacts of climate change on the distribution of waterbird species. To examine Black Tern habitat selection, I surveyed 589 wetlands in North and South Dakota in 2008-09, then created multivariate habitat models. I documented breeding at 5% and foraging at 17% of wetlands surveyed, and found local variables were more important predictors of use than landscape variables, evidence for differential selection of wetlands where breeding and foraging occurred, and evidence for a more limited role of area sensitivity (wetland size). To examine the potential effects of climate change, I created models relating occurrence of five waterbird species to climate and wetland variables for the U.S. PPR. Projected range reductions were 28 to 99%, with an average of 64% for all species. Models also predicted that, given even wetland density, the best areas to conserve under climate change are northern North Dakota and Minnesota.

Use of Anthropogenic Foods by Glaucous Gulls (*Larus hyperboreas*) in Northern Alaska

Student Investigator: Emily Weiser, MS Biology
Advisor: Abby Powell
Funding Agencies: Department of Wildlife Management, North Slope Borough; and Bureau of Land Management

Note: Emily Weiser graduated from the University of Alaska Fairbanks in May 2010. Her thesis abstract follows:

Glaucous Gulls are abundant predators in northern Alaska and prey upon several bird species of conservation concern. To assess the benefit gulls may receive from scavenging garbage, I studied diet and reproduction at eight to ten breeding colonies in northern Alaska in 2008-2009. Garbage occurrence in diet was positively correlated with fledging rate; thus any development that increased available garbage could potentially subsidize gull populations through enhanced reproductive success. Garbage could also increase gull populations by enhancing subadult survival. Subadult gulls around the city of Barrow consumed much more garbage than breeding adults, which apparently switch to a mostly natural diet. If garbage enhances subadult survival, more gulls may survive to adulthood, which could impact prey species. When Barrow switched to incinerating garbage instead of disposing it in

a landfill, garbage in subadult gull diet decreased. Using stable isotope analysis of gull chick feathers, I found that the diet samples (pellets and food remains) I used in these analyses overestimated gull use of birds and underestimated use of fishes, but usually accurately portrayed relative importance of garbage. Biases in these samples should be considered when assessing the potential impact of gulls on their prey.

Common Ravens in Alaska's North Slope Oil Fields: An Integrated Study Using Local Knowledge and Science

Student Investigator: Stacia Backensto, MS Interdisciplinary
Advisor: Abby Powell
Funding Agencies: Coastal Marine Institute/UAF; Regional Resilience and Adaptation Program Fellowship (IGERT, NSF 0114423)/UAF; Minerals Management Service; USFWS; Center for Global Change Fellowship/UAF

Note: Stacia Backensto graduated from the University of Alaska Fairbanks in May 2010. Her thesis abstract follows:

Common ravens (*Corvus corax*) that nest on human structures in the Kuparuk and Prudhoe Bay oil fields on Alaska's North Slope are believed to present a predation risk to tundra-nesting birds in this area. In order to gain more information about the history of the resident raven population and their use of anthropogenic resources in the oil fields, I documented oil field worker knowledge of ravens in this area. In order to understand how anthropogenic subsidies in the oil fields affect the breeding population, I examined the influence of types of structures and food subsidies on raven nest site use and productivity in the oil fields. Oil field workers provided new and supplemental information about the breeding population. This work in conjunction with a scientific study of the breeding population suggests that structures in the oil fields were important to ravens throughout the year by providing nest sites and warm locations to roost during the winter. The breeding population was very successful and appears to be limited by suitable nest sites. The landfill is an important food source to ravens during winter, and pick-up trucks provide a supplemental source of food throughout the year. Further research will be necessary to identify how food (anthropogenic and natural) availability affects productivity and the degree to which ravens impact tundra-nesting birds.

Ecology of Prince of Wales Spruce Grouse

Student Investigator: Aleya Nelson, MS Biology
Co-Advisors: Mark Lindberg and Dale Rabe
Funding Agencies: ADFG; Department of Biology and Wildlife and Institute of Arctic Biology/UAF

Note: Aleya Nelson graduated from the University of Alaska Fairbanks in December 2010. Her thesis abstract follows:

Recently, spruce grouse on Prince of Wales Island (POW) in southeast Alaska have been proposed as a separate subspecies. Furthermore, life-history of spruce grouse on POW, which is temperate coastal rainforest, varies sufficiently from birds in mainland areas, mostly boreal forest, to warrant specific management. Therefore, I examined the ecology of spruce grouse on POW to determine how timber harvest influences their survival and habitat selection and ultimately to provide recommendations for their conservation. During 2007-2009, we found that the greatest variation in survival probability was attributed to breeding status. The annual survival of non-breeding birds was 0.72±0.082 ($\hat{S}$±SEs) while for breeding birds it was 0.08±0.099. Logging did not adequately predict survival, with no differences among habitats. Conversely, I found differences in selection among habitats. At the watershed scale, spruce grouse preferred unharvested forest. At both watershed and homerange scales, spruce grouse avoided edges and preferred roads. Road-related mortality was the largest known source of death. POW spruce grouse and mainland subspecies exhibit sufficiently different survival rates and habitat preference to warrant specific management. We recommend limited road closures during periods when POW spruce grouse are most vulnerable due to the high rates of mortality associated with this preferred habitat.

Inter-Annual Variance in δ^{15}N of Blood Metabolites in a Northern Ungulate in Winter

Student Investigator: Dave Gustine (PhD Biological Sciences; graduated December 2010)
Advisor: Perry Barboza
Funding Agency: U.S. Geological Survey (RWO 162)

Can isotopic ratios of N (δ^{15}N) from routinely collected blood samples be used to assess nutritional constraints in winter for caribou populations? We are developing and refining a blood-based technique to assess body protein loss that will assist management agencies to ascertain mechanisms of population dynamics in caribou herds. We documented and explored the long-term patterns and variance in δ^{15}N in fractions of whole blood and assessed the utility of isotopic correlates of protein status to examine nutritional constraints and maternal investment in offspring in late winter. Specifically, we examined how age, body mass, winter and late winter locations, and winter severity varied with body protein loss in a herd of known annual population size and masses of calves at birth. Protein loss was evaluated with isotopic measures of nitrogen metabolites in blood fractions collected from caribou during late winter. We measured isotopes of N (δ^{15}N) in red blood cells, serum proteins, and serum amino acids in 172 blood samples from 116 adult female caribou of known age and body mass in the Denali herd across 14 years (1993-2007). We evaluated correlates of δ^{15}N for each blood fraction and 2 indices of protein status as well as the estimated the relative importance of year, age, body mass, and spatial location in the models to estimate isotopic parameters. Linear regression was used to assess the effects of winter severity on isotopic parameters and to examine if maternal protein status in March influenced the birth mass of calves. We predicted that variation in all factors (year, age, body mass, locations in winter and late winter, and winter severity) would affect the protein status of female caribou in the Denali herd. We expected that severe winters (year effect) would increase catabolism of body proteins and, thus, reduce the body protein available for reproduction (as indexed by birth masses of calves). Year had a strong effect on isotopic parameters and was typically the most important isotopic correlate. However, after controlling for age, body mass, and spatial location, year effects on isotopic parameters could not be explained by winter severity for this low density, montane caribou herd. Similarly, isotopic correlates of protein status did not vary with birth masses of calves. 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 $\delta^{15}N$ in blood fractions may be difficult for low density, montane populations that typically have the nutritional and physiographic capacity to adapt to variable and often severe winter conditions. Indeed, body mass and isotopic indices suggest that adult females were typically in good to excellent nutritional condition in late winter regardless of winter severity. Blood-based approaches may be better suited for populations with larger annual variance in nutritional condition (e.g., migratory herds at higher densities).

Ongoing Wildlife Studies

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

Student Investigator: Heather "River" Gates, MS Wildlife Biology
Advisor: Abby Powell
Funding Agencies: Migratory Bird Program, USFWS
In-Kind Support: Office space and computer support provided by USFWS

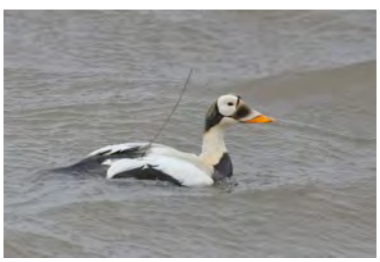
Renesting rates in arctic-breeding shorebirds are largely unknown and are presumed to be low due to females' physiological constraints, short nesting season, and limited food resources. Dunlin are a common arctic-breeder across the North Slope with populations that are reportedly declining. A better 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. Important factors affecting renesting rates include female body condition, julian loss date, julian initiation date, days of incubation at clutch loss and male body condition. 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 female body condition and 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. Preliminary results indicate differences between deltas fed by glacial rivers and non-glacially influenced deltas. Freshwater invertebrates seem to decline in the non-glacial deltas probably due to the sandier substrate and saltier lagoon. One species was completely excluded at the non-glacial delta. Also, triglyceride levels indicate that fatten rates were lower at the non-glacial delta. This finding could have implications for shorebird migration as the glaciers in the Brooks Range are expected to melt and disappear in the next 50-75 years. Several shorebird populations using this habitat are declining and some are listed as species of concern in the U.S. Shorebird Conservation Plan and by U.S. 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: U.S. Bureau of Ocean Energy Management; USGS; USFWS; BLM; NFWF; North Pacific Research Board
In-kind Support: ConocoPhillips Alaska, Inc.; BLM, Columbus Zoo (Ohio); Mesker Park Zoo (Indiana); Point Defiance Zoo (Washington)

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 habitat use by Spectacled Eiders. We are marking Spectacled Eiders with implantable satellite transmitters to collect location and survival data over a period of 2 years each. Data will be incorporated into models of individual home range and habitat use. We marked 13 juveniles (9 males, 4 females) and 82 adults (30 males, 52 females) in 3 years (2008–2010). We expect satellite telemetry data to provide continuous locations over the course of 4 years (2008–2012). In spring and fall, eiders were located in distinct areas of the Bering, Chukchi, and east Siberian seas. In winter, all marked eiders used an area in the northern Bering Sea. Site fidelity among females was higher than males. These data will contribute to Spectacled Eider conservation and recovery efforts in areas where rapid development and environmental change are expected in the future.

Effects of Changing Habitat and Climate on Sitka Black-Tailed Deer Recruitment and Population Dynamics on Prince of Wales Island, Alaska

Student Investigator: Sophie Gilbert, PhD Biological Sciences
Advisor: Kris Hundertmark
Funding Agencies: Wildlife Conservation Division, ADFG; Tongass National Forest, USDA Forest Service; National Science Foundation
In-Kind Support: Field season personnel, logistics, and equipment provided by ADFG

Sitka black-tailed deer are a key subsistence resource in many areas of southeast Alaska, as well as a highly influential herbivore in the forest ecosystem. Currently, we lack a detailed understanding of how expected changes to habitat and climate will affect deer populations, and perhaps the least understood but most variable vital rate for deer populations is recruitment. Prince of Wales Island is one of the most heavily timber-harvested areas in southeast Alaska; the ongoing successional changes to logged habitat will have unknown consequences for the deer population and the forest ecosystem, and for subsistence harvest. Our primary goals are to understand the effect of habitat, and the interaction between habitat and weather, on deer reproduction and survival; and to identify specific causes of deer mortality. These goals have been accomplished by GPS collaring adult does, radio collaring offspring, monitoring survival, and monitoring weather and snowfall. This project is entering year 2 of 3 planned years. Data collection and analysis are ongoing. Fawn mortality rates for the first 4 months were ~48%, and adult female survival rates during the same period were ~95%. Anticipated results in the future will include effects of habitat and weather on deer mortality. Understanding deer population dynamics will allow us to project possible effects of different timber and hunting management scenarios on the deer population, as well as to factor in potentially interacting effects of changing climate, which will help managers ensure adequate supplies of deer for subsistence and recreational harvest in the future.

Completed Ecological Studies

Snow Cover and Biology in the Arctic

Researcher: 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 affects 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. We have written a synthesis paper summarizing the results of these studies (*Euskirchen et al., Canadian Journal of Forest Research, 2010*). 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.

Carbon Responses along Moisture Gradients in Alaskan Landscapes

Student: Jon O'Donnell, PhD Biological Sciences
Faculty: A. David McGuire
Funding Agency: Geologic Division, USGS (RWO 149)

High-latitude regions store large quantities of organic carbon (C) in permafrost soils and peatlands, accounting for nearly half of the global belowground C pool. Projected climate warming over the next century will likely drive widespread thawing of near-surface permafrost and mobilization of soil C from deep soil horizons. However, the processes controlling soil C accumulation and loss following permafrost thaw are not well understood. To improve our understanding of these processes, PhD student Jon O'Donnell examined the effects of permafrost thaw on soil C dynamics in forested upland and peatland ecosystems of Alaska's boreal region. In upland forests, soil C accumulation and loss was governed by the complex interaction of wildfire and permafrost. Fluctuations in active layer depth across stand age and fire cycles determined the proportion of soil C in frozen or unfrozen soil, and in turn, the vulnerability of soil C to decomposition. Under present-day climate conditions, the presence of near-surface permafrost aids C stabilization through the upward movement of the permafrost table with post-fire ecosystem recovery. However, sensitivity analyses suggest that projected increases in air temperature and fire severity will accelerate permafrost thaw and soil C loss from deep mineral horizons. In the lowlands, permafrost thaw and collapse-scar bog formation resulted in the dramatic redistribution of soil water, modifying soil thermal and C dynamics. Water impoundment in collapse-scar bogs enhanced soil C accumulation in shallow peat horizons, while allowing for high rates of soil C loss from deep inundated peat horizons. Accumulation rates at the surface were not sufficient to balance deep C losses, resulting in a net loss of 26 g C m^{-2} y^{-1} from the entire peat column during the 3000 years following thaw. Findings from these studies highlight the vulnerability of soil C in Alaska's boreal region to future climate warming and permafrost thaw. As a result, permafrost thaw and soil C release from boreal soils to the atmosphere should function as a positive feedback to the climate system. This research has led to two published papers and two papers that are currently in review.

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 has involved 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. With respect to the first effort, we found that temperature and landform type were the dominant controls on soil organic carbon (SOC) distribution for selected ecoregions. Mean SOC pools (to a depth of 1-m) varied by three, seven and ten-fold across ecoregion, landform, and ecosystem types, respectively. Climate interactions with landform type and SOC were greatest in the uplands. For upland

SOC there was a six-fold non-linear increase in SOC with latitude (i.e. temperature) where SOC was lowest in the Intermontane Boreal compared to the Arctic Tundra and Coastal Rainforest. Additionally, in upland systems SOC pools decreased as climate became more continental, suggesting that the lower productivity, higher decomposition rates and fire activity, common in continental climates, interacted to reduce SOC. For lowland systems, in contrast, these interactions and their impacts on SOC were muted or absent making SOC in these environments more comparable across latitudes. Thus, the magnitudes of SOC change across temperature gradients were non-uniform and depended on landform type. Additional factors that appeared to be related to SOC distribution within ecoregions included stand age, aspect, and permafrost presence or absence in black spruce stands. Overall, these results indicate the influence of major interactions between temperature controlled decomposition and topography on SOC in high-latitude systems. However, in Alaska, there remains a need for more SOC data from wetlands and boreal-region permafrost soils in order to fully translate the effects of climate change on soils. With respect to the second effort, we have incorporated information from this synthesis into a biogeochemical modeling effort for the Yukon River Basin. The research we have conducted in the project has provided 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.

Ongoing Ecological Studies

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

Researchers: Amy Churchill, MS Biology, and Zaosheng Fen (postdoctoral researcher)
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. Previous results showed no differences in vegetation structure after two years of water table manipulation; however, after four years we found that the lowered water table treatment (drought) had more deciduous shrubs and fewer mosses than the control treatment. Within the raised water table treatment (flooding), graminoids increased in abundance relative to the control. Rates of Gross Primary Productivity (GPP), measured biweekly during the growing season using static chambers, varied significantly among water table treatments, with the lowest GPP in the drought plot and the highest GPP in the flooded plot. Both the control and flooded plots showed little change in GPP in response to natural flooding (2008) or drought (2009). However, low fluxes in these plots in 2010 may indicate a one-year lag in vegetation response to drought. In our drought treatment, natural flooding stimulated GPP in 2008. Our data reveal that directional changes in water table position created by our manipulations have a significant effect on both vegetation structure and function, and govern how vegetation responds to inter-annual variation. Understanding vegetation responses to environmental change over seasonal, annual, and decadal time scales will improve our understanding of peatland complexity and potential adaptations to future climate change. 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 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. Dr. Zhaosheng Fan, who started in January 2011, is conducting the modeling research.

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 Researchers: Fengming Yuan and Daniel Hayes
Faculty: A. David McGuire
Funding Agency: U.S. Department of Agriculture

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 are being 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 have updated TEM to more accurately depict fuel consumption 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 are now using 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 includes 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 is aiding 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 is reducing terrestrial carbon cycle uncertainties in a significant region of the Northern Hemisphere. Drs.

Fengming Yuan and Dan Hayes are the postdoctoral researchers conducting the research with TEM in this project.

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 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 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 summer 2010, graduate student Nicole McConnell conducted ecosystem respiration and root respiration measurements at the Alaskan Peatland Experiment sites located in the Bonanza Creek LTER. Ecosystem respiration measurements were taken using 60cm x 60cm static flux chambers and PP-systems CO_2 gas analyzers. Root respiration measurements were taken by destructively harvesting roots and placing them in a 5cm diameter root cuvette attached to a PP-systems CO_2 gas analyzer. Ecosystem respiration was found to vary between years and along some sites at APEX. Root respiration was found to vary among species. These data will be incorporated into a soil respiration model to understand how the partitioning of soil respiration into heterotrophic and autotrophic components change during the summer growing season.

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

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

Climate warming is marked in the Arctic and sub-Arctic and has been associated with a net loss in the number and area of lakes in wetlands in Alaska and Siberia during the past ~50 years. Lakes and wetlands are the dominant land cover type on National Wildlife Refuges in Alaska and serve as breeding grounds for millions of waterfowl and shorebirds that migrate annually from more southerly parts of North America, South America, Asia, and Australia. The maintenance of this biodiversity is critical to the sustainability of Arctic and global social and ecological systems. Indigenous user groups in Alaska depend on the subsistence resource abundance and accessibility associated with these wetland areas. Lake drying due to climate change could fundamentally alter the nature of these ecosystems and the ecosystem services that they provide. There is a need for an improved understanding of the mechanisms and magnitude of these changes in National Wildlife Refuges in order to

project future landscape conditions and their subsequent implications for wildlife species. Research objectives are to:
(1) Identify the mechanism responsible for losses in lake number and area in National Wildlife Refuges in Alaska. A manuscript detailing these methods, analysis, and results is currently in the review process for journal submission. This work has identified the involvement of increased evapotranspiration, eutrophication, and aquatic vegetation growth in the mechanisms for lake drying. These changes in nutrient concentrations could fundamentally alter the aquatic food webs which waterfowl species depend on for food resources. These results mark a significant advance towards understanding the implications of lake drying for waterfowl and other aquatic species.
(2) Develop and test a method to accurately and objectively measure and monitor past and future changes in lake area. Final analysis and write-up are currently underway. The methods developed under this objective are a substantial improvement upon the labor-intensive and highly subjective methods previously used to compare lake area between current satellite imagery and historical aerial photography. The ability to accurately lengthen a time series from ~25 years (start of TM/ETM imagery availability) to ~60 years (start of aerial photography availability) is critical to the ability to detect climate-related effects on aquatic systems. In addition the objectivity and ease with which these new methods can be applied mean that they will be repeatable and that change can be monitored over a larger spatial and temporal extent, which is essential to distinguish spatial and temporal variability from long-term change.
(3) Estimate the direction and magnitude of changes in lake area since the 1950s in 9 National Wildlife Refuges in both polar and boreal forest ecosystems in Alaska. All imagery for this objective has been collected, processed, and geo-referenced. Final waterbody delineation, statistical analysis, and write-up will be completed by the end of the year. Quantifying the direction and magnitude of long-term lake area change in Alaska's National Wildlife Refuges is a critical next step in assessing the implications of lake drying for wildlife species. This kind of information will enable land managers to identify refuges or regions that are particularly vulnerable to changes in lake area. These results can be used to inform a wide range of management decisions including issues such as federal land exchanges, resource development, and wildlife conservation.

Modeling Interactions between Climate change, Lake change and Boreal Ecosystem Dynamics in the Yukon Flats National Wildlife Refuge

Student Investigator: Vijay Patil, PhD Biological Sciences
Co-Advisors: Brad Griffith and Eugénie Euskirchen
Funding Agency: USGS (RWO 172)

Lakes have been decreasing in size and abundance in boreal ecosystems around the world. However, the ecological consequences of this phenomenon and its implications for northern climate change ecology are not well understood. Continued widespread lake area reduction could act as an important climate feedback in boreal ecosystems by altering rates of carbon sequestration and respiration. It could also affect plant community dynamics, especially succession, and therefore has implications for regional biodiversity and wildlife habitat quality. My objective is to evaluate the relative influence of terrestrial and aquatic ecosystem processes on boreal lake-margin plant communities in central Alaska, in order to predict how climate change and changes in lake area and abundance will influence carbon dynamics and community composition. I will be using a combination of field and remote sensing data collected from the Yukon Flats National Wildlife Refuge to fit statistical and simulation models of plant biodiversity and community dynamics. Vegetation surveys were completed at 58 lakes in the Yukon Flats during the project's first field season in summer 2010, and these data are currently being entered. I recently presented a research proposal to my doctoral committee, and have submitted applications for several supplementary grants and scholarships. In addition to their role in the carbon cycle, boreal ecosystem wetlands like those found in the Yukon Flats provide habitat for big game species such as bear and moose, and support high densities of breeding birds, especially waterfowl. Successful management of these resources will depend on the ability of managers to understand and predict how their habitats will respond to warming.

Investigating Recent Change in Habitat and Avian Communities at Creamer's Refuge, Fairbanks, AK

Student Investigator: Lila Tauzer, MS Interdisciplinary (Ecology, Remote Sensing)
Co-Advisors: Abby Powell and Anupma Prakash
Funding Agencies: Alaska Space Grant, NASA; Angus Gavin Fellowship, UAF

Changes in vegetation have been documented worldwide and a strong avian response has been correlated with recent warming trends, but little baseline data exists in the North where change is predicted to be the most drastic. Our understanding of the extent and consequences of ecosystem change in boreal forest is insufficient. 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 35 years at Creamer's Refuge, and (2) to relate findings with local avian community data gathered during the same time period. First, I will quantify change in land cover class using archived vegetation field data from the 1970s and remote sensing data. Second, I will collect current avian community data and analyze local long-term bird datasets for trends. I predict I will find that changes in both vegetation and birds have occurred during the last 35 years. Habitat maps will be developed to quantify the amount and direction of land-cover change; field data collected will demonstrate the extent of this change and of the simultaneous avian response. This study will give an indication of the spatial and temporal scale needed to accurately document environmental change in the boreal forest ecosystem. Information gathered may provide information about which habitat types and species of birds are most impacted by ecosystem shifts in boreal forest.

Ecosystem Change in Boreal Wetlands and Its Relation to Wetland Associated Bird Communities

Student Investigator: Tyler Lewis, PhD Wildlife Biology
Co-Advisors: Mark Lindberg and Joel Schmutz
Funding Agencies: Yukon Flats National Wildlife Refuge, USFWS; and USGS (RWO 175)

Temperatures in the boreal forest have risen by 3–4°C over the past 60 years, compared to a global mean increase of 0.6°C. Recent research has indicated a drying of boreal wetlands in response to climate warming, potentially altering the basic ecosystem structure of these wetlands. On the Yukon Flats, in eastern interior Alaska, surface water area of wetlands was estimated to have decreased by 18%

from 1952–2000. The Yukon Flats is one of the largest waterbird breeding grounds in North America, producing approximately 1.6 million ducks, geese, and swans annually. For our proposed research, we will compare existing data from the 1980s on water chemistry, invertebrate abundance, and waterbird distributions of boreal wetlands with contemporarily collected data, providing a unique opportunity to understand long-term ecosystem change associated with wetland drying. We will (1) document potential changes in water chemistry and aquatic invertebrate communities in response to drying of boreal wetlands, and (2) relate these changes to waterbird distribution and productivity, providing a crucial understanding of effects of boreal wetland change on continentally important waterbird populations. While we have no results to date, we expect redistributions of waterbirds to be positively related to increased nutrient and invertebrate levels in wetlands. Results from this research will provide a 2- to 3-decade perspective on boreal wetland change, providing a valuable perspective to the Yukon Flats National Wildlife Refuge for anticipating how much climate-driven ecological change to expect in their refuge over the next 20, 30, or 50 years.

Climate Change and Subsistence Fisheries in Northwest Alaska

Student Investigator: Katie Moerlein, MS Fisheries
Advisor: Courtney Carothers
Funding Agency: Office of Subsistence Management, USFWS (RWO 182)

Climate change is predicted to have widespread implications for resource harvesting in Arctic communities. Few studies have specifically addressed current or potential impacts of climate change on subsistence fisheries in Alaska. Communities of Northwest Alaska rely heavily on local fish resources for physical and cultural well-being. A better understanding of the current and potential impacts of climate and related ecological changes on these fisheries will assist the U.S. Fish and Wildlife Service in taking an adaptive approach to managing subsistence fisheries. Our primary objective is to document local observations of climate change relevant to subsistence fisheries in the communities of Noatak and Selawik, and potentially Shungnak, which are located in the Northwest Arctic Borough. We are conducting semi-structured ethnographic interviews with expert informants to explore knowledge about climate and ecological changes related to subsistence fisheries. Based on data analysis of our key informant interviews, we will develop a short survey instrument to systematically gather information on observed changes. It appears that residents of Northwest Alaska are acutely aware of the impacts of climate change on local fish resources. Our informants described the following changes: lower river water levels, increasing beaver abundance, changing weather patterns, changes in the timing of fish movements, melting permafrost, thaw slumps, increased erosion, thinner winter ice conditions on rivers and streams, earlier spring break-up weather, warmer summer weather, more limited access to traditional fishing locations, and changes in fish species composition. Informants also situate observations and impacts of environmental change in a larger context of socioeconomic change in rural villages. Input from local resource users about climate-related changes can significantly enhance adaptive fisheries management.

List of Abbreviations

ADFG	Alaska Department of Fish and Game
AKCFWRU	Alaska Cooperative Fish and Wildlife Research Unit
AYKSSI	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