Alaska Cooperative Fish and Wildlife Research Unit

Annual Research Report—2011




Alaska Cooperative Fish and Wildlife Research Unit
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Unit Roster

Federal Scientists

- Brad Griffith: Leader (effective February 15, 2011)
- A. David McGuire: Assistant Leader-Ecology and Acting Leader
- Abby Powell: Assistant Leader-Wildlife
- Mark Wipfli: Assistant Leader-Fisheries

University Staff

- Karen Enochs: Fiscal Professional (retired July 30, 2011)
- Holly Neumeyer: Travel Coordinator
- Kathy Pearse: Administrative Assistant
- Maria Russell: Fiscal Professional (effective May 1, 2011)

Unit Students

Current

- Jeremy Carlson, MS Fisheries (Wipfli)
- Roy Churchwell, PhD Biological Sciences (Powell)
- Christopher Harwood, MS Biology (Powell)
- Philip Joy, PhD Fisheries (Wipfli)
- Erin Julianus, MS Biology (McGuire and Hollingsworth)
- Sarah Laske, PhD Fisheries (Wipfli and Rosenberger)
- 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)
- Natura Richardson, MS Biology (Wipfli)
- Matt Sexson, PhD Biological Sciences (Powell and Peterson)
- Lila Tauzer, MS Interdisciplinary (Powell and Prakash)
- Jason Valliere, MS Fisheries (Margraf)
- Teri McMillan Wild, MS Wildlife Biology (Powell)

Graduated in CY 2011

- Amy Churchill, MS Biology (McGuire)
- David Esse, MS Fisheries (Margraf)
- Heather "River" Gates, MS Wildlife Biology (Powell)
- Laura Gutierrez, MS Biology (Wipfli)
- Jeff Perschbacher, MS Fisheries (Margraf)
- Jennifer Roach, PhD Biology (Griffith and Verbyla)
- David Roon, MS Biology (Wipfli)
- Audrey Taylor, PhD Biological Sciences (Powell)

Post-Doctoral Researchers

- Rebecca Bentzen (Powell)
- Héléne Genet (McGuire)
- Kirsty Gurney (Wipfli)

- Zhaosheng Fan (McGuire)
- Kristofer Johnson (McGuire)
- Caroline Lundmark (Griffith and Euskirchen)
- Samuel Nicol (Griffith and Hunter)
- Jennifer Roach (Griffith)
- 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
- Knut Kielland, IAB
- Mark Lindberg, DBW/IAB
- Sergey Marchenko, Geophysical Institute (GI)-UAF
- Anupma Prakash, GI
- James Reynolds, Emeritus UAF
- Vladimir Romanovsky, GI
- Amanda Rosenberger, SFOS
- Roger Ruess, DBW/IAB
- T. Scott Rupp, Scenarios Network for Alaska and Arctic Planning (SNAP)-UAF
- Trent Sutton, SFOS
- Dave Verbyla, SALRM
- Donald Walker, IAB

Affiliated Students

Current

- Matthew Albert, MS Fisheries (Sutton)
- Brittany Blain, MS Fisheries (Sutton)
- Tobey Carman, MS Computer Science (Euskirchen)
- Kevin Foley, MS Fisheries (Rosenberger)
- Sophie Gilbert, PhD Biology (Hundertmark)
- Winslow Hansen, MS Natural Resources (Rupp)
- Elchin Jacharov, PhD Geophysics (Romanovsky)
- Tyler Lewis, MS Wildlife (Lindberg)
- Jamie McKellar, MS Fisheries (Iken and Sutton)
- Stephanie Meggers, MS Fisheries (Seitz and Prakash)
- Katie Moerlein, MS Fisheries (Carothers)
- Daniel Rizzolo, PhD Biological Sciences (Lindberg)
- Heather Scannell, MS Fisheries (Sutton and Margraf)
- Nicholas Smith, MS Fisheries (Sutton)
- Jason Stolarski, PhD Fisheries (Sutton and Prakash)
- Mark Winterstein, MS Biology (Walker and Hollingsworth)

Affiliated Post-Doctoral Researchers

- Amy Breen (Rupp)
- Mark Miller (Lindberg)
- Reginald Muskett (Romanovsky)
- Ken Tape (Ruess)

Cooperators

- Brian Barnes–Director, Institute of Arctic Biology, University of Alaska Fairbanks
- Cora Campbell–Commissioner, Alaska Department of Fish and Game
- Geoff Haskett–Director, Region 7, US Fish and Wildlife Service
- F. Joseph Margraf–Unit Supervisor, Cooperative Research Units, US Geological Survey
- Chris Smith–Western Field Representative, Wildlife Management Institute

This is the Annual Report for the Alaska Cooperative Fish and Wildlife Research Unit, highlighting activities for calendar year 2011. 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 Ecosystems 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: 8
Presentations: 43
Scientific and Technical Publications: 13

Courses Taught

- Abby Powell: Effects of Climate Change on Birds (Fall Semester 2011; 1 credit hr)
- Abby Powell: Scientific Writing, Editing, and Reviewing (Fall Semester 2011; 3 credit hr)
- Mark Wipfli: Climate Change Seminar (Fall Semester 2011; 1 credit hr)
- Mark Wipfli: Aquatic Entomology (Fall Semester; 2 credit hr)

Honors and Awards

- Brad Griffith: Star Award presented by US Geological Survey/Cooperative Research Units Program
- Dave McGuire: 2011 Performance Award presented by US Geological Survey/ Cooperative Research Units Program
- Mark Wipfli: 2011 Performance Award presented by US Geological Survey/ Cooperative Research Units Program
- Valerie Steen (Advisor Abby Powell): Recipient of Lynds Jone Prize for the best student poster at the Wilson Ornithological Annual Meeting, March 2011, Kearney, NE.
- Jason Neuswanger (Advisor Mark Wipfli): Recipient of IAB 2011 Summer Fellowship awarded by the Institute of Arctic Biology, UAF
- Lila Tauzer (Co-Advisors Abby Powell and Anupma Prakash): Recipient of IAB 2011 Summer Fellowship
- David Roon (Advisor Mark Wipfli): Recipient of IAB 2011 Summer Fellowship
- David Roon: Recipient of the Erich Follmann Award for Best Oral Presentation at the BGSA (Biology Graduate Student Association) Interdisciplinary Research Symposium, March 2011
- Jason Neuswanger: Recipient of Fall 2011 Student Travel Grant to attend the American Fisheries Society 141st Annual Meeting, Seattle, awarded by College of Natural Sciences and Mathematics, UAF

Outreach and Info Transfer

- Dave McGuire: "The effects of changing soil carbon on ecosystem services in interior Alaska," seminar/webinar presented at the Alaska Center for Climate Assessment and Policy (ACCAP), Fairbanks, AK. (Public Meeting/Talk)
- Abby Powell: Judge, Biology Graduate Student Association Interdisciplinary Research Symposium, Fairbanks, AK (May 2011).

- Mark Wipfli: Led field trip to collect aquatic invertebrates and discuss wetland ecology with 22 7th-grade students and their teacher on Wetland Ecology Field Day, Watershed School, Fairbanks School District. (Exhibit/Field Trip/Tour)
- Mark Wipfli: Led aquatic ecology team for the 2-day BioBlitz public education outreach event sponsored by USFS, NOAA, ADFG, and USFWS, Juneau, AK. (Public Meeting/Talk)

Invited Seminars

Griffith, B. March 2011. Climate, large mammals and wetlands. USGS, Ecosystems Strategic Science Planning Team Symposium, Menlo Park, CA. Invited speaker.

Griffith, B. February 2011. Inconvenient answers: Experiences at the interface between biological research and public policy. Cooperative Research Units New Scientist Training Session, Reston, VA. Invited speaker.

Mark Wipfli: Linkages among ecosystems that drive freshwater productivity: Consequences of environmental change. Presented to the Western Alaska Landscape Conservation Cooperative, Anchorage, AK. Invited speaker.

Mark Wipfli: Linkages among ecosystems that drive freshwater productivity: Consequences of environmental change. Presented to the International Submerged Lands Management Workshop, Girdwood, AK. Workshop plenary speaker.

Mark Wipfli: Linking ecosystems, food webs, and fish production: Nutrient and prey subsidies in salmonid watersheds. Presented to the School of Fisheries and Ocean Sciences, UAF.

Papers Presented

Bali, A., V. Alexeev, R.G. White, D.E. Russell, A.D. McGuire, and G.P. Kofinas. August 2011. Phenology of mosquito activity within the summer ranges of caribou herds in northern Alaska. 2011 Arctic Ungulate Conference, Yellowknife, Northwest Territories, Canada. (Contributed Oral)

Bentzen, R. L. and A. N. Powell. September 2011. Population dynamics of King Eiders breeding in northern Alaska. 4th International Sea Duck Conference, Seward, AK. (Contributed Oral)

Churchwell, R., A. Powell, S. Kendall, and S. Brown. December 2011. Tidal influences on food availability to shorebirds on coastal mudflats of the Arctic National Wildlife Refuge, Alaska. 17th Annual Alaska Shorebird Group Meeting, Anchorage, AK. (Invited Oral)

Churchwell, R.T., S. Kendall, S. Brown, and A. Powell. 2011. Shorebird use of Arctic Refuge coastal mudflats. Invited speaker, Alaska Sealife Center monthly seminar, Seward, AK. (Invited Oral)

Collins, S.F., C.V. Baxter, A.M. Marcarelli, and M. Wipfli. September 2011. Effects of salmon carcass and analog additions on resident trout in Idaho. Annual Meeting, American Fisheries Society, Seattle, WA. (Contributed Oral)

Euskirchen, E.S., C. Edgar, M.R. Turetsky, J.W. Harden, and A.D. McGuire. December 2011. Quantifying CO_2 fluxes across a gradient of permafrost in boreal Alaska. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Oral)

Fan, Z., A.D. McGuire, J.W. Harden, and M.R. Turetsky. December 2011. Modeling the production and transport of methane in an Alaska rich fen peatland. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Poster)

Gates, R., S. Yezerinac, R. Lanctot, A. Powell, P. Tomkovich, and O. Valchuk. August 2011. Differentiating sex and subspecies of Beringia Dunlin using morphometrics.

4th Western Hemisphere Shorebird Group Meeting, Vancouver, BC. (Contributed Oral)

Griffith, B. January 2011. Yukon River Basin: Lake change and biodiversity. Yukon River Basin Investigators Meeting, Portland, OR. (Contributed Oral)

Griffith, B. March 2011. Effects of climate change on the Yukon River Basin: Changes in water and implications for wildlife habitat, human subsistence, and climate regulation. Alaska Cooperative Fish and Wildlife Research Unit Coordinating Committee meeting, University of Alaska Fairbanks. (Contributed Oral)

Grosse, G., J. Harden, M.R. Turetsky, A.D. McGuire, P. Camill, C. Tarnocai, S. Frolking, T. Schuur, T. Jorgenson, S. Marchenko, and V. Romanovsky. February 2011. Vulnerability of high latitude soil carbon in North America to disturbance. Third North American Carbon All-Investigators Meeting, New Orleans, LA. (Contributed Oral)

Harwood, C. and A. Powell. August 2011. Breeding ecology of Whimbrels in interior Alaska. 4th Western Hemisphere Shorebird Group Meeting, Vancouver, BC. (Contributed Oral)

Hayes, D.J., D.P. Turner, G. Stinson, A.D. McGuire, Y. Wei, T.O. West, L.S. Heath, B.H. de Jong, B.G. McConkey, R. Birdsey, W.A. Kurz, A.R. Jacobson, D.N. Huntzinger, Y. Pan, W.M. Post, and R.B. Cook. December 2011. Reconciling estimates of the contemporary North American carbon balance among an inventory-based approach, terrestrial biosphere models, and atmospheric inversions. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Oral)

Hayes, D.J., D.P. Turner, G. Stinson, Y Wei, T.O. West, B. deJong, A.D. McGuire, R. Cook, and W.M. Post III. August 2011. Towards better-constrained assessments of the carbon balance of North America in the 21st century: A comparison of recent model and inventory-based estimates. Annual Meeting, Ecological Society of America, Austin, TX. (Contributed Oral)

Kasischke, E.S., E.S. Kane, J.A. O'Donnell, N.L. Christensen, S.R. Mitchell, M.R. Turetsky, D.J. Hayes, E. Hoy, K.M. Barrett, A.D. McGuire, and F. Yuan. December 2011. Feedbacks between climate, fire severity, and differential permafrost degradation in Alaskan black spruce forests – implications for carbon cycling. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Invited Oral)

Klapstein, S.J., M.R. Turetsky, A.D. McGuire, J.W. Harden, and J.M. Waddington. December 2011. Controls on ebullition and methane emissions in Alaskan peatlands experiencing permafrost thaw. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Poster)

Kohler, A.E., T. Copeland, D.A. Vendetti, M. Wipfli, B. Lewis, L. Denny, and J. Gable. September 2011. Nutrient flux by chinook salmon in Idaho streams: The ins and outs, and implications for management. Annual Meeting, American Fisheries Society, Seattle, WA. (Contributed Oral)

Marcarelli, A.M., C.V. Baxter, M. Wipfli, A.E. Kohler, S.F. Collins, J.E. Ebel, and G. Servheen. September 2011. Salmon nutrient mitigation effects on bottom-up processes in streams: Lessons from large-scale experiments in central Idaho. Annual Meeting, American Fisheries Society, Seattle, WA. (Contributed Oral)

McConnell, N., A.D. McGuire, J.W. Harden, and M.R. Turetsky. December 2011. Controls on ecosystem respiration in a peat plateau and adjacent collapse formations in interior Alaska. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Poster)

McConnell, N., A.D. McGuire, J.W. Harden, E. Kane, and M.R. Turetsky. April 2011. Controls on ecosystem and root respiration in an Alaskan peatland. Annual Meeting of the European Geophysical Union, Vienna, Austria. (Contributed Poster)

McGuire, A.D. December 2011. The importance of representing interactions among permafrost dynamics, soil warming, and fire in modeling soil carbon responses of northern high latitude terrestrial ecosystems to climate change. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Invited Oral)

McGuire, A.D. October 2011. DOS-TEM Modeling Perspective. Workshop to identify data needs for improving model representations of soil carbon responses to climate change in permafrost regions. Argonne National Laboratory, Chicago, IL. (Invited Oral)

McGuire, A.D. October 2011. Identifying indicators of state change and forecasting future vulnerability in Alaska boreal ecosystems. 2011 Alaska Fire Science Workshop, Fairbanks, AK. (Invited Oral)

McGuire, A.D. September 2011. An assessment of the carbon balance of Arctic tundra: Comparisons among observations, process models and atmospheric inversions. GreenCyclesII and DEFROST Conference on Ocean-Land Interactions at High Latitudes, Nuuk, Greenland. (Invited Oral)

McGuire, A.D. September 2011. An assessment of the carbon balance of arctic tundra: Comparisons among observations, process models, and atmospheric inversions. GreenCyclesII and DEFROST Conference on Ocean-Land Interactions at High Latitudes. Nuuk, Greenland. (Invited Oral)

McGuire, A.D., D.J. Hayes, G. Stinson, D. Turner, Y. Wei, L.S. Heath, W. Kurz, T.O. West, B. McConkey, B. de Jong, D.N. Huntzinger, W.M. Post, R.B. Cook, and NACP Regional Synthesis Participants. February 2011. Towards better-constrained assessments of the carbon balance of North America in the 21st Century: A comparison of recent model and inventory-based estimates. Third North American Carbon All-Investigators Meeting, New Orleans, LA. (Contributed Oral)

McGuire, A.D., T.R. Christensen, D.J. Hayes, A. Heroult, J.S. Kimball, C. Koven, P. Lafleur, P. Miller, W.C. Oechel, S. Sitch, and M.D. Williams. December 2011. An assessment of the carbon balance of Arctic tundra: Comparisons among observations, process models, and atmospheric inversions. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Invited Oral)

Neuswanger, J.R., N.F. Hughes, M. Wipfli, and A.E. Rosenberger. September 2011. The effect of drifting debris on drift-feeding fish and foraging models. Annual Meeting, American Fisheries Society, Seattle, WA. (Contributed Oral)

Nolan, M., R. Churchwell, J. Adams, J. McClelland, K. Tape, S. Kendall, A. Powell, K. Dunton, D. Payer, and P. Martin. September 2011. Predicting the impact of glacier loss on fish, birds, floodplains, and estuaries on the Arctic National Wildlife Refuge. 4th Interagency Conference on Research in the Watersheds, Fairbanks, AK. (Contributed Oral)

Powell, A.N., E.L. Weiser, and S.A. Backensto. November 2011. Diets of two human-subsidized predators, common raven and glaucous gull, on Alaska's coastal plain. 18th Annual Conference, The Wildlife Society, Waikoloa, Hawaii. (Contributed Poster)

Roon, D., M. Wipfli, and T. Wurtz. September 2011. Invasive European bird cherry affects terrestrially-derived prey abundance for juvenile coho salmon. Annual Meeting, American Fisheries Society, Seattle, WA. (Contributed Oral)

Schuur, E.A., A.D. McGuire, J. Canadell, J.W. Harden, P. Kuhry, V.E. Romanovsky, M.R. Turetsky, and C. Schadel. December 2011. Vulnerability of permafrost carbon research coordination network. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Poster)

Servheen, G., M. Wipfli, C.V. Baxter, L. Felicetti, A.M. Marcarelli, and K. Kavanagh. September 2011. Managing and mitigating salmon-derived nutrients: Are analogs salmon avatars? Annual Meeting, American Fisheries Society, Seattle, WA. (Contributed Oral)

Sexson, M.G., M.R. Petersen, and A.N. Powell. September 2011. Then and now: a comparison in the distribution of Spectacled Eiders at nonbreeding areas in the past 15 years. 4th International Sea Duck Conference, Seward, AK. (Contributed Oral)

Steen, V. and A. Powell. March 2011. Potential effects of climate change on waterbirds in the Prairie Pothole Region, USA. AFO/COS/WOS Joint Meeting, Kearney, NE. (Contributed Poster)

Steen, V., A. N. Powell, and S. Skagen. March 2011. Potential effects of climate change on the distribution of wetland-associated birds in the Prairie Pothole Region, USA. Waterbird Society Annual Meeting, Grand Island, NE. (Invited Oral)

Taylor, A., R. Lanctot, T. Williams, A. Kitaysky, and A. Powell. August 2011. Evaluating physiologic metrics for assessing site quality for species with varying molt strategies. 4th Western Hemisphere Shorebird Group Meeting, Vancouver, BC. (Contributed Oral)

Waldrop, M.P., J. McFarland, C.I. Czimczik, E.S. Euskirchen, T. Amendolara, G.J. Scott, M.R. Turetsky, J.W. Harden, and A.D. McGuire. December 2011. Changing sources of respiration between a black spruce forest and themokarst bog. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Poster)

Wild, T., S. Kendall, N. Guldager, and A. Powell. March 2011. Breeding Smith's Longspur habitat associations and predicted distribution in the Brooks Range, Alaska. AFO/COS/WOS Joint Conference, Kearney, NE. (Contributed Oral)

Wipfli, M. September 2011. Riparian forest conditions influence food supplies for stream salmonids: Managing for increased aquatic productivity. Annual Meeting, American Fisheries Society, Seattle, WA. (Contributed Oral)

Wipfli, M., A.E. Kohler, B. Lewis, and G. Servheen. September 2011. Marine-derived nutrients and nutrient loss mitigation: Where we've been and where we might be headed. Annual Meeting, American Fisheries Society, Seattle, WA. (Contributed Oral)

Yuan, F., A.D. McGuire, S. Yi, E.S. Euskirchen, T.S. Rupp, A.L. Breen, T. Kurkowski, E.S. Kasischke, and J.W. Harden. December 2011. Effects of future warming and fire regime change on boreal soil organic horizons and permafrost dynamics in interior Alaska. Fall Meeting of the American Geophysical Union, San Francisco, CA. (Contributed Poster)

Yuan, F., S. Yi, A.D. McGuire, K.D. Johnson, J. Liang, J. Harden, and E.S. Kasischke. February 2011. Dynamical basin-scale responses of taiga forest and soil C stocks to climate changes and wild fire history in the Yukon River Basin during the last century. Third North American Carbon All-Investigators Meeting, New Orleans, LA. (Contributed Poster)

Scientific Publications

Grosse, G., J. Harden, M. Turetsky, A.D. McGuire, P. Camill, C. Tarnocoi, S. Frolking, E.A.G. Schuur, T. Jorgenson, S. Marchenko, V. Romanovsky, K.P. Wickland, N. French, M. Waldrop, L. Bourgeau-Chavez, and R. G. Striegl. 2011. Vulnerability of high-latitude soil organic carbon in North America to disturbance. Journal of Geophysical Research 116, G00K06, doi:10.1029/2010JG001507. 23 pp.

Hayes, D.J., A.D. McGuire, D.W. Kicklighter, K.R. Gurney, T.J. Burnside, and J.M. Melillo. 2011. Is the northern high latitude land-based CO2 sink weakening? Global Biogeochemical Cycles 25, GB3018, 14 pp. doi:10.1029/2010GB003813

Hayes, D.J., A.D. McGuire, D.W. Kicklighter, T.J. Burnside, and J.M. Melillo. 2011. The effects of land cover and land use change on the contemporary carbon balance of the arctic and boreal ecosystems of northern Eurasia. Chapter 6 in Eurasian Arctic Land Cover and Land Use in a Changing Climate (edited by G. Gutman and A. Reissell). Springer, New York. Pp. 109-136.

Krankina, O.N., D. Pflugmacher, D. Hayes, A.D. McGuire, M. Hansen, T. Hame, V. Elsakov, and P. Nelson. 2011. Vegetation cover in the Eurasian Arctic: Distribution, monitoring, and role in carbon cycling. Chapter 5 in Eurasian Arctic Land Cover and Land Use in a Changing Climate (edited by G. Gutman and A. Reissell). Springer, New York. Pp. 79-108.

O'Donnell, J.A., J.W. Harden, A.D. McGuire, and V.E. Romanovsky. 2011. Exploring the sensitivity of soil carbon dynamics to climate change, fire disturbance and permafrost thaw in a black spruce ecosystem. Biogeosciences 8 (1367-1382).

O'Donnell, J.A., J.W. Harden, A.D. McGuire, M.Z. Kanevskiy, M.T. Jorgenson, and X. Xu. 2011. The effect of fire and permafrost interactions on soil carbon accumulation in an upland black spruce ecosystem of interior Alaska: Implications for post-thaw carbon loss. Global Change Biology 17:1461-1474, doi: 10.1111/j.1365-2486.2010.02358.x.

Oppel, S., A.N. Powell, and M.G. Butler. 2011. King Eider foraging effort during the pre-breeding period in Alaska. Condor 113:52-60.

Pan, Y., R.A. Birdsey, J. Fang, R. Houghton, P.E. Kauppi, W.A. Kurz, O.L. Phillips, A. Shvidenko, S.L. Lewis, J.G. Canadell, P. Ciais, R.B. Jackson, S. Pacala, A.D. McGuire, S. Piao, A. Rautiainen, S. Sitch, and D. Hayes. 2011. A large and persistent carbon sink in the world's forests. Science 333:988-993, doi:10.1126/science.1201609.

Peirce, J.M., E.O. Otis, M.S. Wipfli, and E.H. Follmann. 2011. Radio-telemetry as a tool for estimating stream life and predation by brown bears for chum salmon at McNeil River, Alaska. North American Journal of Fisheries Management 31(2):315-322.

Rosenberger, A.E., J.B. Dunham, M.S. Wipfli, and J.M. Buffington. 2011. Effects of wildfire and channel reorganization on drifting macroinvertebrates and predation by trout in central Idaho streams a decade after disturbance. Northwest Science 85(1):55-63.

Weiser, E.L. and A.N. Powell. 2011. Evaluating gull diets: A comparison of conventional methods and stable isotope analysis. Journal of Field Ornithology 82(3):297-310.

Weiser, E.L. and A.N. Powell. 2011. Reduction of garbage in the diet of nonbreeding glaucous gulls corresponding to a change in waste management. Arctic 64(2):220-226.

Technical Publications

Michalak, A.M., R.B. Jackson, G. Marland, C. Sabine, and the Carbon Cycle Science Working Group (including A.D. McGuire). 2011. A U.S. Carbon Cycle Science Plan. University Corporation for Atmospheric Research, National Oceanic and Atmospheric Admistration PMEL Contribution 3731. 69 pp.

Theses and Dissertations of Unit-Sponsored Graduate Students

- Churchill, Amber. 2011. The response of plant community structure and productivity to changes in hydrology in Alaskan boreal peatlands. MS thesis, University of Alaska Fairbanks. 110 pp.

- Esse, David A. 2011. Characteristics of the Sulukna River spawning population of inconnu, Yukon River drainage, Alaska. MS thesis, University of Alaska Fairbanks. 55 pp.
- Gates, H. River. 2011. Reproductive ecology and morphometric subspecies comparisons of dunlin (*Calidris alpina*), an arctic shorebird. MS thesis, University of Alaska Fairbanks. 78 pp.
- Gutierrez, Laura. Terrestrial invertebrate prey for juvenile Chinook salmon: Abundance and environmental controls in an interior Alaska river. MS thesis, University of Alaska Fairbanks. 63 pp.
- Perschbacher, Jeff. 2011. The use of aerial imagery to map in-stream physical habitat related to summer distribution of juvenile salmonids in a southcentral Alaskan stream. MS thesis, University of Alaska Fairbanks. 64 pp.
- Roach, Jennifer. 2011. Lake area change in Alaskan National Wildlife Refuges: Magnitude, mechanisms, and heterogeneity. PhD dissertation, University of Alaska Fairbanks. 225 pp.
- Roon, David. 2011. Ecological effects of invasive European bird cherry (*Prunus padus*) on salmonid food webs in Anchorage, Alaska streams. MS thesis, University of Alaska Fairbanks. 101 pp.
- Taylor, Audrey. 2011. Postbreeding ecology of shorebirds on the Arctic coastal plain of Alaska. PhD dissertation, University of Alaska Fairbanks. 216 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

Ecological Effects of Invasive European Bird Cherry (*Prunus padus*) on Salmonid Food Webs in Anchorage, Alaska Streams

Student Investigator: David A. Roon, MS Biology
Advisor: Mark S. Wipfli
Funding Agencies: USDA Forest Service and U.S. Fish and Wildlife Service (USFWS)
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

Note: David Roon graduated from the University of Alaska Fairbanks in August 2011. His thesis abstract follows:

Invasive species are a concern worldwide as they can displace native species, reduce biodiversity, and disrupt ecological processes. European bird cherry (*Prunus padus*) (EBC) is an invasive ornamental tree that is rapidly spreading and possibly displacing native trees along streams in parts of urban Alaska. The objectives of this study were to: 1) map the current distribution of EBC along two Anchorage streams, Campbell and Chester creeks, and 2) determine the effects of EBC on selected ecological processes linked to stream salmonid food webs. Data from the 2009 and 2010 field seasons showed: EBC was widely distributed along Campbell and Chester creeks; EBC leaf litter in streams broke down rapidly and supported similar shredder communities to native tree species; and EBC foliage supported significantly less terrestrial invertebrate biomass relative to native deciduous tree species, and contributed significantly less terrestrial invertebrate biomass to streams compared to mixed native vegetation, but riparian EBC did not appear to affect the amount of terrestrial invertebrate prey ingested by juvenile coho salmon (*Oncorhynchus kisutch*). Although ecological processes 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 over time.

Characteristics of the Sulukna River Spawning Population of Inconnu, Yukon River Drainage, Alaska

Student Investigator: David A. Esse, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Central Yukon Field Office, Bureau of Land Management (BLM)

Note: David Esse graduated from the University of Alaska Fairbanks in December 2011. His thesis abstract follows:

Inconnu *Stenodus leucichthys* are large migratory whitefish harvested in subsistence and sport fisheries in Alaska. Research on the Sulukna River spawning population of inconnu was conducted in September and early October from 2007 to 2009. Samples

were collected to verify maturity and spawning readiness, and to determine age distributions of mature males and females. Spawning abundance was estimated and post-spawning migration timing was identified. Otoliths were analyzed optically to determine age and chemically to determine amphidromy. Maturity sampling indicated that all sampled fish were in spawning condition or had recently spawned. Abundance estimates were 2,079 and 3,531 inconnu in 2008 and 2009, respectively. Post-spawning downstream migration timing was nearly identical between years, with the majority of fish moving downstream between September 30 and October 9. In both years, migrating inconnu displayed a nocturnal migration pattern, with 96% migrating between 2000 and 0900 hours daily. Age estimates ranged between 6 and 26 years. Chemical analysis indicated that some Sulukna River inconnu were amphidromous, making migrations of over 1,300 km to the sea. This information indicates that the Sulukna River spawning population of inconnu has a large and variable abundance, in which amphidromy is facultative.

Terrestrial Invertebrate Prey for Juvenile Chinook Salmon: Abundance and Environmental Controls in an Interior Alaska River

Student Investigator: Laura Gutierrez, MS Biology
Advisor: Mark S. Wipfli
Funding Agency: Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYKSSI), Alaska Department of Fish and Game (ADFG)

Note: Laura Gutierrez graduated from the University of Alaska Fairbanks in December 2011. Her thesis abstract follows:

Terrestrial prey subsidies can be a key food source for stream fish, but their importance and environmental controls on their abundance have not been widely documented in high latitude ecosystems. This study investigated terrestrial invertebrate prey availability and predation by age-0+ juvenile Chinook salmon (*Oncorhynchus tshawytscha*), overlap between terrestrial infall and drift to diet, and the relationship between diet to stream temperature and discharge in the Chena River,Interior Alaska. Terrestrial infall, drift, and juvenile Chinook diet varied widely through the summers (May-Sept) of 2008 and 2009. Drift was comprised of 33% terrestrial and 67% aquatic invertebrate mass, while juvenile Chinook diet contained 19% terrestrial, 80% aquatic, and 1% unidentifiable invertebrate mass. The proportion of terrestrial invertebrate mass consumed increased through summer and, at times, made up to 39% of total diet. Low similarity of invertebrates in diet and infall, and diet and drift suggested that fish were, in part, prey-selective, selecting hymenopterans and chironomid midges (*Diptera*). In both years, prey mass consumed and discharge varied inversely, but no correlation was found between proportion of terrestrial invertebrates consumed and discharge. However, the two sampling dates with the highest proportion of terrestrial invertebrates consumed occurred shortly after a 60-year flood, indicating that terrestrial invertebrates may be important during rain and associated high water. This study found that, although terrestrial infall and drift are highly variable, terrestrial invertebrates are an important prey resource for rearing Chinook salmon in this high latitude riverine system, especially later in the summer.

The Use of Aerial Imagery to Map In-Stream Physical Habitat Related to Summer Distribution of Juvenile Salmonids in a Southcentral Alaskan Stream

Student Investigator: Jeff Perschbacher, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: Sport Fish Division, ADFG Region 2 (RSA)

Note: Jeff Perschbacher graduated from the University of Alaska Fairbanks in December 2011. His thesis abstract follows:

Airborne remote sensing (3-band multispectral imagery) was used to assess in-stream physical habitat related to summer distributions of juvenile salmonids in a south-central Alaskan stream. The objectives of this study were to test the accuracy of using remote sensing spectral and spatial classification techniques to map in-stream physical habitat, and test hypotheses of spatial segregation of ranked densities of juvenile Chinook salmon *Oncorhynchus tschwytscha*, coho salmon *O. kisutch*, and rainbow trout *O. mykiss*, related to stream order and drainage. To relate habitat measured with remote sensing to fish densities, a supervised classification technique based on spectral signature was used to classify riffles, non-riffles, vegetation, shade, gravel, and eddy drop zones, with a spatial technique used to classify large woody debris. Combining the two classification techniques resulted in an overall user's accuracy of 85%, compared to results from similar studies (11-80%). Densities of juvenile salmonids was found to be significantly different between stream orders, but not between the two major drainages. A 500-m stream reach of field collected habitat data was successfully used to map 6 river km of a fourth-order streams in-stream physical habitat. The use of relatively inexpensive aerial imagery to classify in-stream physical habitats is cost effective and repeatable for mapping over large areas, and should be considered an effective tool for fisheries and land-use managers.

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 inInterior 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 objectives 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-masse 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. Movement of fish within the study area appears to be greatest 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 pike 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
Co-Advisors: Anupma Prakash and Trent Sutton
Funding Agencies: Fairbanks Fisheries Resource Office and Arctic National Wildlife Refuge, USFWS (RWO 160)
In-Kind Support: Logistics and field equipment provided by the USFWS Fairbanks Fisheries Resource Office

Very little is known regarding how a changing Arctic climate will affect Dolly Varden char populations. Dolly Varden char support one of the largest subsistence fisheries on the North Slope. Data suggesting how changes in climate might affect this resource will allow proactive management and aid in the long-term sustainability of populations and local fisheries. The primary objective is to determine how temporal changes in North Slope climate are affecting growth rates of Dolly Varden char. Secondary objectives include characterizing annual lipid fluctuations, refining bioelectrical impedance models, and determining the precision of common aging structures. Dolly Varden will be sampled twice annually during spring and fall. Statistical models will be developed to correlate environmental variables to back-calculated estimates of Dolly Varden growth obtained from otoliths. Otoliths from previous projects will be obtained as relevancy permits. Seasonal fluctuations in lipids will be examined using proximate analysis, and measures of electrical resistance and reactance (taken at the time of capture) will be fitted to estimates of lipid content to create predictive models. Bioelectrical impedance data explain up to 85% of the variability in lipid content. Growth estimates extracted from otoliths collected in this research and gathered from other sources suggest a dome-shaped relationship with growth increasing during the 1980s, then reaching an asymptote and possibly declining since 2006. Bioelectrical impedance models will be used to access fish condition in the field. Relationships among growth and environmental data will be used to proactively manage Dolly Varden populations in the face of a constantly changing Arctic.

Growth 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 Agencies: Sport Fish Division, ADFG (Base funding); State Wildlife Grant, USFWS
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, track juvenile clam growth by month, and improve the recognition of annular growth rings. 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 were accomplished with monthly (May–October) sampling of juvenile and adult razor clams to examine growth rates and sexual maturity. Additionally, sediment samples were taken between May through October to detect the presence of newly settled clams. Spawning occurs primarily in July and August at Clam Gulch and Ninilchik. An absence of juvenile 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. Clams at Ninilchik were found to be mature at a smaller size and age than previously documented. Fisheries managers need to respond appropriately to population changes in order to protect the sustainability of this stock.

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 Agencies: AYKSSI, ADFG; IAB; Department of Biology and Wildlife (DBW), UAF

Stock-recruitment analyses suggest that the Chena River Chinook salmon population is positively affected by low to medium river flows during each generation's first summer, but this effect and its mechanistic causes are poorly understood. The fundamental behavioral ecology of juvenile Chinook salmon in this type of system has not been established well enough to explain the observed population-level relationships with flow and understand their predictive utility and consequences. These fish forage in tighter groups than previously studied salmonids, so the competitive mechanisms driving density dependence may be different. They also spend a large amount of time and energy pursuing and rejecting inedible debris, which substantially affects bioenergetics calculations. The objectives of this study were to (1) develop an efficient 3D video measurement system to measure fine-scale behavior, (2) quantify the time fish spend pursuing debris rather than prey, and calculate its implications for growth and competition, and (3) characterize the mechanisms of intra-school territorial competition. Custom software was written to measure and analyze 3D spatial data from video footage. It is being used to quantify the feeding behaviors of individual juvenile Chinook salmon as they grow through the 30-80mm range. A variety of modeling techniques are being used or extended (including bioenergetics, foraging, home range, and stock-recruitment models) to examine population-level implications of individual behavior. Behavioral analyses suggest that flow velocity, cover, and water temperature determine juvenile Chinook distribution. Intra-specific competition for food via territoriality within schools affects fine-scale distribution and individual growth. Foraging bioenergetics depend on both the density of food and that of distracting, inedible detritus, which may explain part of the relationship between population dynamics and flow. Knowledge of environmental influences on juvenile survivorship will help managers predict the strength of each year class before the adults return to spawn. Fundamental research on the mechanisms of juvenile salmonid foraging and competition is relevant and transferable to a broad range of riverine salmonid ecosystems.

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

Student Investigator: Megan Perry, MS Biology
Advisor: Mark Wipfli
Funding Agencies: AYKSSI; DBW; and ADFG

Water temperature and food availability are among the most important variables affecting fish growth, yet these and other environmental variables are not taken into account in salmon stock-recruitment models. Competition further affects fish growth and abundance, but current literature lacks data demonstrating competition in juvenile Chinook salmon. Factors that regulate growth and the abundance of juvenile Chinook salmon need to be identified to improve the reliability of stock-recruitment models. The objectives of this work were to (1) determine whether food or temperature limits juvenile Chinook salmon growth, (2) investigate if seasonal patterns of fish growth or changes in fish abundance give evidence of competitive bottlenecks that cause density dependent mortality, (3) develop a model capable of predicting the effect of stream temperature on juvenile growth, (4) test whether the growth model can be used to predict annual growth and annual variation in smolt size, and (5) determine whether there is a positive correlation between smolt size and the productivity of a brood year in terms of recruits per spawner for the Chena River. We monitored individual growth of juvenile Chinook salmon along the natural temperature gradient in the Chena River using stereo-videogrammetry and conducted a mark-recapture study to estimate population abundance. To determine effects of food limitation on juvenile Chinook growth we supplemented food to half of the study sites and are using a growth model to see how temperature and food intake interact to influence fish growth. This work was supplemented with a retrospective analysis of the relationship between water temperature and growth, utilizing scale data analysis, growth modeling, and bioenergetics modeling to determine how fish productivity is related to growth in fresh water. At fed research sites we observed local aggregations of juvenile Chinook salmon and other fish species, but we observed no significant effects of food supplementation on individual fish growth during summer 2009. Temperature plays an important role in the growth of fish; however, it doesn’t appear to be directly related to the number of recruits per spawner returning to the Chena River. There is some evidence that in years of high spawner returns, fish rearing the next year may experience reduced growth as a result of density dependent interactions. We were able to use the bioenergetics model to predict temperature effects on Chinook salmon smolt size. The ability to forecast estimates of smolt growth from an easily measurable environmental variable such as temperature could increase the rigor of models used to forecast future returns.

Sockeye Rearing Conditions and Food Web Dynamics of Afognak Lake, Alaska

Student Investigator: Natura Richardson, MS Biology
Advisor: Mark Wipfli
Funding Agencies: ADFG; DBW (Teaching Assistantship)
In-kind support: Field logistics provided by ADFG

The Afognak Lake sockeye salmon run declined substantially in 2001, and subsequent adult returns have failed to achieve sustainable yields. In response to declining runs, the Alaska Department of Fish and Game (ADFG) initiated smolt and limnology investigations starting in 2003. In 2009 additional studies including juvenile diet, condition, and energy budgets were added as part of the sampling and monitoring program. The development of a research plan is currently underway, but the main objectives of this study are to (1) evaluate the condition of juvenile sockeye salmon relative to diet and energy density, and (2) assess historical fisheries and limnological data in relation to climate change and evaluate the effects on lake productivity.

MDN Effects on Chinook and Coho Salmon Productivity

Student Investigator: Philip Joy, PhD Fisheries
Advisor: Mark Wipfli
Funding Agencies: Alaska Sustainable Salmon Fund (AKSSF), Sport Fish Division, ADFG; and Norton Sound Economic Development Corporation (NSEDC)

Marine-derived nutrients (MDN) imported to freshwater ecosystems by migrating salmon positively affect growth and survival of rearing juvenile salmon. The effects on stock productivity, however, have not been assessed directly. Given that larger smolt are associated with higher marine survival, understanding the impacts of MDN on juvenile growth, size, and abundance may ultimately improve managers' ability to forecast return rates of adult salmon. The objectives of this study being conducted in 2011-2013 are to identify the degree and route of MDN assimilation in rearing Chinook and coho salmon and to determine the effect on their growth, condition, and size. Chinook and coho salmon smolt productivity is being estimated from two parts of the Unalakleet River drainage. MDN assimilation and growth are being assessed by sampling migrating smolt in the spring and rearing parr before and after the influx of spawning salmon. MDN assimilation is to be assessed using stable isotope and stomach content analysis, while growth will be assessed using RNA:DNA ratios from muscle and Length Frequency Data Analysis (LFDA). The relationship between individual and population growth rates is being compared to MDN assimilation estimates and productivity estimates (smolt abundance and condition) to determine the route and importance of MDN to rearing salmon. Results from this study will quantify the importance of MDN to Chinook and coho salmon stock productivity and improve forecasting models based on these relationships.

Seasonal Movements of Arctic Grayling in the Fish Creek Watershed on the North Slope of Alaska

Student Investigator: Kurt Heim, MS Biology
Advisor: Mark Wipfli
Funding Agency: USFWS (RWO 168)
In-Kind Support: Equipment and support provided by USFWS and BLM

During the short Arctic summer grayling migrate to ephemerally flowing tundra streams to feed almost continuously in preparation for winter. As ice forms in late summer, grayling migrate towards winter refugia to spend up to 9 months under the ice. Summer feeding and overwintering habitats with predictable access are thus very important in the life history of grayling in North Slope watersheds. Oil and gas development in the Arctic Coastal Plain is underway and will require large quantities of freshwater and gravel to support building activities. Water and gravel will be extracted from local sources, potentially impacting aquatic habitats and fish migrations through dispersal corridors. Access roads to these sites may also lead to fragmented habitat connectivity. The objective of this study is to link movements in a representative feeding habitat with environmental cues and habitat selection. We will implant fish with PIT tags in summer 2012 and monitor their movements. We predict movements to correlate with variables such as discharge and water temperatures, with fish migrating into our study area in June then departing in early September. Additionally, movements and habitat selection may correlate with fish size, with larger more dominant fish tending to be less mobile and occupying preferred habitat. A better understanding of these movements and what environmental cues may regulate them will assist management agencies as oil and gas development occurs through the Arctic Coastal Plain.

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 Pacific salmon within the region. 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 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 abundance with habitat features. We continuously sampled headwater tributaries of the Little Susitna drainage to investigate spatial patterns in fish distribution, in conjunction with a streamwide habitat assessment. We used backpack electrofishers to sample fish throughout 200-m stream reaches. We performed mark-recapture of juvenile coho salmon on separate occasions to evaluate our sampling efficiency and validate our 1-pass CPUE as a reliable measure of fish presence and abundance. During 2010 and 2011, habitat characteristics were measured on 83 stream reaches and 77 reaches were sampled for fish. We performed mark-recapture on 27 reaches for validation of abundance estimates. Results from this project will allow for a more strategic 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.

The Reproductive Viability of Yelloweye Rockfish Subjected to Barotrauma and Deepwater Release in Prince William Sound, Alaska

Student Investigator: Brittany Blain, MS Fisheries
Advisor: Trent Sutton
Funding Agency: Sport Fish Division, ADFG (Base Funding)

Rockfish suffer barotrauma, and release of sport-caught rockfish does not ensure survival. Releasing a sport-caught rockfish with a deepwater release device has been studied, and results show high survival. However, the long-term effects on reproduction and embryo quality are unknown. Management staff needs more information on long-term effects. Proposals to the Alaska Board of Fish say there is a need to make deepwater release mandatory for all sport anglers, but no research has looked at the effects deepwater release may have on reproduction. Our primary objective in this study was to determine if yelloweye rockfish had reproduced in the years following a barotrauma event and recompression with a deepwater release device. The second objective was to identify if embryo quality was affected in recaptured fish versus fish with no known capture event. These objectives were accomplished by hook and line sampling at a single, isolated reef in Prince William Sound. Fish were tagged in 2008 and 2009 and recaptured in 2010. Blood sampling was used to reduce mortality. All females were gravid or spent, meaning they had a reproductive event in the years following decompression and recompression. Embryo quality also appeared to be unaffected when looking at oil globule volume and caloric content. No formal stock assessment of rockfish is currently in place. In addition, catch and release of rockfish in PWS has increased, and discard mortality is considered high when fish are not released with a deepwater release. These data will provide managers with valuable information that can be used in the decision making process to make deepwater release of rockfish mandatory. Reduction in discard mortality will help maintain healthy rockfish populations.

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:: Field camp logistics and equipment during field season provided by Fairbanks Fish and Wildlife Field Office and Selawik National Wildlife Refuge, USFWS; Equipment during field season provided by ADFG

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 has been conducted. Inconnu provide an important subsistence food resource for this region of Alaska. To effectively manage the inconnu of this region, winter movement and habitat use need 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. Preliminary results indicate that Selawik and Kobuk river inconnu display a high degree of spatial overlap during the wintering period, and therefore exhibit similar patterns of water depth, temperature, and salinity use. These data will allow managers to determine the appropriateness of winter stock-specific harvest guidelines in the region.

Habitat Use and Genetic Analysis of Main Stem and Tributary Spawning Chinook Salmon in the Togiak River, Alaska

Student Investigator: Stephanie Meggers, M.S. Fisheries
Co-Advisors: Andrew Seitz and Anupma Prakash
Funding Agency: Office of Subsistence Management, USFWS (RWO 191)
In-Kind Support: Anchorage Fish and Wildlife Field Office, U.S. Fish and Wildlife Service Conservation Genetics Laboratory, and Togiak National Wildlife Refuge

Chinook salmon populations are declining in the Togiak River. Reasons for the decline are currently unknown, but traditional ecological knowledge indicates that tributaries are experiencing lower water levels, and spawning distribution of Chinook salmon has shifted from tributaries to the main stem. I will attempt to describe physical and biological factors influencing Chinook salmon spawning site selection and availability that may influence overall abundance. The first objective is to compare habitat characteristics of main stem and tributary spawning areas. The second is to determine if there is a genetic difference between fish spawning in each area. First, I will use radio telemetry and remote sensing to identify and describe spawning site locations and characteristics. Second, I will determine genetic relatedness between main stem and tributary spawning Chinook salmon. Habitat and/or genetic differences influence Chinook salmon spawning site distribution within the Togiak River drainage. Information from this project will aid in understanding and predicting future trends in run strength in the Togiak River, which will be important for setting escapement goals and regulating harvest limits.

Completed Wildlife Studies

Postbreeding Ecology of Shorebirds on the Arctic Coastal Plain of Alaska

Student Investigator: Audrey R. Taylor, PhD Biology
Advisor: Abby Powell
Funding Agencies: Coastal Marine Institute, UAF; Angus Gavin Migratory Bird Research Fund, UA Foundation; Migratory Bird Management, and Arctic National Wildlife Refuge, USFWS; Arctic Field Office, BLM; BPXA, Inc.; and ConocoPhillips Alaska Inc.

Note: Audrey Taylor graduated from the University of Alaska Fairbanks in May 2011. Her dissertation abstract follows:

Previous research on the Arctic Coastal Plain (ACP) of Alaska has shown that postbreeding shorebirds congregate at coastal sites prior to fall migration. Relatively little has been done to compare distribution, community characteristics, or behavior broadly across the ACP landscape, but this information is necessary to set the context for interpreting population demographics and setting conservation priorities.

I collected data on distribution, species composition, phenology, and habitat use of postbreeding shorebirds in 2005-2007. I found that distribution of shorebirds across the ACP was not uniform: I identified persistent "hotspots" at Peard Bay, Pt. Barrow/Elson Lagoon, Cape Simpson, Smith Bay to Cape Halkett, and at the Sagavanirktok and Kongakut Deltas. Staging phenology varied by species and location, and differed than that reported in previous studies for several species. Three foraging habitat guilds existed with birds favoring gravel beach, mudflat, or salt marsh/pond edge habitats.

Using VHF telemetry, I examined how shorebirds moved from tundra breeding sites to and between coastal postbreeding sites. I found that most species exhibited a variable direction of movement compared to their ultimate migration direction; this may be related to each species' overall length of stay on the ACP. I also found species-specific patterns of movements and residence time that were indicative of differing life history strategies.

Lastly, I examined the use of physiological tools (triglyceride and corticosterone levels) to assess function and quality of foraging sites for postbreeding shorebirds, taking into account varying molt strategies. I determined that molt strategies affected physiological profiles and physiologic metrics varied through space and time. However, my hypotheses for variation in physiological patterns for shorebirds employing different molt strategies and using sites of varying quality were not completely upheld. I suggest that assessments of site quality for postbreeding shorebirds should consider species-specific life history strategies, and use multiple species and physiological metrics as indicators.

Given suspected declines in North American shorebird populations, and accelerated rates of environmental change in northern Alaska, this contextual information regarding postbreeding distribution, population characteristics, behavior, and physiology may help interpret changes in shorebird populations or behavior and establish strategies to protect important habitat.

Reproductive Ecology and Morphometric Subspecies Comparisons of Dunlin (*Calidris alpina*), an Arctic Shorebird

Student Investigator: Heather River Gates, MS Wildlife Biology
Advisor: Abby Powell
Funding Agency: Migratory Bird Program, USFWS

Note: River Gates graduated from the University of Alaska Fairbanks in December 2011. Her thesis abstract follows:

The Arctic region provides globally important breeding and migratory habitat for abundant wildlife populations including migratory shorebirds. Due to their remote breeding locations, basic information on breeding ecology, annual productivity, and factors that regulate their populations are poorly studied. Wildlife biologists managing migratory bird populations require detailed information on avian breeding biology, in addition to information on migration ecology including connectivity of migratory stop-over and wintering locations. To address information gaps in fecundity, I conducted an experimental study investigating the renesting ecology of Dunlin (*Calidris alpina arcticola*) by removing clutches at two stages of incubation and by following adults marked with radio transmitters to their replacement clutch. In contrast to predictions for Arctic-breeding species, Dunlin had high (82-95%) rates of clutch replacement during early incubation and moderate (35-50%) rates during late incubation. Female body condition and date of clutch loss were important variables explaining propensity for females to replace a clutch; larger females that lost their nest early in the season were more likely to renest than smaller females who lost their nest later in the season. To delineate Dunlin subspecies in areas where they overlap, I used morphological and molecular approaches to determine sex and subspecies of five subspecies of Dunlin breeding in Alaska and eastern Russia. This analysis yielded discriminant function models to correctly classify unknown individuals to sex (79-98%) and subspecies (73-85%) via morphometric measures. Correct classification of mixed assemblages of subspecies improved when sex, determined though molecular techniques, was known. The equations I derived using discriminant function models can be used to identify the sex and subspecies of unknown Dunlin individuals for studies investigating breeding and migration ecology.

Ongoing Wildlife Studies

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; U.S. Bureau of Ocean Energy Management (BOEM); USGS; and Arctic Landscape Conservation Cooperative
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 are conducting shorebird surveys in conjunction with collecting invertebrate core samples on delta mudflats during the post-breeding season. We are also measuring physiological parameters using blood samples from captured birds. We have completed four field seasons and collected roughly 1,300 invertebrate core samples, captured 240 semipalmated sandpipers, and completed 60 shorebird survey days. 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 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 the 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.

Movements of Juvenile and Subadult King Eiders around the Bering, Chukchi, and Beaufort Seas

Postdoctoral Researcher: Rebecca Bentzen
Faculty: Abby Powell
Funding Agency: OCS Program, USGS
In-Kind Support: North Slope Borough; BLM

Post-fledging dispersal is poorly understood for most birds and particularly for those which spend the majority of their time at sea. King Eiders (*Somateria spectabilis*) do not breed until at least three years of age, and nothing is known about their movements during this period. The objective of this study was to describe the movements and timing of migration for first (juvenile) and second year (subadult) King Eiders. Hatch-year birds were tagged with satellite transmitters at the breeding grounds in northern Alaska, 2006-2009. Juveniles and subadults wintered in three regions around the Bering Sea (southwestern Alaska, northern Bering Sea, and the Kamchatka Peninsula), using multiple discrete sites, but did not move between regions within a winter. Large winter ranges and lack of fidelity to the juvenile wintering region suggest that this is a period of exploration. Juveniles either remained on the winter area or moved north along the coast during the summer period, while subadult females largely returned to the natal breeding grounds, likely prospecting for future reproduction, and subadult males were widely dispersed in summer. Areas that were used by a large proportion of the juvenile and subadult King Eider population and which are likely critical habitats include the eastern Chukchi Sea, Bristol Bay in the eastern Bering Sea, Smith and Harrison Bays in the Beaufort Sea, and the nearshore waters of the Chukotka Peninsula. Information on the use, and timing of use, of these areas is vital to mitigating impacts of future development.

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: BOEM; USGS; USFWS; BLM; NFWF; North Pacific Research Board
In-kind Support: ConocoPhillips Alaska, Inc.: field camp logistics and supplies; BLM: field camp logistics and field work assistance; Columbus Zoo (Ohio): veterinarian; Mesker Park Zoo (Indiana): veterinarian; Point Defiance Zoo (Washington): veterinarian

Spectacled Eiders are sea ducks that spend 9 to 12 months of the year in Arctic and sub-Arctic seas along the coasts of Russia and Alaska. The species is listed as "threatened" under the U.S. Endangered Species Act. To date, the species' non-breeding distribution and patterns of habitat use at sea are understudied. Information regarding the distribution and habitats used by Spectacled Eiders will help managers to identify potential threats to the species away from breeding areas. This information is also needed to improve development plans for offshore natural resources in the Chukchi and Beaufort seas, mitigate for increased commercial and research vessel traffic in the Arctic, and understand population level effects resulting from ecosystem changes. The primary objective of our study is to assess the distribution, migratory patterns, and habitat use of Spectacled Eiders at sea. We marked Spectacled Eiders with implantable satellite transmitters to collect location data from each individual over a two year period. Preliminary data were summarized to describe spatiotemporal patterns in distribution and migration. Data will also be incorporated into species distribution models. We marked 37 juveniles (20 males, 17 females) and 92 adults (30 males, 62 females) over 4 years (2008-

2011). 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. Information regarding the spatiotemporal patterns of Spectacled Eiders at sea is valuable to conservation and recovery efforts. In addition, this information is necessary when planning the development of offshore natural resources in the Chukchi and Beaufort seas, mitigating for commercial and research vessel traffic in the Arctic, and understanding potential effects of changing prey regimes and habitat components such as sea ice.

Breeding Ecology of Whimbrels (*Numenius phaeopus*) in Interior Alaska

Student Investigator: Christopher M. Harwood, MS Wildlife Biology
Advisor: Abby Powell
Funding Agency: Kanuti National Wildlife Refuge (NWR), USFWS
In-Kind Support: Equipment used during field season provided by AKCFWRU

Studies of Whimbrel breeding ecology are limited in North America, despite suspected population declines and an official designation as a species of conservation concern in both the U.S. and Canada. The ecology and distribution of the species inInterior Alaska have been particularly understudied. This research addresses critical information gaps identified in conservation status reviews of Whimbrels, including breeding distribution, densities, and factors affecting breeding success. Our first objective is to establish benchmark metrics on the breeding ecology of a local population of Whimbrels at Kanuti National Wildlife Refuge in northcentral Alaska. Additionally, we will identify potential breeding locations for the entire Interior of Alaska. We are collecting information on timing, breeding success, habitat associations, and the factors affecting these attributes, during two summers of intensive field research. We are further using GIS-based spatial analysis to identify and predict breeding sites elsewhere in the Interior. The local Whimbrel population has shown annual variability in both breeding propensity and success. Identification of a second, disjunct local population on the refuge suggests a species with a patchy distribution and a metapopulation structure in the Interior. Migratory birds like the Whimbrel are officially regarded as “trust species” of the USFWS and thus must be managed as such both locally on Kanuti NWR and regionally in Alaska. This research addresses information gaps about the species at both spatial scales.

Completed Ecological Studies

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

Post-Doctoral Researchers: Fengming Yuan and Dan Hayes
Faculty: A. David McGuire
Funding Agency: U.S. Department of Agriculture (USDA)

The overall goal of the proposed research is to analyze the impacts of disturbances from insects and fire on the terrestrial carbon budget for the forested ecoregions of Canada, Alaska, and the western U.S. We conducted two studies as part of this project. The first study, conducted by Dr. Dan Hayes, was a synthesis study for the North American Carbon Program. In this study, we developed an approach for estimating net ecosystem exchange (NEE) using inventory-based information over North America (NA) for a recent seven-year period (ca. 2000–2006). The approach notably retains information on the spatial distribution of NEE, or the vertical exchange between land and atmosphere of all non-fossil fuel sources and sinks of CO_2, while accounting for lateral transfers of forest and crop products as well as their eventual emissions. The total NEE estimate of a -327 ± 252 TgC yr^{-1} sink for NA was driven primarily by CO_2 uptake in the Forest Lands sector (-248 TgC yr^{-1}), largely in the Northwest and Southeast regions of the U.S., and in the Crop Lands sector (-297 TgC yr^{-1}), predominantly in the Midwest U.S. states. These sinks are counteracted by the carbon source estimated for the Other Lands sector (+218 TgC yr^{-1}), where much of the forest and crop products are assumed to be returned to the atmosphere (through livestock and human consumption). The ecosystems of Mexico are estimated to be a small net source (+18 TgC yr^{-1}) due to land use change between 1993 and 2002. We compare these inventory-based estimates with results from a suite of terrestrial biosphere and atmospheric inversion models, where the mean continental-scale NEE estimate for each ensemble is -511 TgC yr^{-1} and -931 TgC yr^{-1}, respectively. In the modeling approaches, all sectors, including Other Lands, were generally estimated to be a carbon sink, driven in part by assumed CO_2 fertilization and/or lack of consideration of carbon sources from disturbances and product emissions. Additional fluxes not measured by the inventories, though highly uncertain, could add an additional -239 TgC yr^{-1} to the inventory-based NA sink estimate, thus suggesting some convergence with the modeling approaches. The second study, conducted by Dr. Fengming Yuan, was focused on representing the response of organic horizons to fire in estimating carbon dynamics of the Yukon River Basin. Representing the role of organic horizons in models is important because the thickness and structure of soil organic horizons in boreal forests have important influences on soil thermal dynamics that affect biogeochemical responses to warming and wildfire. However, regional analyses to date have treated soil organic horizon as static. In this study we apply a large-scale ecosystem model that represents the dynamics of organic fibrous and amorphous soil horizon characteristics to estimate changes in forest C stocks of the Yukon River Basin (YRB) in Alaska and Canada, which has experienced substantial warming of climate and increases in wildfire, from 1960 through 2006. Our analyses indicate that forest vegetation C storage increased in the YRB by 2.3 g C m^{-2} yr^{-1} during this period but that total soil C storage did not change appreciably. However, our analyses also suggest that C has been continuously lost from the mineral soil horizon since warming began in about 1970, while C has increased in the amorphous organic soil horizon. Based on a factorial experiment, soil C stocks would have increased by 158 Tg C (7.9 g C m^{-2} yr^{-1}) if this region had not undergone warming and changes in fire regime from 1960-2006. It also identified that warming and fire regime changes are approximately equivalent in their effects on soil C storage, and analysis of interactions between wildfire and warming suggests that the loss of organic horizon thickness associated with wildfire made deeper soil C stocks more vulnerable to loss. Sub-basin analyses indicate that simulated C stock changes were primarily sensitive to the fraction of burned forest area within each sub-basin. The fraction of area burned across the entire YRB between 1960 and 2006 is approximately at the sink-to-source transition point identified by the sub-basin analyses. We conclude that it is important for large-scale biogeochemical and earth system models to represent the dynamics of organic soil horizon thickness and structure in applications to assess changes in regional C dynamics of boreal forests responding to changes in climate and fire regime.

The Response of Plant Community Structure and Productivity to Changes in Hyrology in Alaskan Boreal Peatlands

Student Investigator: Amber Churchill, MS Biology
Advisor: A. David McGuire
Funding Agency: National Science Foundation (NSF)

Note: Amy Churchill graduated from the University of Alaska Fairbanks in December 2011. Her thesis abstract follows:

Northern peatlands have been a long-term sink for atmospheric CO_2, and have had a net cooling effect on global climate for the last 8,000 to 11,000 years. Across Alaska, peatlands face increased effects of climate change through hydrologic disturbance, both drying and flooding, and these conditions alter the ability of peatlands to accumulate carbon. Here, I examined the influence of changing hydrology in a moderate rich fen and a bog located in the discontinuous permafrost zone ofInterior Alaska. In both sites, I quantified how changing hydrology affected vegetation composition and ecosystem carbon uptake. At the fen, drying via a lowered water table treatment caused larger changes in vegetation composition and primary productivity than flooding via a raised water table treatment. In the bog, an area of recent permafrost thaw (collapse scar) had increased rates of understory net primary production and gross primary production, relative to an adjacent but older collapse scar and the surrounding permafrost plateau. Together, results from these studies highlight possible community responses to projected change in water availability, whether through drying or flooding, and demonstrate initial mechanisms for community responses altering ecosystem processes.

Lake Area Change in Alaskan National Wildlife Refuges: Magnitude, Mechanisms, and Heterogeneity

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

Note: Jennifer Roach graduated from the University of Alaska Fairbanks in December 2011. Her dissertation abstract follows:

The objective of this dissertation was to estimate the magnitude and mechanisms of lake area change in Alaskan National Wildlife Refuges. An efficient and objective approach to classifying lake area from Landsat imagery was developed, tested, and

used to estimate lake area trends at multiple spatial and temporal scales for ~23,000 lakes in ten study areas. Seven study areas had long-term declines in lake area and five study areas had recent declines. The mean rate of change across study areas was -1.07% per year for the long-term records and -0.80% per year for the recent records. The presence of net declines in lake area suggests that, while there was substantial among-lake heterogeneity in trends at scales of 3-22 km a dynamic equilibrium in lake area may not be present. Net declines in lake area are consistent with increases in length of the unfrozen season, evapotranspiration, and vegetation expansion.

A field comparison of paired decreasing and non-decreasing lakes identified terrestrialization (i.e., expansion of floating mats into open water with a potential trajectory towards peatland development) as the mechanism for lake area reduction in shallow lakes and thermokarst as the mechanism for non-decreasing lake area in deeper lakes. Consistent with this, study areas with non-decreasing trends tended to be associated with fine-grained soils that tend to be more susceptible to thermokarst due to their higher ice content and a larger percentage of lakes in zones with thermokarst features compared to study areas with decreasing trends. Study areas with decreasing trends tended to have a larger percentage of lakes in herbaceous wetlands and a smaller mean lake size which may be indicative of shallower lakes and enhanced susceptibility to terrestrialization. Terrestrialization and thermokarst may have been enhanced by recent warming which has both accelerated permafrost thawing and lengthened the unfrozen season.

Future research should characterize the relative habitat qualities of decreasing, increasing, and stable lakes for fish and wildlife populations and the ability of the fine-scale heterogeneity in individual lake trends to provide broad-scale system resiliency. Future work should also clarify the effects of terrestrialization on the global carbon balance and radiative forcing.

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 (Post-Doctoral Researchers)
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 have developed a peatland biogeochemistry model as a tool to simulate the exchange of CO_2 and CH_4 fluxes with the atmosphere in response to climate change. The application of the model indicates that projected warming has a stronger influence on these fluxes than changes in precipitation. Amy Churchill was the graduate student on the project who graduated in December 2011 after studying vegetation responses to the manipulations. Dr. Zhaosheng Fan, who started in January 2011, is conducting the modeling research on this project.

Partitioning of Soil Respiration along Moisture Gradients in Alaskan Landscapes

Student Investigator: Nicole McConnell, MS Biology
Advisor: 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 responses 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 of the response of decomposition to changes in soil climate. Because measurements of soil respiration include both decomposition (heterotrophic respiration) and plant respiration (autotrophic respiration), it is important to separate these components to properly interpret how decomposition is responding to changes in soil climate. Graduate student Nicole McConnell has conducted studies to understand controls of ecosystem respiration n two landscape settings. One setting is a gradient from a black spruce stand underlain by permafrost to a rich fen peatland that has no permafrost. The gradient is made up of five communities varying in vegetation and permafrost characteristics: (1) a black spruce-dominated permafrost forest, (2) a shrub-dominated system underlain by permafrost, (3) a tussock grassland with no permafrost, (4) a sedge/forb-dominated fen with no permafrost, and (5) a brown moss-dominated rich fen. Five years of ecosystem respiration data indicated that the sedge/forb dominated ecosystem had the highest mean growing season ecosystem respiration fluxes. Root respiration rates explained 38-45% of variation in ecosystem respiration. The other setting is a chronosequence from a stable permafrost bog and two adjacent bogs that have collapsed after thaw. The stable permafrost bog (non collapse) has an average thaw depth of 40 cm in the summer and is believed to be what the system was “pre-collapse.” The first collapse (new collapse) found directly adjacent collapsed around 25 years ago, and the second collapse (old collapse) was created around 40 years ago. Both collapse scars can have an extremely variable thaw depth ranging anywhere from 20 cm to more than 92 cm. Ecosystem respiration was measured weekly during the 2008-2010 summer field seasons at all three sites. Soil temperature, soil moisture, water table depth, and active layer depth were measured concurrently with ecosystem respiration fluxes. Root biomass was also measured once at each site to determine the vegetation changes below-ground. Ecosystem respiration was significantly higher in the non-collapse compared to both the new and old collapse. The old collapse had the lowest ecosystem respiration with the new collapse in the middle. Soil temperature ($p < .0001$), water table depth ($p < .0001$), and active layer depth ($p=0.0036$) were all significant predictors of ecosystem respiration with a soil temperature and water table interaction ($p < .0001$), while soil moisture ($p=.7133$) was a nonsignificant predictor. Root biomass also followed the same pattern as ecosystem respiration suggesting that root respiration could also be an important predictor of ecosystem respiration. An important next step at these sites is to partition heterotrophic and autotrophic respiration.

Research Coordination Network: Vulnerability of Permafrost Carbon

Post-Doctoral Researcher: Zhaosheng Fan
Faculty: A. David McGuire
Funding Agency: NSF

The objective of the Vulnerability of Permafrost Carbon Research Coordination Network (RCN) is to link biological C cycle research with well-developed networks in the physical sciences focused on the thermal state of permafrost. This interconnection will produce new knowledge through research synthesis that can be used to quantify the role of permafrost C in driving climate change in the 21st century and beyond. This will be achieved by synthesizing information in a format that can be assimilated by biospheric and climate models, and that will be contributed to future assessments of the Intergovernmental Panel on Climate Change (IPCC). Our proposed activities to reach this goal are (1) organization of an interrelated sequence of meetings and working groups designed to synthesize existing permafrost C research, and (2) formation of a consortium of interconnected researchers to disseminate synthesis results about permafrost C to other scientific networks and activities. These two research coordination activities are aimed at developing and disseminating algorithms that encapsulate the new process knowledge and datasets in support of model development. The first year of this project has produced significant advancements in both of these areas, culminating with the first all-scientist meeting held June 1-3, 2011 in Seattle, WA. Forty participants from a range of institutions and career levels met over the course of two and a half days to discuss issues surrounding the magnitude, timing, and form of carbon loss from permafrost to the atmosphere in a warmer world. The workshop was organized around two main products. The first was an expert opinion assessment of the vulnerability of permafrost carbon. Because process knowledge and models are currently limited, this workshop provided the opportunity to quantify the professional assessment of experts in this area. This activity served to focus the participants toward the overall question of the workshop, as well as providing a discussion thread that carried throughout the workshop. At the conclusion of the workshop we decided as a group to update answers that were provided at the outset based on clarifications made during the workshop and to present the results of the assessment as a published statement of the Permafrost Carbon RCN group. The second activity of the workshop was to solicit and prioritize synthesis products that would be conducted by members of the network over the course of the 4-year RCN project. This activity was achieved with a combination of overview presentations by steering committee members followed by breakout discussions to generate additional ideas. Results of these breakout sessions were summarized and organized into working groups. The final day of the workshop saw team leaders emerge to organize smaller working group activities over the next 12-18 month timeframe. Working groups will continue to coordinate with the leadership team, and will meet together at annual meetings.

Identifying Indicators of State Change and Forecasting Future Vulnerability in Alaskan Boreal Ecosystems

Post-Doctoral Researcher: Héléne Genet
Faculty: A. David McGuire
Funding Agency: Department of Defense (DoD)

This study is designed to understand the mechanistic connections among vegetation, the organic soil layer, and permafrost ground stability in Alaskan boreal ecosystems. Permafrost is a major control over the structure and function of boreal ecosystems, and the soil organic layer mediates the effects of a changing climate on the ground thermal regime and permafrost stability. Understanding the links between vegetation, organic soil, and permafrost is critical for projecting the impact of climate change on permafrost in ecosystems that are subject to abrupt anthropogenic and natural disturbances (fire) to the organic layer. This study will combine field measurements (Objective 1) with models (Objective 2) to detect and predict state changes in boreal ecosystems of Interior Alaska in response to changing climate and land management. Objective 1, which is being led by the University of Florida, is to determine mechanistic links among fire, soils, permafrost, and vegetation succession in order to develop and test field-based ecosystem indicators that can be used to directly predict ecosystem vulnerability to state change. Activities to develop these indicators include (a) monitoring vegetation recolonization, soils, and permafrost on a previously existing network of sites located in recent, severe wildfires adjacent to, and on, Department of Defense (DoD) lands in Interior Alaska; (b) extending this network to include parallel measurements from sites located in recent prescribed fires and fuel treatments on DoD lands; and (c) conducting studies of vegetation stand history and organic layer re-accumulation on an established network of mid-successional boreal ecosystems adjacent to, and on, DoD lands in Interior Alaska. Objective 2, which is being led by the University of Alaska Fairbanks, is to forecast landscape change in response to projected changes in climate, fire regime, and fire management. We will conduct four activities to be able to accurately forecast how fire regime and fire management will interact with climate change to shape the future structure, function, and distribution of Alaskan boreal ecosystems on DoD and surrounding lands. These activities include (a) incorporating field data sets on vegetation, soils, and permafrost into a model of landscape fire dynamics and into a model of ecosystem structure and function; (b) coupling these two stand-alone models so that the influence of a changing climate on permafrost and vegetation can be assessed together with natural and managed changes in the fire regime; (c) evaluating the performance of the coupled model using retrospective statistical datasets of past fire regime and forest structure in Interior Alaska; and (d) projecting future landscape distribution of vegetation and permafrost using the coupled model in combination with different scenarios of climate change, fire regime, and fire management. The University of Florida conducted field research in support of objective 1 during summer 2011. Dr. Héléne Genet, who recently started a post-doctoral position at the University of Alaska Fairbanks, is responsible for the further development and application of the model of ecosystem structure and function in the project.

Development and Application of an Integrated Ecosystem Model for Alaska

Post-Doctoral Researchers: Amy Breen, Reginald Muskett, and Fengming Yuan
Student Investigators: Tobey Carman (MS Computer Science), Winslow Hansen (MS Natural Resources), and Elchin Javarov (PhD Geophysics)
Faculty: A. David McGuire, T. Scott Rupp, Vladimir Romanovsky, Eugénie Euskirchen, and Sergey Marchenko
Funding Agencies: USGS and USFWS (RWO 190)

Our primary goal in this project is to develop a modeling framework that integrates the driving components for and the interactions among disturbance regimes, permafrost dynamics, hydrology, and vegetation succession/migration for the state of Alaska. This framework will couple (1) a model of disturbance dynamics and species establishment (the Alaska Frame-Based Ecosystem Code, ALFRESCO); (2) a model of soil dynamics, hydrology, vegetation succession, and ecosystem biogeochemistry (the dynamic organic soil/dynamic vegetation model version of the Terrestrial Ecosystem Model, TEM); and (3) a model of permafrost dynamics (the Geophysical Institute Permafrost Lab model, GIPL). Together, these three models comprise the AIEM (Alaska Integrated Ecosystem Model). The AIEM provides an integrated framework to provide natural resource managers and decision makers an improved understanding of the potential response of ecosystems due to a changing climate and to provide more accurate projections of key ecological variables of interest (e.g., wildlife habitat conditions). In this study our objectives are to (1) synchronously couple the models, (2) develop data sets for Alaska and adjacent areas of Canada, also known as the Western Arctic, and (3) phase in additional capabilities that are necessary to address effects of climate change on landscape structure and function. In preparation for the synchronous coupling of the models, we have conducted a study in which we have asynchronously coupled the models. In this study, changes in fire regime were simulated by the Alaska Frame-based Ecosystem Code (ALFRESCO) model driven by downscaled global climate model outputs from CCCMA-CGCM3.1 and MPI ECHAM5 models under the A1B emissions scenario at 1 km x 1 km resolution for the Yukon River Basin in Alaska. The fire regime outputs of ALFRESCO were used to drive the dynamic organic soil version of the Terrestrial Ecosystem Model (DOS-TEM), and then the moss and organic layer thickness outputs from DOS-TEM were used to drive the Geophysical Institute Permafrost Lab Model (GIPL-1). Fire as simulated by ALFRESCO was enhanced through the middle of the 21st century, after which fire activity reverted to pre-1990 levels because of a shift in forest composition to more low-flammability deciduous forest. Simulations by the Dynamic Organic Soil version of the Terrestrial Ecosystem Model (DOS-TEM) driven by ALFRESCO fire indicate that carbon in vegetation and in soil organic horizons will decrease in response to more frequent fire in the first half of the 21st century, but will generally accumulate after fire became less frequent in the middle of the 21st century, with accumulation being slower for the warmer ECHAM5 climate. In contrast, carbon in the mineral horizon accumulated throughout the 21st century. Soil temperature simulated by DOS-TEM continues to warm throughout the 21st century for both climate projections, with the rate of warming greater for the warmer ECHAM5 climate. Similarly, DOS-TEM predicts that the area occupied by permafrost will decrease from occupying 68% of the basin in 2006 to occupying 20% and 30% of the basin by 2100 for the warmer ECHAM5 and less warm CCCMA climates, respectively. Simulations by the GIPL-1 model driven by ALFRESCO coupled with DOS-TEM organic layers indicate fire produces significant changes in ground temperatures and permafrost throughout the 21st century for both climate projections. These results suggest that there are important linkages among the fire regime, forest composition, and the structure of soil organic horizons that influence the vulnerability of permafrost degradation in interior Alaska.

Collaborative Research on Characterizing Post-fire Successional Trajectories in Tundra Ecosystems

Post-Doctoral Researcher: Amy Breen
Faculty: Scott Rupp and Teresa Hollingsworth
Funding Agency: USGS Alaska Science Center (RWO 195)

Changes in fire regime are predicted to increase the extent and frequency of wildfires through the tundra region of Alaska in the coming century, yet the implication and consequences are poorly understood. As tundra fires become more frequent, accurate prediction of post-fire successional trajectories is critical due to impacts on wildlife habitat, permafrost degradation, carbon release, and range expansion of species from the neighboring boreal forest. Our study objectives are to determine (1) spatial trends in lightning strikes, fire frequency, and fire extent on the Seward Peninsula; (2) if particular tundra vegetation communities are more prone to fire; and (3) how various tundra vegetation responds and accumulates fuel over time post-fire. This work will be accomplished via spatial analyses using GIS layers and remote sensing imagery, a retrospective time series analysis of historical fire regime and fieldwork on the Seward Peninsula to quantify post-fire plant communities and fuel accumulation. Our expectations are (1) the lightning strike record will show spatial trends, where certain vegetation or landscapes on the Seward Peninsula will be more likely to experience strikes, (2) fire records will show an increase in lightning strikes resulting from large fires over the last 30 years, and (3) fire disturbance will facilitate greater fuel loads and recruitment than adjacent unburned tundra. This work will develop a conceptual modeling framework that integrates wildfire disturbance, vegetation succession, and climate dynamics in tundra ecosystems in western Alaska to inform land mangers of the implications of a changing fire regime.

Plant Community Succession on Drying Lakes in the Yukon Flats, Alaska

Student Investigator: Mark Winterstein, MS Biology
Advisor: Teresa Hollingsworth
Funding Agency: USGS Climate Effects Network, LTER (RWO 180)
In Kind Support: Field personnel and use of laboratory provided by Bonanza Creek LTER

Increases in mean annual temperature and their effect on ecosystem properties have been linked to the reduction in the total surface area and number of closed-basin lakes in the Yukon Flats, Alaska. These drying events expose lacustrine sediments to colonization by terrestrial vegetation and initiate plant community succession. Plant communities influence ecosystem processes and climate interactions on the landscape as well as providing food and habitat to humans and subsistence wildlife.

Changes in habitat abundance can alter distributions of wildlife populations and affect subsistence hunting and gathering activities. The objectives of this study are to (1) determine the environmental variables controlling the change in plant communities as lakes dry, and (2) investigate how rapidly plant communities are changing post-drying. Fourteen drying lakes were selected based on decreasing lake area from satellite imagery in the years 1985 and 2009. Plant functional group abundance, shrub and tree density, and soil moisture were sampled along transects between the existing lake edge and historic lake edge. Plant communities were identified from changes in dominant functional group abundances, and within each community type vascular and non-vascular plant species cover, soil samples, and thaw depths were collected. Temporal variability in plant communities will be measured using Landsat satellite imagery and correlated to changing lake areas over time. Preliminary results indicate that soil moisture is related to differences in plant community, functional group, and distance from existing lake edge. The results from this study will provide baseline data for the greater scientific community for the modeling of ecosystem processes, services, and wildlife habitat. It will also provide information for the local people of the Yukon Flats to understand how global warming may be changing the vegetation of the Yukon Flats and how it has the potential to impact their subsistence activities.

Implications of Climate Change for Biodiversity in Yukon River Basin Wetlands: Yukon Flats National Wildlife Refuge as a Test Case

Postdoctoral Researcher: Jennifer Roach
Faculty: Brad Griffith
Funding Agencies: USFWS; USGS (RWO 172)

Recent studies have identified net regional-scale declines in lake area in the Arctic and sub-Arctic that have been coincident with climate warming. Lakes are important breeding grounds for global migratory waterfowl populations and the effect of lake area decline on avian species biodiversity, habitat, and aquatic food sources is unknown. The objectives of this study are to (1) build spatially explicit models of biodiversity of four major taxa (birds, small mammals, vegetation, and aquatic invertebrates) based on a suite of variables including lake size, habitat characteristics, lake water chemistry, invertebrate abundance and diversity, and characteristics of the broader lake and landscape matrix and 2) use these models to project changes in biodiversity as a result of climate-induced changes in lake size, hydrology, and vegetation structure. We will estimate avian, invertebrate, small mammal and vegetation biodiversity along with a suite of potential explanatory variables such as lake water chemistry and bathymetry at a randomly spatially distributed sample of ~120 lakes in the Yukon Flats National Wildlife Refuge. Data collection is complete and data entry is near completion. Preliminary results suggest that avian species richness is positively related to lake size and other characteristics that will enable us to produce a spatially explicit map projecting the effects of climate-induced changes in lake size on avian biodiversity. This information will provide land managers with spatially explicit projections of climate-induced changes on avian species biodiversity. This information will identify specific habitats and species that should be targeted by conservation efforts.

Implications of Climate Variability for Optimal Monitoring and Adaptive Management in Wetland Systems

Postdoctoral Researcher: Sam Nicol
Faculty: Brad Griffith and Christine Hunter
Funding Agencies: USGS (RWO 172)
In-kind support: USFWS; AKCFWRU

The lakes of the prairie pothole region (PPR) and Alaska provide habitat that is crucial for breeding waterfowl. Evidence suggests that climate is changing the water balance of the lakes in both regions which may affect the future of breeding waterfowl. National Wildlife Refuge managers operating in the PPR and Alaska need to understand how climate will affect their refuges and how to change their management practices to adapt to future climate scenarios. Our goal is to enhance the potential for monitoring and adaptive management of the habitats of waterbirds that will be affected by changing global temperatures. In Alaska we used remote sensing data to predict the power to detect changes in lake area over Alaskan refuges. In the PPR we applied an adaptive management approach to give specific water levels that should be maintained at each refuge pool under both an increasing and decreasing inflow scenario. Three of the six Alaskan refuges studied are drying. The power to detect change is low. In the PPR all study refuges are located on rivers so are not greatly affected by the changes in inflow that we predict under either climate scenario. In Alaska, small trends in lake area are hard to detect but have big effects over time. A refuge-wide monitoring scheme carried out over at least a decade is the only way to detect change. In the PPR, we gave specific weir heights to manage expected future inflows. Management is similar under increasing and decreasing inflow scenarios.

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
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Funding Agency: USGS (RWO 172)

Interior Alaskan boreal lakes have been decreasing in size and abundance, which could act as an important climate feedback by altering rates of carbon sequestration and respiration. Lake drying could also affect plant community structure and biodiversity via altered successional pathways. However, many apparent drying lakes in Alaska exhibit large annual fluctuations in lake area as a result of spring flooding. The ecological significance of lake drying is unclear and cannot be quantified without separating the effects of lake drying from the influence of flooding and other forms of disturbance. The objective of this study is to estimate the influence of lake drying and flooding regimes on terrestrial ecosystem dynamics in the Yukon Flats National Wildlife Refuge. We will meet this objective using a combination of remote sensing and field surveys to fit statistical and simulation models of plant biodiversity, productivity, and dynamics of carbon and nitrogen. In 2010 and 2011, we completed vegetation surveys at 130 lakes. We also sampled aboveground net primary productivity (ANPP) and soil characteristics, including soil moisture, carbon, and nitrogen, at a subset of eight lakes in 2011. Preliminary results indicate that frequently flooded lake-margin communities have rapid transitions from grass/sedge vegetation to upland forest, elevated soil moisture, and reduced soil nitrate availability compared to other lakes. This research will increase our understanding of the factors governing the factors governing current and future spatial patterns of vegetation in an environment that is highly valuable as habitat for a variety of wildlife, especially breeding waterfowl.

Climate Change and the Nutrient Dynamics of Ungulate Forages in Arctic Alaska

Post-Doctoral Researcher: Ken Tape
Faculty: Roger Ruess
Funding Agency: Alaska Science Center, USGS (RWO 196)

Climate is warming in Arctic Alaska, and there is a pressing need to understand the current and future changes in vegetation, permafrost, and hydrology, so that land managers can better understand and predict the impacts of these changes on herbivores, notably caribou and migratory birds. Caribou and geese are integral subsistence and personal use resources. Monitoring and preservation of the habitat used by these herbivores are therefore critical to maintaining the resource. Our primary objective is to inventory and provide paired old and new imagery for several USGS groups studying birds and caribou in Arctic Alaska. We are also interested in changes in seasonality and timing of leaf-out, so any records of that nature would be critical. The imagery often reveals changes in habitat during the 20^{th} century, so the first step has been scanning, georeferencing, and comparing old and new. I am also developing a record of snowmelt timing from 1971-2010 using the Kuparuk River discharge records and a satellite snow-free index. This project started in November 2010. At this time I've scanned, georeferenced, and made available <1-m resolution black and white aerial photography from the late 1940s. An initial look at the river discharge data shows that spring (snowmelt/leaf-out) has advanced approximately 1 week since 1971. These data will help managers understand how herbivores are responding to landscape changes associated with climate warming.

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

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Funding Agencies: Alaska Space Grant, NASA; Angus Gavin Fellowship, UAF; IAB; AKCFWRU
In-Kind Support: Alaska Bird Observatory

Changes in vegetation have been documented worldwide and correlated with recent warming trends. Little baseline data exists in Alaska, 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 these findings to changes observed in the local avian community. First, I quantified change in vegetation structure using remote sensing data and archived field data from the 1970s. Second, I assessed the simultaneous habitat-specific change in avian communities. Marked changes in both vegetation and birds have occurred during the last 35 years. While direction and magnitude of this change varied with habitat type, there has been an overall decrease in shrub habitat and increase in forest. Change in bird abundances reflected this shift and additionally suggests a drying trend. This study gives an indication of the spatial and temporal scale needed to accurately document environmental change in a boreal wetland ecosystem. Information gathered provides habitat-specific information about local ecosystem changes and about avian response to continuous habitat shifts.

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 easternInterior 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.

Comparative Ecology of Loons Nesting Sympatrically on the Arctic Coastal Plain, Alaska

Student Investigator: Daniel Rizzolo, PhD Biological Sciences
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Funding Agencies: US Bureau of Ocean Energy Management; USGS (RWO 193)

Red-throated Loons are listed as a Bird of Conservation Concern by the USFWS due to a 53% population decline in Alaska between 1971 and 1993. The dependence of nesting Red-throated Loons on marine forage fish distinguishes them from Pacific Loons, which forage primarily in their nesting lakes. Thus, like true seabirds, Red-throated Loon populations are likely responsive to changes in the marine environment, and a connection between their population dynamics and changes in populations of prey fish species has been hypothesized. In this study we are using biochemical methods (C and N stable isotope ratios in blood, and fatty acid composition of adipose tissue) to characterize diet in Red-throated and Pacific Loons nesting sympatrically on the Chukchi Sea coast. Differences in diet composition between these species are relevant to understanding how their contrasting use of the marine environment during nesting may contribute to their divergent population trends. To determine the potential fitness costs of variation in diet composition, we are examining associations between diet, adult condition, and productivity. These data will improve our understanding of Red-throated Loon population dynamics and aid in understanding how loons may be affected by changes in prey resources associated with climate change, fisheries activities, and offshore oil and gas development in the Arctic.

Detection of Climate-linked Distributional Shifts of Breeding Waterbirds across North America

Postdoctoral Researcher: Mark W. Miller
Co-Principal Investigators: Mark Lindberg and Joel Schmutz
Funding Agency: USGS (RWO 192)

Extensive and long-term sampling is necessary to identify demographically important changes in the distribution of wildlife populations that may be linked to climate processes. Few survey data streams exist for such an assessment. The Waterfowl Breeding Population and Habitat Survey is one notable exception to this limitation. This survey, conducted annually through the leadership of the Division of Migratory Bird Management of the U.S. Fish and Wildlife Service (USFWS), samples 5 million square kilometers and covers prairies, parklands, boreal forest, and coastal habitats. Additional surveys similarly cover tundra areas of the U.S. and Canada. Data from these surveys are used annually in an adaptive management and decision framework that provides objective model output for how harvest regulations across the continent should be implemented to maintain existing populations. We propose to estimate rates of species colonization or extinction (i.e., "occupancy") using a spatially and temporally explicit model. We will also model the relationship between occupancy and habitat and climate covariates. These analyses will identify how distributions of waterbirds for much of the continent are responding to climate processes. We anticipate that our results could affect monitoring design and the adaptive harvest management (AHM) process in several ways. One outcome may be a recommendation to eliminate some survey segments or strata or add in new ones. A second possibility is that the underlying demographic model structures that drive the adaptive management decision models may need to be modified to include progressive environmental change that is ultimately driven by climate. Our results and how they will impact future surveys and AHM will be presented both in publications and in meetings, including presentations at conferences, flyway meetings, and other appropriate venues. We will work closely through all phases of this project with USFWS colleagues.

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 Wildlife Biology
Advisor: Kris Hundertmark
Funding Agencies: Wildlife Conservation, ADFG; Tongass National Forest, USDA Forest Service; NSF
In-Kind Support: Assistance from ADFG personnel; equipment and vehicles provided by ADFG during field season

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 the final year of field data collection (3 years total). Data collection and analysis are ongoing. Fawn survival rates were ~45% and ~24% for years 1 and 2, respectively, and adult female survival rates during the same period were ~90% for both years. Anticipated results in the future will include effects of habitat and weather on deer population dynamics, evaluation of relative importance of vital rates for different age classes, and modeling of deer population response to future climate and habitat-alteration scenarios. 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. This will help managers ensure adequate supplies of deer for subsistence and recreational harvest in the future.

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 three Northwest Arctic Borough communities: Noatak, Selawik, and Shungnak. We conducted semi-structured ethnographic interviews with expert informants to explore knowledge about climate and ecological changes related to subsistence fisheries. Based on these interview data, we developed a survey instrument to systematically assess agreement about climate change observations and subsistence fishery impacts using cultural consensus analysis. Residents of Northwest Alaska are acutely aware of changing environmental conditions. Our informants consistently described the following changes: lower river water levels, increasing beaver abundance, changing weather patterns, changes in the timing of fish movements, melting permafrost, increased erosion, thinner winter ice conditions, earlier spring break-up, more limited access to traditional fishing locations, changes in fish species composition, and increasing presence of parasites in whitefish. Informants also situate observations and impacts of environmental change in a larger context of social, cultural, and economic change in rural villages. Initial analysis of cultural consensus data reveals that both Noatak and Selawik subsistence fishers display an overall consensus about observations of change.

Climate-induced Mismatch between Breeding Shorebirds and Their Invertebrate Prey

Postdoctoral Researcher: Kirsty E. B. Gurney
Faculty: Mark Wipfli
Funding Agency: Alaska Science Center, USGS (RWO 185)

Climate is changing on the Arctic Coastal Plain. Although wildlife outcomes are unclear, survival and recruitment of breeding bird populations may decline if these consumers become temporally mismatched with their food resources. To accurately predict how avian consumers will respond to climate changes on the Arctic Coastal Plain, it is critical to understand relationships between birds, climate, habitat, and their food resources. This study focuses on understanding interactions between climate change and invertebrate food resources, which have received little attention so far. Our primary objective is to examine several mechanisms that are hypothesized to be responsible for variation in wetland invertebrate communities. Specifically, we will determine how invertebrate biomass, phenology, and community structure respond to changes in nutrient flux and temperature. We are using a series of field-based wetland observations and manipulations to assess changes in wetland invertebrate communities. This research program is in the preliminary stages, and results are not yet available. Invertebrate prey on the breeding grounds is a key determinant of breeding success for migratory shorebird populations. Our study will thus increase the accuracy with which we can predict potential impacts of climate change on such populations.

Impacts of Climate Warming on Arctic Freshwater Food Webs

Student Investigator: Sarah Laske, PhD Fisheries
Co-Advisors: Mark Wipfli and Amanda Rosenberger
Funding Agency: Alaska Science Center, USGS (RWO 188)

Arctic systems are projected to warm at a rate twice the global average. With such rapid change, there is a sense of urgency to describe systems and study function and process. Additionally, Arctic systems can act as harbingers of climate change for lower latitudes and provide information for developing strategies to preserve ecosystems. On the Arctic Coastal Plain (ACP) of Alaska, a complex of streams, lakes, and wetlands dominates the landscape and provides essential habitat and food resources to many bird and fish species. Understanding the role of fishes on the ACP is a critical component of understanding food web function and whether controls of aquatic community structure are top-down (predator driven) or bottom-up (environmentally driven). In summer 2011 (year 1 of a 3-year study), we sampled the relative abundance of fish from streams and lakes at two sites on the ACP. The data were collected as part of a pilot study to understand fish distributions across the local landscape and inform project planning. Sampling revealed that fish distributions varied from system to system with differing assemblages of fish within each stream or lake. Of seven fish species found on the ACP in 2011, only the ninespine stickleback *Pungitius pungitius* was found at every sampling location. Because fish affect wildlife directly and indirectly through trophic linkages, understanding what controls Arctic food web structure can elucidate forthcoming changes due to climate warming.

Terrestrial-Aquatic Linkages: Controls on Riparian Prey Subsidies for Arctic Grayling on the North Slope

Student Investigator: Jason J. McFarland, MS Biology
Advisor: Mark Wipfli
Funding Agency: Bureau of Land Management (BLM) (RWO 179)
In-Kind Support: Field camp logistics and equipment provided by BLM; Teaching Assistantship provided by Department of Biology and Wildlife

Climate change and increased oil and gas activities on Alaska's North Slope pose probable threats to ecological processes in aquatic ecosystems. The National Petroleum Reserve-Alaska (NPRA) is an ecologically and biologically poorly understood area, particularly with regard to the food webs that support fishes. Understanding the structure and function of these lotic systems is paramount to understanding how the future Arctic aquatic habitats and ecosystems will be influenced by changes in climate and land use. Small, lower order streams are potentially most susceptible to physical and chemical alterations associated with changes in climate and land use. These small systems provide habitat for fishes and other biota. To evaluate potential ecological changes, land managers must first understand the basic ecology of these abundant streams and ecological processes that govern them. The objectives of this study are to (1) contrast terrestrial invertebrate communities (potential prey for stream fishes) associated with different types of riparian vegetation along low-order rearing streams, (2) determine how riparian vegetation affects Arctic grayling prey intake, and (3) predict how terrestrial invertebrate prey availability to fishes may change through vegetation cover changes, as a consequence of climate change. These objectives are being accomplished using Arctic grayling diets, terrestrial invertebrate prey inputs to streams under differing riparian plant species compositions, and mapping riparian vegetation descriptions. Preliminary results suggest differences in terrestrial invertebrate prey inputs among riparian vegetation types. Terrestrial invertebrates are important food items for both juvenile and adult Arctic grayling in beaded streams on the Coastal Plain of the North Slope, Alaska. The findings of this study are expected to help guide future management of small streams on Alaska’s North Slope by state and federal agencies involved in managing these ecosystems.

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	U.S. Bureau of Land Management
BOEM	U.S. Bureau of Ocean Energy Management
DBW	Department of Biology and Wildlife, UAF
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
GI	Geophysical Institute, UAF
GIS	Geographical Information System
IAB	Institute of Arctic Biology, UAF
NASA	U.S. National Aeronautics and Space Administration
NFWF	National Fish and Wildlife Foundation
NPS	U.S. 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