Alaska Cooperative Fish and Wildlife Research Unit Annual Research Report—2015

Alaska Cooperative Fish and Wildlife Research Unit
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Cover Photo 1: Dan Govoni and Jón S. Ólafsson sampling hyporheic invertebrates in Hengill goethermal area in southwest Iceland in June 2015. Photo: TK Harms.

Cover Photo 2: An Arctic fox removes an egg from a Common Eider nest on a barrier island of the Arctic National Wildlife Refuge, July 2015. Photo: USFWS.

Cover Photo 3: A beach seine set in Kotlik Lagoon sorted by Trevor Haynes and Nicole Farnham yielded ice and few fish. Photo: Marguerite Tibbles.

Unit Roster

Federal Scientists

- Brad Griffith: Leader
- Jeff Falke: Assistant Leader-Fisheries
- Dave McGuire: Assistant Leader-Ecology
- Abby Powell: Assistant Leader-Wildlife
- Mark Wipfli: Assistant Leader-Fisheries

University Staff

- Monica Armbruster: Fiscal Professional
- Kathy Pearse: Administrative Generalist

Unit Students and Post-Doctoral Researchers

Current

- Megan Boldenow, MS Biological Sciences (Powell)
- Chelsea Clawson, MS Fisheries (Falke)
- Dan Govoni, PhD Biological Sciences (Wipfli)
- Jess Grunblatt, PhD Interdisciplinary Studies (Wipfli/Alessa)
- Christopher Harwood, MS Wildllfe Conservation (Powell)
- Philip Joy, PhD Fisheries (Wipfli)
- Erin Julianus, MS Biology (McGuire and Hollingsworth)
- Sarah Laske, PhD Fisheries (Wipfli and Rosenberger)
- Jason Leppi, PhD Fisheries (Wipfli)
- Allison (Martin) Matter, MS Fisheries (Falke)
- Benjamin Meyer, MS Fisheries (Wipfli)
- Kristin Neuneker, MS Fisheries (Falke)
- Kelly Overduijn, MS Wildlife Biology and Conservation (Powell)
- Vijay Patil, PhD Biological Sciences (Griffith and Euskirchen)
- Brian Robinson, MS Wildlife Biology and Conservation
- Matt Sexson, PhD Biological Sciences (Powell and Peterson)
- Morgan Sparks, MS Fisheries (Falke)
- Eric Torvinen, MS Fisheries (Falke)

Post-Doctoral Researchers

- Trevor Haynes (Wipfli)
- Brock Huntsman (Falke)
- Yanjiao Mi (McGuire)
- Jennifer Roach (Griffith)
- Erik Schoen (Wipfli)

Graduated in CY 2015

- Roy Churchwell, PhD Biological Sciences (Powell)
- Heather Craig, MS Wildlife Conservation (Powell)
- Kevin Fraley, MS Fisheries (Falke)

- Jason McFarland, MS Biological Sciences (Wipfli)
- Kristin Rine, MS Biological Sciences (Wipfli)

University Cooperators

- Milo Adkison, School of Fisheries and Ocean Sciences (SFOS)-UAF
- Chris Arp, Institute of Northern Engineering (INE)-UAF
- Lilian Alessa, University of Idaho
- Perry Barboza, Department of Biology and Wildlife(DBW) and Institute of Arctic Biology (IAB)-UAF
- Ron Barry, Mathematics and Statistics
- Amy Breen, International Arctic Research Consortium (IARC)-UAF
- F. Stuart Chapin, III, Emeritus IAB
- Courtney Carothers, SFOS
- Eugénie Euskirchen, IAB
- Hèléne Genet, IAB
- Teresa Hollingsworth, Boreal Ecology Cooperative Research Unit-UAF
- Tuula Hollmen, SFOS/Institute of Marine Science (IMS)
- Karsten Hueffer, IAB
- Kris Hundertmark, DBW and IAB
- Katrin Iken, SFOS
- Knut Kielland, IAB
- Mark Lindberg, DBW and IAB
- J. Andrés López, SFOS
- Sergey Marchenko, Geophysical Institute (GI)-UAF
- Reginald Muskett, GI
- Anupma Prakash, GI and College of Natural Sciences and Mathematics
- Daniel Rinella, University of Alaska Anchorage
- James Reynolds, Emeritus UAF
- Vladimir Romanovsky, GI
- Amanda Rosenberger, University of Missouri
- Roger Ruess, DBW and IAB
- T. Scott Rupp, Scenarios Network for Alaska and Arctic Planning-UAF
- Andy Seitz, SFOS
- Trent Sutton, SFOS
- Dave Verbyla, School of Natural Resources and Extension
- Diana Wolf, IAB

Affiliated Students and Post-Doctoral Researchers

Current

- Matthew Albert, MS Fisheries (Sutton)
- Iris Cato, MS Biology (Ruess and Wolf)
- Adam DuBour, MS Wildlife (Lindberg)
- Graham Frye, PhD Biological Sciences (Lindberg)
- Cristina Hansen, PhD Biological Sciences (Hueffer)
- Christopher Latty, PhD Marine Biology (Hollmen)
- Stephanie Meggers, MS Fisheries (Seitz and Prakash)
- Dana (Nossov) Brown, PhD Biological Sciences (Kielland)
- Daniel Rizzolo, PhD Biological Sciences (Lindberg)
- Wilhelm Wiese, MS Wildlife Conservation (Hollmenn and Lindberg)

Graduated in CY 2015

- Sophie Gilbert, PhD Biological Sciences (Hundertmark)
- Tyler Lewis, PhD Biological Sciences (Lindberg)

Affiliated Post-Doctoral Researchers

- Jana Canary (Euskirchen)
- Cristina Hansen (Hueffer)
- Mark Lara (Euskirchen)
- Colin Tucker (Euskirchen)

Cooperators

- Brian Barnes–Director, Institute of Arctic Biology, University of Alaska Fairbanks
- Sam Cotten–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 2015. 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 US 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 US Geological Survey, a State fish and game agency, a host university, and the Wildlife Management Institute. Staffed by Federal personnel, Cooperative Research Units conduct research on renewable natural resource questions; participate in the education of graduate students destined to become natural resource managers and scientists; provide technical assistance and consultation to parties who have legitimate interests in natural resource issues; and provide continuing education for natural resource professionals. Presently, there are 40 Cooperative Research Units in 38 states, conducting research on virtually every type of North American ecological community. The Program is staffed by more than 100 PhD scientists who advise as many as 675 graduate student researchers per year.

Statement of Direction

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

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

Unit Cost-Benefit Statements

In-Kind Support

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

Benefits

Students Graduated: 7 (5, Unit faculty, and 2, cooperating faculty)
Presentations: 48
Scientific and Technical Publications: 22

Courses Taught

- Jeff Falke: Stream Fish Community Ecology (Spring 2015; 2 credits) and Physical Processes in Freshwater Ecosystems (Fall 2015; 3 credits)
- Dave McGuire: Interdisciplinary Modeling of High Latitude Global Change (Fall 2015; 4 credits)
- Abby Powell: Scientific Writing, Editing, and Revising in the Biological Sciences (Spring 2015; 3 credits)
- Mark Wipfli: Aquatic Entomology 665 (Fall 2015; 2 credits) and Climate Change Seminar (Fall 2015; 1 credit)

Honors and Awards

- Jeff Falke, USGS Performance Award, 2015.
- Kevin Fraley (MS Fisheries candidate advised by Jeff Falke):
    - Best Oral Presentation award, Alaska Chapter, 19th American Fisheries Society Student Research Symposium. Video-conference, April 2015.
    - Travel Grant, Western Division, American Fisheries Society, 2015 Annual Meeting.
    - Finalist for Best Student Paper Award, American Fisheries Society, 2015 Annual Meeting, Portland, OR, August 2015.
    - Rasmuson Graduate Student Fellowship, 2015.
- Sarah Laske (PhD Fisheries candidate advised by Mark Wipfli and Amanda Rosenberger), finalist for Best Student Paper awarded by the American Institute of Fishery Research Biologists (AIFRB) at the Alaska Chapter Annual Meeting, American Fisheries Society, Homer, AK, November 2015.
- Ben Meyer (MS Fisheries candidate advised by Mark Wipfli) won the AIFRB Best Student Poster award at the Alaska Chapter Annual Meeting, American Fisheries Society, Homer, AK, November 2015.
- Abby Powell
    - USGS Performance Award, 2015.
    - Outstanding Graduate Mentor and Advisor Award awarded by UAF College of Natural Science and Mathematics, December 2015.

Outreach and Info Transfer

- Jeff Falke: Chena River Watershed Resource Action Plan—The process included three 2.5-day workshops with the planning team to target areas in the Chena River Watershed (focusing on ecosystem-level resources), assess current and projected future health of the resources, identify critical threats, and develop conservation strategies to enhance health and abate threats. The workshops were held in November 2014, February 2015, and April 2015.
- Brad Griffith: Invited speaker in the session "From the boreal forest to the open ocean: How climate change impacts the Alaskan Arctic," The Conference on Global Leadership in the Arctic: Cooperation, Innovation, Engagement and Resilience (GLACIER) sponsored by the U.S. Department of State, Anchorage, AK. August 2015.

- Dave McGuire presented a webinar on "The Integrated Ecosystem Model (IEM) for Alaska and Northwest Canada: Current Status and Applications in Natural Resource Management and Policy" to the science coordinators of the DOI Landscape Conservation Cooperatives (LCCs) in Alaska and to natural resource managers in the region. The webinar provided information on the progress of the IEM project, the data sets that the project has produced, and how natural resource managers might make use of those data sets for assessing the potential impacts of climate change on the resources that they manage. The webinar was well-received, and an in-depth discussion followed about how data sets could be used to assess changes in ecosystem services in the Yukon Flats National Wildlife Refuge. April 2015.
- Mark Wipfli: Organizer and moderator of a special Fish-Forestry multi-agency workshop, which was a crucial gathering of DEC, ADFG, Department of Forestry, USFWS, USFS, TU, Native Corporations, private consultants, and NGOs to hammer out the co-management approaches to fisheries and forestry in coastal US. January 2015.

Papers Presented

Boldenow, M.L., R.B. Lanctot, A.S. Kitaysky, and A.N. Powell. 2015. Are winter conditions driving population trends in Semipalmated Sandpipers? Evidence from a feather corticosterone biomarker. 6th Western Hemisphere Shorebird Group Meeting, Wallops Island, VA, 12-16 September 2015. (Contributed Oral)

Bolton, R., M. Lara, H. Genet, V. Romanovsky, and A.D. McGuire. 2015. Conceptualization and initial application of the Alaska Thermokarst Model. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Contributed Poster)

Calef, M.P., A. Varvak, L. DeWilde, A.D. McGuire, and F.S. Chapin III. 2015. Variability in the geographic distribution of fires in Interior Alaska considering cause, human proximity, and level of suppression. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Contributed Poster)

Clawson, C., J. Falke, J. Rose, A. Martin, J. Cristóbal, and A. Prakash. 2015. Chandalar River Chum Salmon (*Oncorhynchus keta*) riverscape-scale salmon habitat assessment and monitoring. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November 2015. (Contributed Poster)

Conaway, C., T. Lorenson, C. Johnson, M. Waldrop, A.D. McGuire, M. Turetsky, E. Euskirchen, and P.W. Swarzenski. 2015. Application of electrical resistivity tomography in two wetland systems north of the Tanana River, Interior Alaska. Society on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP) Annual Conference, Austin, TX, 22-26 March 2015. (Contributed Poster)

Euskirchen, E.S., J.K. Roach, V. Patil, B. Griffith, and A.D. McGuire. 2015. Inclusion of additional plant species and trait information in dynamic vegetation modeling of Arctic tundra and boreal forest ecosystems. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Invited Oral)

Falke, J., J. Ching, M. Sparks, C. Cunningham, and P. Westley. 2015. Fine-scale resource selection by Sockeye Salmon (*Oncorynchus nerka*) in groundwater-fed ponds, Bristol Bay, Alaska. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November, 2015. (Contributed Poster)

Falke, J.A., and L.T. Bailey. 2015. Development and calibration of bioelectric impedance analysis as a measure of energetic status of Arctic Grayling

(*Thymallus arcticus*). American Fisheries Society Annual Meeting, Portland, OR, 17-20 August 2015. (Contributed Oral)

Falke, J.A., J.S. Perkin, K.B. Gido, H.J. Crockett, J.S. Sanderson, E.R. Johnson, and K.D. Fausch. 2015. Groundwater depletion in Western Great Plains projected to dry 250 stream-km of fish habitat in the next 45 years. American Fisheries Society Annual Meeting, Portland, OR, 17-20. August 2015. (Contributed Oral)

Fraley, K.M., J.A. Falke, R. Yanusz, and S. Ivey. 2015. Seasonal movements of Rainbow Trout (*Oncorhynchus mykiss*) in the Susitna River Basin, Southcentral Alaska. American Fisheries Society Annual Meeting, Portland, OR, 17-20 August 2015. (Contributed Oral)

Genet H., Y. Zhang, A.D. McGuire, Y. He, K. Johnson, D. D'Amore, X. Zhou, A. Bennett, F. Biles, N. Bliss, A. Breen, E.S. Euskirchen, T. Kurkowski, N. Pastick, S. Rupp, B. Wylie, Z. Zhu, and Q. Zhuang. 2015. The importance of permafrost thaw, fire and logging disturbances as driving factors of historical and projected carbon dynamics in Alaskan upland ecosystems. North American Carbon Program All Scientists Meeting, Washington, DC, 26-29 January 2015. (Contributed Oral)

Genet, H., A.D. McGuire, Y. He, K. Johnson, B. Wylie, N. Pastick, Q. Zhuang, Z. Zhu, and Y. Zhang. 2015. Identifying the main drivers of soil carbon response to climate change in arctic and boreal Alaska. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Contributed Poster)

Hayes, D., G. Chen, W. Kurz, G. Stinson, and A.D. McGuire. 2015. On the integration of inventory- and process- based approaches to determine Canada's full forest carbon budget and the forces that drive it. North American Carbon Program Meeting. Washington, DC, 26-29 January 2015. (Contributed Poster)

Hayes, D.J., C.E. Smyth, G. Chen, W.A. Kurz, A.D. McGuire, and G. Stinson. 2015. Improving the assessment of the State of the Carbon Cycle in North America by integrating inventory- and process- based approaches: A case study for Canada. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Contributed Poster)

Huntsman, B.M., J.A. Falke, J. Saveride, and K. Bennett. 2015. Density-dependent and -independent mechanisms influencing spawning habitat selection by Chinook Salmon (*Oncorhynchus tshawytscha*) in the Chena River basin, Alaska. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November 2015. (Contributed Oral)

Joy, P., W. Jones, C. Stricker, and M. Wipfli. 2015. Seasonal and landscape patterns of marine-nutrient assimilation in rearing juvenile Coho and Chinook Salmon in western Alaska. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November 2015. (Contributed Oral)

Koven, C.D., E.A.G. Schuur, C. Schadel, T.J. Bohn, E.J. Burke, G. Chen, X. Chen, P. Ciais, G. Grosse, J.W. Harden, D.J. Hayes, G. Hugelius, E.E. Jafarov, G. Krinner, P. Kuhry, D.M. Lawrence, A.H. MacDougall, S.S. Marchenko, A.D. McGuire, S.M. Natali, D.J. Nicolsky, D. Olefeldt, S. Peng, V.E. Romanovsky, K.M. Schaefer, J. Strauss, C.C. Treat, and M. Turetsky. 2015. A simplified, data-constrained approach to estimate the permafrost carbon-climate feedback: The PCN Incubation-Panarctic Thermal (Pinc-PanTher) Scaling approach. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Contributed Oral)

Lara, M.J., H. Genet, A.D. McGuire, E.S. Euskirchen, Y. Zhang, D. Brown, T. Jorgenson, V.E. Romanovksy, A.L. Breen, and W.R. Bolton. 2015. Thermokarst rates intensify due to climate change and forest fragmentation in an Alaskan boreal forest lowland. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Contributed Poster)

Laske, S., T. Haynes, A. Rosenberger, J. Koch, M. Wipfli, M. Whitman, and C. Zimmerman. 2015. Influence of surface water connectivity on fish species richness and assemblages on the Arctic Coastal Plain, Alaska. American Fisheries Society Annual Meeting, Portland, OR, 17-20 August 2015. (Contributed Oral)

Laske, S., A. Rosenberger, W. Kane, M. Wipfli, and C. Zimmerman. 2015. Top-down effects of Ninespine Stickleback on invertebrate communities of small Arctic ponds: An experimental approach. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November, 2015. (Contributed Oral)

Loboda, T., E. Kasischke, A.D. McGuire, H. Genet, and El. Hoy. 2015. The Alaska Forest Disturbance Carbon Tracking System. North American Carbon Program Meeting, Washington, DC, 26-29 January 2015. (Contributed Poster)

Luo et al. (including A.D. McGuire). 2015. Representing soil carbon dynamics in global land models to improve future IPCC assessments. North American Carbon Program Meeting, Washington, DC, 26-29 January 2015. (Contributed Oral)

Marchenko, S., D. Streletskiy, V. Romanovsky, A.D. McGuire, and N. Shiklomanov. 2015. The vulnerability of permafrost from 1960 to 2300 based on simulations of the process-based model GIPL2 across the permafrost region in the northern hemisphere: Implications for soil carbon vulnerability. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Contributed Poster)

Martin, A.N., J.A. Falke, J.W. Savereide, and J.A. Lopez. 2015. Estimating the distribution of juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) using habitat modeling and eDNA in an interior Alaska river basin. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November, 2015. (Contributed Oral)

McGuire, A.D., and Members of the Alaska Land Carbon Assessment Team. 2015. A synthesis of terrestrial carbon balance of Alaska and projected changes in the 21st century: Implications for climate policy and carbon management at local, regional, national, and international scales. North American Carbon Program Meeting, Washington, DC, 26-29 January 2015. (Contributed Poster)

McGuire, A.D., H. Genet, Y. He, S. Stackpoole, D. D’Amore, T.S. Rupp, B. Wylie, X. Zhou, and Z. Zhu. 2015. The Alaska Land Carbon Assessment: Baseline and projected future carbon storage and greenhouse-gas fluxes in ecosystems of Alaska. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Invited Oral)

McGuire, A.D., H. Genet, and Members of the Alaska Land Carbon Assessment Team. 2015. A synthesis of carbon balance of Alaska and projected changes in the 21st century: Implications for climate policy and carbon management at local, regional, national, and international scales. 17th International Boreal Forest Research Association Meeting, Rovaniemi, Finland, 24-29 May 2015. (Contributed Oral)

McGuire, A.D., D. Lawrence, E. Burke, G. Chen, E. Jafarov, C. Koven, A. MacDougall, D. Nikolsky, S. Peng, and A. Rinke. 2015. The temporal evolution of changes in carbon storage in the northern permafrost region simulated by carbon cycle models between 2010 and 2300: Implications for atmospheric carbon dynamics. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Contributed Oral)

Meyer, B., D. Rinella, and M Wipfli. 2015. Effects of temperature regime on juvenile Chinook and Coho Salmon growth in three geomorphologically distinct sub-basins of the Kenai River. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November 2015. AK AFS (Contributed Poster)

Neuneker, K., J. Falke, T. Jaecks, P. Richards, and P. Etherton. 2015. Distribution and movement rates of Chinook Salmon *Onchorhynchus tshawystcha* in the Stikine River based on radio telemetry. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November 2015. (Contributed Poster)

Olefeldt, D., S. Goswami, G. Grosse, D. Hayes, G. Hugelius, P. Kuhry, A.D. McGuire, V.E. Romanovsky, A.B.K Sannel, E.A.G. Schuur, and M.R. Turetsky. 2015. Thermokarst terrain: Circumpolar distribution and soil carbon vulnerability. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Invited Oral)

Pastick, N.J., M.T. Jorgenson, B.J. Minsley, B.K. Wylie, D.R.N. Brown, H. Genet, K.D. Johnson, A.D. McGuire, M.A. Kass, and J.F. Knight. 2015. Towards a better understanding of the sensitivity of permafrost and soil carbon to climate and disturbance-induced change in Alaska. Fall Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Contributed Poster)

Perkin, J.S., K.B. Gido, J.A. Falke, H.J. Crockett, J.S. Sanderson, E.R. Johnson, and K.D. Fausch. 2015. Groundwater depletion in Western Great Plains projected to dry 250 stream-km of fish habitat in the next 45 years. Society for Freshwater Science Annual Meeting, Milwaukee, WI, 17-21 May 2015. (Invited Oral)

Rine, K., M. Wipfli, E. Schoen, C. Stricker, J. Jones, and T. Nightengale. 2015. Patterns of cross-ecosystem food subsidies to rearing salmonids within a large glacial Alaskan river. American Fisheries Society Annual Meeting, Portland, OR, 17-20 August 2015. (Invited Oral)

Rine, K., M. Wipfli, E. Schoen, C. Stricker, and T. Nightengale. 2015. Patterns of cross-ecosystem food subsidies to rearing salmonids within a large glacial Alaskan river. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November 2015. (Contributed Oral)

Robinson, B., A. Powell, L. Phillips, and H. Coletti. 2015. Are prey remains accurate indicators of chick diet? Implications for long-term monitoring of Black Oystercatchers. 6th Western Hemisphere Shorebird Group Meeting, Wallops Island, VA, 12-16 September 2015. (Contributed Oral)

Schoen, E., M. Wipfli, K. Rine, and T. Nightengale. 2015. Pulsed food subsidies across a habitat mosaic shape growth opportunities for rearing salmon in a glacial Alaskan river. American Fisheries Society Annual Meeting, Portland, OR, 17-20 August 2015. (Invited Oral)

Schoen, E., M. Wipfli, K. Rine, and T. Nightengale. 2015. Pulsed food subsidies across a habitat mosaic provide heterogeneous growth opportunities for rearing salmon in a glacial Alaskan river. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November, 2015. (Contributed Oral)

Sellmer, K., M. Wipfli, E. Schoen, and A Lopez. 2015. Juvenile Chinook Salmon predation in freshwater within the AYK Region. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November, 2015. (Contributed Oral)

Sparks, M., P. Westley, J. Falke, and M. Adkison. 2015. Predicting Sockeye Salmon (*Oncorhynchus nerka*) hatch timing by incorporating natural variability into an existing model. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November 2015. (Contributed Poster)

Torvinen, E., J. Falke, C. Arp, M. Whitman, J. Adams and C. Zimmerman. 2015. Lake Trout (*Salvelinus namaycush*) otoliths as biochronological indicators of recent climate patterns in Arctic lakes. Alaska Chapter American Fisheries Society Annual Meeting, Homer, AK, 4-6 November 2015. (Contributed Oral)

Turetsky, M., A.D. McGuire, and D. Olefeldt. 2015. Assessing the contributions of thermokarst and thermo-erosion in permafrost feedbacks to climate. Fall

Meeting of the American Geophysical Union, San Francisco, CA, 14-18 December 2015. (Invited Oral)

Turetsky, M.R., D. Olefeldt, and A.D. McGuire. 2015. Pan-arctic trends in lake and wetland thermokarst: Implications for carbon storage and methane fluxes. Goldschmidt 2015 Conference, Prague, Czechoslovakia, 16-21 August 2015. (Contributed Oral)

Turetsky, M.R., E.A.G. Schuur, C. Schadel, A.D. McGuire, D. Olefeldt, and G. Hugelius. 2015. Recent synthesis of research on the permafrost carbon feedback. 68th Canadian Geotechnical Conference and 7th Canadian Permafrost Conference, Quebec City, Quebec, Canada, 20-23 September 2015. (Contributed Oral)

White, R., D. Russell, K. Gerhart, B. Griffith, and A. Gunn. 2015. Milk composition: Is it a tool to assess weaning strategies in relation to milk production and plane of nutrition? 14th Arctic Ungulate Conference, Roros, Norway, 17-21 August 2015. (Contributed Oral)

Wipfli, M., K. Heim, J. McFarland, S. Laske, and M. Whitman. 2015. Arctic Grayling movement and foraging ecology in Arctic Alaska. Advances in the Population Ecology of Salmonids, Girona, Spain, 25-29 May 2015. (Invited Oral)

Wipfli, M.S., K. Heim, J. McFarland, S. Laske, and M. Whitman. 2015. How important are prey subsidies for fishes in Arctic freshwater ecosystems? American Fisheries Society Annual Meeting, Portland, OR, 17-20 August 2015. (Invited Oral)

Woodall, C.W., S.M. Ogle, A.D. McGuire, H.E. Anderson, J.A. Smith, R. Pattison, G.M. Domke, and S.S. Saatchi. 2015. National greenhouse gas inventories in boreal forests: The US Experience in interior Alaska. 17th International Boreal Forest Research Association Meeting, Rovaniemi, Finland, 24-29 May 2015. (Contributed Oral)

Scientific Publications

Calef, M.P., A. Varvak, A.D. McGuire, F.S. Chapin III, and K.B. Reinhold. 2015. Recent changes in annual area burned in interior Alaska: The impact of fire management. Earth Interactions 19: Paper 5, 17 pp. doi:10.1175/EI-D-14-0025.1.

Churchill, A.C., M.R. Turetsky, A.D. McGuire, and T.N. Hollingsworth. 2015. Response of plant community structure and primary productivity to experimental drought and flooding in an Alaskan fen. Canadian Journal of Forest Research 45:185-193. doi:10.1139/cjfr-2014-0100.

Collins, S.F., A.M. Marcarelli, C.V. Baxter, and M.S. Wipfli. 2015. A critical assessment of the ecological assumptions underpinning compensatory mitigation of salmon-derived nutrients. Environmental Management 3:571-586.

Falke, J.A., R.L. Flitcroft, J.B. Dunham, K.M. McNyset, P.F. Hessburg, and G.H. Reeves. 2015. Climate change and vulnerability of bull trout (*Salvelinus confluentus*) in a fire-prone landscape. Canadian Journal of Fisheries and Aquatic Sciences 72:304-318.

Halm, D.R., and B. Griffith. 2014. Water-quality data from lakes in the Yukon Flats, Alaska, 2010–2011. U.S. Geological Survey Open-File Report 2014–1181, 6 pp. http://dx.doi.org/10.3133/ofr20141181.

He, Y., J. Yang, Q. Zhuang, A.D. McGuire, Q. Zhu, Y. Liu, and R.O. Teskey. 2014. Uncertainty in the fate of soil organic carbon: A comparison of three conceptually different decomposition models in a larch plantation. Journal of

Geophysical Research Biogeosciences 119:1892-1905. doi:10.1002/2014JG002701.

Heim, K.C., M.S. Wipfli, M.S. Whitman, C.D. Arp, J. Adams, and J.A. Falke. 2015. Seasonal cues of Arctic Grayling movement in a small Arctic stream: The importance of surface water connectivity. Environmental Biology of Fishes 99:49-65.

Heim, K.C., M.S. Wipfli, M.S. Whitman, and A.C. Seitz. 2014. Body size and condition influence migration timing of Arctic grayling. Ecology of Freshwater Fish. DOI: 10.1111/eff.12199. First published online 7 November 2014.

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Theses and Dissertations of Unit-Sponsored Graduate Students

Churchwell, R.T. 2015. Stopover ecology of Semipalmated Sandpipers (*Calidris pusilla*) at coastal deltas of the Beaufort Sea, Alaska. PhD dissertation, University of Alaska Fairbanks. 149 pp.

Craig, H. 2015. Breeding ecology of Smith's longspurs (*Calcarius pictus*) in the Brooks Range, Alaska. MS thesis, University of Alaska Fairbanks. 77 pp.

Fraley, K. 2015. Seasonal movements and habitat use of rainbow trout in the Susitna River basin, southcentral Alaska. MS thesis, University of Alaska Fairbanks. 107 pp.

Gilbert, S. 2015. Environmental drivers of deer population dynamics and spatial selection in Southeast Alaska. PhD dissertation, University of Alaska Fairbanks. 161 pp.

Lewis, T. 2015. Trophic dynamics of boreal lakes in a changing northern landscape — impacts of lake drying and forest fires. PhD dissertation, University of Alaska Fairbanks. 221 pp.

McFarland, J. 2015. Trophic pathways supporting Arctic grayling in a small stream on the Arctic Coastal Plain, Alaska. MS thesis, University of Alaska Fairbanks. 56 pp.

Rine, K. 2015. Trophic pathways supporting juvenile Chinook and Coho Salmon in the glacial Susitna River, Alaska: Patterns of freshwater, terrestrial, and marine resource use across a seasonally dynamic habitat mosaic. MS thesis, University of Alaska Fairbanks. 82 pp.

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

Seasonal Movements and Habitat Use of Rainbow Trout in the Susitna River Basin, Southcentral Alaska

Student Investigator: Kevin Fraley, MS Fisheries
Advisor: Jeff Falke
Funding Agencies and Partners: ADFG; MatSu Salmon Habitat Partnership (RWO 202)
In-Kind Support: Personnel, boats, logistics provided by Sport Fish Division, ADFG Region 2

Note: Kevin Fraley graduated from the University of Alaska Fairbanks in December 2015. His thesis abstract follows:

Potamodromous Rainbow Trout are an important ecological and recreational resource in freshwater systems of Alaska, and increased human development, hydroelectric projects, declining Pacific salmon stocks, and climate change may threaten their populations. We used aerial and on-the-ground telemetry tracking, field-measured and remotely-sensed aquatic habitat characteristics, snorkel surveys, and resource selection and occupancy models to characterize seasonal movements and habitat use of adult Rainbow Trout (>400 mm FL) at multiple spatial and temporal scales across the large (31,221 km2) and complex Susitna River basin of southcentral Alaska during 2003-2004 and 2013-2014. We found that trout overwintered in mainstem habitats near tributary mouths from November to April. After ice-out in May, trout ascended tributaries up to 51 km to spawn, and afterward moved downstream to lower tributary reaches to intercept egg and flesh subsidies provided by spawning salmon in July and August. Trout transitioned back to mainstem overwintering habitats at the onset of autumn when salmon spawning activity waned. Fidelity to tributary of capture varied across seasons, but was high in three out of four drainages. Different habitat characteristics influenced Rainbow Trout habitat use during each season, including stream gradient and sinuosity in the winter, substrate suitability and sinuosity during spawning, mean annual flow during the pre-salmon feeding season, and Chinook salmon spawning potential after the arrival of adult salmon in freshwater. We found that during the ice-free feeding season trout responded to fine-scale (channel unit) characteristics rather than more coarse-scale (stream reach) variables. Weekly movements were significantly longer when spawning salmon were present compared to pre-arrival. We found no difference in movements and habitat use for a subset of fish for which sex was identified using genetic analysis. However, the observed sex ratio was heavily female-biased, which contrasts with what has been observed in other non-anadromous salmonid populations. As most trout undertake extensive movements within and among tributaries and make use of a variety of seasonal habitats to complete their life histories, it will be critical to take a broad and multiscale approach to their management in light of anticipated future land use and climate change.

Trophic Pathways Supporting Juvenile Chinook and Coho Salmon in the Glacial Susitna River, Alaska: Patterns of Freshwater, Terrestrial, and Marine Resource Use across a Seasonally Dynamic Habitat Mosaic

Student Investigator: Kristin Rine, MS Wildlife Biology
Advisor: Mark Wipfli
Funding Agency: Alaska Energy Authority (AEA)

Note: Kristin Rine graduated from the University of Alaska Fairbanks in December 2015. Her thesis abstract follows:

In large, seasonally dynamic and spatially complex watersheds, the availability and relative importance of various food resources for stream fishes can be expected to vary substantially. While numerous studies have attempted to uncover the trophic linkages that support stream salmonids, much of these efforts have occurred at small scales that disregard variability of food resources inherent in lotic systems. This study aimed to determine large-scale patterns in the contributions of freshwater, terrestrial, and marine-derived food resources to juvenile Chinook and Coho salmon (*Oncorhynchus tshawytscha* and *O. kisutch*) in the large, glacially influenced Susitna River, Alaska. I quantified diet patterns both spatially, across different macrohabitat types positioned along a 169-km segment of the river corridor, and temporally, from June to October, using stable isotope and stomach content analyses. To further resolve energy pathways from basal carbon sources to juvenile salmon, I determined the relative roles of terrestrial organic matter and freshwater periphyton food sources to aquatic benthic invertebrate diets. The latter analysis showed that invertebrate consumers were more reliant on freshwater periphyton than on terrestrial organic matter. Bayesian stable isotope mixing models indicated that juvenile salmon in the middle Susitna River were, in turn, largely supported by freshwater invertebrate prey regardless of spatial and temporal context. The relative contribution of marine-derived prey (salmon eggs) to juvenile salmon diets was greatest in the fall within tributary mouth and off-channel macrohabitats during both years of the study. Terrestrial invertebrate prey contributions were generally greatest during mid-summer within all macrohabitat types sampled, however this pattern varied across years. No upstream to downstream diet pattern was apparent from the data. These results underscore the importance of freshwater energy pathways for sustaining juvenile Chinook and Coho salmon in the Susitna River and provide further spatial and temporal context for the importance of pulsed marine and terrestrial prey subsidies. As Pacific salmon stocks continue to decline, management and mitigation efforts should operate on knowledge gained from studies that encompass the largescale spatial and temporal variability inherent in riverine landscapes.

Development and Calibration of Bioelectrical Impedance Analysis as a Measure of Energetic Status of Arctic Grayling (*Thymallus arcticus*)

Student Investigator: Lauren Bailey, BS Fisheries (Intern)
Advisor: Jeff Falke
Funding Agency: USGS, Cooperative Research Unit Program
In-Kind Support: Fish sample collection, site access: ADFG

The energetic status of fish is represented by the energy stored as protein and lipids and reflects an individual's ability to reproduce, migrate, and transition through life stages, and ultimately influences survival. Currently, little information exists on how the energetic status of individuals varies across seasons and life stages. Traditional methods, such as proximate analysis, while highly accurate, can be time consuming, expensive, and lethal. Nonlethal methods, like condition factor, are often imprecise. We used bioelectrical impedance analysis (BIA) to characterize the energetic status of Arctic Grayling (*Thymallus arcticus*) and provide researchers a non-lethal method of accurately assessing condition. As a first step, we developed statistical models specific to Arctic Grayling that describe the relationship between BIA readings and estimates of energy content based on proximate analysis (e.g., percent dry mass and lipids). We collected 160 grayling (range 142-435 mm FL) from four interior Alaska river basins during early summer and fall 2013 and used multiple regression and model selection to evaluate the efficacy of BIA readings to predict dry mass (%) estimated from proximate analysis. Our results indicated that BIA readings are a precise (RMSE = 1.5%) estimate of dry mass for Arctic Grayling. Moreover, our analysis showed that fish energy density varied across seasons, basins, and sex; these results were not evident based solely on length-weight indices. Overall, the BIA approach shows promise as a rapid, precise, and non-lethal measurement of energy density for Arctic Grayling.

Pulsed Food Subsidies Across a Habitat Mosaic Provide Heterogeneous Growth Opportunities for Rearing Salmon in a Glacial Alaskan River

Post-Doctoral Researcher: Erik Schoen
Student Investigator: Kristin Rine, MS Wildlife Biology
Faculty: Mark Wipfli
Funding Agency: Alaska Energy Authority (AEA)
In-Kind Support: ADFG, R2 Resource Consultants, Golder Associates, and Alaska Earth Sciences

The State of Alaska has proposed constructing a hydroelectric dam on the Susitna River, but little information exists on energy flow within the river's food webs and how changes in hydrology might affect them. Further, little is known about how environmental drivers influence food resources and affect the growth and productivity of salmonids in large glacial floodplain rivers. Hydropower operations may alter the habitat and food supply of economically important fish species. Knowledge of existing trophic relationships and the environmental limitations on salmonid productivity are necessary to inform mitigation efforts. The objectives of this study were to (1) compare patterns of energy flow from freshwater, terrestrial, and marine sources to stream salmonids among macrohabitat types along the river corridor, (2) describe spatial and temporal variability in diet and growth of stream salmonids, and (3) determine how water temperature, food availability, and food quality influence growth of salmonids. In 2013 and 2014, we measured aquatic habitat characteristics and quantified diet composition and growth patterns of juvenile Chinook and Coho Salmon, Rainbow Trout, and Arctic Grayling. We also sampled tissues of major food web components for stable isotope analysis. Juvenile salmon primarily consumed aquatic invertebrates, seasonal pulses of terrestrial invertebrates, and salmon eggs. Surprisingly, juvenile Chinook Salmon reared not only in clear tributaries and sloughs, but also in the glacially turbid mainstem. Salmon growth rates differed substantially between warm and cool years and among macrohabitat types. This study provided baseline information for evaluating potential effects of the proposed dam on food webs, energy flow, and fish resources in the Susitna River. Understanding how environmental factors interact to provide a mosaic of growth opportunities within complex watersheds is important for managing fish stocks and their habitats, particularly in the face of environmental change.

Ongoing Aquatic Studies

Marine-Derived Nutrient 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; Norton Sound Economic Development Corporation (NSEDC)

Marine-derived nutrients (MDN) imported to freshwater systems by migrating salmon can affect growth and survival of juvenile salmon. The effects on stock productivity, however, have not been assessed. Given that larger smolt are associated with higher marine survival, understanding the effects of MDN on juvenile growth, size, and abundance may ultimately improve management. The objectives of this study were to identify the degree, route, and effects of MDN assimilation in a naturally rearing salmon population. A simulation study of spawner-recruit data was used to examine if MDN from Pink Salmon were influencing productivity of Coho Salmon in Norton Sound. Within the Unalakleet River MDN assimilation was assessed with stable isotopes, gut fullness was assessed with stomach content analysis, growth was assessed through RNA:DNA ratios, and length frequency analysis and condition was assessed via length:weight relationships. Simulation results demonstrated that observed relationships between Pink and Coho Salmon are most likely from MDN. Seasonal fluctuations of MDN in the Unalakleet River were related to spawner density and escapement levels, with MDN retention greatest in areas with substantial off-channel habitat. Gut fullness in juvenile salmon was significantly correlated with MDN levels. Growth rates, but not fish condition, was related to MDN levels, although fish condition was related to stomach fullness. Results from this study help quantify MDN effects on Chinook and Coho Salmon stock productivity and provide a basis for improving management in a multi-species framework.

Predation Mortality as a Potential Source of Chinook Salmon Declines in the Arctic-Yukon-Kuskokwim Region

Post-Doctoral Researcher: Erik Schoen
Research Technician: Kristen Sellmer
Faculty: Mark Wipfli
Funding Agency: ADFG and USFWS
In-Kind Support: ADFG, NSEDC, and subsistence and sport fishers in Eagle, Unalakleet, and Fairbanks

Chinook Salmon populations have recently declined throughout Alaska, particularly in the Arctic-Yukon-Kuskokwim (AYK) region. Predation can represent an important source of mortality for juvenile salmon during their freshwater residence, but little is known about the predators of juvenile Chinook Salmon in the AYK region. The recent Chinook Salmon declines in the AYK region have led to closures of subsistence, commercial, and sport fisheries, causing significant economic and cultural hardship. Many piscivorous freshwater fish species in the region are also harvested, so their predation impacts on juvenile salmon, if significant, could potentially be influenced through changes in fishery management. The objectives of this study were to (1) quantify the diet composition of key piscine predators in the AYK region, with a focus on predation on juvenile Chinook Salmon, and (2) determine if the diets of these predators vary by season, habitat, or predator size**.** We sampled 548 Arctic Grayling, Burbot, Dolly Varden, and Northern Pike during 2014 and 2015 in the Chena, Tanana, upper Yukon, and Unalakleet Rivers and their tributaries. We sampled stomach contents non-lethally and collected stomachs from fish harvested by subsistence and sport fishers. We identified prey items in the lab using morphology and genetic sequencing. Chinook Salmon were present but infrequent in the stomach contents of Arctic Grayling, Burbot, and Northern Pike at interior sampling sites, but were not detected in Grayling or Dolly Varden stomachs from the Unalakleet River. Most predation was documented during May and September, periods of juvenile salmon movement. Pike and Chinook Salmon rarely co-occurred, suggesting predation may exclude salmon from preferred pike habitat. Determining what factors affect predation risk can help managers understand how other fish species might influence Chinook Salmon populations. Climatic and habitat changes that expand the distribution of piscivores such as Pike may have negative consequences for Chinook and other salmon.

Movement, Habitat Selection and Foraging Ecology of Broad Whitefish (*Coregonus nasus*) in the Colville River, Alaska

Student Investigator: Jason Leppi, PhD Fisheries
Co-Advisors: Mark Wipfli and Dan Rinella
Funding Agencies and Partners: BLM; Alaska Science Center, USGS; The Wilderness Society; EPSCoR

Subsistence fisheries provide an important food resource for communities on Alaska's Arctic Coastal Plain. Despite the historical importance of the Colville River's summer run of Broad Whitefish to the native community of Nuiqsut, their basic ecology remains poorly understood. This study, conducted in the Colville River, addresses three main questions: (1) What are the seasonal migration and life history patterns of Broad Whitefish? (2) Where are critical freshwater habitats and what local and landscape attributes are associated with these habitats? (3) Are anadromy and marine food resources important for Broad Whitefish? In this ongoing study we are targeting migratory fish in summer and winter riverine habitats; sampling diet, muscle tissue for stable isotope dietary analysis, otoliths for strontium signatures; and using radio transmitters to determine seasonal movements among habitat types. Preliminary results from gonadosomatic indices show that adult non-spawning and pre-spawning fish migrate up the lower Colville River during July but that only pre-spawning fish continue through the middle Colville River during August to access upstream spawning habitat. These results will help guide future tagging efforts, and samples collected will be important to understand Broad Whitefish life history patterns. Climate change and petroleum development are expected to alter freshwater habitats and identifying key habitats is critical to better understand impacts to this important subsistence resource.

The Role of Environmental Processes in Structuring the Distribution of Chinook Salmon Spawning and Rearing Habitats across a Large Alaska River Basin

Post-Doctoral Researcher: Brock Huntsman
Faculty: Jeff Falke
Funding Agency: State of Alaska
In-Kind Support: Logistical support provided by ADFG Region 3; USFWS

Chinook salmon (*Oncorhynchus tshawytscha*) are an important commercial, subsistence, and recreational fishery resource in Alaska. Substantial declines in escapement from many Alaskan watersheds in recent years have resulted in closures of Chinook Salmon fishing in more imperiled drainages, such as the Chena River, Alaska. Environmental factors such as flow and temperature are important mechanisms that influence fish population dynamics in stream ecosystems. A better understanding of the relative role of physical processes in Chinook salmon population distribution and dynamics in the Chena River basin is warranted. Study objectives are to (1) develop spatially continuous metrics that describe historic, current, and future physical habitat, and flow and temperature regimes within the Chena River basin; and (2) investigate the relative role of spatial, physical, and biological processes in describing Chinook Salmon population dynamics and distributions. Stream temperature loggers were deployed at >50 sites throughout the Chena watershed in summer 2013 and 2014, and retrieved during summer 2015. Based on these data we will develop a predictive model of stream thermal regimes to investigate riverscape-scale patterns in juvenile salmon bioenergetic performance. Flow regimes were modelled with a macro-scale hydrologic model downscaled to stream reaches of 100-1000 m. Lastly, juvenile Chinook Salmon were collected from 24 sites longitudinally along the Chena main stem in summer 2015 to assess environmental and density-dependent factors influencing population dynamics and distributions. Discharge predictions were similar to observed discharge at USGS gauging stations. These data along with thermal regimes from network temperature models will allow for modeling density-independent factors influencing spatial population dynamics of Chinook Salmon throughout the Chena River. A manuscript on density-dependent habitat selection of spawning Chinook Salmon is nearly ready for submission, and analysis of juvenile Chinook Salmon dynamics data collected in 2015 is in progress. The results of this study will help identify mechanisms limiting Chinook salmon productivity within the Chena watershed.

Development of Rapid-Assessment Methods to Estimate the Distribution of Juvenile Salmon in River Networks

Student Investigator: Allison (Martin) Matter, MS Fisheries
Advisor: Jeff Falke
Funding Agency: Sport Fish Division, ADFG
In-Kind Support: Logistical support provided by ADFG Region 3

Identifying and quantifying distributions of organisms through time and across space is challenging when scale, species, and budgetary constrictions are considered. Newly developed non-traditional techniques (e.g., environmental DNA; eDNA) can reduce costs and effort without causing harm to the study species while increasing detectability (i.e., probability of observing an individual). Owing to declining stocks and general lack of knowledge of processes driving freshwater

Allison Matter snorkeling for juvenile Chinook salmon, Monument Creek near Chena Hot Springs, AK. Photo by Jeff Falke.

mortality, a better understanding of the environmental features (i.e., physical habitat) that support high-quality Chinook Salmon rearing habitats in the Chena River basin is warranted. Study objectives are to (1) develop an intrinsic potential (IP) model from the literature for the Chena River to estimate the distribution of Chinook Salmon rearing habitats and aid with sample site prioritization, (2) use eDNA to assess presence/absence of juvenile salmon in tributaries, and (3) determine the distribution of rearing juvenile Chinook Salmon within tributaries via calibrated snorkel surveys. Predictive models of juvenile habitat intrinsic potential (IP) will be built based on covariates representing immutable factors of the physical environment derived from a digital landscape model parameterized for the Chena River basin (NetMap). Model results will be used to predict the upstream and downstream limits of juvenile Chinook Salmon rearing habitats. Sampling will be conducted using rapid-assessment methods such as snorkeling and eDNA analysis under an occupancy estimation framework. The IP model predicted over 900 stream-km in the basin to support high-quality (IP > 0.75) rearing habitat. Occupancy estimation based on eDNA samples indicated that 80.2% (± 9.6 SE) of previously unsampled sites classified as high IP were occupied, supporting the utility of this model framework. The probability of detection of Chinook Salmon DNA from three replicate water samples was high (0.74 ± 0.05 SE) but varied with tributary area. Information resulting from this study will inform managers of where critical habitats occur along the riverscape and which are occupied, and will lead to a better understanding of juvenile salmon ecology and improved management of the fisheries that rely on Yukon River Chinook Salmon stocks.

Chandalar River Fall Chum Salmon Riverscape-Scale Habitat Assessment and Monitoring

Student Investigator: Chelsea Clawson, MS Fisheries
Advisor: Jeff Falke
Funding Agency: USFWS

Drastic declines in Chinook Salmon (*Oncorhynchus tshawytscha*) stocks over the past decade have resulted in closures or severe restrictions to subsistence, commercial, and recreational fisheries throughout the region. In light of these conservation efforts, many subsistence users are relying more on other salmon species such as Chum (*O. keta*) and Coho (*O. kisutch*) Salmon. All three species are discrete spawners, utilizing hyporheic groundwater upwellings to provide their eggs and juveniles proper water temperatures for thermal refugia (e.g. incubation, rearing) throughout the winter months. As a result, the abundance and location of these upwellings are likely a density-dependent factor for these stocks, yet little is known of their spatial distribution nor their relationship with spawning site selection.

The Chandalar River has been shown to produce over 30% of Fall Chum Salmon in the Yukon River basin. Mapping the abundance and location of groundwater upwellings on the Chandalar River and the occurrence of spawning Fall Chum Salmon will help guide future management decisions to mitigate potential population declines. Study objectives are to (1) map thermal variability in river temperatures across the core Fall Chum Salmon spawning area of the Chandalar River using remote sensing; (2) validate and calibrate imagery by measuring habitat characteristics throughout a sub-set of core spawning areas; and (3) use aerial surveys to count spawning Fall Chum Salmon and evaluate physical and biological factors that influence their occurrence and abundance. Longitudinal patterns of thermal variability and locations of groundwater discharge zones will be mapped using Forward-Looking Infrared (FLIR). On-the-ground water chemistry, interstitial gravel temperature, and velocity measurements will be used to validate FLIR imagery. Aerial surveys will be conducted to quantify Fall Chum spawning distribution and abundance and to relate spawning locations to groundwater discharge zones. FLIR imagery was collected in 2014 and 2015, and processing is currently underway. On-the-ground water chemistry, water temperature, and velocity measurements were collected during September 2015 and will be used to validate FLIR imagery. Interstitial gravel temperature loggers will be retrieved in March 2016. Aerial surveys were conducted in 2013-2015. Results of this work will contribute toward a long-term plan to monitor Chum Salmon spawning and rearing habitat (i.e., upwellings) in the Chandalar River to allow resource managers to better understand potential effects of future climate change in the region.

Genetic Diversity and Population Relationships of Resident Kokanee and Anadromous Sockeye Salmon in Copper Lake (Wrangell-St. Elias National Park)

Student Investigator: Genevieve Johnson, MS Fisheries
Co-Advisors: Jeff Falke and Andrés López
Funding Agency: National Park Service

Copper Lake in the Wrangell-St. Elias National Park (WSTP) is thought to be home to a population of Kokanee Salmon, a non-migratory (i.e., resident) form of Sockeye Salmon. Field surveys have produced small Sockeye Salmon specimens in reproductive condition. Whether these fish belong to a self-perpetuating population of resident salmon or to a sockeye population that expresses both migratory and non-migratory life history variants remains to be determined. The specific objectives of this study are to (1) conduct an assessment of genetic variability in Sockeye Salmon populations of the Copper and Tanada Lakes, (2) compare measures of genetic variation in the target lakes with previously published estimates of variation in other populations of the target species, and (3) determine the degree of differentiation of Copper Lake Sockeye Salmon populations when compared to other populations in the drainage. Methods include:

1. Field surveys—in collaboration with the National Park Service we will conduct field sampling in Tanada and Copper Lakes to obtain tissue samples from resident and migratory Sockeye Salmon. Fish that may be confidently assigned to the resident category based on size, morphology, and spawning condition will be analyzed separately. Surveys will use non-lethal sampling and will aim to assemble the largest set of individual samples feasible during one field season.
2. Generate a dataset consisting of genotypes from 14 loci (microsatellite) for a sample of at least 50 individuals from Tanada and Copper Lakes.

3. Computational analysis of multi-locus genotypes. Each dataset will be checked for potential lab-generated artifacts. From genotypes in verified and vetted datasets, measures of diversity (e.g. heterozygosity, allelic richness) will be calculated. Indices of fixation (e.g. Fst and related measures) will be calculated to estimate degree of differentiation.

We have obtained preserved tissue samples from 100 Copper drainage sockeye spawners and from 50 Copper Lake kokanee. We have isolated high quality total genomic DNA from the entire sample set and evaluated quantity from each DNA preparation. We have completed preliminary amplification of the 14 target microsatellite loci and optimized reaction conditions for genotype determinations. We are currently carrying out the genotype determinations for the full set of tissues and expect to have a complete data set for analysis by May 2016. This project aims to produce a thorough baseline assessment of Sockeye Salmon genetic variability in Copper and Tanada Lakes using suites of genetic markers widely deployed for Sockeye Salmon assessments in the state. The resulting measures of genetic diversity (from multi-locus genotypes) will be summarized in indices of variation within and between groups (e.g. lakes, resident vs. migratory, drainage), which serve as estimates of the degree of genetic differentiation between groups.

Completed Wildlife Studies

Stopover Ecology of Semipalmated Sandpipers (*Calidris pusilla*) at Coastal Deltas of the Beaufort Sea, Alaska

Student Investigator: Roy Churchwell, PhD Biology
Advisor: Abby Powell
Funding Agencies: USFWS; BOEM; USGS; and Arctic Landscape Conservation Cooperative (LCC)
In-kind Support: USFWS provided housing and logistical support

Note: Roy Churchwell graduated from the University of Alaska Fairbanks in December 2015. His dissertation abstract follows:

Avian migration is one of the wonders of the natural world. Stored fats are the main source of nutrients and fuel for avian migration and it is assumed the fat deposition at stopover sites is a critical component of a successful migration. Stopover sites are crucial in the successful migration of many birds, but particularly for arctic-breeding shorebirds that migrate long distances from breeding to wintering grounds. Despite the importance of stopover sites, it is often difficult to determine the importance of these sites to migrating shorebirds.

I investigated three aspects of stopover ecology of Semipalmated Sandpipers (*Calidris pusilla*) foraging at coastal deltas on the Beaufort Sea coast, Alaska. First, I quantified the spatial and temporal distribution and abundance of the benthic macroinvertebrate community living within the mudflats. I found that there were two ecological groups of macroinvertebrates using river deltas, one originated in terrestrial freshwater habitats and most importantly could withstand freezing in delta sediments over the winter, and the other originated from the marine environment, could not withstand freezing and had to migrate to intertidal habitats each summer from deeper water areas that did not freeze over the winter. Stable isotope analysis allowed me to describe the origin of carbon consumed by invertebrates in intertidal habitats. I predicted freshwater invertebrates would consume terrestrial carbon, and marine invertebrates would consume marine carbon, but I found that both groups utilized the same carbon, which was a mixture of terrestrial and marine sources. My second research question determined the importance of delta foraging habitat for fall migrating Semipalmated Sandpipers. I mapped the temporal distribution and abundance of birds and quantified this relationship to invertebrate distribution and abundance. I researched fattening rates of shorebirds by measuring triglycerides in the blood of shorebirds I captured. I hypothesized that triglyceride levels would be correlated with invertebrate abundance and related to habitat quality; however, I found no relationship. Next, I determined shorebird dependence on marine invertebrates using the stable isotope signature of invertebrates and shorebird plasma. I found that shorebird abundance was associated with invertebrate abundance, and that shorebirds did feed almost exclusively on invertebrates from the mudflats later in the season. I did not find a significant difference in habitat quality among the deltas, although more birds were counted at the Jago Delta than at the other two deltas. Finally, I researched the question of how change in water levels due to lunar tides and storm surge events impacted the availability of foraging habitat. I assessed the phenology of Semipalmated Sandpiper migration and how this related to the availability of forage based on abundance, distribution, and accessibility of macroinvertebrates. There was a significant decline in the calories available for forage when there was a lunar tide and when there was a storm surge event. The most foraging habitat was available late in the migration period, while the peak in Semipalmated Sandpiper

migration was early in the period. Late in the season there is also a greater chance of a storm surge event occurring due to the lack of sea ice during that period. In summary, I found Beaufort Sea deltas were more diverse than I expected both in macroinvertebrate community and in how shorebirds use the available foraging habitat. After completing this research I feel this habitat is critical to Semipalmated Sandpiper migration; however, there is a real risk of extensive change to these deltas due to future warming with negative consequences for shorebirds.

Breeding Ecology of Smith's Longspurs (Calcarius Pictus) in the Brooks Range, Alaska

Student Investigator: Heather Craig, MS Wildlife Biology
Advisor: Abby Powell
Funding Agency: USGS
In-Kind Support: Additional support provided by USFWS and BLM

Note: Heather Craig graduated from the University of Alaska Fairbanks in August 2015. Her thesis abstract follows:

Alaska's arctic ecosystem provides critical habitat for nesting songbirds. However, within this region climate change projections indicate a shrubbier future, as well as major shifts in summer weather patterns. The polygynandrous Smith's Longspur (*Calcarius pictus*) is a little-known species that is closely tied to treeless tundra habitat in northern Alaska. I evaluated Smith's Longspur dispersal ability and annual survival rates using seven years of banding data, as well as breeding habitat requirements and reproductive success in two populations in the Brooks Range. Most adults (88%; n = 34) returned to nest in the same breeding neighborhood as previous years, and dispersal distance ($\bar{\chi}$ ± SE = 301 ± 70 m) did not differ between sexes. Only 4% of juvenile birds were resighted as adults and dispersal distance ($\bar{\chi}$ = 1674 ± 500 m; n = 6) was significantly greater for juveniles than for adults. From 674 capture-recapture histories, I evaluated annual survival and found that adult female survival (50-58%) was only slightly lower than for males (60-63%); juvenile survival was 41%, but was also paired with a low (13%) encounter probability. I examined nest-site selection patterns by comparing habitat measurements from 86 nests to paired random points within the nest area. Nests were typically found in open low shrub tundra and never among tall shrubs (height of tallest shrub $\bar{\chi}$ = 26.8 ± 6.7 cm). However, the only predictor of nest location I found was variation in willow height, which was slightly lower at nests than at random points. Daily nest survival rates were estimated from 257 nests and found to be relatively high (0.97–0.99) and consistent across years, and the best approximating model indicated that nest survival was negatively related to the numbers of days below freezing and season date. Despite dispersal ability and resilience to harsh conditions, Smith's Longspurs' response to climate change is unknown. The lack of sex-bias in dispersal and the low sex bias in survival, as well as the weak nest-site selection, may be attributed to the species' social mating system. Unlike most songbirds, multiple inter-mated individuals exist within each breeding neighborhood, altering social dynamics and likely demographic patterns. This is the first study to investigate the breeding biology of Smith's Longspurs at the western extent of their range and provides important conservation information as Arctic regions change.

Ongoing Wildlife Studies

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

Student Investigator: Christopher M. Harwood, MS Wildlife Biology
Advisor: Abby Powell
Funding Agencies: USFWS; UA Foundation; Arctic Audubon Society
In-Kind Support: AKCFWRU

Studies of Whimbrel breeding ecology are limited in North America (especially in Alaska), despite multiple official designations as a species of conservation concern (U.S., Canada, and Alaska). This research addresses critical information gaps identified in conservation status reviews of Whimbrels including breeding distribution, habitat associations, and nesting success. Our first objective was to establish benchmark metrics on the breeding ecology of a boreal population of Whimbrels at Kanuti National Wildlife Refuge for 2011–2012. In 2013 we attempted to identify and characterize breeding locations for interior Alaska. Most recently we are summarizing habitat features and the avifaunal community for count points surveyed in 2013 for Whimbrels along interior Alaska's road system. We are also using multivariate logistic regression to assess factors possibly important at points where Whimbrels were found. Whimbrels were detected on 42 of 279 count points, with new breeding locations identified for the Dalton and Elliot Highways; none were detected at points along the Steese or Taylor Highways. The most promising area for future research was Stampede Road, just north of Denali National Park and Preserve. Additional analyses are pending. There is a paucity of information about the distribution and ecology of boreal-breeding shorebirds, including Whimbrels, in Alaska. Our most recent work will update the state of knowledge for Whimbrels, and again highlight the need for more study of shorebirds in the Interior.

Reproductive Success of Arctic-breeding Shorebirds in a Changing Climate

Student Investigator: Kelly Overduijn, MS Wildlife Biology and Conservation
Advisor: Abby Powell
Funding Agency: Alaska Science Center, USGS (RWO 194)

Worldwide, declines in shorebird populations, including Arctic-breeding species, have become apparent. Reductions in the quantity and quality of open tundra habitat and changes in prey availability may adversely affect shorebird reproduction and exacerbate current population declines. Habitat change can alter the abundance of prey that are available to shorebirds and change the quantity and quality of potential nesting and brood-rearing areas. This work will contribute to understanding the habitat needs of two shorebird species. The objective of this research is to evaluate how the reproductive success of American Golden Plover (*Pluvialis dominica*) and Pacific Golden Plover (*P. fulva*) is influenced by climate-mediated effects on the vegetation structure and prey availability for these species. We monitored reproductive success, classified habitat in nesting and brood-rearing areas, and collected arthropods throughout two breeding seasons (2012-2013) across an elevational gradient. We found that both species of plovers select nest-sites that are higher and drier than the available habitat within their nesting territories. Data analysis and writing will continue through summer 2016. This research will elucidate the importance of vegetation structure on shorebird habitat use, implications for reproductive success, and the effects of seasonal phenology changes on shorebird breeding ecology.

Chick Diet and Productivity of Black Oystercatchers in Kenai Fjords National Park

Student Investigator: Brian Robinson, MS Wildlife Biology
Advisor: Abby Powell
Funding Agency: Kenai Fjords National Park, NPS

Monitoring strategies are critical to the conservation and management of many species. Yet these monitoring efforts must provide unbiased information while being cost-effective and time-efficient. The collection of prey remains at nest sites is a simple and widely used method for monitoring the diet of Black Oystercatcher chicks; however, these estimates may be subject to biases. Identifying biases can lead to refinement of monitoring protocols and ensure robust interpretation of monitoring data. To determine the accuracy of prey remains in estimating chick diet, we compared it with two methods commonly used to characterize diet: direct observation of parents feeding young, and diet reconstruction by stable isotope analysis. From May to August 2014, we collected prey remains at nests, conducted provisioning observations, and collected blood plasma samples from a population of Black Oystercatchers in Kenai Fjords National Park and adjacent islands. In 2015, we completed statistical analyses. Prey composition of broods differed by methodology. Collections of prey remains overestimated the proportion of limpets in diet (63% for prey collections vs. 37%, 17% for observations and stable isotopes respectively), underestimated the proportion of barnacles (1% vs. 6%, 16% respectively), and failed to detect soft-bodied prey such as worms. Prey collections also varied according to nesting habitat. Our findings demonstrate that the collection of prey remains, while being a simple method to infer diet, provides a coarse resolution of prey composition and has inherent biases according to prey body type and nesting habitat.

Post-Breeding Surveys of the Shorebird Community at Cape Krusenstern National Monument

Student Investigator: Megan Boldenow, MS Wildlife Biology and Conservation
Advisor: Abby Powell
Funding Agencies: USGS and NPS (through NRPP)
In-Kind Support: USFWS (Selawik NWR and MBM) and NPS

Habitats along the coastline of Cape Krusenstern National Monument (CAKR) include areas important for migratory waterbirds. These habitats are vulnerable to potential impacts from climate change, offshore energy development, and increased arctic shipping. Waterbirds may be especially vulnerable to oil spills during the post-breeding season, given their large aggregations in concentrated areas. Post-breeding fieldwork is contributing to an updated assessment of the importance of Western Arctic Parks, particularly the Sisualik Lagoon area of CAKR, to migratory waterbirds. This work provides the NPS with critical baseline data and addresses the following objectives, focusing on shorebirds: (1) determine timing of use,)2) determine species abundance and diversity, (3) document habitat use around and within the lagoon, and (4) provide a comparison to anecdotal, historic records. Ground-based surveys were conducted during late summer 2014. Survey plots were discrete habitats that could be distinguished on the ground. We attempted to establish a sample in all unique types. We visited each plot regularly and kept a running tally of all waterbirds observed during area searches, communicating to avoid double-counting. A report is in progress. Data from these surveys are being used in conjunction with ground-based shorebird surveys from Bering Land Bridge National Preserve (BELA), aerial shorebird surveys from CAKR and BELA, and work focused on fish and fish food webs taking place in lagoons in both parks. We hope to incorporate information from a USFWS project from a nearby site (breeding season 2010-2014) in order to better understand the phenology of bird activity in the area. Results will be reported at the Centennial Science and Stewardship Symposium. Of the known species occurring in CAKR and the neighboring BELA, 18 are species of concern (Alaska Shorebird Group, Boreal Partners in Flight Working Group).

Spatiotemporal Distribution and Habitat Use of Spectacled Eiders

Student Investigator: Matt Sexson, PhD Biological Sciences
Advisor: Abby Powell
Funding Agencies: BOEM, USGS, USFWS, BLM, National Fish and Wildlife Foundation, NPRB
In-Kind Support: Field logistics and assistance: ConocoPhillips Alaska, Inc. and BLM; Veterinarians: Columbus Zoo (OH), Mesker Park Zoo (IN), and Point Defiance Zoo (WA)

Spectacled Eiders spend most of the year at sea along the coasts of Russia and Alaska. The species is listed as 'threatened' under the U.S. Endangered Species Act, yet spatiotemporal distribution and habitat use at sea are understudied. Information regarding the spatiotemporal distribution and habitats used by Spectacled Eiders will help managers identify and mitigate potential threats to the species away from breeding areas. The primary objective of this study is to assess the distribution, migratory patterns, and habitat use of Spectacled Eiders at sea. We collected satellite telemetry data from 129 Spectacled Eiders in 2008–2012. We summarized the data to describe spatiotemporal distribution and migratory patterns. We also compared the data to telemetry data collected in the 1990s. Data will be incorporated into winter habitat use models and accompany a population genetics study. Eiders used distinct regions of the Bering, Chukchi, Beaufort, and East Siberian Seas to stage and molt. Eiders wintered in a single area in the northern Bering Sea. Eiders used the same molting regions in the 2000s as in the 1990s, although we found significant inter-decadal variation in the core distribution of eiders within molting regions. Information regarding the spatiotemporal patterns of Spectacled Eiders at sea is valuable to conservation and recovery efforts. This information is necessary when planning for development of natural resources in the Chukchi and Beaufort seas, minimizing disturbance from vessel traffic in the Arctic, and understanding potential effects of changing prey regimes and habitat.

Prevalence, Sources and Effects of Strontium in Waterfowl Eggs

Student Investigator: Christopher Latty, PhD Marine Biology
Advisor: Tuula Hollmen
Funding Agency: USFWS (RWO 205)
In-Kind Support: USFWS

Strontium (Sr) is a naturally occurring element, chemically similar to calcium (Ca). Stable Sr in environmental samples derives from weathering of local sources and atmospheric deposition. Strontium's chemical similarity to calcium leads to substitution for Ca in biota. Strontium has been implicated as a potential contaminant of concern for wild birds and effluent from power generation has been linked to elevated concentrations in avian eggs. Previous research has suggested that high concentrations of Sr in eggs may affect eggshell quality and reduce hatchability by interference with normal Ca metabolism and bone growth. Although elevated levels of strontium have been documented in waterfowl in interior Alaska, concentrations are highly variable, and it is unclear if strontium is causing deleterious effects. The objectives of this study are to assess the sources and effects of elevated strontium in waterfowl eggs in interior Alaska. We analyzed strontium in 2,112 eggs from 751 nests from 9 species of waterfowl collected over a 5-year period. Data analysis is ongoing, but preliminary results suggest strontium may be correlated with reduced eggshell quality. We also found that eggshell strontium is partly driven by the chemistry of the local environment and may also be affected by the use stored reserves during egg production. The results of this project will be used to assess strontium as a contaminant of concern for waterfowl breeding in interior Alaska.

Microbial Infection as a Source of Embryo Mortality in Greater White-fronted Geese

Student Investigator: Cristina Hansen, PhD Biological Sciences
Advisor: Karsten Hueffer
Funding Agency: USGS (RWO 214)
In-Kind Support: Transportation, logistics, and field sampling provided by USGS

Microbial infections cause embryo mortality in birds and may represent a threat to populations. Processes involved are poorly understood. Route(s) of infection, infectious dose, geographic extent, and bacterial species involved in embryo infection in Arctic and subarctic settings have not been characterized. The objectives of this research are to further assess bacterial infection of avian embryos in Alaska. This study expanded the geographic scope of monitoring by cooperating with field camps in Alaska and Canada. Additionally, we aimed to determine the source of infection by testing environmental samples and tissue samples from nesting white-fronted geese. Finally, we aim to determine whether infection by the most common bacteria isolated (a *Neissera* species) is vertical or horizontal. Samples from the 2014 hatching season (n=470) were assessed using standard culture methods and 16S rRNA gene sequencing. Tissue samples from 20 nesting females will be assessed using PCR and/or culture methods. A laboratory-based infection model using fertilized chicken eggs will be used to determine route of infection and infectious dose of our *Neisseria* species. Analysis is nearly complete. Results show many of the same bacterial species as in 2013 samples, though new species were isolated. Two of 25 tundra samples (8%), 8 of 19 cloacal samples (42%), 46 of 75 nest samples (62%), and 48 of 76 shell samples (63%) were positive for *Neisseria* DNA. Tissue samples are just starting to be analyzed for *Neisseria* DNA. Many species of bacteria, most notably a *Neisseria* species, are commonly found in addled goose eggs and are likely contributing to embryo mortality in wild populations.

Seasonal Movements and Population Ecology of Willow Ptarmigan in Interior Alaska

Student Investigator: Graham Frye, PhD Wildlife Biology
Advisor: Mark Lindberg
Funding Agencies: AEA, ADFG

Willow Ptarmigan are among the most popular upland game birds in Alaska. Because of limited road access to ptarmigan populations in Alaska, most individuals are harvested from a small number of road-accessible areas. Little information exists on the seasonal movements or population ecology of ptarmigan in interior Alaska, making it difficult to assess the impact of concentrated harvest pressure on these populations. Managers currently lack detailed information on the population ecology and seasonal movements of Willow Ptarmigan in interior Alaska, making it difficult to assess the impact of harvest in road-accessible areas. Moreover, projects such as the formerly proposed Susitna-Watana Hydroelectric Project will involve the construction of additional roads in a region that already receives some of the highest levels of hunting pressure in the state. Information on the survival, abundance, habitat selection, and seasonal movements of Willow Ptarmigan relative to road access will facilitate better management of the species in this region. The objective of this study is to quantify survival, abundance, habitat selection, and seasonal movements of Willow Ptarmigan in ADFG administrative units 13E and 13A. Comparisons will be made between areas that are accessible by road and those that are not. We radio-marked Willow Ptarmigan with necklace-style VHF transmitters during spring and fall from 2013-2015. Radio-marked individuals were relocated monthly to document movements, survival, and habitat selection throughout the year. Distance sampling was used during spring to estimate breeding season abundance. This study was initiated during spring/summer 2013. We are presently collecting data from radio-marked individuals and have not yet conducted comprehensive analyses. Raw data suggest that ptarmigan in the study area make seasonal movements ranging in magnitude from ~8-100 km from breeding/natal sites, with high return rates the following season. Preliminary analyses of survey data suggest that spring survey results are sensitive to the time of day and time of season in which they are conducted. Results from this study will help to inform future Willow Ptarmigan management and monitoring efforts in interior Alaska.

Effects of Disturbance and Predation on Nesting Success of Pacific Common Eiders on the Beaufort Sea Coast

Student Investigator: Wilhelm Wiese, MS Wildlife Biology
Co-Advisors: Tuula Hollmen and Mark Lindberg
Funding Agency: USFWS (RWO 215)
In-Kind Support: Personnel and logistical support provided by Arctic NWR, USFWS

Pacific Common Eider populations decreased over 50% from the 1950s to 1990s. The population nesting along the Beaufort Sea coast is at risk of further declines from coastal erosion and oil development. Development may lead to an increase in predator populations and increased nest-site disturbance. Disturbance increases risk of nest abandonment and can affect predation rates. Understanding the specific mechanisms by which disturbance affects nest fate is difficult when using the traditional method of locating and revisiting nest sites because this approach is itself a source of disturbance. Additionally, quantification of specific nest predators has been limited by reliance on small-scale observational studies and post-hoc assessments of evidence at destroyed nests. Our objectives are to determine the role of disturbance on nest fate and to quantify nest abandonment and predation rates for common eiders nesting along the Beaufort Sea coast using cameras, which do not cause disturbance. We will be surveying barrier islands of the Arctic National Wildlife Refuge and will place small, time-lapse cameras at approximately 200 nests over the next 2 years to capture information on abandonment and nest predation. Preliminary results from a pilot study conducted in 2015 suggest that nest abandonment rates during the incubation period are generally low (less than 3%); however, flushing a hen eider from the nest increases likelihood of abandonment in the following 12 hours. Glaucous gulls and Arctic foxes were the most prevalent predators, although golden eagles also caused nest failure. Glaucous gull predation appeared more likely to occur following human disturbance. Results from this study will inform managers about the implications of human disturbance from commercial, recreational, and research activities on the breeding success of common eiders.

A grizzly bear searches for eider eggs on a barrier island of Arctic National Wildlife Refuge, July 2015. Photo courtesy of USFWS.

A Pacific Common Eider stands over her nest on a windswept barrier island of the Beaufort Sea, June 2015. Photo courtesy of USFWS.

Completed Ecological Studies

Evaluating Moose (*Alces alces gigas)* Browse and Habitat Resources and Resource Use in Response to Post-Fire Succession on Kanuti National Wildlife Refuge, Alaska

Student Investigator: Erin Julianus, MS Biology
Co-Advisors: A. David McGuire and Teresa Hollingsworth
Funding Agency: USFWS Region 7 (RWO 204)
In-Kind Support: Personnel and project support provided by USFWS

The Kanuti National Wildlife Refuge (NWR) is managed by the U.S. Fish and Wildlife Service (USFWS), a federal agency mandated to manage Refuge lands for the conservation of wildlife habitats. Wildfire is a primary source of natural disturbance on Kanuti NWR, and there is a need to understand how wildfire dynamics will alter moose habitat resources and impact moose populations. Much is known about moose ecology and their response to fire on a general level, but fire-driven habitat dynamics and the specific ways in which moose use burns on Kanuti NWR are not well studied. Moose have been identified as a priority management species on Kanuti NWR because they are an important subsistence resource for four rural communities that boarder the Refuge boundary, are an integral part of predator-prey relationships on the Refuge, and are valued generally as a member of the intact ecosystem maintained by the preservation of Refuge lands. Wildfire is the dominant disturbance regime on the Kanuti flats. It changes vegetation dynamics on the Refuge annually both through wildfire events, and through vegetative succession in fire scars. Moose utilize mid-successional stands maintained through wildfire disturbance. It is important to understand local habitat characteristics and how they are changing through time in order to understand and anticipate subsequent changes in moose distribution on the Refuge. This study focuses on improving the understanding of habitat changes in three large burn scars on Kanuti NWR. The goal of this project is to evaluate the effects of fire history, plant community composition, and landscape characteristics on moose habitat, forage resources, and resource use by moose on Kanuti NWR. Data were collected on summer browse quantity and quality at 34 sites within three large burn scars of varying ages in late summer 2012 and 2013. Summer browse use by moose was also quantified at these sites. In March 2013 and 2014, these sites were revisited to determine woody browse availability and removal by moose in winter, when moose are most limited by available food resources. Results include the following:

- estimates of summer (leaf and current annual growth stems) and winter (woody current annual growth stems) browse quantity in each burn stratum (reported as shrub density/ha and kg biomass/ha);
- estimates of summer and winter browse removal (kg/ha) in each burn stratum;
- estimates of browse quality in each burn stratum (evaluated by measuring %C and N); and
- community composition and stand characteristic data

Summer browse production and winter browse availability were highest in the 1990 and 2005 burns. Summer and winter browse use was highest in the 1990 burn. Collared moose generally avoided recently burned stands and demonstrated preference for >30 year old stands in both summer and winter. Moose demonstrated preference for unburned stands during calving. Although biomass production and availability were highest in 11 – 30 year old stands, disproportionate use of food resources in burns was evident. This disproportionate use of burns and food resources could be due to a variety of reasons including resource type, historic moose distribution patterns, and predation avoidance strategies. Findings associated with this habitat study will be integrated with available data from current and past management activities on Kanuti NWR, including moose population surveys and local subsistence user needs. The results of this study will be useful in informing land management decisions related to moose management objectives on Kanuti NWR as burn scars age and progress through post-fire vegetative succession.

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

Post-Doctoral Researcher: Hèléne 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 combined 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 was led by the University of Florida, was 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 included (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 was led by the University of Alaska Fairbanks, forecasted landscape change in response to projected changes in climate, fire regime, and fire management. Four activities were conducted 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 included (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. Dr. Hèléne Genet, who is a postdoctoral researcher at the University of Alaska Fairbanks, was responsible for the development and application of the model of ecosystem structure and function in the project. She has conducted and analyzed model simulations over interior Alaska. During the projected period, carbon sequestration of terrestrial ecosystems of interior Alaska increased substantially because of increased productivity associated to warming and a slowing down of fire intensification related to land cover change toward less flammable deciduous forests in Interior Alaska.

Trophic Dynamics of Boreal Lakes in a Changing Northern Landscape — Impacts of Lake Drying and Forest Fires

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)

Note: Tyler Lewis graduated from the University of Alaska Fairbanks in August 2015. His dissertation abstract follows:

The abundant lakes of northern latitudes are the primary breeding grounds for many waterbird species. In recent decades, temperatures in the north have increased by twice the global average. This substantial warming has caused lake drying and increased wildfires, both of which may impact waterbird habitats. Fires release nutrients locked in terrestrial resources, making them available for transport to lakes, while lake drying concentrates nutrients and other solutes into smaller water volumes. Increased nutrients may fundamentally alter ecosystem processes of lakes by changing the timing and abundance of phytoplankton blooms, which in turn affects the abundance of aquatic invertebrates – the primary food source for breeding waterbirds and their broods. I examined effects of forest fires and lake drying on ecosystems of Subarctic boreal lakes in the Yukon Flats, Alaska, documenting changes to (1) aquatic nutrient and chlorophyll concentrations, (2) aquatic invertebrate densities, and (3) abundance and occupancy of waterbirds. Nutrient, chlorophyll, and invertebrate levels were largely unaffected by a recent forest fire. This ecosystem stability transferred upward to waterbirds, as brood abundance was also unaffected by the fire. On drying lakes, nitrogen and phosphorus concentrations increased >200% and >100%, respectively, from the 1980s to present. At the same time, concentrations of 4 major ions increased, including increases of >500% for chloride and >100% for sodium. Nonetheless, chlorophyll levels, aquatic invertebrate abundance, and occupancy of waterbird broods were largely unaffected by these chemical changes on drying lakes. Overall, ecosystems of Yukon Flats were largely resilient to short-term effects of forest fires and rising chemical concentrations associated with lake drying. Moreover, this resilience spanned multiple trophic levels, from phytoplankton to aquatic invertebrates to waterbirds.

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

Student Investigator: Sophie L. Gilbert, PhD Biological Sciences
Advisor: Kris Hundertmark
Funding Agencies: Primary: Division of Wildlife Conservation, ADFG. Secondary: US Forest Service (Tongass); National Science Foundation; Alaska Trapper's Association Scholarship; UAF Graduate School Dissertation Completion Grant

In-Kind Support: Equipment and vehicles provided by ADFG during field season. Assistance from ADFG personnel and US Forest Service personnel.

Note: Sophie Gilbert graduated from the University of Alaska Fairbanks in August 2015. Her dissertation abstract follows:

The coastal temperate rainforest is one of the rarest ecosystems in the world, and a major portion of the global total is found in Southeast Alaska. In this ecosystem, Sitka black-tailed deer are the dominant large herbivore, influencing large carnivores that prey on deer such as wolves and bears, as well as plant species and communities through browsing. In addition, deer play an important economic and cultural role for humans in Southeast Alaska, making up the large majority of terrestrial subsistence protein harvested each year as well as providing the backbone of a thriving tourism industry built around sport hunting. Given the importance of deer in this system, there remain a surprisingly large number of key gaps in our knowledge of deer ecology in Southeast Alaska.

These knowledge gaps are potentially troubling in light of ongoing industrial timber-harvest across the region, which greatly alters habitat characteristics and value to wildlife. This dissertation research project was undertaken with the aim of filling several connected needs for further understanding deer ecology, specifically 1) patterns of reproduction and fawn survival, 2) population dynamics in response to environmental variability, and the underlying drivers of spatial selection during 3) reproduction and 4) winter. To fill these knowledge gaps, I developed robust statistical tools for estimating rates of fawn survival, and found that fawns must be captured at birth, rather than within several days of birth, in order to produce unbiased estimates because highly vulnerable individuals died quickly and were thus absent from the latter sample. I then use this robust approach to estimate vital rates, including fawn survival in winter and summer, and developed a model of population dynamics for deer. I found that winter weather had the strongest influence on population dynamics, via reduced over-winter fawn survival, with mass at birth and gender ratio of fawns important secondary drivers.

To better understand deer-habitat relationships, I examined both summer and winter habitat selection patterns by female deer. Using summer-only data, I asked how reproductive female deer balance wolf and bear predation risk against access to forage over time. Predation risks and forage were strong drivers of deer spatial selection during summer, but reproductive period and time within reproductive period determined deer reaction to these drivers. To ensure adequate reproductive habitat for deer, areas with low predation risk and high forage should be conserved. Focusing on winter, I evaluated deer spatial selection during winter as a response to snow depth, vegetation classes, forage, and landscape features. I allowed daily snow depth measures to interact with selection of other covariates, and found strong support for deer avoidance of deep snow, as well as changes in deer selection of old-growth and second-growth habitats and landscape features with increasing snow depth. Collectively, this dissertation greatly improves our understanding of deer ecology in Alaska, and suggests habitat management actions that will help ensure resilient deer populations in the future.

Trophic Pathways Supporting Arctic Grayling in a Small Stream on the Arctic Coastal Plain, Alaska.

Student Investigator: Jason J. McFarland, MS Biology
Advisor: Mark Wipfli
Funding Agency: BLM (RWO 179)
In-Kind Support: Field camp logistics and equipment provided by BLM; Teaching assistantship provided by DBW

Note: Jason McFarland graduated from the University of Alaska Fairbanks in May 2015. His thesis abstract follows:

Arctic Grayling (*Thymallus arcticus*) are widely distributed on the Arctic Coastal Plain (ACP) of Alaska, and are one of the few upper level consumers in streams, but the trophic pathways and food resources supporting these fish are unknown. Grayling migrate each summer into small beaded streams, which are common across the landscape on the ACP, and appear to be crucial foraging grounds for these and other fishes. I investigated prey resources supporting different size classes of grayling in a beaded stream, Crea Creek, where petroleum development is being planned. The specific objectives were to measure terrestrial prey subsidies entering the stream, quantify prey ingested by Arctic Grayling and Ninespine Stickleback (*Pungitius pungitius)*, determine if riparian plant species affect the quantity of terrestrial invertebrates ingested by grayling, and determine if prey size and type ingested were a function of predator size. Results indicated that small grayling (< 15 cm fork length (FL)) consumed mostly aquatic invertebrates (caddisflies, midges, and blackflies) early in the summer, and increasing quantities of terrestrial invertebrates (wasps, beetles, and spiders) later in summer, while larger fish (> 15 cm FL) foraged most heavily on stickleback. Riparian plant species influenced the quantity of terrestrial invertebrates entering the stream, however these differences were not reflected in fish diets. This study showed that grayling can be both highly insectivorous and piscivorous, depending upon fish size class, and that both aquatic and terrestrial invertebrates, and especially stickleback, are the main prey of grayling. These results highlight the importance of beaded streams as summer foraging habitats for grayling. Understanding prey flow dynamics in these poorly studied aquatic habitats, prior to further petroleum development and simultaneous climate change, establishes essential baseline information to interpret if and how these freshwater ecosystems may respond to a changing Arctic environment.

Ongoing Ecological Studies

Development and Application of an Integrated Ecosystem Model for Alaska

Post-doctoral Researcher: Yanjiao Mi
Faculty and Research Associates: Hèléne Genet, 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 Integrated Ecosystem Model (IEM) for Alaska and Northwest Canada. The IEM 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. The scenario data for IPCC AR4 climate model simulations has been downscaled and is available online. The data group is currently downscaling the IPCC AR5 climate model simulations. Production runs that include improved fire and treeline dynamics are being conducted over the entire IEM domain to drive TEM with fire disturbance outputs from ALFRESCO. Progress is being made in the synchronous coupling of the models so that ALFRESCO can make use of fire severity information from TEM in its simulations. The thermokarst modeling group has completed the development of conceptual models of thermokarst dynamics and is now implementing those conceptual models in proof of concept studies in both the Barrow Peninsula and the Tanana Flats regions. The thermokarst group has also developed a thermokarst predisposition model for application across the entire IEM domain. New research on improving the modeling of wetland dynamics has been initiated.

Projected Effects of Climate-induced Vegetation Changes on Caribou (*Rangifer tarandus*) in Northern Alaska

Post-doctoral Researcher: Jennifer Roach
Faculty: Brad Griffith, Eugénie Euskirchen, and A. David McGuire
Funding Agencies: USFWS, USGS, ADFG, Alaska EPSCoR (RWO 170)

Dynamic Vegetation Models (DVMs) predict that climate warming will affect the phenology, production, abundance, and distribution of plant species in the Arctic, but the effects on caribou populations are unknown. There is a need to understand the effects of climate on caribou forage and population dynamics. Our objectives were to use DVMs to (1) identify effects of forage net primary productivity (NPP) on caribou population sizes from 1972-2013 and (2) simulate future changes in caribou forage and effects on the sizes of the Central Arctic (CAH), Teshekpuk (TCH), Porcupine (PCH), and Western Arctic (WAH) herds. Autoregressive regression models were used to relate DVM NPP output of preferred forage types to herd sizes from 1972-2013. Mixed models were used to estimate trends and significant changes in forage on calving grounds and non-calving ranges from 1970-2100. Graminoid NPP during July and lichen NPP during September were significant drivers of TCH herd size ($R^2 = 0.72$). Total lichen NPP from May to September on the non-calving range was a significant driver of herd size for both the PCH ($R^2 = 0.40$) and CAH ($R^2 = 0.28$). There were no significant relationships between forage NPP and herd size for the WAH. Projections of herd size based on these forage variables suggest the potential for continued, but variable, net growth of the PCH, TCH, and CAH through 2100. Our spatially-explicit results can be used to identify which herds and which portions of their ranges may be most affected by climate-induced changes in forage.

Differential Effects of Climate-Mediated Forest Change on the Habitats of Two Ungulates Important to Subsistence and Sport Hunting Economies

Post-Doctoral Researcher: Jennifer Roach
Faculty: Brad Griffith, Eugénie Euskirchen, and A. David McGuire
Funding Agency: Alaska Climate Science Center, USGS (RWO 212)

In winter, caribou rely on low stature lichens for food while moose rely on deciduous shrubs that protrude above the snow. Fire favors deciduous shrubs at the expense of lichens, and caribou movement is impeded by shallower snow than moose. Rain-on-snow may restrict access to lichens but not shrubs. As a result, effects of climate change are expected to be different between the species. Moose and caribou are the most important terrestrial species to subsistence and sport hunting economies in Alaska. Our objective is to use output from the Integrated Ecosystem Model (IEM) to project the differential effects of climate change (e.g., vegetation dynamics, snow and rain, fire frequency/severity and successional trajectories) on the quantity of food available to these two species throughout most of Alaska and parts of Canada, ~1970-2100. We will refine IEM output to be relevant to ungulate forages. IEM NPP output will be restricted by winter weather (snow depth and icing events) derived from a dynamically downscaled daily climate dataset (Bieniek et al. in prep). Regression models will be used to estimate spatial and temporal trends in habitat value. We are currently awaiting dynamically downscaled winter weather projections and NPP outputs from the IEM model. Maps and models of spatial and temporal trends in habitat value will be stratified by land ownership and explicitly tailored to stakeholder needs. Maps can be used to inform conservation plans and management actions.

Development of an Alaska-based Research Framework for Migratory Waterfowl

Post-doctoral Researcher: Jennifer Roach
Faculty: Brad Griffith and Abby Powell
Funding Agency: Alaska Climate Science Center, USGS (RWO 218)

The direction and magnitude of climate effects on the seasonal ranges of migratory species are unlikely to be consistent. Thus, the cumulative effects across annual life cycles and decades will be difficult to predict without a coordinated and focused effort to integrate research across the entire annual range. A multi-regional framework is needed to efficiently integrate management-focused research among seasonal ranges and focus limited resources on the most critical season-specific links between climate change and waterfowl population trends. Our objective is to identify and prioritize the most critical cross-seasonal information needs regarding climate effects on the factors (e.g., habitat, species interactions, distribution and phenology, among others) most likely to affect waterfowl demography. We will use a literature review, a questionnaire survey of waterfowl researchers and managers representing state, federal, and non-governmental organizations, and a panel discussion at an international conference to identify and prioritize research needs. Results from a preliminary literature review have been used to develop a questionnaire survey which will be administered during spring 2016. This prioritization of management-focused research needs will be used to more efficiently and effectively allocate limited resources and will enable researchers and managers from widely-separated ranges to communicate in common terms.

Modeling Interactions between Lake Change and Boreal Ecosystem Dynamics in the Yukon Flats National Wildlife Refuge

Student Investigator: Vijay Patil, PhD Biological Sciences
Co-Advisors: Brad Griffith and Eugénie Euskirchen
Funding Agency: USGS (RWO 172), USFWS, Center for Global Change Student Fellowship, Global Lake Ecology Network Student Fellowship

Interior Alaskan boreal lakes have been decreasing in size and abundance due to warming and permafrost degradation. These lakes and adjacent wetlands provide valuable ecosystems services as sources of plant biodiversity and major carbon sinks. Our objective was to determine the current and future influence of shrinking lakes on diversity, carbon storage, and dissolved organic carbon (DOC) export into lakes. Our approach was to measure wetland plant diversity and water chemistry at 130 lakes in the Yukon Flats National Wildlife Refuge (YFNWR) and estimate organic soil carbon and above-ground biomass (AGB) using field sampling and remote sensing. We then modeled relationships between lake size, landscape variables, plant diversity, and terrestrial/aquatic carbon stocks using structural equation models and random forest analyses. Shrinking lakes showed significantly reduced AGB, but no significant change in soil carbon or DOC, and higher plant diversity compared to stable lakes. DOC and soil organic carbon showed significant positive responses to increased wetland area, but AGB and plant diversity showed the opposite response. Results suggest that the functional value of refuge lands across multiple ecosystem services may be maximized by protecting heterogeneous landscapes with both stable and shrinking lakes. We are currently evaluating the regional-scale significance of these findings by projecting changes in wetland area and carbon stocks for the entire YFNWR (with associated uncertainty) using a multi-stage Monte Carlo method, and by simulating the influence of lake dynamics on terrestrial productivity and carbon flux using a process-based ecosystem model (DVM-DOS-TEM).

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

Student Investigator: Daniel Rizzolo, PhD Biological Sciences
Advisor: Mark Lindberg
Funding Agencies: BOEM; USGS (RWO 193)

Numbers of Red-throated Loons in Alaska declined by >50% over three decades until the early part of this century. In contrast, sympatric populations of Pacific Loons have remained stable. If differences in diet between species (Red-throated Loons rely on marine prey, Pacific Loons on freshwater prey) are associated with fitness, diet may contribute to divergent population trends. We determined diet composition at a site on the Chukchi Sea coast. To determine potential fitness, we examined the association between diet composition and body condition. We used carbon and nitrogen stable isotope ratios in blood, and fatty acid composition of adipose tissue, to characterize diet. We used deuterium dilution to determine body condition. Results showed variable amounts of freshwater and marine prey in diets of Pacific Loons, while Red-throated Loons relied exclusively on marine prey. Freshwater invertebrates Anostraca (fairy shrimp) and Notostraca (tadpole shrimp), along with a variety of marine fishes, were important in Pacific Loon diet. Rainbow Smelt and Slender Eelblenny were important in Red-throated Loon diet. Variation in diet was unrelated to body condition. Thus, loons of both species were able to obtain sufficient prey to maintain similar body condition despite differences in diet composition and energy content. Variation in Pacific Loon diet composition indicates flexibility in their foraging behavior. In contrast, Red-throated Loons relied exclusively on marine fishes. The use of multiple foraging habitats may insulate Pacific Loons against a decline in prey availability or quality in one habitat or the other. The reliance of Red-throated Loons on marine fishes may more tightly link their productivity to forage fish availability.

Feeding Ecology of Lesser Scaup Ducklings in the Boreal Forest of Alaska

Student Investigator: Adam DuBour, MS Wildlife Biology
Co-Advisors: Mark Lindberg and Kirsty Gurney
Funding Agencies: Alaska Science Center, USGS; Angus Gavin Memorial Migratory Bird Grant
In-Kind Support: Equipment, and flight and logistic support provided by Yukon National Wildlife Refuge, USFWS

Lesser Scaup (hereafter Scaup) have experienced prolonged population declines since the 1980s. Several non-mutually exclusive hypotheses, including habitat change to boreal wetlands, have been implicated in the declines. Scaup ducklings require abundant aquatic invertebrate prey for growth and survival. Spatiotemporal changes in availability of invertebrates may result in a trophic mismatch with duckling demand. However, information gaps exist about the variation in Scaup duckling diet and the potential fitness consequences of such variability. The Yukon Flats National Wildlife Refuge (YFNWR), and associated boreal wetlands, is a continentally important breeding area for Scaup and as such is suitable for examining these issues. The objectives of this study are to evaluate variation in diet of Scaup ducklings across lakes with varying prey communities and to determine how such variation affects growth of ducklings. We collected ducklings and invertebrates from wetlands across the YFNWR. To assess diet variation we are using the Bayesian stable isotope mixing model, MixSIAR. We will use ANCOVA to examine how lake characteristics affect duckling mass, corrected for age and body size. Preliminary results examining the drivers of variation in duckling mass do not show significant variation among lakes, suggesting that ducklings from our study lakes are not limited by aquatic invertebrate prey abundances. Understanding duckling diets and fitness consequences of variation in food resources will aid in identifying habitats that provide adequate food sources for Lesser Scaup and that should be protected in the face of environmental change.

Influence of Fish and Surface Water Connectivity on Arctic Freshwater Food Webs in a Changing Climate

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

The rapid rate of climate warming in the Arctic requires understanding of ecological baseline conditions to understand long-term effects. In freshwater systems, hydrological processes and associated species responses are predicted to change with increasing temperatures, affecting surface water distribution and connectivity, and fish species distributions. Understanding how fish distributions and freshwater food webs shift as a result of climate-induced change to hydrological processes is important not only for aquatic biota, but also for the many species of wildlife that rely upon them for food. To assess current biotic and abiotic controls on Arctic freshwater food webs we investigated the following hypotheses: (1) lacustrine community and food web structure differs with the degree of surface water connectivity; (2) fish predation and number of consumer levels affect food web structure; (3) the effect of fish species in structuring food webs depends on their relative position in the food web; and (4) fish feeding habits and trophic position differ with assemblage of sympatric fish species. We sampled fish and invertebrates from 32 water bodies at two locations within the Chipp River drainage on the Arctic Coastal Plain. Water bodies varied in size and degree of surface water connectivity to surrounding water bodies. Fish species richness and composition differed with surface water connectivity—permanent, ephemeral, or disconnected. Fish species influenced invertebrate assemblages through top-down processes, and the combination of hydrologic connectivity and predation appears to structure these Arctic food webs. Information gathered in this study will provide important baseline data, inform us about long-term changes in ecosystem services, and help guide fish and wildlife management as the aquatic landscape responds to climate change.

Hyporheic Food Web Dynamics Across a Thermal Gradient within Small Icelandic Streams

Student Investigator: Daniel P. Govoni, PhD Biological Sciences
Advisor: Mark Wipfli
Funding Agency: Rannsóknamiðstöð Íslands (Icelandic Centre for Research – RANNIS)
In-Kind Support: Hólar University, Freshwater Fisheries Institute of Iceland, Blönduós Academic Center

Food webs and invertebrate communities have been reasonably well studied in small streams, but there has been relatively little research done on the trophic linkages between subsurface and surface communities (i.e., within hyporheic habitats). Hyporheic habitats may play a major role in shaping stream food webs and are likely very susceptible to warming temperatures. Climate change and resource development could alter the trophic linkages between surface and subsurface habitats upon which stream food webs depend. Understanding these linkages better, in the face of increasing resource development and climate change, will help inform aquatic resource management. The objectives are to determine (1) how water temperature and seasonal thermal variability influence invertebrate communities at the stream surface-hyporheic interface, and (2) how temperature affects surface and hyporheic food webs. We are studying streams with different

Dan Govoni cleaning the pump after sampling hyporheic invertebrates in Borgarfjörður, Iceland in August 2015. Photo: A-K Kreiling.

thermal regimes and taking samples from four stations within each stream. At each station, we collect benthic samples and hyporheic samples of invertebrates at 25 and 50 cm below the streambed. Gut contents will be used to construct the food web. Multivariate analyses indicate that seasonal thermal variability, temperature, and conductivity significantly explain 32.4% of the variability in the community structure. Invertebrate abundances at the streambed surface are much greater than in the hyporheic zone, but taxa richness is similar between the surface and hyporheic zone. Although richness is similiar in the surface and hyporheos, faunal composition (assemblage) is highly dissimilar. Food webs will again be sampled and analyzed June-August 2016. The results of this study will provide insight into the community and trophic linkages between streams and hyporheic habitats and the influence of climate change on these linkages.

Role of Perception in Determining Adaptive Capacity: Communities Adapting to Environmental Change

Student Investigator: Jess Grunblatt, Interdisciplinary PhD, Department of Biology and Wildlife
Advisors: Mark S. Wipfli and Lilian Alessa
Funding Agency: Alaska EPSCoR

There is a need to investigate how personal perception of risk due to environmental change influences the interpretation of science-based assessments of environmental change. Most individuals strive to understand the risks associated with change based on logic, probability, and impact; however, personal perception of risk is conditioned by personal experience and psychological processes. Analysis of shared perceptions, attitudes, and experiences within a community can improve the communication of science-based assessment of risk due to environmental change. Within a community, we identify shared attitudes and perceptions of change. This will allow the development of associative frames that can facilitate communication about environmental change in a manner that is appropriate within the context of the community. To evaluate community perception of environmental change, we investigated the following hypotheses: (1) An environmental change perception scale can be constructed that effectively partitions individuals into groups with differing levels of likely environmental change perception; (2) Individual respondent perception of likely environmental change can be predicted from respondent attitudes; (3) Respondents grouped according to differing perceptions of likely environmental change will exhibit shared attitudes and perceptions of likely change. A general population mail-out survey instrument was designed that contained questions exploring respondent perception of likely change within three dimensions: environment (air/land/water), development (tourism/infrastructure) and ecosystem services (salmon). Questions about respondent attitudes, demographics and behavior were also included. A total of 528 responses were received from Kenai Peninsula residents. Perception of environmental change was evaluated by constructing an environmental perception scale. Respondents were grouped using the environmental perception scale to form environmental perception groups (EPG). Mean values for EPG were significantly different. Binary logistic regression verified that EPG group assignment could be accurately predicted based on respondent attitudes. Despite differing environmental perception, the cultural consensus model (CCM) identified shared respondent perceptions and attitudes. Quantitative evaluation of community perceptions of change and attitudes can identify areas of agreement among diverse community respondents. These areas of agreement can be used to develop science-based descriptions of likely environmental change that are relevant to the community and which allow for more effective communication of risk.

Spatial and Temporal Patterns of Growth and Consumption by Juvenile Chinook and Coho Salmon in Three Geomorphically Distinct Sub-Basins of the Kenai River

Student Investigator: Benjamin Meyer, MS Fisheries
Advisor: Mark Wipfli
Funding Agency: EPSCoR (NSF), State of Alaska
In-Kind Support: Kenai Peninsula College, Kenai Watershed Forum, Cook Inletkeeper

Changes in temperature and precipitation as a result of ongoing warming climate trends in South-central Alaska will impact freshwater juvenile salmon habitat differently on the basis of local watershed. Landscape and hydrology interact in complex ways with climate, introducing uncertainty into how climate change will affect juvenile salmon rearing habitat. Regional stakeholders in the study area have expressed concern regarding the resilience of salmon populations in the face of climate change. Knowledge of the ways in environmental factors such as water temperature and food availability contribute to somatic growth rates of juvenile salmon will provide insight into how climate change influences their habitat quality. Objectives are (1) Air and water temperature relationships: define relationships between air temperature and water temperature for Beaver Creek, Russian River, and Ptarmigan Creek. Investigate the degree of water temperature heterogeneity within study areas; (2) Bioenergetics and growth models—Define relationships linking stream temperature and diet to growth rates of juvenile Chinook and Coho Salmon that rear in Beaver Creek, Russian River, and Ptarmigan Creek. We collected growth and diet data from 1442 juvenile Chinook and Coho Salmon in our study drainages in summer 2015, including gastric lavage and scales samples from a subset of 452 fish. Diet samples were identified to the lowest feasible taxa. We also collected air and water temperature data from nine sites throughout the Kenai River watershed. We anticipate low-elevation tributaries such as Beaver Creek will demonstrate water temperature regimes with higher sensitivity to air temperature, and juvenile salmon populations there will be exposed to more pronounced shifts in thermal experience. Conversely, high-elevation drainages such as Ptarmigan Creek will demonstrate water temperature regimes with lower sensitivity to air temperature, and juvenile salmon populations there will experience less pronounced shifts in thermal experience. Climate change-induced shifts in water temperature may either enhance somatic growth rates if thermal optima is approached or inhibit them if thermal optimum is exceeded. However, these effects will be mediated by dietary consumption rates. Thus the impacts of climate change on somatic growth rates of juvenile Chinook and Coho Salmon will be influenced both by landscape characteristics as well as their diet. We anticipate our results will underscore a growing consensus that a diverse portfolio of interconnected habitats best ensures the sustainability of wild salmon populations in the face of climate change.

Understanding the Ecology of Arctic Coastal Lagoons through Fisheries Research and Monitoring

Post-doctoral Researcher: Trevor Haynes
Faculty: Mark Wipfli and Martin Robards (Wildlife Conservation Society)
Funding Agency: National Park Service
In-Kind Support: Wildlife Conservation Society

Nicole Farnham and Marguerite Tibbles pulling a gillnet in from shore at Anigaaq camp. Photo: Ryan Sherman.

Coastal lagoons in the Western Arctic National Parklands are important habitat for a diversity of fish species and support a vital subsistence fishery for Alaskan villages. However, despite their ecological and cultural importance, little is known about fish ecology in Arctic coastal lagoons. Our project, supported by the National Park Service, seeks to understand the ecology and seasonal dynamics of fish species in coastal lagoons in the Arctic. During the ice-free season, we sampled the fish in five lagoons within in Cape Krusenstern National Monument and Bering Land Bridge National Preserve to examine fish condition, foraging patterns, growth rates, fish community composition, and patterns of lagoon use. We documented 27 fish species, five of which have not been recorded in these lagoons before and 33 instances where species were new to specific lagoons. Our observations of fish stomach contents suggest that mysids (small, shrimp-like crustaceans), chironomids (midges) and ninespine stickleback (*Pungitius pungitius*) are the primary fish prey, and therefore critical for transferring energy from lower to upper trophic levels. Mysid densities in the lagoons were remarkable; mysids were present in the stomachs of almost every species we sampled for diet. Ninespine Stickleback, also highly abundant in the lagoons, were fed on heavily by pisciviorous fish (e.g., Sheefish) and birds (e.g., Arctic Terns). Data we collected in 2015 builds on traditional knowledge and prior scientific research. Our results provide ecological information vital for management, and inform our understanding for telling the "Story of the Lagoons"—a key priority for the Native Village of Kotzebue, the Wildlife Conservation Society, and the National Park Service.

Temperature, Phenology, and Embryo Survival in Western Alaska Sockeye Salmon Populations: The Potential for Adaptation to a Warming World?

Student Investigator: Morgan Sparks, MS Fisheries
Co-Advisors: Jeff Falke and Peter Westley (SFOS)
Funding Agency: Western Alaska Landscape Conservation Cooperative
In-Kind Support: Data and logistical support provided by University of Washington and National Park Service Southwest Alaska Network

Morgan Sparks and Jeff Falke collecting gametes for experiment, Iliamna Lake, AK. Photo: Peter Westley.

Climate change and associated rapid regional warming present unique challenges and opportunities for organisms in their respective environments. Based on the predicted warming trends of Alaska's climate and the relationship between phenology and survival with temperature, regional climatic changes may produce conservation challenges in regionally important fish such as sockeye salmon. This study addresses how populations of Bristol Bay sockeye salmon have responded and might respond to experienced and predicted temperature regimes. Specifically, this study will illuminate how potentially locally adapted sockeye salmon early life history and survival relates to temperature. The study seeks to estimate hatching and emergence timing in Bristol Bay sockeye populations, given experienced temperature, to model potential changes in Lake Iliamna temperature regimes, and to estimate hatch timing and embryo survival in a controlled laboratory experiment using predicted Lake Iliamna temperature regimes based on future climate predictions. Lake and air temperature data will come from preexisting regional datasets. An Iliamna Lake temperature model will be created from empirical relationship between air temperature and lake temperature. Hatch timing and survival for sockeye salmon embryos will be measured during a laboratory experiment, which will incorporate both experienced and climate-change-based predicted lake temperature regimes. While the project is still in its early stages, we expect to find local adaptation in early life history phenology in different populations of Bristol Bay sockeye salmon. Additionally, we expect that because of local adaptation, the fish in our experiment will have differential responses for both hatching and survival when reared in predicted temperature regimes for Iliamna Lake. The results of this work will aid managers in understanding how climate change might affect sockeye salmon at the population level.

Lake Trout (*Salvelinus namaycush*) Otoliths as Biochronological Indicators of Recent Climate Patterns in High Arctic Lakes

Student Investigator: Eric Torvinen, MS Fisheries
Advisor: Jeff Falke
Funding Agency: USGS Alaska Climate Science Center
In-Kind Support: Bureau of Land Management; USGS Alaska Science Center

Eric Torvinen sampling lake trout, Fish Creek watershed, AK.

Lake trout otoliths. Photo: Eric Torvinen.

High latitude ecosystems show increased effects of climate change. Long-term air temperature data only exist from a few locations, and freshwater temperature records are scarce. Studies to obtain spatially comprehensive data are needed. In terrestrial systems, tree-ring data are often used as a reliable proxy to reconstruct temperature regimes, yet most of Arctic Alaska is devoid of trees. These same techniques could be applied to growth-increment widths found in lake trout otoliths. These increment widths may provide a reliable multi-decadal proxy to reconstruct temperature regimes across the region. The Arctic Landscape Conservation Cooperative has identified the Fish Creek Watershed as a focal watershed due to documented effects of climate change and intensive oil and gas development. The effects of these stressors on aquatic ecosystems are largely unknown. Study objectives are to (1) develop Lake Trout otolith growth-increment chronologies to be used as a tool for recent historic temperature reconstruction, and (2) describe the relationship between climate and Lake Trout growth across a diverse set of lake types located in the Fish Creek Watershed, Arctic Coastal Plain, Alaska. Lake trout and limnologic data will be sampled from lakes with variable physicochemical conditions and connectivity in the Fish Creek watershed during 2014 and 2015. Otolith increment analysis and dendrochronology techniques will be used to calculate growth rate variability over time and relationships with lake characteristics. A sample of 53 lake trout otoliths was collected from 25 lakes. Otolith increment analysis is in progress, but preliminary results indicate that Lake Trout ages varied from 12 to 46 years. These data will be used to build a growth chronology that will be correlated with lake characteristics and existing temperature data, as well as being used to validate existing climate models. This master growth chronology may be used as a multi-decadal proxy of recent past air and lake temperature regimes and thus will be an important addition to climatological data for the region.

Interactive Effects of Wildfire and Climate on Permafrost Degradation in Alaskan Lowland Forests

Student Investigator: Dana (Nossov) Brown, PhD Biological Sciences
Co-Advisors: Knut Kielland and Torre Jorgenson
Funding Agency: USGS (RWO 189)
In-Kind Support: Bonanza Creek LTER, DoD

The degradation of ice-rich permafrost in lowland ecosystems may have particularly strong ecological impacts due to the effects of thaw settlement and subsequent water impoundment. Considering the high frequency of wildfires and the potential for large shifts in boreal ecosystems from permafrost thaw, there is a need to better understand the sensitivity of permafrost to fire in lowland landscapes. We investigated the effects of fire on permafrost within lowland forests of the Tanana Flats, interior Alaska. We compared vegetation, soil, and permafrost characteristics across a chronosequence of fire scars (1930-2010) in a field study; and we utilized a soil thermal model (GIPL) to assess the soil physical and climatic controls of post-fire permafrost dynamics. We documented substantial permafrost thawing, thaw settlement, and water impoundment in the few years after severe fire. Variation in soil texture/moisture across the landscape influenced soil thermal regimes after fire. Simulated removal of the organic layer resulted in the loss of permafrost under all climatic conditions of the last century. With moderate simulated reductions in organic layer thickness, permafrost was resilient to degradation until the 1970s due to increased air temperatures and interactions with increased snow depth. The response of permafrost to fire is a complex interaction of fire severity, soil properties, and climatic conditions. These lowland forest ecosystems may be reaching a tipping point where they are highly vulnerable to severe thaw collapse after fire, with the potential for permafrost recovery diminishing as the climate continues to warm.

Genetic and Physiological Variation among Alaskan Sub-Arctic and Arctic *Carex*

Student Investigator: Iris Cato, MS Biological Sciences
Co-Advisors: Roger Ruess and Diana Wolf
Funding Agency: Alaska Science Center, USGS (RWO 217)

Carex subspathacea (CSUB) is a short-statured sedge and a preferred food source for multiple species of geese. In the absence of grazing, CSUB grows taller and resembles *Carex ramenskii* (CRAM), which the geese avoid. Since there has been no genetic research to determine if CRAM and CSUB on the Yukon-Kuskokwim Delta, Alaska, (YKD) are the same species, it is unclear if their differences are due to genotypic and/or environmental factors. Extensive grazing lawns of CSUB have converted to a form indistinguishable from CRAM over recent decades as goose populations have declined on the YKD. Understanding this change and its effects on plant-herbivore interactions will be helpful when management strategies are designed and implemented for regions where these sedges are prevalent. The objective is to determine the genetic and physiological differences among CSUB and CRAM from sub-Arctic and Arctic Alaska. Next Generation Sequencing will be used to quantify genetic differences between 100 samples of CSUB and CRAM. Common gardens in Arctic and sub-Arctic Alaska will be used to test for physiological differences. We predict that CSUB and CRAM are the same species, and will become indistinguishable from each other when transplanted to the sub-Arctic garden.

However, the growth of both taxa will be stunted in the Arctic garden. Research findings will be shared with scientists at state and federal agencies that are involved in the management of Alaskan coastal ecosystems, and with Native communities who have strong cultural ties to the subsistence harvest of wildlife species.

Changes in Plant Community Composition near Nuiqsut, Alaska under Various Climate Change Scenarios and implications for the Subsistence Harvest

Post-Doctoral Researcher: Jana Canary
Faculty: Eugénie Euskirchen
Funding Agency: EPSCoR

The subsistence lifestyle of indigenous people of the Arctic depends on the availability of forage for subsistence species, such as moose, caribou, and ptarmigan, as well as the availability of edible plants and berries. Significant warming in the Arctic region over the past four decades has resulted in a longer growing season, and a reduction in both the stability of permafrost and the duration and extent of snow cover. Changes in these environmental responses affect the cycling of carbon and nitrogen in Arctic terrestrial ecosystems, and can alter the composition of plant communities, affecting the subsistence harvest in these areas. Because the subsistence harvest of Arctic communities depends on the availability of certain plants and animals nearby, predicting the distribution and plant community composition in these areas would assist in planning for subsistence harvest and improve food security. The objective of this study is to use a terrestrial ecosystem computer model to predict changes to plant community composition near Nuiqsut, Alaska, and to assess how the predicted changes might affect future subsistence harvests in this area. We are developing a terrestrial ecosystem computer model that can be used to predict the abundance and landscape level distribution of plant communities that are important for a successful subsistence harvest. The results of our model simulations will predict how the composition of plant communities near Nuiqsut will change under a variety of climate scenarios. The predicted changes to plant communities will inform stakeholders concerned with the availability of subsistence foods and with food security in the Nuiqsut area.

List of Abbreviations

ACP	Arctic Coastal Plain
ADFG	Alaska Department of Fish and Game
AEA	Alaska Energy Authority
AKCFWRU	Alaska Cooperative Fish and Wildlife Research Unit
AKSSF	Alaska Sustainable Salmon Fund
AYKSSI	Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative
BLM	US Bureau of Land Management
BOEM	US Bureau of Ocean Energy Management
DBW	Department of Biology and Wildlife, UAF
DoD	US Department of Defense
DOE	US Department of Energy
EPSCoR	Experimental Program to Stimulate Competitive Research
GI	Geophysical Institute, UAF
GIS	Geographical Information System
IARC	International Arctic Research Consortium
IAB	Institute of Arctic Biology, UAF
INE	Institute of Northern Engineering
LCC	Landscape Conservation Cooperative
LTER	Long Term Ecological Research Network, NSF
NASA	US National Aeronautics and Space Administration
NDEP	Nevada Department of Environmental Protection
NFWF	National Fish and Wildlife Foundation
NPS	US National Park Service
NSB	North Slope Borough
NSEDC	Norton Sound Economic Development Corporation
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
TBN	To be named
UAF	University of Alaska Fairbanks
USDA	US Department of Agriculture
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey