

Alaska Cooperative Fish and Wildlife Research Unit

Annual Research Report—2014



Alaska Cooperative Fish and Wildlife Research Unit
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Cover Photo 1: Nesting Black Oystercatcher in Kenai Fjords National Park. Photo by Brian Robinson.

Cover Photo 2: Sitka black-tailed deer, Prince of Wales Island, Southeast Alaska. Photo by Sophie Gilbert.

Cover Photo 3: Post-breeding Western and Semipalmated Sandpipers forage in the shallow water covering a mudflat at Sisualik Lagoon, Cape Krustenstern National Monument. Photo by Megan Boldenow.

Not for Publication: Because this report is one of progress, the data presented are often incomplete, and the conclusions reached may not be final. Consequently, permission to publish any of the information herein is withheld pending approval from the Alaska Cooperative Fish and Wildlife Research Unit.

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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 (August 25, 2014)
- Kathy Pearse: Administrative Generalist
- Maria Russell: Fiscal Professional (FT through April 19, 2014; PT through September 27, 2014)

Unit Students and Post-Doctoral Researchers

Current

- Megan Boldenow, PhD Biological Sciences (Powell)
- Roy Churchwell, PhD Biological Sciences (Powell)
- Heather Craig, MS Wildlife Conservation (Powell)
- Kevin Fraley, MS Fisheries (Falke)
- Dan Govoni, PhD Biological Sciences (Wipfli)
- Jess Grunblatt, PhD Interdisciplinary Studies (Wipfli/Alessa)
- Christopher Harwood, MS Wildlife Conservation (Powell)
- Philip Joy, PhD Fisheries (Wipfli)
- Erin Julianus, MS Biology (McGuire and Hollingsworth)
- Sarah Laske, PhD Fisheries (Wipfli and Rosenberger)
- Allison Martin, MS Fisheries (Falke)
- Jason McFarland, MS Biological Sciences (Wipfli)
- 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)

Graduated in CY 2014

- Kurt Heim, MS Fisheries (Wipfli)
- Jason Neuswanger, PhD Biological Sciences (Wipfli and Rosenberger)

Postdoctoral Researchers

- Kirsty Gurney (Wipfli)
- Brock Huntsman (Falke)
- Yanjiao Mi (McGuire)
- Jennifer Roach (Griffith)

- Erik Schoen (Wipfli)
- Yujin Zhang (McGuire)

University Cooperators

- Milo Adkison, School of Fisheries and Ocean Sciences (SFOS)-UAF
- Lilian Alessa, University of Idaho
- Perry Barboza, Department of Biology and Wildlife(DBW) and Institute of Arctic Biology (IAB)-UAF
- 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
- 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

Affiliated Students and Post-Doctoral Researchers

Current

- Matthew Albert, MS Fisheries (Sutton)
- Adam DuBour, MS Wildlife (Lindberg)
- Graham Frye, PhD Biological Sciences (Lindberg)
- Sophie Gilbert, PhD Biological Sciences (Hundertmark)
- Cristina Hansen, PhD Biological Sciences (Hueffer)
- Christopher Latty, PhD Marine Biology (Hollmen)
- Tyler Lewis, PhD Biological Sciences (Lindberg)
- Stephanie Meggers, MS Fisheries (Seitz and Prakash)
- Dana (Nossov) Brown, PhD Biological Sciences (Kielland)
- Daniel Rizzolo, PhD Biological Sciences (Lindberg)

Graduated in CY 2014

- Brittany Blain, MS Fisheries (Sutton)
- Kevin Foley, MS Fisheries (Rosenberger)
- Jamie McKellar, MS Fisheries (Iken and Sutton)
- Matthew Smith, MS Wildlife Biology and Conservation (Lindberg)
- Lindsay VanSomeren, MS Wildlife Biology and Conservation (Barboza)

Affiliated Post-Doctoral Researchers

- Mark Lara (Euskirchen)
- Mark Miller (Lindberg)
- Reginald Muskett (Romanovsky)
- Colin Tucker (Euskirchen)

Cooperators

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

This is the Annual Report for the Alaska Cooperative Fish and Wildlife Research Unit, highlighting activities for calendar year 2014. 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

Presentations: 30

Scientific and Technical Publications: 18

Courses Taught

- Jeff Falke: Fisheries Division Seminar (Spring 2014; 2 credit hr)
- Brad Griffith: Professional Opportunities in Natural Resources (Spring 2014; 1 credit hr)
- Dave McGuire: Research Design (Spring and Fall 2014; 3 credit hr ea)
- Abby Powell: Animal Migration (Spring 2014; 1 credit hr)
- Mark Wipfli: Climate Change Seminar (Fall 2014; 1 credit hr)

Honors and Awards

- Monica Armbruster, Fiscal Professional at the Alaska Unit, attained her Certified Research Administrator (CRA) credential, awarded by the National Council of University Research Administrators (NCURA) in November 2014.
- Lauren Bailey, UAF Fisheries undergrad and Intern for AUL Fisheries Jeff Falke, was awarded the 2014 Molly Ahlgren Scholarship for \$6000 at the annual meeting of the Alaska Chapter, American Fisheries Society (AFS), 20-24 October 2014, Juneau, AK.
- Kevin Fraley, MS Fisheries student advised by Jeff Falke, won the best presentation award for "Seasonal movements and habitat use of rainbow trout (*Oncorhynchus mykiss*) in the Susitna River basin, Southcentral Alaska," at the 18th Annual AFS Student Symposium, 4 April 2014.
- Sophie Gilbert (PhD Biological Sciences); Kelly Overduijn (MS Wildlife Biology and Conservation); and Lindsay VanSomeren (MS Wildlife Biology and Conservation) received travel awards from the IAB Director, Brian Barnes.
- Allison Martin, MS Fisheries student advised by Jeff Falke, won the Best Student Poster at the annual meeting of the Alaska Chapter AFS, 20-24 October 2014, Juneau, AK.
- Abby Powell, AUL Wildlife, was awarded Honorary Membership in the Cooper Ornithological Society, 22 September 2014.

Outreach and Info Transfer

Brad Griffith, "Effects of climate-related drying on biodiversity in Alaska." Summer Speaker Series, Murie Science and Learning Center, Denali National Park, National Park Service. August 2014.

Abby Powell, "Life of a Little Known Bird in Alaska: Smith's Longspur." Summer Speaker Series, Murie Science and Learning Center, Denali National Park, National Park Service. August 2014.

Papers Presented

Arp, C., B. Jones, A. Liljedahl, M. Whitman, and M. Wipfli. 2014. Response of an Arctic freshwater ecosystem to climate and land-use change: Interdisciplinary research in the Fish Creek watershed, northern Alaska, USA. Joint Aquatic Sciences Meeting, 18-23 May 2014, Portland, OR. (Contributed Oral)

Bailey, L.T. and J.A. Falke. 2014. Development and calibration of bioelectric impedance analysis as a measure of energetic status of Arctic grayling

- (*Thymallus arcticus*). Alaska Chapter American Fisheries Society (AFS) Annual Meeting, Juneau, AK, 21-24 October 2014. (Contributed Oral)
- Bentzen, R.L. and A.N. Powell. 2014. Dispersal, movements, and site fidelity of post-fledging king eiders and their attending females. 5th International Seaduck Conference, 8-12 September 2014, Reykjavík, Iceland (Contributed Oral)
- Birdsey, R., Y. Pan, A.D. McGuire, F. Zhang, and J. Chen. 2014. Past and prospective carbon stocks of United States forests: Implications for research priorities and mitigation policies. American Geophysical Union (AGU) Fall Meeting 2014, San Francisco, CA, 15-19 December 2014. (Contributed Poster)
- Bolton, W.R., V. Romanovsky, A.D. McGuire, G. Grosse, and M. Lara. 2014. Initial conceptualization and simulation of arctic tundra landscape evolution using the Alaska Thermokarst Model. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Contributed Oral)
- Churchwell, R., A. Powell, S. Kendall, and S. Brown. 2014. Assessing eastern Beaufort Sea deltas as fall stopover sites for semipalmated sandpipers. COS (Cooper Ornithological Society)/AOU (American Ornithological Union) Joint Conference, 23-28 September 2014, Estes Park, CO. (Contributed Oral)
- Churchwell, R., A. Powell, S. Kendall, and S. Brown. 2014. Shorebird use of river delta habitat on the Eastern Beaufort Sea coast, Alaska. Alaska Chapter The Wildlife Society (TWS) Annual Meeting, 31 March-3 April 2014, Anchorage, AK. (Contributed Oral)
- Churchwell, R., A. Powell, S. Kendall, and S. Brown. 2014. The Delta Diner: Assessing eastern Beaufort Sea deltas as fall stopover sites for Semipalmated Sandpipers. 16th Alaska Bird Conference, 9-11 December 2014, Juneau, AK. (Contributed Oral)
- Churchwell, R.T., A.N. Powell, S. Kendall, and S. Brown. 2014. Forage quality for pre-migratory semipalmated sandpipers using three river deltas on the Beaufort Sea, Alaska. Alaska Marine Science Symposium, 20-24 January 2014, Anchorage, AK. (Contributed Oral)
- Collins, S., C. Baxter, A. Marcarelli, M. Wipfli, S. Florin, L. Felicetti, and G. Servheen. 2014. Direct and indirect responses of stream and riparian organisms to experimental subsidies of salmon. Joint Aquatic Sciences Meeting, 18-23 May 2014, Portland, OR. (Contributed Oral)
- Craig, H., S. Kendall, and A. Powell. 2014. Reproductive success of Smith's Longspurs in Alaska's Brooks Range. 16th Alaska Bird Conference, 9-11 December 2014, Juneau, AK. (Contributed Oral)
- Falke, J.A., A.N. Martin, and B.M. Huntsman. 2014. Chena River basin juvenile Chinook salmon and physical habitat studies (2013-2016). Yukon Basin Interagency Fisheries Meeting, Fairbanks, AK, 18 April 2014. (Invited Oral)
- Falke, J.A., J.B. Dunham, D. Hockman-Wert, and R. Pahl. 2014. Integrating models of species distributions, physiological thresholds, and physical potential to diagnose temperature impairment in Great Basin streams. Joint Aquatic Sciences Meeting, Portland, OR, 19-23 May 2014. (Contributed Oral)
- Falke, J.A., J.B. Dunham, K.M. McNyset, C.E. Jordan, and G.H. Reeves. 2014. The relative influence of ecological processes in predicting steelhead redd abundance along a complex riverscape in the John Day River basin, Oregon. Pacific States Marine Fisheries Commission Steelhead Managers Meeting, Stevenson, OR, 19 March 2014. (Invited Oral)
- Falke, J.A., R.L. Flitcroft, J.B. Dunham, K.M. McNyset, P.F. Hessburg, and G.H. Reeves. 2014. Fish, forests, and fire: vulnerability analysis for threatened salmonids under a changing climate. Alaska Chapter AFS Annual Meeting, Juneau, AK, 21-24 October 2014. (Invited Oral)

- Falke, J.A., R.M. Flitcroft, J.B. Dunham, K.M. McNyset, P.H. Hessburg, and G.H. Reeves. 2014. Climate change and vulnerability of bull trout in a fire-prone landscape. 144th Annual Meeting AFS, Quebec City, Quebec, Canada, 17-21 August 2014. (Invited Oral)
- Fraleley, K.M. and J.A. Falke. 2014. Seasonal movements of rainbow trout (*Oncorhynchus mykiss*) in the Susitna River Basin, Southcentral Alaska. Alaska Chapter AFS Annual Meeting, Juneau, AK, 21-24 October 2014. (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. 2014. The importance of permafrost thaw, fire and logging disturbances as driving factors of historical and projected carbon dynamic in Alaska ecosystems. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Contributed Oral)
- Harwood, C.M. and A.N. Powell. 2014. Nesting Whimbrels: The rush to flush. 16th Alaska Bird Conference, 9-11 December 2014, Juneau, AK. (Contributed Oral)
- Koch, J., J. Schmutz, K. Gurney, S. Laske, M. Wipfli, and T. Fondell. 2014. The effect of ephemeral ponds, streams, and large lakes on nutrient fluxes, ecosystems and wildlife of the Arctic Coastal Plain of Alaska. Joint Aquatic Sciences Meeting, 18-23 May 2014, Portland, OR. (Contributed Oral)
- Lara, M., A.D. McGuire, and E.S. Euskirchen. 2014. Century time-scale implications for change in peak growing season carbon flux in ice wedge polygonal tundra on the Barrow Peninsula. Annual Symposium, US–International Association of Landscape Ecologists, Anchorage, AK, 18-22 May 2014. Invited. (Contributed Oral)
- Lara, M.J., A.D. McGuire, E.S. Euskirchen, H. Genet, V. Sloan, C. Iversen, R. Norby, Y. Zhang, and F. Yuan. 2014. Changes in landscape-level carbon balance of an arctic coastal plain tundra ecosystem between 1970-2100, in response to projected climate change. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Contributed Oral)
- Laske, S., A. Rosenberger, M. Wipfli, and C. Zimmerman. 2014. Feeding frenzy: Exploring the role of ninespine stickleback in Arctic freshwater food webs. Joint Aquatic Sciences Meeting, 18-23 May 2014, Portland, OR. (Contributed Oral)
- Laske, S., A.E. Rosenberger, J.C. Koch, C.E. Zimmerman, and M.S. Wipfli. 2014. Feeding frenzy: Exploring the role of ninespine stickleback in Arctic freshwater food webs. Annual Meeting, Society for Freshwater Science, 18-23 May 2014, Portland, OR. (Contributed Oral)
- Marchenko, S., D. Nicolsky, V. Romanovsky, and A.D. McGuire. 2014. 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. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Contributed Oral)
- Martin, A.N., J.A. Falke, J.F. Pomeranz, and J.W. Saveride. 2014. Habitat potential for juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Chena River basin, Alaska. Alaska Chapter AFS Annual Meeting, Juneau, AK, 21-24 October 2014. (Contributed Poster)
- McGuire, A.D. and Members of the Model Integration Team of the Vulnerability of Permafrost Carbon Research Coordination Network. 2014. The importance of explicitly representing soil carbon with depth over the permafrost region in Earth system models: Implications for atmospheric carbon dynamics at multiple temporal scales between 1960 and 2300. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Invited Oral)

- McGuire, A.D., and Members of the Permafrost Carbon Vulnerability Research Coordination Modeling Working Group. 2014. Retrospective and future assessments of the vulnerability of permafrost and carbon in the earth system: Comparison of dynamics among process-based models. Third Carbon Pools in Permafrost Regions Workshop, Stockholm, Sweden, 12-14 May 2014. (Invited Oral)
- McGuire, A.D., T.S. Rupp, A. Breen, E. Euskirchen, and V. Romanovsky. 2014. The Integrated Ecosystem Model (IEM) for Alaska and Northwest Canada: An interdisciplinary tool to assess the responses of natural resources to climate change. Annual Symposium, US–International Association of Landscape Ecologists, Anchorage, AK, 18-22 May 2014. (Invited Oral)
- Overduijn, K., C.M. Handel, and A.N. Powell. 2014. Nest site selection by American and Pacific Golden-Plovers. 16th Alaska Bird Conference, 9-11 December 2014, Juneau, AK. (Contributed Oral)
- Parmentier, F.-J.W., W. Zhang, Y. Mi, X. Zhu, P.A. Miller, K. van Huissteden, D. Hayes, Q. Zhuang, A.D. McGuire, and T.R. Christensen. 2014. Higher methane emissions in regions of sea ice retreat. European Geophysical Union, Vienna, Austria, 27 April -2 May 2014. (Contributed Oral)
- Parmentier, F.J.W., W. Zhang, Y. Mi, X. Zhu, P.A. Miller, J. van Huissteden, D. Hayes, Q. Zhang, A.D. McGuire, and T.R. Christensen. 2014. Higher methane emissions in regions of sea ice retreat. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Contributed Poster)
- Rawlins, M.A., A.D. McGuire, J.S. Kimball, P. Dass, and Members of the Model Integration Team of the Vulnerability of Permafrost Carbon Research Coordination Network. Assessment of model estimates of land-atmosphere CO₂ exchange across northern Eurasia. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Contributed Oral)
- Rine, K., M. Wipfli, E. Schoen, and C. Stricker. 2014. Patterns of energy flow in salmonid food webs within a large glacial Alaskan river. Joint Aquatic Sciences Meeting, 18-23 May 2014, Portland, OR. (Contributed Poster)
- Robinson, B., A. Powell, L. Phillips, and H. Coletti. 2014. Are prey remains accurate indicators of chick diet? Implications for long-term monitoring of Black Oystercatchers. 16th Annual Alaska Bird Conference, 9-11 December 2014, Juneau, AK. (Contributed Oral)
- Robinson, B., A.N. Powell, and L.M. Phillips. 2014. Chick provisioning and nutritional quality of Black Oystercatcher prey. Alaska Chapter TWS Annual Meeting, 31 March-3 April 2014, Anchorage, AK. (Contributed Poster)
- Schuur, E.A.G., A.D. McGuire, G. Grosse, J.W. Harden, D.J. Hayes, G. Hugelius, C.D. Koven, P. Kuhry, D.M. Lawrence, S.M. Natali, D. Olefeldt, V.E. Romanovsky, C. Schädel, K. Schaefer, M. Turetsky, C. Treat, and J.E. Vonk. 2014. Climate change and the permafrost carbon feedback. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Invited Oral)
- Tucker, C., E. Euskirchen, H. Genet, and A.D. McGuire. 2014. Modeled changes in terrestrial C storage on the Arctic coastal plain of Alaska suggest a mid-century 21st shift from C sink to source. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Contributed Oral)
- Turetsky, M.R., E.S. Euskirchen, C.I. Czimczik, M.P. Waldrop, D. Olefeldt, Z. Fan, E.S. Kane, A.D. McGuire, and J.W. Harden. 2014. Controls on northern wetland methane emissions: insights from regional synthesis studies and the Alaska Peatland Experiment (APEX). AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Invited Oral)
- Wipfli, M., J. McFarland, K. Heim, K. Gurney, S. Laske, M. Whitmann, C. Arp, J. Adams, and J. Koch. 2014. Freshwater food web processes on the Arctic Coastal

- Plain, Alaska: Vulnerabilities in a changing environment. Joint Aquatic Sciences Meeting, 18-23 May 2014, Portland, OR. (Contributed Oral)
- Xia, J., A.D. McGuire, D. Lawrence, E. Burke, X. Chen, C. Delire, C. Koven, A. MacDougall, S. Peng, A. Rinke, K. Saito, W. Zhang, R. Alkama, T.J. Bohn, P. Ciais, B. Decharme, I. Gouttevin, T. Hajima, D. Ji, G. Krinner, D.P. Lettenmaier, P.A. Miller, J.C. Moore, B. Smith, T. Sueyoshi, Z. Shi, Yan, L., and Y. Luo. 2014. Terrestrial ecosystem model performance for net primary productivity and its vulnerability to climate change in permafrost regions. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Contributed Oral)
- Zhang, Y., H. Genet, M. Lara, A.D. McGuire, J. Roach, V. Patil, V. Romanovsky, B. Bolton, B., and R. Rutter. 2014. An assessment of thermokarst driven changes in land cover of the Tanana Flats wetland complex of Alaska from 2009-2100 in response to climate warming. AGU 2014 Fall Meeting, San Francisco, CA, 15-19 December 2014. (Contributed Poster)

Scientific Publications

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- Euskirchen, E.S., T.B. Carman, and A.D. McGuire. 2014. Changes in the structure and function of northern Alaskan ecosystems when considering variable leaf-out times across groupings of species in a dynamic vegetation model. *Global Change Biology* 20:963-978, doi: 10.1111/gcb.12392. — IPDS: IP-049058; BAO Date: July 1, 2013
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Theses and Dissertations of Unit-Sponsored Graduate Students

- Blain, Brittany. 2014. The effects of barotrauma and deepwater-release mechanisms on the reproductive viability of yelloweye rockfish in Prince William Sound, Alaska. MS thesis, University of Alaska Fairbanks. 77 pp.
- Foley, Kevin. 2014. Longitudinal distribution patterns and habitat associations of juvenile coho salmon *Oncorhynchus kisutch* in tributaries of the Little Susitna River, Alaska. MS thesis, University of Alaska Fairbanks. 143 pp.
- Heim, Kurt C. 2014. Seasonal movements of Arctic grayling in a small stream on the Arctic Coastal Plain, Alaska. MS thesis, University of Alaska Fairbanks. 82 pp.
- McKellar, Jamie. 2014. Growth and maturity of the Pacific razor clam, *Siliqua patula*, in eastern Cook Inlet, Alaska. MS thesis, University of Alaska Fairbanks. 56 pp.
- Neuswanger, Jason. 2014. New 3-D video methods reveal novel territorial drift-feeding behaviors that help explain environmental correlates of Chena River chinook salmon productivity. PhD dissertation, University of Alaska Fairbanks. 181 pp.
- Smith, Matthew. 2014. Infection rates, parasitemia levels, and genetic diversity of hematozoa in New World waterfowl. MS thesis, University of Alaska Fairbanks. 67 pp.
- VanSomeren, Lindsay. 2014. Monitoring energy and nitrogen availability for Arctic caribou (*Rangifer tarandus*). MS thesis, University of Alaska Fairbanks. 128 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

The Effects of Barotrauma and Deepwater-Release Mechanisms on the Reproductive Viability of Yelloweye Rockfish in Prince William Sound, Alaska

Student Investigator: Brittany Blain, MS Fisheries

Advisor: Trent Sutton

Funding Agency: ADFG

Note: Brittany Blain graduated from the University of Alaska Fairbanks in December 2014. Her thesis abstract follows:

Previous research has shown that releasing sport-caught Yelloweye Rockfish *Sebastes ruberrimus* with a deepwater-release mechanism (DRM) can alleviate anatomical damage due to barotrauma. However, it is unknown if a Yelloweye Rockfish remains a viable member of the population and reproduces in subsequent years following a barotrauma event and recompression with a DRM. The objectives of my study were to: 1) determine if Yelloweye Rockfish were able to reproduce one to two years following known forced decompression and recompression event(s); and 2) evaluate if barotrauma and recompression affected the quality of developing embryos. In 2010, Yelloweye Rockfish were sampled from an isolated reef in Prince William Sound, Alaska. Fifteen females tagged in 2008 and 2009 were recaptured in 2010, and reproductive status was identified by visual observation of the gonads and hematological sampling (i.e., vitellogenin and calcium²⁺ plasma concentrations). Oil globule volume, percent lipid, and caloric content were also measured for the embryos from seven of these females and these values were compared to embryos from 13 females with no previously documented barotrauma and recompression events. These results showed that all 15 Yelloweye Rockfish recaptured in 2010 were gravid (with eggs) or spent (having released eggs). In addition, there were no differences in median oil globule volume, caloric content, and percent lipid between individual embryos from new captures and recaptures. Results indicated that there is no evidence that reproduction and embryo quality of Yelloweye Rockfish is adversely affected one to two years following forced decompression and recompression with a DRM at the depths sampled in this study. This research provides information on the utility of DRMS as a tool for rockfish conservation and supports the importance of utilizing these devices by sport anglers.

Longitudinal Distribution Patterns and Habitat Associations of Juvenile Coho Salmon *Oncorhynchus kisutch* in Tributaries of the Little Susitna River, Alaska

Student Investigator: Kevin Foley, MS Fisheries

Advisors: Amanda Rosenberger

Funding Agency: Anchorage Field Office, USFWS (RWO 174)

Note: Kevin Foley graduated from the University of Alaska Fairbanks in May 2014. His thesis abstract follows:

Understanding how headwater streams function as rearing habitats for juvenile coho salmon *Oncorhynchus kisutch* is essential for effective population management and conservation. To inform habitat restoration activities within the Matanuska-Susitna Valley, Alaska, I determined upstream distribution limits, validated abundance estimates, and established fish habitat relationships in two headwater stream tributaries of the Little Susitna River in 2010-11. Using a low-effort, spatially continuous sampling approach and linear mixed-effects models, I related local- and landscape-scale habitat associations to abundance estimates. All-aged coho salmon composed approximately 98% of all fish sampled and inhabited the entire stream length to their upstream limits. Age-1+ fish resided in 64% and 44% of the stream length for the two sampled streams. The mean upstream elevation limit for all-aged fish in these streams was 278m and 267m. For age-1+ fish, the upstream elevation limit in the two streams was 275m and 238m. Percent slope at the distribution limit of all-aged fish was consistent across streams at 5%, whereas percent slope for age-1+ fish correspond to 4% and 6%. Elevation and percent slope consistently described upstream distribution limits among age classes. Therefore, we must consider these landscape features when prioritizing restoration projects in headwater streams.

Seasonal Movements of Arctic Grayling in a Small Stream on the Arctic Coastal Plain, Alaska

Student Investigator: Kurt Heim, MS Fisheries

Advisor: Mark Wipfli

Funding Agencies: USFWS (RWO 168) and BLM (RWO 179)

Note: Kurt Heim graduated from the University of Alaska Fairbanks in August 2014. His thesis abstract follows:

In watersheds of the Arctic Coastal Plain (ACP) of Alaska, Arctic Grayling adopt a migratory life history strategy to persist in a landscape with long (~ 8 month), cold winters that cause shallow aquatic habitats to freeze solid. We investigated movement patterns of adult and juvenile Arctic Grayling in a shallow beaded stream (Crea Creek), a dominant headwater stream type on the ACP. From 2012–2013 Arctic Grayling ($N = 1035$) were tagged with passive integrated transponder tags and monitored using an array of stream-wide antennae. Migration into Crea Creek peaked immediately after ice break-up in the main channel of the study area. Fish caught within the stream in June were in relatively poor body condition compared to fish captured later in summer. In both years, fish entering the stream during high flow and colder temperatures swam farther upstream than those entering during low flow and warmer temperatures. Migration of adult fish out of the stream was most strongly correlated with decreasing stream discharge, whereas juvenile downstream migration occurred in two peaks and was negatively correlated to minimum stream temperature and discharge. Among juveniles, fish of larger size and higher body condition tended to emigrate earlier. These results indicate that the population level migratory response is strongly tied to seasonal changes in hydrology, though heterogeneity among individuals also influences the response to seasonal change. This work demonstrates the importance of environmental cues, and surface-water flow mediated connectivity during the open-water period, and provides information needed to identify susceptibilities of migratory fishes to climate change and petroleum development on the ACP.

Growth and Maturity of the Pacific Razor Clam, *Siliqua patula*, in Eastern Cook Inlet, Alaska

Student Investigator: Jamie McKellar, MS Fisheries

Co-Advisors: Katrin Iken and Trent Sutton

Funding Agency: Sport Fish Division, ADFG (Base funding); State Wildlife Grant, USFWS

Note: Jamie McKellar graduated from the University of Alaska Fairbanks in December 2014. Her thesis abstract follows:

In Alaska, the only road-accessible fishery for the Pacific razor clam, *Siliqua patula*, is located in eastern Cook Inlet, and has been monitored by the Alaska Department of Fish & Game (ADF&G) since 1964. In recent years, a shift has been observed in size, age, and number of clam cohorts in this region, yet little is known about the early life history of razor clams in this region. This study aimed to provide information on length and age at maturity, growth rates, and spawn timing at two beaches in eastern Cook Inlet, Ninilchik and Clam Gulch, in 2009 and 2010. At Clam Gulch, only 20% of the sampled population was reproductive, compared with 83% at Ninilchik. At Ninilchik, clams were reproductive at a smaller size and younger age ($p < 0.05$) than previously documented. The Ninilchik clams grew faster and had a larger size at age ($p < 0.05$) than at Clam Gulch. A body condition index of clams from Clam Gulch was consistently 50% lower than at Ninilchik. Despite the relative proximity (25 km) of these locations, it is possible that environmental conditions may be different, resulting in differences in growth and reproductive output. This information is of special interest to fisheries managers as they address recent declines in the eastern Cook Inlet razor clam population and provides a benchmark for future management decisions.

New 3-D Video Methods Reveal Novel Territorial Drift-feeding Behaviors that Help Explain Environmental Correlates of Chena River Chinook Salmon Productivity

Student Investigator: Jason Neuswanger, PhD Biological Sciences

Co-Advisors: Mark Wipfli and Amanda Rosenberger

Funding Agencies and Partners: Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYKSSI), ADFG; IAB; DBW, UAF Graduate School

Note: Jason Neuswanger graduated from the University of Alaska Fairbanks in August 2014. His dissertation abstract follows:

Chinook salmon (*Oncorhynchus tshawytscha*) are critical to subsistence and commerce in the Yukon River basin, but several recent years of low abundance have forced devastating fishery closures and raised urgent questions about causes of the decline. The Chena River subpopulation in interior Alaska has experienced a decline similar to that of the broader population. To evaluate possible factors affecting Chena River Chinook salmon productivity, I analyzed both population data and the behavior of individual fish during the summer they spend as fry drift feeding in the river. Using a stereo pair of high definition video cameras, I recorded the fine-scale behavior of schools of juvenile Chinook salmon associated with woody debris along the margins of the Chena River. I developed a software program called VidSync that recorded 3-D measurements with sub-millimeter accuracy and provided a streamlined workflow for the measurement of several thousand 3-D points of

behavioral data (Chapter 1). Juvenile Chinook salmon spent 91% of their foraging attempts investigating and rejecting debris rather than capturing prey, which affects their energy intake rate and makes foraging attempt rate an unreliable indicator of foraging success (Chapter 2). Even though Chinook salmon were schooling, some were highly territorial within their 3-D school configurations, and many others maintained exclusive space-use behaviors consistent with the population regulatory effects of territoriality observed in other salmonids (Chapter 3). Finally, a twenty-year population time series from the Chena River and neighboring Salcha River contained evidence for negative density dependence and a strong negative effect of sustained high summer stream discharge on productivity (Chapter 4). The observed territoriality may explain the population's density dependence, and the effect of debris on foraging efficiency represents one of many potential mechanisms behind the negative effect of high stream discharge. In combination, these findings contribute to a statistically and mechanistically plausible explanation for the recent decline in Chena River Chinook salmon. If they are, in fact, major causes of the decline (other causes cannot be ruled out), then we can be tentatively hopeful that the population may be experiencing a natural lull in abundance from which a recovery is possible.

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 be an important variable affecting growth and survival of juvenile salmon. The effects on stock productivity, however, have not been assessed directly. Given that larger smolt are associated with higher marine survival, understanding the impacts of MDN on juvenile growth, size, and abundance may ultimately improve management of salmon stocks. The objectives of this study are to identify the degree, route, and effects of MDN assimilation in a naturally rearing salmon population. Chinook and coho salmon smolt productivity was examined with mark-recapture experiments on migrating smolt. MDN assimilation and growth were assessed using stable isotope and stomach content analysis, while growth is being assessed using RNA:DNA ratios from muscle and Length Frequency Data Analysis (LFDA). Preliminary results indicated seasonal fluctuations of MDN in salmon tissue were greatest in areas with little off-channel habitat and less in areas with substantial off-channel habitat. However, more complex habitat showed greater retention of MDN in salmon tissue. Gut content analysis showed the bulk of MDN was acquired indirectly through predation on invertebrates, although fry predation was notable in smolt and larger coho salmon parr. The relationship between MDN assimilation and the growth and condition of juvenile salmon is currently being analyzed. Results from this study will quantify the importance of MDN to Chinook and coho salmon stock productivity and improve forecasting models based on these relationships.

Thermal Criteria for Nevada Coldwater Stream Fishes

PI: Jeff Falke

Funding Agency: Nevada Division of Environmental Protection (NDEP)

In-Kind Support: Sample collection and logistics provided by NDEP

Past efforts to set thermal standards for coldwater fishes have focused on overly detailed or not detailed enough (i.e., insufficiently documented) criteria based upon point estimates of acute and chronic exposure. As a result, traditional temperature metrics are poorly suited to describe instream conditions that can be affected by management, and as a consequence, often fail to protect populations and set unrealistic expectations for natural thermal conditions. A need exists to update and develop protective criteria and monitoring designs for thermal conditions that support coldwater stream fishes in the state of Nevada. This project has two main objectives, to (1) develop a matrix of recommended temperature standards for coldwater stream fishes in Nevada and (2) review approaches for monitoring thresholds that incorporate spatio-temporal variability in stream water temperatures. Recommended temperature standards will be based on a combination of literature review and analysis of the current distribution of coldwater fishes and thermal regimes in the state. Spatio-temporal variability in water temperature metrics will be assessed using existing temperature data and a subset collected during this project. Water and air temperature data were collected in summer 2012 from 54 sites in the Reese River and Stewart Creek, Nye County, Nevada. A draft manuscript is currently under review by NDEP with a goal to submit for publication by April 2014. Current numeric criteria for mainstem habitats exist, but sources are poorly documented. Smaller streams are currently classified by water quality, and within each category a single criterion is applied across the year. New thermal criteria for Nevada's coldwater fishes are needed that are clear, consistent, supportable, and easily measurable.

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: Cooperative Research Unit Program, USGS (RWO 202)

In-Kind Support: Fish sample collection and site access provided by ADFG

Relatively little information is available on how the energetic status of salmonids fluctuates across life stages, seasons, and environments at the individual level. Much of this uncertainty results from the relative difficulty (i.e., expense) of obtaining precise estimates of proximate composition (PC). Moreover, PC analysis is expensive, time consuming, lethal, and not practical for repeated measures, field applications, or large numbers of individuals. Recent advancements in bioelectrical impedance analysis (BIA) show promise in developing precise non-lethal estimates of individual fish condition. Development of rapid, precise, and non-lethal methods of estimating energetic status is critical for successful fisheries management and for contributing to our understanding of bioenergetics and the flow of energy through populations, communities, and ecosystems. The main objective of this research is to build and validate BIA models for Arctic grayling. Grayling will be collected from streams and lakes near Fairbanks, Alaska, sacrificed, weighed, measured, and BIA measures of resistance and reactance recorded. Samples will be frozen and transported to UAF where they will be analyzed for proximate composition using

standardized methods. Models will be built relating PC metrics to BIA measurements using generalized linear models. Sampling occurred in spring and fall 2013. One-hundred-sixty fish were collected from four interior Alaska river basins. Lab PC analyses are currently underway. Quantifying the range of variation in late-summer energy density within a population may contribute towards the ability to predict overwinter survival. Moreover, linking environmental characteristics to energy allocation through time would provide insight into conditions that ultimately influence individual performance and population productivity, with implications for conservation, management, and restoration actions.

Seasonal Movements and Habitat Use of Rainbow Trout (*Oncorhynchus mykiss*) in the Susitna River Basin, Southcentral Alaska

Student Investigator: Kevin Fraley, MS Fisheries

Advisor: Jeff Falke

Funding Agencies: ADFG; MatSu Salmon Habitat Partnership (RWO 202)

In-Kind Support: Personnel, boats, logistics provided by Sport Fish Division, ADFG Region 2

Rainbow trout in the Susitna River basin of southcentral Alaska (particularly Willow Creek) are the target of a popular sportfishery and are sensitive to habitat degradation that is often caused by human activities. Little is known about the seasonal habitat use and movement patterns of these fish. Land development is expected to double within the next 50 years in the Susitna River basin and may lead to aquatic habitat alteration and increased sportfishing. In light of these pressures, it is necessary to gain an understanding of the movements and habitat utilization of rainbow trout in this region to protect this ecologically and recreationally important fish species. The objectives of this project are to (1) use a combined resource selection and occupancy estimation approach to characterize seasonal habitat preference of adult rainbow trout, (2) describe the timing and distance of trout movements between important seasonal habitats, and (3) investigate the prevalence of sex-biased (male vs. female) differences in trout habitat use and movements through genetic analysis. Project objectives will be addressed by relating location and timing of movement from radiotagged fish to aquatic habitat characteristics measured at channel unit, reach, and basin scales under resource selection and occupancy estimation frameworks. Preliminary results suggest that trout undertake extensive movements among seasonal (e.g., overwintering, spawning, and feeding) habitats in the Susitna River basin. The majority of overwintering occurs in the mainstem Susitna River, although most individuals remained near the mouths of "home" tributaries. Spawning and feeding habitat fidelity varied among tributaries, with inter-tributary movements occurring relatively frequently. Modeling of fish location-habitat use relationships is currently underway. The results of this research will lead to better understanding of Susitna River rainbow trout life histories and population dynamics, and aid fishery managers in setting sportfishing regulations and protecting critical trout habitat.

Predation Mortality as a Potential Contributor to AYK Juvenile Chinook Declines

Postdoctoral Researcher: Erik Schoen

Research Technician: Kristen Sellmer

Advisor: Mark Wipfli

Funding Agency: ADFG

In-Kind Support: ADFG, NSEDC, and subsistence and sport fishers

Freshwater predation can reduce juvenile salmon abundance, but little is known about the predators of juvenile Chinook salmon in interior and western Alaska and their potential role in recent salmon declines. Declines have been cause for economic, subsistence, and cultural hardship throughout Alaska and there is a need to better understand specific freshwater stressors on juvenile Chinook. The early life-history stage of Chinook salmon in freshwater is a period of high mortality and growth with important consequences for population dynamics. Addressing freshwater predation as a possible limiting factor to juvenile Chinook survival will help fill current knowledge gaps regarding freshwater limits on overall abundance. Objectives are to determine (1) the key predators of juvenile Chinook salmon, and when and where they inflict the greatest mortality, and (2) if predators are size selective. We sampled fish predators in the Chena, Yukon, and Unalakleet rivers across seasons and among habitats where juvenile Chinook salmon are present. Two-hundred-seventeen non-empty stomach samples from predators were collected non-lethally and analyzed in the lab. Genetic analysis of potential Chinook salmon prey is in progress. While results are contingent on the completion of the genetic analysis, work is underway to develop a model of interaction strength between juvenile Chinook salmon and their predators. The data set considers season, species, and environmental factors known to influence fish behavior as factors that influence the proportion of juvenile Chinook salmon in predator diets. If predation in freshwater is an important source of mortality, managers could potentially mitigate these losses through predator harvest or habitat restoration.

Susitna River Food Web Study

Postdoctoral Researcher: Erik Schoen

Student Investigator: Kristin Rine, MS Wildlife Biology

PI/Advisor: Mark Wipfli

Funding Agency: Alaska Energy Authority (AEA)

The Alaska Energy Authority (AEA) has proposed the construction of a hydroelectric dam on the Susitna River, but little information exists on energy flow within the river's food webs and how environmental drivers influence food resources and affect the growth and productivity of salmonids. Hydropower operations may alter environmental variables that affect food webs, in turn affecting salmonids. Knowledge of existing trophic relationships and the environmental limitations on salmon productivity is necessary to inform mitigation efforts. Objectives are to (1) compare patterns of energy flow from freshwater, terrestrial, and marine sources to stream salmonids among habitat types and 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, and develop a model for predicting growth under changing conditions. In 2013 and 2014, we measured aquatic habitat characteristics and determined the diets and growth patterns of juvenile Chinook salmon and coho

salmon, rainbow trout, and Arctic grayling. We also sampled tissues of major food web components for stable isotope analysis. In 2013, juvenile salmon consumed aquatic and terrestrial invertebrates throughout the growing season and heavily utilized salmon eggs during spawning runs. Feeding rate was the primary factor limiting growth of juvenile Chinook and coho salmon. We are currently analyzing 2014 data. This study will provide baseline information for evaluating potential effects of the proposed dam on food webs and fish resources in the Susitna River.

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

Student Investigator: Allison Martin, 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 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. Project 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 environmental DNA to assess presence/absence of juveniles among selected tributary habitats, and (3) determine the spatial distribution of rearing juvenile Chinook salmon within tributaries in the Chena River via calibrated snorkel surveys. Sampling will be conducted using rapid-assessment methods such as snorkeling and eDNA analysis under an occupancy estimation framework. Predictive models of juvenile occurrence 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. Environmental DNA samples were collected from 40 tributaries in the Chena River basin in summer 2014. A preliminary IP model based on literature values predicted ~900 stream-km of high-potential juvenile Chinook salmon rearing habitat in the basin. Snorkeling and calibration sampling will be conducted in summer 2015. Information resulting from this study will inform managers regarding 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.

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

Postdoctoral Researcher: Brock Huntsman

Advisor: Jeff Falke

Funding Agency: State of Alaska

In-Kind Support: Logistical support provided by Sport Fish Division ADGF Region 3 and 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 stream flow and temperature often influence fish population dynamics within stream ecosystems. Identifying and managing freshwater habitats suitable for Chinook salmon populations in the Chena would be extremely useful for helping restore productivity to historic levels. The objectives of this study are to (1) develop spatially continuous metrics that describe historic, current, and future flow and temperature regimes within the Chena River basin, and (2) determine whether these spatially continuous metrics are effective in describing Chinook salmon population dynamics and distributions. Stream temperature loggers (N=52) were deployed throughout the Chena watershed in summer 2014. Flow regimes were modelled with a macro-scale hydrologic model downscaled to stream reaches of 100-1000 m. Lastly, juvenile Chinook salmon will be collected from 24 sites longitudinally along the Chena mainstem 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, once fish surveys are complete. The results of this study will help identify mechanisms limiting Chinook salmon productivity within the Chena watershed.

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

Student Investigator: TBN, MS Fisheries

Co-Advisors: Jeff Falke and Andrés López (SFOS)

Funding Agency: NPS

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.

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. F_{st} and related measures) will be calculated to estimate degree of differentiation.

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

Relative Parasitemia Levels in Alaska Waterfowl

Student Investigator: Matthew Smith, MS Wildlife Biology and Conservation

Advisor: Mark Lindberg

Funding Agency: Alaska Science Center, USGS (RWO 199)

Note: Matthew Smith graduated from the University of Alaska Fairbanks in December 2014. His thesis abstract follows:

Blood parasites can limit the productivity of birds and increase the vulnerability of isolated and naive populations to extinction. I examined 804 blood samples collected from 11 species of South American waterfowl to assess infection by *Haemoproteus*, *Plasmodium* and/or *Leucocytozoon* parasites. In addition, I strove to develop a new molecular tool to quickly and accurately determine relative parasitemia rates of *Leucocytozoon* parasites in avian blood. I used samples collected from waterfowl in interior Alaska ($n = 105$) to develop and optimize a real-time, quantitative PCR methodology using TaqMan fluorogenic probes.

Molecular screening produced an apparent prevalence rate of 3.1% for hematozoa infections in South American waterfowl samples, and analysis of hematozoa mitochondrial DNA produced 12 distinct hematozoa haplotypes, four of which were identical to hematozoa lineages previously found infecting waterfowl in North America. Phylogenetic analyses of hematozoa DNA revealed close relationships between parasite lineages infecting waterfowl on both continents. Our qPCR assay showed high levels of sensitivity (91%) and specificity (100%) in detecting *Leucocytozoon* DNA from host blood when compared to results from a well-used nested-PCR protocol. Additionally, statistical results of a linear regression supported correlation between relative parasitemia estimates from our qPCR assay and greater numbers of parasites observed on blood smears ($R^2 = 0.67$, $P = 0.003$).

Monitoring Energy and Nitrogen Availability for Arctic Caribou (*Rangifer tarandus*)

Student Investigator: Lindsay VanSomeren, MS Wildlife Biology and Conservation

Advisor: Perry Barboza

Funding Agency: Alaska Science Center, USGS (RWO 197)

In-Kind Support: Fort Collins Science Center, USGS; ADFG; BLM

Note: Lindsay VanSomeren graduated from the University of Alaska Fairbanks in December 2014. Her thesis abstract follows:

Arctic caribou and reindeer (*Rangifer tarandus*) are an economically and ecologically important species. *Rangifer* populations are often affected by nutritional factors. Our ability to monitor nutrient supply to arctic ungulates is presently limited by a lack of techniques to consistently and easily measure availability of specific nutrients and which may disproportionately affect different segments of *Rangifer* populations. I refined and validated a method to measure availability of specific nutrients including nitrogen (N) and energy to caribou using purified fibrolytic enzymes and acid/pepsin to simulate digestion. I then used this method to measure how availability of nitrogen and energy was altered by anti-nutrients such as indigestible fiber and toxins. Digestible N contents in forages declined to almost zero by the end of the growing season, whereas digestible energy concentrations were still sufficient to

meet basic maintenance requirements for caribou by the end of the growing season in shrub and forb forages. Shrubs contained the highest amounts of total N and energy, however this was reduced by fiber and toxins so that shrubs contained the lowest digestible N contents, especially for *Betula nana*. Graminoids were extremely low in digestible energy content, which may necessitate a high degree of selection among plant parts by herbivores.

Dietary choice over long- and short-term periods may be assessed using non-invasive stable isotope techniques, nevertheless, the understanding of how isotopic signatures vary over spatial, temporal, and species-specific scales and how isotopic signatures are changed by digestive processes is limited. Monocot (graminoid) and dicot (browse and forb) forages both differed in values of ^{13}C and ^{15}N , however regional and seasonal shifts in ^{13}C were larger than the differences among forage groups themselves. Forage isotopic signatures also changed after *in vitro* simulated digestive processes, yet this was only significant for species with very low (< 52.6 % N) or very high (> 36.6 % C) digestibilities.

These studies suggest that nitrogen may be a limiting nutrient for caribou populations. Persistence of arctic caribou populations in a changing climate may depend, in part, upon continued access to calving grounds, the change in abundance of individual shrub species, and/or the ability of caribou to behaviorally and physiologically cope with increasing amounts of toxins in shrubs.

Ongoing Wildlife Studies

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

Student Investigator: Roy Churchwell, PhD Biology

Advisor: Abby Powell

Funding Agencies: USFWS; BOEM; USGS; and Arctic Landscape Conservation Cooperative (LCC)

In-kind Support: USFWS provided housing and logistical support

There is little knowledge of shorebird biology in the Arctic and what draws these birds to littoral delta mudflats during the post-breeding period; it is thought that food resources may influence shorebird use and distribution. The Arctic National Wildlife Refuge is investigating these questions to manage and preserve shorebird species and habitat along the refuge's coast. Potential impacts to the coast have developed through offshore oil development and climate change. We will determine shorebird distribution in relation to invertebrate food resources spatially and temporally and investigate how resource differences among study sites influence length of stay and shorebird physiological parameters. We have completed the fieldwork portion of this research, and we are currently writing manuscripts. The first was recently submitted, while two more are partially completed. We have determined that at least some shorebird species exclusively feed on deltas during the post-breeding period. Semipalmated Sandpipers are positively associated with invertebrate abundance. Semipalmated Sandpipers were found to feed on different invertebrate taxa depending on the delta where they were feeding, which could allow them to procure adequate food across the Beaufort Sea coast during their southern fall migration. This may explain why we did not find a difference in habitat quality among the different deltas. We are providing information on several shorebird populations using this habitat, including some that are declining and some that are listed as species of concern in the US Shorebird Conservation Plan and by US Fish and Wildlife Service.

Breeding Ecology of Smith's Longspurs in Northern Alaska

Student Investigator: Heather Craig, MS Wildlife Biology

Advisor: Abby Powell

Funding Agency: USGS

In-Kind Support: Additional support provided by USFWS and BLM

Smith's Longspurs have been listed as a species of concern because of threats on both wintering and breeding grounds. In Alaska, the species breeds in open low shrub habitat in the Brooks Range where they could be very susceptible to habitat changes or climatic changes. Limited data is available on micro-habitat requirements, nest site selection, and nest survival of Smith's Longspurs. This information is particularly useful to management agencies for developing appropriate conservation strategies for the species. The objectives of this study were to examine nest habitat requirements, nest site selection, and nest survival. We located and monitored a total of 271 Smith's Longspur nests during the six years (2007–13, no data from 2010) of our study. We determined daily survival rate from the 95% of these nests with known fate. To identify nest site selection we measured and described microhabitat at 86 Smith's Longspur nests and used logistic regression to compare nest habitat to random locations within each nest territory. At least one chick successfully fledged from 77% ($n = 197$) of the nests. The top survival model suggested that daily survival rate is related to the number of days each season below freezing. There did not appear to be a relationship between nest survival and nest site selection, although Smith's Longspurs tended to select nest sites with less variance in willow height than random sites within the nest territory. Baseline information on habitat selection and reproductive success, prior to further climate change, is needed in order to evaluate community-wide impacts within this quickly changing landscape.

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 (NFWF); North Pacific Research Board

In-kind Support: ConocoPhillips Alaska, Inc. provided field logistics and assistance; Columbus Zoo, OH, Mesker Park Zoo, IN, and Point Defiance Zoo, WA, provided veterinarians

Spectacled Eiders spend most of the year at sea along the coasts of Russia and Alaska and are listed as 'threatened' under the US Endangered Species Act. Their circannual distribution and patterns of habitat use at sea are understudied. Information regarding the distribution and habitats used by Spectacled Eiders will help managers identify potential threats to the species away from breeding areas. The primary objective of our 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. Females demonstrated greater migratory connectivity among regions. Females also demonstrated greater site fidelity throughout the annual cycle. 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, indicative of past variation in the distribution of benthic prey. 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.

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, despite multiple designations as a species of conservation concern (US, 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 local population of Whimbrels at Kanuti National Wildlife Refuge for 2011–2012. In 2013, we attempted to identify potential breeding locations for interior Alaska. Most recently we used multivariate logistic regression at three spatial scales to compare multiple habitat features of 39 Whimbrel nests and paired, random “non-nests” to test if Whimbrels select nest sites potentially offering better predator visibility and/or cryptic complexity. At the 1-m scale, location on top of a hummock was the most important predictor of nest-site selection. At the 10-m scale, there was little predictive support for heterogeneity in vegetative cover, number of medium/tall shrubs, or surface unevenness. At the unlimited scale, distances to vegetation types (i.e., low, medium, and tall shrubs; trees) were not important predictors. Preliminary results suggest greater support for the visibility component in nest-site selection. Sampling techniques currently employed may be inadequate for properly characterizing nesting habitat complexity. Alternatively, such complexity may be less important to nest-site selection in Whimbrels than we suspected.

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 2015. This research will elucidate the effects of shrub increase 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. 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, PhD Biological Sciences

Advisor: Abby Powell

Funding Agency: USGS and NPS (through NRPP) (RWO 210)

In-Kind Support: USFWS (Selawik National Wildlife Refuge 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 will contribute 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. This work 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 spatially balanced sample in all unique types. We visited each plot regularly with a one- to two-person crew and kept a running tally of all waterbirds observed during area searches, communicating to avoid double-counting. A report is in progress. We hope to incorporate information from a US Fish and Wildlife Service project from a nearby site (breeding season 2010-2014), in order to better understand the phenology of bird activity in the area. Of the known species occurring in CAKR and the neighboring Bering Landbridge National Preserve, 18 are species of concern (Alaska Shorebird Group, Boreal Partners in Flight Working Group).

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

Causes of hatching failure in birds include infertility and embryo mortality. Embryonic mortality in birds is poorly understood and has been attributed to inbreeding depression, contaminants, or microbial infection. Microbial infection contributing to hatching failure could result in avian population declines and has never been studied in an Arctic environment. The objectives of this study were to replicate field investigations conducted in 2013 to further assess bacterial infection of white-fronted goose embryos on the Arctic coastal plain of Alaska. Further objectives were to expand the geographic scope of monitoring by cooperating with other field camps in Alaska and Canada, and to determine the source of egg infection by testing reproductive tracts of hens and the environment of eggs with PCRs specific to the newly identified *Neisseria* species. During the 2014 hatching season on the Arctic coastal plain of Alaska nonviable eggs from greater white-fronted geese (*Anser albifrons*) were collected and assessed for bacterial infection using standard culture methods and 16S rRNA gene sequencing. Additionally, and to determine source of infection, 20 adult females were lethally collected and reproductive and gastrointestinal tracts were sampled for PCR and/or culture analysis. More than 200 egg aspirate samples were collected from the Point Lonely field site and others. Samples are still being analyzed. *Neisseria* has been isolated from numerous eggs, as it was in last year's sample set. Additionally, *Streptococcus uberis* and *Macrococcus caseolyticus* were identified, as last year. Swab samples and tissue samples have yet to be analyzed. *Neisseria* appears to be commonly found in addled eggs again this year and is likely continuing to cause embryo mortality in greater-white fronted geese.

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 for hunters 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, the 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 will radio-mark willow ptarmigan with necklace-style VHF transmitters during spring and fall from 2013-2015. Radio-marked individuals will be relocated monthly to document movements, survival, and habitat selection throughout the year. Distance sampling will be used during spring to estimate breeding season abundance. This study was initiated during the spring/summer of 2013. 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 analysis 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.

Completed Ecological Studies

Research Coordination Network: Vulnerability of Permafrost Carbon

Postdoctoral Researcher: Yujin Zhang

Faculty: A. David McGuire

Funding Agency: National Science Foundation (NSF)

The objective of the Vulnerability of Permafrost Carbon Research Coordination Network (RCN) is to link biological C cycle research with well-developed networks in the physical sciences focused on the thermal state of permafrost. This interconnection will produce new knowledge through research synthesis that can be used to quantify the role of permafrost C in driving climate change in the 21st century and beyond. This will be achieved by synthesizing information in a format that can be assimilated by biospheric and climate models, and that will be contributed to future assessments of the Intergovernmental Panel on Climate Change (IPCC). Our proposed activities to reach this goal are (1) organization of an interrelated sequence of meetings and working groups designed to synthesize existing permafrost C research, and (2) formation of a consortium of interconnected researchers to disseminate synthesis results about permafrost C to other scientific networks and activities. These two research coordination activities are aimed at developing and disseminating algorithms that encapsulate the new process knowledge and datasets in support of model development. The fourth and final year of this project has produced significant advancements in both of these areas. A workshop in Year 4 was held in conjunction with the American Geophysical Union meeting in San Francisco, CA. Here, nearly 100 participants from a range of institutions and career levels met for a full day to discuss issues surrounding the magnitude, timing, and form of carbon loss from permafrost to the atmosphere in a warmer world. This workshop was held the day before the official start of AGU and so we were able to capitalize on travel funds that were already being used to attend the AGU meeting. Working group leads gave presentations about the synthesis activities that have been completed and are in progress. There has been substantial progress in the development of published products from the synthesis activities of the RCN. We have put together a synthesis paper based on the activities of the last four years of the project, and that paper has been accepted for publication.

Ongoing Ecological Studies

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

Research Associate–Academic: H el ene Genet

Faculty: A. David McGuire

Funding Agency: Department of Defense (DoD)

This study is designed to understand the mechanistic connections among vegetation, the organic soil layer, and permafrost ground stability in Alaskan boreal ecosystems. Permafrost is a major control over the structure and function of boreal ecosystems, and the soil organic layer mediates the effects of a changing climate on the ground thermal regime and permafrost stability. Understanding the links between vegetation, organic soil, and permafrost is critical for projecting the impact of climate change on permafrost in ecosystems that are subject to abrupt anthropogenic and natural disturbances (fire) to the organic layer. This study will

combine field measurements (Objective 1) with models (Objective 2) to detect and predict state changes in boreal ecosystems of interior Alaska in response to changing climate and land management. Objective 1, which is being led by the University of Florida, is to determine mechanistic links among fire, soils, permafrost, and vegetation succession in order to develop and test field-based ecosystem indicators that can be used to directly predict ecosystem vulnerability to state change. Activities to develop these indicators include (a) monitoring vegetation recolonization, soils, and permafrost on a previously existing network of sites located in recent, severe wildfires adjacent to, and on, Department of Defense (DoD) lands in interior Alaska; (b) extending this network to include parallel measurements from sites located in recent prescribed fires and fuel treatments on DoD lands; and (c) conducting studies of vegetation stand history and organic layer re-accumulation on an established network of mid-successional boreal ecosystems adjacent to, and on, DoD lands in interior Alaska. Objective 2, which is being led by the University of Alaska Fairbanks, is to forecast landscape change in response to projected changes in climate, fire regime, and fire management. Four activities are being 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 include (a) incorporating field data sets on vegetation, soils, and permafrost into a model of landscape fire dynamics and into a model of ecosystem structure and function; (b) coupling these two stand-alone models so that the influence of a changing climate on permafrost and vegetation can be assessed together with natural and managed changes in the fire regime; (c) evaluating the performance of the coupled model using retrospective statistical datasets of past fire regime and forest structure in interior Alaska; and (d) projecting future landscape distribution of vegetation and permafrost using the coupled model in combination with different scenarios of climate change, fire regime, and fire management. The University of Florida conducted field research in support of objective 1 during summers 2011, 2012, and 2013. Dr. Hélène Genet, who is an academic research associate at the University of Alaska Fairbanks, is responsible for the further development and application of the model of ecosystem structure and function in the project. During the past year Dr. Genet has conducted model simulations over interior Alaska. Simulation results indicate that boreal forest will experience significant increases in productivity during the 21st century under either or both very warm/dry and warm/moist climates.

Development and Application of an Integrated Ecosystem Model for Alaska

Postdoctoral Researcher: Yanjiao Mi

Faculty and Research Associates: Hélène 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

Postdoctoral Researcher: Jennifer Roach

Faculty: Brad Griffith, Eugénie Euskirchen, and A. David McGuire

Funding Agencies: USFWS, USGS, ADFG

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. Identifying the spatial distribution of climate-induced changes in forage and their effects on population dynamics will enable managers to enhance conservation planning. Our objectives were to use DVMs to (1) identify potential forage drivers of caribou population dynamics from 1972-2013 and (2) simulate future changes in caribou forage quantity and quality on the ranges of the Central Arctic (CAH), Teshekpuk (TCH), Porcupine (PCH), and Western Arctic (WAH) herds. The magnitude and significance of correlation coefficients between forage characteristics and herd sizes from 1972 to 2013 were used to identify potential forage drivers of population dynamics. Regression models were used to quantify trends and significant changes in forage projections from 1970 to 2100. Potential drivers of population dynamics were the amount of lichen forage on the non-calving ground, amount of vascular forage (graminoids, *Salix*, forbs) on the non-calving ground, and the quality of vascular forage during June on the calving ground for the PCH and CAH, TCH, and WAH, respectively. Future projections of these putative drivers suggest that PCH may continue to increase, TCH and CAH may decline until ~2030 and then increase, and the WAH may be variable and difficult to predict. We provide land managers with spatially explicit projections of changes in caribou forage that can be used for conservation planning.

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

Postdoctoral Researcher: Jennifer Roach

Faculty: Brad Griffith

Funding Agencies: USFWS; USGS (RWO 172)

Coincident with climate warming, studies have identified regional-scale declines in lake size across the circumpolar region. Lakes are important breeding grounds for migratory waterfowl populations, and the effect of changing lake size on waterfowl species biodiversity is unknown. The objectives of this study were to (1) build a model of waterfowl species richness based on broadly mapped landscape characteristics, (2) use the model to generate spatial and temporal projections of species richness as a result of potential climate-induced changes in lake size, and (3) rank-order waterfowl species in terms of vulnerability to decreasing lake size. The model was built using estimates of waterfowl species richness from 123 lakes in the Yukon Flats National Wildlife Refuge. Monte Carlo simulation was used to generate species richness projections for ~5500 lakes. We used nested patterns of species composition at lakes of different sizes to identify vulnerable waterfowl species. Variation in waterfowl species richness was explained by lake size, proportion of lake perimeter within wetlands, proximity to rivers, and the size of the largest lake within 5 km. Species richness predictions ranged from 2 to 22 species per lake (mean = 5.3). An average decline of -0.6 species per lake was projected from 1986 to 2050. Species vulnerability was due more to a species rarity than to its life history strategy. This information will provide land managers with spatially explicit projections of changes in waterfowl biodiversity and will enable land managers to target specific habitats and species in conservation efforts.

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

Student Investigator: Vijay Patil, PhD Biological Sciences

Co-Advisors: Brad Griffith and Eugénie Euskirchen

Funding Agency: USGS (RWO 172), 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 ecosystem services as major carbon sinks and as waterfowl habitat. Previous work has demonstrated that waterfowl diversity declines are associated with decreased lake and wetland area, but it is not clear whether carbon storage will show similar responses to lake shrinkage. Our objective was to determine the relative influence of shrinking lakes on terrestrial productivity, carbon storage, and dissolved organic carbon (DOC) export into lakes, compared to other landscape variables. Our approach was to measure wetland plant diversity and water chemistry at 130 lakes in the Yukon Flats National Wildlife Refuge and also estimate organic soil carbon and above-ground biomass (AGB) using field sampling and remote sensing. The response of terrestrial carbon stocks and lake DOC to lake shrinkage diverged from the response observed for waterfowl, with shrinking lakes showing significantly reduced AGB, but no significant change in soil carbon or DOC compared to stable lakes. At the same time, all carbon variables except AGB were similar to waterfowl diversity in showing a significant positive response to increased wetland size (AGB and wetland size were significantly negatively correlated). To

maximize the functional value of refuge lands across multiple ecosystem services, protecting heterogeneous landscapes with both stable and shrinking lakes may be indicated. Wetland size is a key variable for predicting carbon distribution that may be useful for assessing the carbon storage potential for drying boreal landscapes.

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

Student Investigator: Tyler Lewis, PhD Wildlife Biology

Co-Advisors: Mark Lindberg and Joel Schmutz

Funding Agencies: Yukon Flats National Wildlife Refuge, USFWS; and USGS (RWO 175)

Recent research indicated a drying of boreal wetlands and increased fire frequency in forested uplands surrounding wetlands, with unknown consequences for wetland ecosystems. On the Yukon Flats, Alaska, 9-16% of wetlands decreased in surface area from 1979–2009. At the same time, the region's forests experienced increased frequency and intensity of fires. These habitat changes may affect waterbird populations of the Yukon Flats. The objectives of this study are to (1) document changes in water chemistry, aquatic invertebrates, and waterbirds in response to drying of boreal wetlands, and (2) determine impact of forest fires on ecosystems of boreal wetlands. For objective 1, we compared existing data from the 1980s on water chemistry, invertebrate abundance, and waterbird distributions with contemporarily collected data. For objective 2, we compared pre-fire versus post-fire data documenting water chemistry, invertebrate abundance, and waterbird distributions of boreal wetlands. Nutrient and ion concentrations increased on drying lakes, while not changing on stable lakes. These changes in water chemistry had little impact on waterbird distributions. Wetland ecosystems, from plankton to waterbirds, were resilient to impacts from forest fires. Our results provide a two- to three-decade perspective on boreal wetland change, helping the Yukon Flats National Wildlife Refuge anticipate how much climate-driven change may occur in the future.

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. The dependence of breeding Red-throated Loons on marine prey distinguishes them from Pacific Loons, which feed primarily in freshwater lakes. Thus, like true seabirds, Red-throated Loon populations likely respond to changes in prey availability associated with changes in oceanography. These differences in diet may explain the differences in population status between these species. However, we currently have a poor understanding of diet composition and the association between diet and individual fitness. We will determine diet composition of Red-throated and Pacific Loons breeding on the coast of the Chukchi Sea near the village of Point Lay. To determine the potential fitness costs of variation in diet composition, we will examine associations between diet, adult

condition, and productivity. We will apply biochemical methods (carbon and nitrogen stable isotope ratios in blood and fatty acid composition of adipose tissue) to characterize the diet and deuterium dilution to determine body condition. Differences in diet composition and fitness parameters between these species are relevant to understanding how their contrasting use of the marine environment during breeding may contribute to their divergent population trends. This information will improve our understanding of loon population dynamics and aid in predicting how these species may be affected by changes in prey associated with climate change, fisheries activities, and oil and gas development in the Arctic.

Estimating Effects of Climate on Settlement Patterns of Breeding Waterfowl in the US and Canada

Postdoctoral Researcher: Mark W. Miller

Co-Principal Investigators: Mark Lindberg and Joel Schmutz

Funding Agency: USGS (RWO 192)

The global mean surface temperature increased from 1906–2005. An additional warming of up to 4°C over the next 100 years is predicted by some climate models for the primary waterfowl production area in North America. Such an increase could reduce or redistribute mid-continent breeding duck populations by >70%. Managing continental duck populations in the face of climate change requires understanding how waterfowl have responded to historical spatio-temporal climatic variation. We are estimating effects of climate on the settlement patterns of breeding ducks in the Prairie-Parkland Region (PPR), boreal forest, and tundra accounting for potential confounding effects of variation in major land cover types. We are relating 1958–2012 duck counts from the Waterfowl Breeding Population and Habitat Survey data to annual temperature, precipitation, crop acreage, pond abundance, and forest fires using multi-season occupancy models. Models have been created for most species/region combinations. Best models often were among the most complex in our model sets, suggesting all covariates influenced duck settlement patterns across space and time. Climate and fire were important in the boreal forest. Climate, ponds, and cropland were important in the Canada PPR and Dakotas. Climate was less important in Montana. Models with a trend effect were frequently selected for the tundra. We are examining how occupancy varied with each covariate accounting for interactions.

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 Agency: 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), a boreal wetland basin, 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 from isotope mixing models suggest that Scaup ducklings are generalist consumers that rely on a variety of food sources with significant variation in diet across lakes. 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.

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.

Sitka black-tailed deer are a key subsistence resource in many areas of southeast Alaska, as well as a highly influential herbivore in the forest ecosystem. Currently, we lack a detailed understanding of how expected changes to habitat and climate will affect deer populations, and perhaps the least understood but most variable vital rate for deer populations is recruitment. Prince of Wales Island is one of the most heavily timber-harvested areas in southeast Alaska; the ongoing successional changes to logged habitat will have unknown consequences for the deer population and the forest ecosystem, and for subsistence harvest. Our primary goals are to understand the effect of habitat, and the interaction between habitat and weather, on deer reproduction and survival; and to identify specific causes of deer mortality. These goals have been accomplished by GPS-collaring adult does, radiocollaring offspring, monitoring survival, and monitoring weather and snowfall. Deer occupy a complex, highly seasonal environment, and must balance multiple sources of predation with access to forage. Young fawns are highly vulnerable to predation, with many dying during the first days following birth or even at the birth site. This early left truncation of sampled fawns can result in positively biased survival estimates, if fawns are not captured at birth but rather captured several days later (Gilbert et al. 2014). Black bears are the primary cause of death during summer, although we also documented drowning and eagle predation events. During winter, fawns are most vulnerable to starvation, although this risk varies greatly depending on snow levels, with almost no fawns dying of starvation during mild winters. Notably, only two fawns and no adult females were killed by wolves during the course of this study, considerably fewer than expected. Wolf populations are quite low currently, and the Alexander Archipelago wolf is currently under consideration for listing under the Endangered Species Act. Adult female survival was high during all seasons, with human harvest as the primary cause of mortality. During summer,

reproductive female deer alter selection of habitat relative to bear and wolf predation risk and forage, with selection for forage dominating selection patterns during late pregnancy and after fawn predation, but with a more balanced selection relative to risk and forage when fawns are young. We are currently working to analyze winter data, which will examine the effects of snow depth on selection by adult female deer relative to various vegetation classes and landscape features. Understanding how habitat and winter weather variability affect deer population dynamics will allow us to understand possible effects of different timber and hunting management decisions on the deer population, as well as to factor in potentially interacting effects of changing climate. This will help managers ensure adequate supplies of deer for subsistence and recreational harvest in the future, as well as ensure the populations of Alexander Archipelago wolves, a genetically unique type of wolf that depends on Sitka black-tailed deer as prey.

Climate-induced Mismatch between Breeding Shorebirds and Their Invertebrate Prey

Postdoctoral Researcher: Kirsty E. B. Gurney

Faculty: Mark Wipfli

Funding Agency: Alaska Science Center, USGS (RWO 185)

Climate is changing on the Arctic Coastal Plain (ACP). Although wildlife outcomes are unclear, survival and recruitment of breeding bird populations may decline if these consumers become temporally mismatched with their food resources. To accurately predict how avian consumers will respond to climate changes on the ACP, it is critical to understand relationships between birds, climate, habitat, and their food resources. This study focuses on understanding interactions between climate change and invertebrate food resources, which have received little attention so far. Our primary objective is to evaluate two key mechanisms that are hypothesized to be responsible for variation in wetland invertebrate communities. Specifically, we will determine how invertebrate biomass and phenology respond to changes in water nutrient concentrations, autotroph biomass (chlorophyll-*a*), and temperature. We are using a series of field-based wetland observations and manipulations to assess changes in wetland invertebrate communities in response to increases in temperature and nutrient concentrations. Field work for this research program is now complete and all samples have been processed. Modeling exercises indicate that nutrient concentrations have no detectable effect on biomass or seasonal patterns of abundance for key invertebrate taxa, suggesting that productivity of invertebrates in shallow tundra ponds is not resource limited. Rather, invertebrate biomass is strongly influenced by temperature—our models show a non-linear relationship between biomass and cumulative degree days for all the taxa we assessed. Invertebrate prey on the breeding grounds is a key determinant of breeding success for migratory shorebird populations. Our study will thus increase the accuracy with which we can predict potential impacts of climate change on such populations.

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 baseline conditions in freshwater systems. Hydrological processes are predicted to change with increasing temperatures. Fish and aquatic invertebrates must respond to these changes to survive. Understanding how freshwater food webs shift as a result of climate change 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 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. Species richness and composition differed with extent of surface water connectivity, and fish assemblages influenced invertebrate assemblages through top down processes. A combination of hydrologic connectivity and predation appears to structure these food webs. Information gathered in this study will provide important baseline data and help guide fish and wildlife management as the aquatic landscape responds to changes in climate.

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

Student Investigator: Jess Grunblatt, PhD Interdisciplinary Studies

Co-Advisors: Mark Wipfli and Lilian Alessa (University of Idaho)

Funding Agency: NSF/EPSCoR

The natural environment of Alaska is changing. How Alaskans perceive those changes will play a large part in determining how they respond to change. This study explores the perceptions of environmental change and contrasts that perceived change with actual (measured) environmental change. Confronted with change, communities can be reactive. Alternatively communities can proactively respond to change through anticipation and planning. The choice of a reactive or proactive response will be a function of the perceptions and values within the community. Consequently a better understanding of those perceptions and values is important in evaluating community response to environmental change. In this study, the difference between perceived and actual environmental change is hypothesized to be a predictor of adaptive capacity. The objective is to develop indices of perceived and measured environmental change in a manner that allows for the evaluation of community adaptive capacity. Surveys of Kenai Peninsula residents are being conducted. To date, 3500 surveys have been mailed. Results of this survey are being used to develop and validate indices for perception of environmental change. Indices of actual environmental change will be developed from existing literature and current monitoring activities. So far, 534 responses have been received for a response rate of 15.23%. A scale for perception of general

environmental change is being constructed from survey responses, along with subscales for environmental, salmon and development changes. This scale and subscales are being used to partition survey respondents into groups that perceive climate change as “likely,” “neutral,” and “unlikely.” Data are being evaluated for shared values in a Cultural Consensus Model (CCM). The primary outcome of this study will be an evaluation of actual and perceived environmental change within the context of adaptive capacity. This work will provide tools that allow for a better understanding of how perception influences management decisions.

Trophic Pathways Supporting Arctic Grayling (*Thymallus arcticus*) 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

Aquatic ecosystems on the Arctic Coastal Plain (ACP) in Alaska are threatened by rapidly increasing oil and gas activities and climate change. Freshwater ecosystem function on the ACP is poorly understood, particularly the food webs that support fishes. Understanding the structure and function of these lotic systems is paramount to understanding how the future Arctic ecosystems will be influenced by changes in climate and land use. The ACP is comprised of a water-dominated landscape consisting of complex networks of interconnected lakes, rivers, and small streams. The small size of many of these streams makes them potentially very susceptible to impacts from land use and climate change. These understudied, yet abundant aquatic environments provide habitat for multiple species of fish, with Arctic grayling being one of the most common and widespread. Specific objectives were to (i) quantify terrestrial invertebrate in-fall into stream reaches within prevailing habitat types, (ii) identify and quantify prey (aquatic and terrestrial) ingested by Arctic grayling, (iii) determine if prey type ingested is a function of grayling size, and (iv) determine if plant species affects the quantity of terrestrial invertebrates ingested by grayling. We chose the relatively pristine and roadless Fish Creek watershed within the National Petroleum Reserve-Alaska (NPR-A) of the ACP as our model system for this study. We examined prey consumption of small to large size classes of fish, estimated terrestrial invertebrate prey inputs to streams with differing riparian plant species, and compared quantities of terrestrial invertebrates consumed by fish from stream reaches bordered by differing riparian plants. Greater quantities of terrestrial invertebrates entered stream reaches and were found in the guts of grayling along riparian habitats dominated by willows. Small Arctic grayling consumed inverse proportions of aquatic and terrestrial invertebrates over the summers sampled. Large Arctic grayling consumed mostly ninespine stickleback (*Pungitius pungitius*). Arctic grayling are not commonly known to be piscivorous, although we consistently found large amounts of ninespine stickleback in their guts, especially larger grayling, suggesting that these fish rely heavily on piscivory. Findings from this study will shed light on prey flow and trophic pathways that support grayling in Arctic ecosystems and will provide baseline information to predict how petroleum development and climate change may affect these ecosystems in the coming decades.

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 thoroughly 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 influences invertebrate community assemblage, density, and diversity at the stream surface-subsurface interface, and (2) how hyporheic communities and processes influence stream food webs. We are studying streams on two spatial scales: landscape and catchment. At both scales, we have selected streams with different thermal regimes and are taking samples from four stations within each stream. At each station, we are collecting surface samples and subsurface samples at 25 and 50 cm below the streambed. Stable isotopes are being used for determining trophic position of invertebrates within the food web. A redundancy analysis found that three variables (hydrologic source, temperature, and conductivity) significantly explain 32.4% of the variability in invertebrate community responses. Surface invertebrate communities have greater abundance than their subsurface counterparts, but taxa richness is similar between surface and subsurface communities. Although richness is the same between the surface and subsurface, the community compositions are dissimilar, so the two habitat types are supporting different taxa. Food webs have not yet been analyzed. The results of this study will provide insight into the trophic linkages between streams and hyporheic habitats and the influence of climate change on these linkages. This will help determine whether and which stream types should receive special consideration for conservation.

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

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.

Vulnerability of Permafrost to Fire-initiated Thaw in Lowland Forests of the Tanana Flats, Interior Alaska

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 a 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. Thus, the likelihood of thermokarsting is an interaction of slow variables (climate change) and rapid disturbance events (wildfire), the magnitudes of which control permafrost integrity. 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.

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
IAB	Institute of Arctic Biology, UAF
LCC	Landscape Conservation Cooperative
ILTER	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
UAF	University of Alaska Fairbanks
USDA	US Department of Agriculture
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey