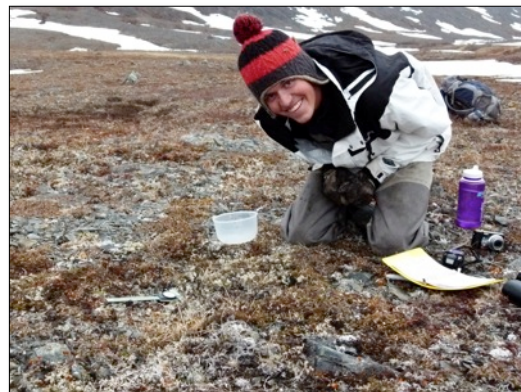


Alaska Cooperative Fish and Wildlife Research Unit Annual Research Report—2013



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Photo Captions, left to right:

1. UAF graduate student Heather Craig holds a male Smith's Longspur captured during summer 2013 in Atigun Gorge, Alaska. Craig is the first to place tiny tracking devices called geolocators on the backs of the species. Photo credit: Jared Hughey.
2. Marion Bigot and Diane Delaigue sample the hyporheic zone of the stream Myllulækur in Skagafjörður, Iceland in June 2013. Photo credit: Dan Govoni.
3. UAF graduate student Kevin Fraley radiotagging rainbow trout in Willow Creek, AK.
4. Research technician Mitch Parson discovers his first plover nest, summer 2013. Photo credit: Kelly Overuijn.
5. Tundrascape: Sunshine and rainbows delight the Chipp camp fish crew after an afternoon of August rain showers. Summer 2013. Photo credit: Constance Johnson.

Not for Publication: Because this report is one of progress, the data presented are often incomplete, and the conclusions reached may not be final.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

- Holly Neumeyer: Travel Coordinator
- Kathy Pearce: Administrative Assistant
- Maria Russell: Fiscal Officer

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)
- Christopher Harwood, MS Wildlife Conservation (Powell)
- Kurt Heim, MS Fisheries (Wipfli)
- Philip Joy, PhD Fisheries (Wipfli)
- Erin Julianus, MS Biology (McGuire and Hollingsworth)
- Sarah Laske, PhD Fisheries (Wipfli and Rosenberger)
- Jason McFarland, MS Biological Sciences (Wipfli)
- Jason Neuswanger, PhD Biological Sciences (Wipfli and Rosenberger)
- 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)

Graduated in CY 2013

- Teri Wild, MS Wildlife Biology (Powell)
- Lila Tauzer, MS Wildlife Biology and Conservation (Powell and Prakash)

Post-Doctoral Researchers

- Hélène Genet (McGuire)
- Kirsty Gurney (Wipfli)
- Jennifer Roach (Griffith)

University Cooperators

- Milo Adkison, School of Fisheries and Ocean Sciences (SFOS)-UAF
- Perry Barboza, Department of Biology and Wildlife(DBW) and Institute of Arctic Biology (IAB)-UAF
- Amy Breen, Institute of Arctic Research Consortium (IARC)
- F. Stuart Chapin, III, Emeritus IAB
- Courtney Carothers, SFOS
- Eugénie Euskirchen, IAB
- Teresa Hollingsworth, Boreal Ecology Cooperative Research Unit (BECRU)-UAF
- 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
- Kevin McCracken, DBW and IAB
- Anupma Prakash, GI and College of Natural Sciences and Mathematics
- 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 (SNAP)-UAF
- Andy Seitz, SFOS
- Trent Sutton, SFOS
- Dave Verbyla, SALRM
- Donald Walker, IAB

Affiliated Students and Post-Doctoral Researchers

Current

- Matthew Albert, MS Fisheries (Sutton)
- Brittany Blain, MS Fisheries (Sutton)
- Adam DuBour, MS Wildlife (Lindberg)
- Kevin Foley, MS Fisheries (Rosenberger)
- Graham Frye, PhD Biological Sciences (Lindberg)
- Sophie Gilbert, PhD Biological Sciences (Hundertmark)
- Tyler Lewis, PhD Biological Sciences (Lindberg)
- Jamie McKellar, MS Fisheries (Iken and Sutton)
- Stephanie Meggers, MS Fisheries (Seitz and Prakash)
- Dana Nossov, PhD Biological Sciences (Kielland)
- Daniel Rizzolo, PhD Biological Sciences (Lindberg)
- Matthew Smith, MS Wildlife Biology and Conservation (McCracken)
- Lindsay VanSomeren, MS Wildlife Biology and Conservation (Barboza)
- Mark Winterstein, MS Biology (Walker and Hollingsworth)

Graduated in CY 2013

- Elchin Jafarov, PhD Geophysics (Romanovsky)
- Nicholas Smith, MS Fisheries (Sutton)
- Jason Stolarski, PhD Fisheries (Sutton and Prakash)

Affiliated Post-Doctoral Researchers

- Mark Miller (Lindberg)
- Reginald Muskett (Romanovsky)
- Ken Tape (Ruess)
- 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 2013. The Unit engages in research on living natural resources for a variety of State and Federal agencies. As an unbiased research organization, the Unit provides information requested and funded by these agencies. When studies are completed, the agencies use the information to assist in their natural resource management efforts. Most of the research is conducted by graduate students, many of whom go on to work for the agencies upon graduation.

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

Statement of Direction

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

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

Unit Cost-Benefit Statements

In-Kind Support

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

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

Benefits

Students Graduated: 5

Presentations: 30

Scientific and Technical Publications: 25

Courses Taught

- Jeff Falke: Stream Fish Community Ecology (Fall 2013; 2 credit hr)
- Abby Powell: Scientific Writing, Editing, and Revising in the Biological Sciences (Spring 2013: 3 credit hr)
- Mark Wipfli: Aquatic Entomology (Fall 2013; 2 credit hr)
- Mark Wipfli: Climate Change Seminar (Fall 2013; 1 credit hr)

Honors and Awards

- Heather Craig (MS student advised by Abby Powell): Changing Alaska Science Education (CASE) Fellowship for academic year 2013-2014. A GK-12 Project at the University of Alaska Fairbanks.
- Sophie Gilbert (PhD student advised by Kris Hundertmark): Graduate School Travel Award to attend the American Society of Mammalogists (ASM) Annual Meeting, Philadelphia, PA, June 2013.
- Nina Hansen (PhD student advised by Karsten Hueffer): Best Microbiology Individual Session and Best Overall Talk, Midnight Sun Science Symposium, University of Alaska Fairbanks, March 2013.
- Kurt Heim (MS student advised by Mark Wipfli): 2nd Place Poster, Midnight Sun Science Symposium, University of Alaska Fairbanks, March 2013.
- Jason McFarland (MS student advised by Mark Wipfli): Best Trophic Interactions Individual Session Talk, Midnight Sun Science Symposium, University of Alaska Fairbanks, March 2013.

Outreach and Info Transfer

Abby Powell. Scientific Writing and Publishing Workshop, a full-day course at the 5th Western Hemisphere Shorebird Group meeting in Santa Marta, Colombia, 16 September 2013 (co-taught with Rick Lanctot, USFWS).

Invited Seminars

Jeff Falke. February 2013. Fish and fire: Vulnerability analysis for bull trout across a wildfire-prone landscape. Fairbanks Fisheries Seminar, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks.

Papers Presented

Churchwell, R.T., A.N. Powell, S. Kendall, and S. Brown. September 2013. Shorebird Use of Foraging Habitat during the Post-breeding Season on the Coast of the Beaufort Sea, Alaska, USA. 5th Western Hemisphere Shorebird Group Meeting, Santa Marta, Colombia. (Contributed Oral)

Collins, S., C. Baxter, A. Marcarelli, and M. Wipfli. April 2013. Spatiotemporal complexity in stream food web responses to salmon subsidies. Annual Meeting, Western Division, American Fisheries Society, Boise, ID. (Contributed Oral)

- Euskirchen, E., T.B. Carman, and A.D. McGuire. August 2013. Vegetation dynamics in a changing Arctic: Improved biogeochemistry response to warming climate through a detailed representation of leaf phenology. Annual Meeting, Ecological Society of America, Minneapolis, MN. (Contributed Oral)
- Euskirchen, E.S., C. Edgar, M.R. Turetsky, M. Waldrop, J.W. Harden, and A.D. McGuire. October 2013. Patterns in and controls over CO₂ fluxes across a gradient of permafrost thaw in boreal Alaska. 16th International Boreal Forest Research Association Conference, Edmonton, Alberta, Canada. (Contributed Oral)
- Euskirchen, E., C. Edgar, M. Waldrop, M. Turetsky, J. Harden, and A.D. McGuire. February 2013. Quantifying CO₂ fluxes across a gradient of permafrost thaw in boreal Alaska. 4th North America Carbon Program All Investigators Meeting, Albuquerque, NM. (Contributed Poster)
- Falke, J.A., L. Benda, and F.J. Adams. October 2013. Chena River basin landscape-scale freshwater physical habitat studies. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK. (Contributed Poster)
- Falke, J.A., C.E. Torgersen, and J.K. Walter. June 2013. Predicting the distribution of fish in headwaters: A test of the efficacy of spatial stream network models in capturing fish abundance variability across multiple spatial scales. 23rd Annual Conference, The International Environmetrics Society, Anchorage, AK. (Invited Oral)
- Fraley, K.M., M.J. Lunde, L.T. Bailey, J.A. Falke, and A.D. Gryska. October 2013. Bioelectrical impedance analysis as a measure of energy density in arctic grayling (*Thymallus arcticus*). Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK. (Contributed Poster)
- Genet H., K. Barrett, A.D. McGuire, E.S. Kasischke, M. Turetsky, S. Rupp, E.S. Euskirchen, and F.M. Yuan. October 2013. Modeling the effects of fire severity on soil organic horizons and its effects on permafrost and vegetation composition in Interior Alaska. 16th International Boreal Forest Research Association Conference, Edmonton, Alberta, Canada. (Contributed Oral)
- Goswami, S., D. Hayes, P. Kuhry, G. Hugelius, A.D. McGuire, and E. Schuur. February 2013. The Permafrost Regionalization Map (PeRM) for studying the vulnerability of permafrost carbon. 4th North America Carbon Program All Investigators Meeting, Albuquerque, NM. (Contributed Poster)
- Goswami, S., D.J. Hayes, P. Kuhry, G. Hugelius, C. Schaedel, D. Olefeldt, G. Grosse, G. Chen, A. Lewkowicz, V. Romanovsky, S. Zubrzycki, S. Gruber, J. Vonk, A.D. McGuire, and E.A.G. Schuur. August 2013. A regionalization approach to study vulnerability of Pan-Arctic permafrost stock to climate change. Annual Meeting, Ecological Society of America, Minneapolis, MN. (Contributed Oral)
- Griffith, B. (Chair), V.J. Meretsky, and L.A. Maguire. July 2013. Symposium: "A National Network for Wildlife Conservation: Challenges and Solutions." 26th International Congress for Conservation Biology, Baltimore, MD. (Contributed Oral)
- Griffith, B., J. Roach, and V. Patil. April 2013. Lake shrinkage in Alaskan National Wildlife Refuges: Heterogeneity and implications. Annual Meeting, Alaska Chapter, The Wildlife Society, Fairbanks, AK. (Contributed Oral)
- Harwood, C.M. and A.N. Powell. April 2013. Breeding ecology of Whimbrels in Interior Alaska. Annual Meeting, Alaska Chapter, The Wildlife Society, Fairbanks, AK. (Contributed Oral)
- Harwood, C.M. and A.N. Powell. September 2013. Breeding distribution of Whimbrels in Alaska. 5th Western Hemisphere Shorebird Conference, Santa Marta, Colombia. (Contributed Oral)

- Hayes, D., D. Kicklighter, A.D. McGuire, Q. Zhuang, J. Melillo, and S. Wullschlegler. February 2013. The impacts of permafrost thaw on land-atmosphere greenhouse gas exchange. 4th North America Carbon Program All Investigators Meeting, Albuquerque, NM. (Contributed Poster)
- Hayes, D., G. Stinson, W. Kurz, and A.D. McGuire. October 2013. Multi-factor analysis of the forces driving carbon dynamics in the North American Boreal Forest over recent decades. 16th International Boreal Forest Research Association Conference, Edmonton, Alberta, Canada. (Contributed Oral)
- Kelly, R., H. Genet, A.D. McGuire, and F.S. Hu. August 2013. Model simulations driven by paleo-forcing data reveal large and rapid responses of carbon storage to boreal fire-regime shifts. Annual Meeting, Ecological Society of America, Minneapolis, MN. (Contributed Oral)
- Laske, S.M., J.C. Koch, C.E. Zimmerman, M.S. Wipfli, and A.E. Rosenberger. October 2013. Fish distribution in a warming Arctic: What current patterns may tell us about the future. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK. (Contributed Oral)
- Liang, J., M. Zhou, P. Tobin, and A.D. McGuire. October 2013. Biodiversity increases individual productivity: Evidence and mechanism. Society of American Foresters 2013 National Convention, Charleston, SC. (Contributed Oral)
- Marcarelli, A., J. Ebel, C. Baxter, A. Kohler, S. Collins, and M. Wipfli. April 2013. Integrating ecosystem science into fisheries-targeted nutrient enhancement programs aimed to mitigate for the loss of Pacific salmon. Annual Meeting, Western Division, American Fisheries Society, Boise, ID. (Contributed Oral)
- McGuire, A.D., D.J. Hayes, T.R. Christensen, A. Heroult, E.S. Euskirchen, J.S. Kimball, C. Koven, P. Lafleur, P. Miller, W.C. Oechel, P. Peylin, M.D. Williams, and Y. Yi. February 2013. An assessment of the carbon balance of arctic tundra in North America: Comparisons among observations, process models, and atmospheric inversions. 4th North America Carbon Program All Investigators Meeting, Albuquerque, NM. (Contributed Oral)
- Neuswanger, J.R., N.F. Hughes, M.S. Wipfli, and A.E. Rosenberger. October 2013. 3-D territoriality and shadow competition within schools of juvenile chinook salmon. Annual Meeting, Alaska Chapter, American Fisheries Society, Fairbanks, AK. (Contributed Oral)
- Overduijn, K.S., C.M. Handel, and A.N. Powell. April 2013. Brood movement and habitat use by American and Pacific Golden-Plovers. Annual Meeting, Alaska Chapter, The Wildlife Society, Fairbanks, AK. (Contributed Oral)
- Overduijn, K.S., C.M. Handel, and A.N. Powell. September 2013. The effects of habitat change on shorebirds in the Arctic. 5th Western Hemisphere Shorebird Conference, Santa Marta, Colombia. (Contributed Oral)
- Parmentier, F.-J., T.R. Christensen, L.L. Sorensen, S. Rysgaard, A.D. McGuire, P.A. Miller, and D.A. Walker. April 2013. The impact of a low sea ice extent on arctic greenhouse gas exchange. Annual Meeting, European Geophysical Union, Vienna, Austria. (Contributed Oral)
- Powell, A.N., R. Bentzen, and S. Opper. January 2013. Survival, site use, and fidelity of king eiders: A large, multiple year study. North American Duck Symposium, Memphis, TN. (Invited Oral)
- Waldrop, M., J. McFarland, E. Euskirchen, M. Turetsky, J. Harden, K. Manies, M. Jones, and A.D. McGuire. February 2013. CO₂ and CH₄ fluxes and net C storage following permafrost thaw in Interior Alaska. 4th North America Carbon Program All Investigators Meeting, Albuquerque, NM. (Contributed Poster)
- Wipfli, M.S., D. Rinella, and P. Joy. April 2013. Nutrient amendments vs salmon runs: What are we trying to accomplish and are we seeing the bigger picture?

Annual Meeting, Western Division, American Fisheries Society, Boise, ID.
(Invited Oral)

Zhang, Y., H. Genet, A.D. McGuire, W.R. Bolton, V. Romanovsky, G. Grosse, and T. Jorgenson. October 2013. Modeling thermokarst dynamics in Alaskan ecosystems. 16th International Boreal Forest Research Association Conference, Edmonton, Alberta, Canada. (Contributed Poster)

Scientific Publications

- Cameron, R.D., B. Griffith, L.S. Parrett, and R.G. White. 2013. Efficacy of calf:cow ratios for estimating calf production of arctic caribou. *Rangifer* 33, Special Issue No. 21:27-34. — IPDS: IP-034317
- Falke, J.A., J.B. Dunham, C.E. Jordan, K.M. McNyset, and G.H. Reeves. 2013. Spatial ecological processes and local factors predict the distribution and abundance of spawning by steelhead (*Oncorhynchus mykiss*) across a complex riverscape. *Plos One* 8(11):e79232.
- Fan, Z., A.D. McGuire, M.R. Turetsky, J.W. Harden, J.M. Waddington, and E.S. Kane. 2013. The response of soil organic carbon of a rich fen peatland in Interior Alaska to projected climate change. *Global Change Biology* 19:604-620. doi:10.1111/gcb.12041. — IPDS: IP-042131; BAO Date: November 7, 2012
- Gates, H.R., R. Lanctot, and A.N. Powell. 2013. High re-nesting rates in arctic-breeding Dunlin (*Calidris alpina*): A clutch-removal experiment. *Auk* 130:372:380 — IPDS: IP-037244
- Gates, H.R., S. Yezerinac, A.N. Powell, P.S. Tomkovich, O.P. Valchuk, and R.B. Lanctot. 2013. Differentiation of subspecies and sexes of Beringian Dunlin using morphometric measures. *Journal of Field Ornithology* 84:389-402. — IPDS: IP-042609; BAO Date: December 8, 2012
- He, Y., Q. Zhuang, A.D. McGuire, Y. Liu, and M. Chen. 2013. Alternative ways of using field-based estimates to calibrate ecosystem models and their implications for ecosystem carbon cycle studies. *Journal of Geophysical Research – Biogeosciences* 118, 11 pages, doi:10.1002/jgrg.20080. — IPDS: IP-042199; BAO Date: November 13, 2012
- Jafarov, E.E., V.E. Romanovsky, H. Genet, A.D. McGuire, and S.S. Marchenko. 2013. The effects of fire on the thermal stability of permafrost in lowland and upland black spruce forests of Interior Alaska in a changing climate. In preparation for *Environmental Research Letters* 8, 11 pages, doi:10.1088/1748-9326/8/3/035030. — IPDS: IP-045567; BAO Date: May 2, 2013
- Johnson, K.D., J.W. Harden, A.D. McGuire, M. Clark, F.M. Yuan, and A. Finley. 2013. Permafrost and organic layer interactions over a climate gradient in a discontinuous permafrost zone. *Environmental Research Letters* 8, 12 pp., doi:10.1088/1748-9326/8/3/035028.
- Kane, E.S., M.R. Chivers, M.R. Turetsky, C.C. Treat, D.G. Petersen, M. Waldrop, J.W. Harden, and A.D. McGuire. 2013. Response of anaerobic carbon cycling to water table manipulation in an Alaskan rich fen. *Soil Biology and Biochemistry* 58:50-60.
- Kohler, A., P. Kusnierz, T. Copeland, D. Venditti, J. Gable, R. Kinzer, B. Lewis, D. Lytle, B. Barnett, and M. Wipfli. 2013. Salmon-mediated nutrient flux in selected streams of the Columbia River Basin, USA. *Canadian Journal of Fisheries and Aquatic Science* 70:502-512. — IPDS: IP-039469; BAO Date: July 7, 2012
- McGuire, A.D. 2013. Ecosystem Element Cycling. In: *Encyclopedia of Environmetrics* 2nd Edition (eds. El-Shaarawi A.H., Piegorisch W.W.). John Wiley & Sons Ltd,

- Chichester, UK, pp. 779-783. doi 10.1002/9780470057339.vae011.pub2. — IPDS: IP-037985
- Mishra, U., J.D. Jastrow, R. Matamala, G. Hugelius, C.D. Koven, J.W. Harden, C.L. Ping, G.J. Michaelson, Z. Fan, R.M. Miller, A.D. McGuire, C. Tarnocai, P. Kuhry, W.J. Riley, K. Schaefer, E.A.G. Schuur, M.T. Jorgenson, and L.D. Hinzman. 2013. Empirical estimates to reduce modeling uncertainties of soil organic carbon in permafrost regions: A review of recent progress and remaining challenges. *Environmental Research Letters* 8, 9 pp., doi:10.1088/1748-9326/8/3/035020.
- Nicholson, C.R., M.D. Berman, C.T. West, G.P. Kofinas, B. Griffith, S. Russell, and D. Dugan. 2013. Seasonal climate variation and caribou availability: Modeling sequential movement using satellite-relocation data. *Ecology and Society*, <http://dx.doi.org/10.5751/ES-05376-180201>
- Nicol, S., J.K. Roach, and B. Griffith. 2013. Spatial heterogeneity in power to detect changes in lake area in Alaskan National Wildlife Refuges. *Landscape Ecology* 28(3):507-517. DOI: 10.1007/s10980-013-9853-5
- Nicolson, C., M. Berman, C. Thor West, G.P. Kofinas, B. Griffith, D. Russell, and D. Dugan. 2013. Seasonal climate variation and caribou availability: Modeling sequential movement using satellite-relocation data. *Ecology and Society* 18(2): 1. <http://dx.doi.org/10.5751/ES-05376-180201>
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Theses and Dissertations of Unit-Sponsored Graduate Students

- Jafarov, Elchin. 2013. The effects of changes in climate and other environmental factors on permafrost evolution. PhD thesis, University of Alaska Fairbanks. 115 pp.
- Smith, Nicholas J. 2013. Seasonal movement patterns and habitat occupancy of Kotzebue region inconnu. MS thesis, University of Alaska Fairbanks. 113 pp.
- Stolarski, Jason T. 2013. Growth and energetic condition of Dolly Varden char in coastal Arctic waters. PhD thesis, University of Alaska Fairbanks. 176 pp.
- Tauzer, Lila M. 2013. Recent changes in plant and avian communities at Creamer's Refuge, Alaska using field and remote sensing observations. MS thesis, University of Alaska Fairbanks. 116 pp.
- Wild, Teri C. 2013. Habitat associations, distribution, and abundance of Smith's longspur (*Calcarius pictus*), an uncommon species of concern in the Brooks Range, Alaska. MS thesis, University of Alaska Fairbanks. 82 pp.

Reports are listed as Completed or Ongoing, in the categories of Aquatic, Terrestrial, or Ecological Studies. The List of Abbreviations appears on the final page of the report.

Completed Aquatic Studies

Seasonal Movement Patterns and Habitat Occupancy of Kotzebue Region Inconnu

Student Investigator: Nicholas Smith, MS Fisheries

Advisor: Trent Sutton

Funding Agency: Office of Subsistence Management, USFWS (RWO 177)

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

Note: Nick Smith graduated from the University of Alaska Fairbanks in December 2013. His thesis abstract follows:

Inconnu *Stenodus leucichthys* are large, long-lived piscivorous whitefish harvested in subsistence and sport fisheries in Alaska. My study was conducted to describe the seasonal movements and habitat occupancy of inconnu in the Selawik and Kobuk River drainages, Alaska, from 2010 through 2012. Methods consisted of surgically implanting acoustic telemetry tags in 80 fish from both rivers in 2010 and 2011 ($n = 320$), and deploying a fixed array of 20 Vemco VR2W acoustic receiving stations affixed with archival tags throughout Selawik Lake and Hotham Inlet. Tagged inconnu detections revealed that Selawik and Kobuk River inconnu displayed a high degree of spatial and temporal overlap while co-located in the Hotham Inlet/Selawik Lake complex. During the winter period, tagged fish predominately occupied the northern end of Hotham Inlet. In the summer period, fish transitioned from the northern end of Hotham Inlet to Selawik Lake and also the southern end of Hotham Inlet. Average daily displacements for Selawik and Kobuk River inconnu ranged from 2,000 to 10,000 m/day. Water temperature and salinity occupancy ranged from -1.39 to 18.69°C and 0 to 31.3 psu, respectively. No stock-specific or temporal trends in temperature and salinity occupancy by inconnu from the Selawik and Kobuk rivers were detected during my study. In addition to providing a more complete account of the life history of inconnu, these results will aid managers in developing future management strategies.

Growth and Energetic Condition of Dolly Varden Char in Coastal Arctic Waters

Student Investigator: Jason Stolarski, PhD Fisheries

Co-Advisors: Anupma Prakash and Trent Sutton

Funding Agency: Arctic National Wildlife Refuge/USFWS (RWO 160)

In-Kind Support: Logistics provided by the Fairbanks Field Office/FWS

Note: Jason Stolarski graduated from the University of Alaska Fairbanks in May 2013. His dissertation abstract follows:

Dolly Varden char *Salvelinus malma* are a dominant member of the nearshore Arctic ichthyofauna and support one of the largest subsistence fisheries within Arctic coastal

communities in Alaska. Despite this importance, numerous aspects of Dolly Varden ecology remain poorly understood, which inhibits efforts to assess the biological consequences of anthropogenic disturbances such as hydrocarbon extraction and climate change within nearshore areas. The goal of this research was to develop and apply new techniques to measure and assess the biological integrity of Dolly Varden populations. To do so, I evaluated the precision of age determination generated from scales, otoliths, and fin rays, developed and validated bioelectrical impedance analysis (BIA) models capable of predicting non-lethal estimates of Dolly Varden proximate content, calculated and correlated retrospective estimates of Dolly Varden growth from archived otolith samples to broad-scale environmental variables, and investigated trends in whole body and tissue proximate content among years and demographics (i.e. reproductive versus non-reproductive individuals). Dolly Varden age determinations can be produced nonlethally using scales for fish up to age 5, while otoliths should be used for fish age 6 and greater. Multi-surface BIA models produced estimates of whole body proximate content with high precision. Retrospective growth analyses indicated growth increased significantly during the early 1980s, and was positively correlated to air temperature, sea surface temperature, and discharge and negatively correlated to ice concentration. Analyses of proximate content suggested that non-reproductive fish contained greater lipid concentrations than reproductive fish. Growth and condition analyses suggest that these metrics vary among years and are a function of reproductive cycles and environmental variability operating at multiple temporal and spatial scales. The adoption of scale-based aging and BIA technology will increase the precision of age-based biological statistics and aid in the detection of change within future Dolly Varden research and monitoring.

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 (NSEDG)

Marine nutrients imported to freshwater systems by migrating salmon, or marine-derived nutrients (MDN), have been identified as a significant 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 managers' ability to forecast return rates of adult salmon. The objectives of this study are to identify the degree and route of MDN assimilation in rearing Chinook and coho salmon and determine the effect on growth and size. Two-thousand thirteen (2013) was the third year of a three-year project. Chinook and coho salmon smolt productivity is being examined with mark-recapture experiments on migrating smolt. MDN assimilation and growth are being assessed using stable isotope and stomach content analysis, while growth will be assessed using RNA:DNA ratios from muscle and Length Frequency Data Analysis (LFDA). Results from the 2011 and 2012 field seasons indicated seasonal fluctuations in MDN assimilation rates indicative of substantial usage of MDN subsidies during the spawning season and significant predation on salmon fry by migrating Chinook and coho salmon smolt. 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.

Seasonal Movements and Habitat Use of Arctic Grayling in a Beaded Stream on the Arctic Coastal Plain

Student Investigator: Kurt Heim, MS Fisheries

Advisor: Mark Wipfli

Funding Agencies: USFWS (RWO 168) and Bureau of Land Management (BLM) (RWO 179)

In Arctic Coastal Plain (ACP) watersheds, Arctic grayling and other fishes move among habitats to persist in a landscape with long, cold winters that freeze solid many lotic and lentic water bodies. Little is known about how grayling migration timing and within-stream movements relate to hydrologic events and surface water flow. The objective of this study was to quantify movement and habitat use of grayling in a small beaded stream, the dominant headwater stream type on Alaska's ACP, and determine how movement relates to environmental variability. We PIT tagged 1035 Arctic grayling in Crea Creek in 2012–2013 and used an array of antenna stations to quantify migration into and out of the stream, and in-stream summer movement. Migration into Crea Creek peaked several days after ice-out in 2013, when stream flow was high and stream temperatures were increasing. Fish that entered the stream during high flow and cold temperatures swam farther upstream than those entering during low discharge and warmer temperatures. We modeled migration out of Crea Creek in response to abiotic cues and fish size, and found that adult migration was most strongly correlated with stream discharge, while juvenile migration was strongly influenced by minimum stream temperature and fish size. These results demonstrate the importance of small streams and their connectivity to lakes and larger rivers during the open water period. Similarly, changes in hydrology and surface water dynamics from climate change are likely to influence fish migration timing and aquatic habitat accessibility and use in Arctic ecosystems.

Thermal Criteria for Nevada Coldwater Stream Fishes

Student Investigator: None

Advisor: 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

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



Kevin Fraley with a grayling sampled from Fielding Lake, AK. Photo by Jeff Falke.



Measuring electrical resistance and reactance of an Arctic grayling from Julius Creek, AK. Photo by Jeff Falke.

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 are 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. 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.

Characterization of Resident Rainbow Trout Seasonal Habitats in Willow Creek, Alaska

Student Investigator: Kevin Fraley, MS Fisheries

Advisor: Jeff Falke

Funding Agencies: Alaska Department of Fish and Game; MatSu Salmon Habitat Partnership

In-Kind Support: Personnel, boats, logistics: ADFG Region 2



Floy-tagging a rainbow trout recently implanted with a radio tag in Willow Creek, AK. Photo by Kevin Fraley.



A radiotagged rainbow trout from Willow Creek, AK, upon release. Photo by Kevin Fraley.

Native inland resident rainbow trout are an important ecological and fishery resource in the Susitna River basin, Alaska, yet the distribution of their seasonal habitats is poorly understood. Variable spawning site fidelity, long-range movements, and potential land use and climate change effects add to the uncertainty surrounding conservation and management of this species. The Susitna River basin is transected by one of the busiest road corridors in Alaska, the Parks Highway. As a result, areas within this region are among the most developed in the state. Projected land-use changes will likely result in degraded critical habitats for salmon and resident species. The primary objective of this project is to determine the distribution of seasonal habitats for potamodromous rainbow trout in the Willow Creek watershed, Southcentral Alaska. Seasonal habitat use by rainbow trout will be assessed using radiotelemetry and linked to habitat characteristics (physical habitat, water temperature, and flow). Habitat availability will be assessed by spatially-continuous mapping of geomorphic channel types and water temperature metrics, and will be conducted during summer 2013. Habitat use will be quantified by

radiotagging a sample of rainbow trout and tracking them throughout the spawning and rearing seasons in 2014. Aquatic habitat was mapped in the field for 26 km of Willow and Deception Creeks designated as the study area during July 2013. Forty-three rainbow trout were captured and tagged with radio transmitters within the study area in 2013 and will be tracked via aerial and on-the-ground surveys in 2014. It is likely that trout will use different habitats within the Susitna drainage depending on the season (spawning, feeding, overwintering), and that male and female trout will exhibit different movement patterns. Additionally, it is expected that trout will follow spawning runs of salmon very closely during the summer months in order to feed on eggs and decomposing salmon flesh. 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.

Factors Influencing Chinook Salmon Spawning Distribution in the Togiak River, Alaska

Student Investigator: Stephanie Meggers, MS Fisheries

Co-Advisors: Andrew Seitz and Anupma Prakash

Funding Agencies: Office of Subsistence Management, USFWS (RWO 191), and National Fish Habitat Action Plan

In-Kind Support: USFWS Anchorage Fish and Wildlife Field Office and Togiak National Wildlife Refuge

Chinook salmon populations are declining in the Togiak River, but the reasons for the decline are currently unknown. However, traditional ecological knowledge indicates that the spawning distribution of Chinook salmon has shifted from tributaries to the mainstem, with significantly more Chinook salmon spawning in the mainstem than in tributaries. I will attempt to describe physical factors influencing Chinook salmon spawning habitat availability and distribution that may influence overall abundance. The objectives of this project are to determine areas of high and low density Chinook salmon spawning using radiotelemetry data and to describe the habitat characteristics associated with these areas using visible and forward-looking infrared (FLIR) imagery collected over the Togiak River. I used radiotelemetry data in a GIS framework to determine areas of high and low density Chinook salmon spawning. Next, remote sensing imagery was collected over two mainstem and one tributary area. This imagery will be analyzed to describe and compare the physical habitat characteristics and thermal differences in high and low density spawning areas. Areas with a low density of Chinook salmon spawning activity will have different habitat characteristics than areas with a high density of spawning activity. Information from this project will aid in understanding habitat characteristics important for Chinook salmon spawning that can be derived from remote sensing imagery, which may provide an alternative method to ground-based studies.

Predation as a Source of Juvenile Chinook Salmon Mortality in the Yukon River**Research Technicians:** Kristen Sellmer and Erik Schoen**Advisor:** Mark Wipfli**Funding Agency:** ADFG**In-Kind Support:** Samples and supplies provided by ADFG, Norton Sound Economic Development Corporation, and subsistence fishers

Chinook salmon declines have persisted in Alaska for the last decade, yet the causes of declines are not understood. Some evidence suggests that predation in fresh water may be a contributing factor to declines, but little is known about the predators of juvenile Chinook salmon in Alaska or their potential role in recent salmon declines. The early life-history stage of Chinook salmon in fresh water can be a period of high mortality and growth with important consequences for population dynamics. Addressing freshwater predation as a possible limiting factor to juvenile Chinook salmon survival will help fill current knowledge gaps regarding freshwater limits on overall abundance. This study is just getting underway and will address two main objectives: (1) determine the key predators that prey on juvenile Chinook salmon, and how predation may vary over time and across habitats; and (2) determine how size and nutritional status of juvenile Chinook salmon affect predation risk. We will sample the diet of potential freshwater predators, likely including northern pike, burbot, inconnu, Arctic grayling, and common merganser. We will also sample juvenile Chinook salmon directly and compare the size and body condition of live-captured salmon to those collected from predator stomachs (recently ingested). Sampling will be stratified across a range of conditions (season, region, habitat type, and flow level) to identify factors associated with possible elevated predation risk. Pilot sampling during fall 2013 guided improved site selection for focused sampling in the Chena River beginning in spring 2014, as well as refined methods for sample collection and protocol. Understanding the importance of predation in fresh water as a source of juvenile Chinook salmon mortality will contribute to the growing body of knowledge that aims to understand the causes of Chinook salmon declines, and will aid salmon management.

Susitna River Food Web Study**Student Investigator:** Kristin Rine, MS Wildlife Biology**Research Technician:** Erik Schoen, IAB**Advisor:** Mark Wipfli**Funding Agency:** Alaska Energy Authority (AEA)**In-Kind Support:** Sample collection and data management efforts are shared with R2 Resource Consultants. Alaska Earth Sciences and AEA provide transportation to remote field sites and coordinate field logistics.

The Alaska Energy Authority (AEA) is proposing 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 in-river, terrestrial, and marine sources to invertebrates and focal fish species among habitat types and along the river

corridor; (2) describe spatial and temporal variability in diet composition and growth rates of focal fish species; and (3) determine how water temperature, food availability, and food quality influence growth of focal fish species, and develop a growth-rate potential analysis for predicting growth under changing conditions. We measured water temperature, stream flow, and other habitat characteristics, and determined the distribution, diets, and growth rates of juvenile Chinook salmon, juvenile coho salmon, and rainbow trout. We also sampled tissues of major food web components for stable isotope analysis. Preliminary findings indicate that juvenile salmon consumed aquatic and terrestrial invertebrates throughout the growing season and heavily utilized salmon eggs during spawning runs. Food resources and favorable conditions for feeding and growth varied between turbid and clear habitats. This study will provide important baseline information for evaluating potential effects of the proposed dam on food webs and fish resources in the Susitna River drainage.

Completed Wildlife Studies

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

Student Investigator: Teri Wild, MS Wildlife Biology

Advisor: Abby Powell

Funding Agencies: Arctic National Wildlife Refuge/USFWS; Gates of the Arctic National Park and Preserve/NPS

In-Kind Support: Technical assistance, vehicle, and logistical support provided by USFWS and NPS

Note: Teri Wild graduated from the University of Alaska Fairbanks in December 2013. Her thesis abstract follows:

Smith's Longspur (*Calcarius pictus*) is a species of conservation concern in the U.S. and Canada, yet few studies have been conducted on their breeding grounds in the Arctic, which are expected to undergo dramatic changes due to climate change. For effective conservation, we need information on breeding distribution and abundance; thus I conducted surveys for Smith's Longspur and habitat characteristics across a broad geographic range that included twelve sites within Alaska's Brooks Range, June 2003-2009. My main objectives were to (1) locate breeding populations (2) describe habitats at local and broader geographic scales, (3) develop a predictive distribution map based on habitat characteristics, and (4) estimate densities and abundance of Smith's Longspurs. Smith's Longspurs were detected at seven of twelve sites and were associated with mixed sedge and shrub habitats with high cover of moss and sedges. Across the Brooks Range, I predicted patchy occurrence in valleys and foothills in the north- and south-eastern mountains and in upland plateaus in the western mountains. Density estimates varied, ranging from 0 - 0.39 males/ha due to their patchy distribution within and among sites. I estimated abundance as ~30,000 males in the Brooks Range. My data provides a baseline for future monitoring of this little-known species.

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; U.S. Bureau of Ocean Energy Management (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 five field seasons and collected roughly 1,900 invertebrate core samples, captured 240

semipalmated sandpipers, and completed 70 shorebird survey days. Stable isotopes allowed us to distinguish between the macroinvertebrates that shorebirds use as food on the delta and those from nearby tundra ponds. Also, blood samples from semipalmated sandpipers indicate that shorebirds have a tundra food signature when they first arrive on the delta, but this changes to a strictly delta signature later in the season. This association demonstrates the importance of delta food resources to shorebirds preparing for migration. Several shorebird populations using this habitat are declining and some are listed as species of concern in the US Shorebird Conservation Plan and by US Fish and Wildlife Service. This research will give insight into how climate change may influence shorebird habitat.

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: USFWS and BLM provided additional support

Smith's Longspurs have been listed as a species of concern, due to potential threats on both wintering and breeding grounds and to the general lack of information about all aspects of the species ecology. Smith's Longspurs breed in dwarf shrub habitat in northern Alaska and Canada where they could be particularly susceptible to habitat shifts due to climate change. Because of the limited data available on Smith's Longspurs, information pertaining to local scale habitat requirements in addition to life history information can help management agencies develop appropriate conservation strategies for the species. The objective of this study is to further the understanding of breeding Smith's Longspurs in northern Alaska. Additionally, we aim to investigate migration timing and routes in order to better understand the whole life cycle of Smith's Longspurs. We located and monitored 74



Smith's Longspur nests during summer 2013 at two study sites in the northern Brooks Range and Brooks Range foothills region of Alaska. We monitored these nests to fledge in order to determine nesting success rates. Throughout the season we resighted 50 previously color-banded Smith's Longspurs. Additionally, 270 adult and hatch-year birds were captured and banded. We deployed 22 light-level geolocators on male Smith's Longspurs captured in Atigun Gorge. Preliminary results indicate nesting preference in dwarf shrub tundra habitat with a negative association with tall or dense shrub cover. A 79.6% nesting success was observed along with 60% annual survival of adult Smith's Longspurs. The results of this study will provide a baseline understanding of breeding Smith's Longspurs that will be useful for conservation planning and future research.

Heather Craig prepares to weigh and band a Smith's Longspur chick as part of a nesting study on the species, summer 2013, Atigun Gorge.

Spatiotemporal Distribution and Habitat Use of Non-Breeding 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 U.S. 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 implanted satellite transmitters in Spectacled Eiders to collect location data from individuals to describe spatiotemporal patterns in distribution and migration. Location data will also be incorporated into habitat use models and accompany a population genetics study. We marked 129 Spectacled Eiders at breeding sites in Alaska, 2008–2011. In spring and fall, eiders were located in distinct areas of the Bering, Chukchi, Beaufort, and East Siberian seas. In winter, all eiders used an area in the northern Bering Sea. Information regarding the spatiotemporal patterns of Spectacled Eiders at sea is valuable to conservation and recovery efforts. This information is necessary when planning the development of offshore natural resources in the Chukchi and Beaufort seas, mitigating for 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: Kanuti National Wildlife Refuge, USFWS; UA Foundation (Angus Gavin Bird Research); Arctic Audubon Society

In-Kind Support: Equipment used during field season provided by AKCFWRU

Studies of Whimbrel breeding ecology are limited in North America, despite suspected population declines and an official designation as a species of conservation concern (U.S., Canada, and Alaska). The ecology and distribution of the species in Interior Alaska have been particularly understudied. This research addresses critical information gaps identified in conservation status reviews of Whimbrels including breeding distribution, habitat associations, and factors affecting breeding 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.



A Whimbrel found near Donnelly Dome with the Alaska Range in the background to the south. Photo by Jessica McLaughlin.

Additionally, we attempted to identify potential breeding locations for Interior Alaska in spring-summer 2013. We applied habitat associations observed from known breeding season locations on Kanuti NWR to a GIS-based analysis to identify and predict breeding sites elsewhere in Interior Alaska. In 2013 we conducted surveys along Interior highways to determine shorebird species presence/absence, as well as describe the actual (vs. predicted) habitats encountered. We completed approximately 300 10-min point counts, with Whimbrels being detected on 42 (14%). Actual nests were found along Stampede Road, near Donnelly Dome, and Chandalar Shelf, and we further suspected breeding along the Elliot Highway and near Finger Mountain (Dalton Highway). No Whimbrels were detected in the Twelvemile and Eagle Summit areas (Steese Highway) despite historical reports there, nor along the Taylor Highway, where suitable habitat seemed limited. This research addresses information gaps about Whimbrels at local and regional scales.

Reproductive Success of Arctic-breeding Shorebirds in a Changing Climate

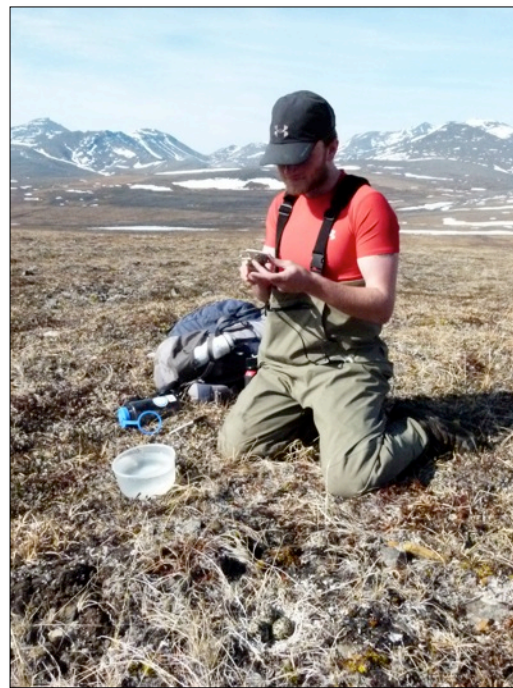
Student Investigator: Kelly Overduijn, MS Wildlife Biology and Conservation

Advisor: Abby Powell

Funding Agency: Alaska Science Center, USGS (RWO 194)



During the 2013 field season in Nome, we banded 37 adult Golden Plovers (both American and Pacific Golden Plovers). While tracking chicks, we used individually marked adults to identify broods throughout the brood-rearing period.



Skyler Jordan takes egg measurements after finding a Pacific Golden Plover nest.

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. Elevational gradients may function as spatial proxies for temporal habitat changes projected to occur in response to climate change. Arthropod sample processing is currently underway. Data analysis and writing will begin in summer/fall 2014. 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

Black Oystercatchers are important members of intertidal communities, completely dependent on nearshore marine habitats for all life history components, and are vulnerable to disturbance that occurs within nearshore systems. For these reasons, and a small estimated population size, oystercatchers have been recognized as a species of concern and are the focus of monitoring efforts. The NPS Nearshore Monitoring Protocol incorporates annual monitoring of oystercatchers from a single visit to Kenai Fjords and Katmai National Parks. However, estimates obtained from a single observation may be subject to potential biases. These and related issues need to be accounted for to ensure robust interpretation of monitoring data. To address these issues, we are conducting a two-year study (2013-14) of the breeding and feeding ecology of oystercatchers in Kenai Fjords National Park. We use direct and indirect (remote cameras) methods to monitor oystercatcher nests and chick provisioning. We collect prey samples and blood from chicks for nutritional and isotopic analyses. We monitored 15 nests throughout the 2012 breeding season, 40% of which hatched at least one chick. Additional analyses are in progress and we will collect more data in 2014. Results of this study will inform and improve long-term monitoring studies and management of Black Oystercatchers in Alaska.

Breeding Ecology and Seasonal Interactions in the Shorebird Community at Cape Krusenstern National Monument

Student Investigator: Megan Boldenow

Advisor: Abby Powell

Funding Agency: USFWS Region 7 (Migratory Bird Management)

In-Kind Support: USFWS (Selawik National Wildlife Refuge), NPS (Western Arctic Parks), and Manomet Center for Conservation Sciences

Researchers are working to understand the causes behind population declines in Arctic-breeding shorebirds and document population trends when status is unknown. Determining environmental influences throughout their annual cycle is

important for understanding population trends. We have little data on conditions encountered outside of the breeding season or how these conditions carry over to influence individual fitness and population dynamics. Cape Krusenstern National Monument (CAKR) is important for breeding shorebirds, yet they spend nine months each year away from their breeding grounds. We are attempting to evaluate seasonal carry-over effects that may influence individual fitness and population dynamics. The objectives of this research are to (1) compare historic and contemporary data on shorebird communities to examine changes in species presence and abundance, habitat use, and phenology; and (2) understand the effects of ecological conditions outside of the breeding season on the subsequent reproductive success of individual shorebirds. I will compare historic data and data recently collected through the Arctic Shorebird Demographic Network. I will measure corticosterone present in winter-grown feathers and relate levels to nest initiation date, clutch and egg size, and hatching success. Field data are still being collected. This work can improve development of international, scientific-based strategies to manage arctic-breeding shorebirds.



Floating shorebird eggs allows researchers to age the egg and calculate nest initiation date. Photo by Fang-Yee Lin, USFWS volunteer.



A researcher holds four day-old semipalmated chicks. They will fly thousands of miles to their wintering grounds by the end of summer. Photo by Fang-Yee Lin.



Megan Boldenow and Fang Yee-Lin hold Dunlin chicks, banded in their nest cup one week earlier. Photo by Jennifer Kardiak, USFWS volunteer.



A researcher shows off the lobed toes of a Red-necked Phalarope. Photo by Jennifer Kardiak.

Relative Parasitemia Levels in Alaska Waterfowl

Student Investigator: Matthew Smith, MS Wildlife Biology and Conservation

Advisor: Kevin McCracken

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

Current molecular methods for assessing hematozoa infections in wild bird species are incapable of quantifying parasitemia levels of *Leucocytozoon* spp. in infected individuals. While this can be done effectively using microscopy, this method is time consuming and there is potential for low-level infections to avoid detection. A new methodology utilizing quantitative-PCR will allow researchers to determine the levels of hematozoa infection in waterfowl in order to assess pathological effects of *Leucocytozoon* infections. Studies have shown that hematozoa infections in certain regions or species can have pathogenic effects. Recent surveys of blood parasite prevalence in Alaska waterfowl have shown high infection rates among multiple species. The purpose of this study is to develop a molecular methodology that will allow researchers to determine the parasitemia level of an infected bird in order to better understand dynamics of blood parasite infection and how they relate to host health. The objectives of this study are to (1) develop, optimize, and validate a molecular method to quickly and accurately assess parasitemia levels for *Leucocytozoon* blood parasites, and (2) apply this method to samples collected from Alaska waterfowl. A total of 105 waterfowl were sampled from the Chena River and from the Minto Flats Stage Game Refuge in fall 2013. DNA extracted from blood samples will be used to optimize and validate methodology using quantitative PCR methods and microscopic examination of peripheral blood smears. We expect this study to result in an efficient, easily reproducible method to quantify infection rates of *Leucocytozoon* spp. that can be applied to blood samples collected from a broad range of avian host species. This study will produce a molecular protocol that can quickly and efficiently quantify parasitemia levels of *Leucocytozoon* infections in Anatid waterfowl species that will facilitate assessments of pathogenic effects of parasites. Furthermore, this method may allow for assessments of differences in the relative parasitemia levels of individuals among populations, season, and years.

Microbial Infection as a Source of Embryo Mortality in Greater White-fronted Geese (*Anser albifrons*) on the Arctic Coastal Plain of Alaska

Student Investigator: Cristina Hansen, PhD Biological Sciences

Advisor: Karsten Hueffer

Funding Agency: USGS (RWO 206)

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 identify potentially pathogenic bacteria in contents of nonviable eggs and to determine egg mortality potential. During the 2013 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. Isolates recovered were inoculated into fertilized chicken eggs to fulfill Koch's postulates. A *Neisseria* sp. was isolated from

23 of 35 addled eggs (and from no infertile eggs), *Macrococcus caseolyticus* was isolated from 6 eggs, and *Streptococcus uberis* and *Rothia nasimurium* were each isolated from 4 eggs. Other species were isolated from eggs rarely. Chicken egg infections show that between 60-100% of eggs died by 7 days post-infection with these species. 16S rRNA gene sequences from the *Neisseria* sp. most closely match *N. animaloris* or *N. canis* (96-97% identity) but suggest that this might be a new species. Sequences from *M. caseolyticus*, *S. uberis*, and *R. nasimurium* all matched GenBank accessions 99-100%. Four commonly isolated bacterial species caused mortality in chicken eggs and are likely causing mortality in greater white-fronted goose eggs on the North Slope of Alaska.

Seasonal Movements and Population Ecology of Willow Ptarmigan in Interior Alaska

Student Investigator: Graham Frye, PhD Wildlife Biology

Advisor: Mark Lindberg

Funding Agencies: Alaska Department of Fish and Game; Alaska Energy Authority

The Willow Ptarmigan is one of the most popular upland game bird species 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 the spring to estimate breeding season abundance. This study was initiated during the spring/summer of 2013. We are presently collecting data from radio-marked individuals, but do not yet have sufficient information to present results. Results from this study will help to inform future Willow Ptarmigan management and monitoring efforts in Interior Alaska.

Characterizing Variation of Isotopic Markers in Northern Alaskan Caribou Forages

Student Investigator: Lindsay VanSomerén, MS Wildlife Biology and Conservation

Advisor: Perry S. Barboza

Funding Agency: Alaska Science Center, USGS

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

Caribou migrate from dry upland habitats to coastal wetlands of the North Slope of Alaska each summer and consume a wide range of forages of varying quality. Stable isotopes of ^{13}C and ^{15}N in plants and tissues of caribou can be used to track resources used by the animals through the annual cycle. However, isotopic values vary with forage species, location, season, and digestion. We collected 150 samples of seven forage species in 2011 and 2012 to describe latitudinal and temporal variation in stable isotope values and fractionation during digestion. We were able to use values for both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ to distinguish between forage functional groups (graminoids, willows, birch, and a forb). However, the range of $\delta^{15}\text{N}$ values was more than twice as large (range: 13.8) as those of $\delta^{13}\text{C}$ (range: 5.6). Values for $\delta^{13}\text{C}$ declined with increasing latitude over the course of the season probably due to changes in water availability. Conversely, $\delta^{15}\text{N}$ values were neither affected by latitude nor season. Digestion decreased values for $\delta^{13}\text{C}$ in residues of forbs and birch and increased values of $\delta^{15}\text{N}$ in residues of willow and birch. Seasonal changes in forage quality affected fractionation of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ especially among browse species with high concentrations of plant secondary metabolites. Values of $\delta^{15}\text{N}$ can best distinguish plant functional groups used by caribou, but seasonal changes in quality increase the error in estimating diet from undigested residues in feces or absorbed components in the animal.

Completed Ecological Studies

Recent Changes in Plant and Avian Communities at Creamer's Refuge, Fairbanks, Alaska, Using Field and Remote Sensing Observations

Student Investigator: Lila Tauzer, MS Biology and Wildlife Conservation

Advisor: Abby Powell

Funding Agencies: Alaska Space Grant, NASA; Angus Gavin Memorial Bird Research Grant, UAF; IAB Summer Fellowship; AKCFWRU; Calvin J. Lensink Graduate Fellowship

In-Kind Support: Alaska Bird Observatory

Note: Lila Tauzer graduated from the University of Alaska Fairbanks in May 2013. Her thesis abstract follows:

Plant communities in the north are being profoundly altered by climate warming, but our understanding of the extent and outcomes of this ecosystem shift is limited. Although we assume local vegetation changes will affect avian communities, few data exist to investigate this relationship. In an Interior Alaska boreal forest ecosystem, this study capitalized on available resources to assess simultaneous change in plant and avian communities over 35 years. I quantified biological change in summer avian community data (species composition, diversity, and richness) and in vegetation using archived field data, and supplemented this data with remote sensing observations for a similar time period to assess the validity of this method for documenting environmental change. Field and remote sensing data both documented successional changes resulting in denser, more coniferous-dominated habitats. Birds responded accordingly, which indicates a rapid avian response to habitat change and that they are good indicators of environmental change. Information gained provides more accurate evaluations of habitat dynamics throughout the interior boreal forest and highlights the importance of considering successional change in all long-term climate studies. It allows for better predictions of future habitat change and acts as a strong baseline for future environmental monitoring.

Ongoing Ecological Studies

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

Postdoctoral Researcher: H       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 a postdoctoral researcher 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 focused on improving the spatial and temporal resolution of fire severity on soil organic horizons and to evaluate its long-term consequences on forest composition in Interior Alaska. Existing field observations were analyzed to build a predictive model of the depth of burning of soil organic horizon after a fire. The model includes descriptors of fire, climate and topography characteristics. She has published a paper on this model development. We are now conducting production runs over Interior Alaska and are working with DoD fire managers to identify additional simulations that would be useful for their long-term plans to manage wildfire on military lands in Alaska.

Research Coordination Network: Vulnerability of Permafrost Carbon

Postdoctoral Researcher: Yujin Zhang

Faculty: A. David McGuire

Funding Agency: National Science Foundation

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 third year of this project has produced significant advancements in both of these areas. A workshop in Year 3 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. This meeting brought in a number of new participants into the network; we essentially doubled the size of the network from the attendance at the previous workshop. 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.

Development and Application of an Integrated Ecosystem Model for Alaska

Postdoctoral Researchers: Hélène Genet, Colin Tucker, and Yujin Zhang

Faculty: A. David McGuire, T. Scott Rupp, Vladimir Romanovsky, Eugénie Euskirchen, and Sergey Marchenko

Funding Agencies: USGS and USFWS (RWO 190)

Our primary goal in this project is to develop a modeling framework that integrates the driving components for and the interactions among disturbance regimes, permafrost dynamics, hydrology, and vegetation succession/migration for the state of Alaska. This framework will couple (1) a model of disturbance dynamics and species establishment (the Alaska Frame-Based Ecosystem Code, ALFRESCO), (2) a model of soil dynamics, hydrology, vegetation succession, and ecosystem biogeochemistry (the dynamic organic soil/dynamic vegetation model version of the Terrestrial Ecosystem Model, TEM), and (3) a model of permafrost dynamics (the Geophysical Institute Permafrost Lab model, GIPL). Together, these three models comprise the 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.

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

Student Investigator: Erin Julianus, MS Biology

Co-Advisors: A. David McGuire and Teresa Hollingsworth

Funding Agency: Region 7, USFWS (RWO 204)

In-Kind Support: USFWS provided personnel

The Kanuti National Wildlife Refuge (NWR) is managed by the U.S. Fish and Wildlife Service (USFWS), a federal agency mandated to manage Refuge lands for the conservation of wildlife habitats. Wildfire is a primary source of natural disturbance on Kanuti NWR, and there is a need to understand how wildfire dynamics will alter moose habitat resources and impact moose populations. Much is known about moose ecology and their response to fire on a general level, but fire-driven habitat dynamics and the specific ways in which moose use burns on Kanuti NWR are not well studied. Moose have been identified as a priority management species because they are a vital subsistence resource for many communities in Interior Alaska, a primary food source for several apex predators, and are an important part of boreal forest ecology in North America. As the changing climate continues to alter the environment, particularly in northern latitudes, land managers are faced with the challenge of achieving pre-existing management goals for moose. This requires the use of adaptive management strategies that have been developed based on an improved understanding of local habitat characteristics. This study focuses on improving the understanding of habitat characteristics related to fire history on the Kanuti NWR. The goal of this project is to evaluate the effects of fire history, plant community composition, and landscape characteristics on moose habitat, forage resources, and resource use by moose on Kanuti NWR. Data were collected on summer browse quantity and quality at 34 sites within burn scars of varying ages in late summer 2012 and 2013. Summer browse use by moose was also quantified at these sites. In winter 2013, 13 sites were revisited to determine woody browse removal by moose, and the remaining sites will be revisited in April 2014. Results will include estimates of browse quantity in each burn age stratum (reported as shrub density/ha) and quality per burn (evaluated by measuring %C and N). Additionally, browse use by moose as a percent of the total browse biomass available per burn will be determined. These findings will be integrated with current and past management activities on Kanuti NWR, including moose population dynamics and subsistence resource demand. The results of this study will be useful in informing land management decisions related to moose management objectives on Kanuti NWR as burn scars age and progress through post-fire vegetative succession.

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)

Interior Alaskan boreal lakes have been decreasing in size and abundance, which could act as an important climate feedback by affecting productivity and carbon storage in adjacent wetlands. Lake drying could also influence biodiversity via altered successional pathways. Our objective is to estimate the influence of drying on terrestrial ecosystem dynamics in the Yukon Flats National Wildlife Refuge. Between 2010 and 2012, we surveyed vegetation at 130 lakes. We sampled aboveground biomass, net primary productivity, and soil characteristics at a subset of 16 lakes, and estimated biomass and soil carbon for all lakes using remote sensing. Recent work has focused on identifying relationships between plant species diversity and aboveground biomass and examining the influence of these relationships on wetland ecosystem responses to lake drying, using regression tree analysis and structural equation models. Lake drying was positively correlated with species richness in adjacent wetlands. However, species richness was negatively correlated with aboveground biomass, and aboveground biomass was more strongly predicted by species composition (the presence/absence of a few key species) than by species diversity per se. The top models of biomass included a combination of species richness, species composition, patch size, and lake size trends ($R^2 = 0.69$). Models without richness and composition had lower predictive power ($R^2 = 0.38$).

These results suggest that the response of boreal wetlands to drying is mediated by both the composition and the diversity of plant communities. Management strategies aimed at maximizing ecosystem services like carbon storage and forage availability should account for plant community composition.

Changing Habitat and Seasonality in Arctic Alaska and Impacts to Migrating Caribou and Birds

Postdoctoral Researcher: Ken Tape

Faculty: Roger Ruess

Funding Agency: Alaska Science Center, USGS (RWO 196)

Warming in Arctic Alaska has led to accelerated coastal erosion and earlier seasonal disappearance of snow, among other things. There is a need to understand these changes and their effects on caribou and migratory birds so that land managers can better understand and predict the impacts of ongoing changes to those animals. Caribou and geese are integral subsistence and personal use resources. Monitoring and preservation of their habitat are therefore critical to maintaining the resource. Our primary objective is to inventory, provide, and interpret paired old and new imagery for several USGS groups studying birds and caribou in Arctic Alaska, and to use that data to identify landscape change. We are also exploring changes in seasonality and relating that to timing of animal migration. I scanned, georeferenced, and compared time series of imagery-revealed changes in goose habitat during the 20th century. We augmented the imagery with fieldwork specifying the nature of geomorphic and vegetation changes underway. We also deployed time-lapse cameras to monitor caribou and ptarmigan migrations in relation to spring snow cover. Results from repeat imagery and fieldwork indicate that coastal and near-coastal areas of the TLSA (Teshekpuk Lake Special Area) became inundated between 1960 and 1990, which triggered sedimentation and formation of salt marshes currently being exploited by Brant geese. Results from other projects established significant linkages between the timing of snow disappearance and arrival of avian migrants. The camera deployment yielded a novel method for quantifying caribou and ptarmigan migration timing and (forthcoming) correlations with snow cover. Two publications resulting from the work are:

- Tape, K.D., and D Gustine. 2014. Capturing migration phenology of terrestrial wildlife using camera traps. *BioScience* 64(2):117-124.
doi:10.1093/biosci/bit018
- Tape, K.D., P.L. Flint, B.W. Meixell, and B.V. Gaglioti. 2013. Inundation, sedimentation, and subsidence creates habitat favorable for geese along the Arctic coast of Alaska. *Environmental Research Letters* 8, 9 pp.
doi:10.1088/1748-9326/8/4/045031

Press related to these projects appeared in the *Alaska Dispatch* and *Anchorage Daily News*, among other outlets. These data will help managers understand how migrants are responding to a variety of landscape changes associated with climate warming.

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 has indicated a drying of boreal wetlands and increased fire frequency in forested uplands surrounding wetlands. On the Yukon Flats, in Interior Alaska, surface water area of wetlands was estimated to have decreased by 18% from 1952–2000. The Yukon Flats is one of the largest waterbird breeding grounds in North America, producing approximately 1.6 million ducks, geese, and swans annually. For our proposed research, we will compare existing data from the 1980s on water chemistry, invertebrate abundance, and waterbird distributions of boreal wetlands with contemporarily collected data, providing a unique opportunity to understand long-term ecosystem change associated with wetland drying. We will also examine effects of a recent forest fire on wetland ecosystems. We will document (1) changes in water chemistry, aquatic invertebrates, and waterbirds in response to drying of boreal wetlands, and (2) multi-trophic response of wetlands to forest fires. Nutrient and ionic concentrations have increased on drying lakes, while not changing on lakes with stable water levels. Lakes were resilient to impacts from forest fires across multiple trophic levels, from plankton to waterbirds. Results from this research will provide a valuable 2- to 3-decade perspective on boreal wetland change to the Yukon Flats National Wildlife Refuge for anticipating how much climate-driven ecological change to expect in their refuge 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:** US Bureau of Ocean Energy Management (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 U.S. 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 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. Results could affect monitoring design and the adaptive harvest management process. We might recommend eliminating some survey segments or strata or adding new ones. Temporal environmental change may need to be added to demographic models that underlie adaptive management. A monograph is being prepared and an abstract is being submitted to the 2014 Wildlife Society National Conference.

Feeding Ecology of Lesser Scaup Ducklings in the Boreal Forest of Alaska: An Examination of a Trophic Mismatch

Student Investigator: Adam DuBour, MS Wildlife Biology

Advisor: Mark Lindberg

Funding Agency: Alaska Science Center, USGS

In-Kind Support: Yukon Flats NWR provided equipment, and flight and logistic support

Lesser Scaup (hereafter Scaup), the most abundant diving duck in North America, have experienced prolonged population declines since the 1980s. The Yukon Flats National Wildlife Refuge (YFNWR), a boreal wetland basin, is a continentally important breeding area for Scaup. Several non-mutually exclusive hypotheses, including habitat change to boreal wetlands and aquatic invertebrates, have been implicated in the declines. Scaup ducklings require abundant aquatic invertebrate prey for growth and survival with amphipod crustaceans being indicated as their

main prey. Spatiotemporal changes in availability of invertebrates may result in a trophic mismatch with duckling demand. However, information gaps exist about the variability in Scaup duckling prey selection. The objective of this study is to assess the vulnerability of Scaup ducklings to a trophic mismatch by assessing their degree of dietary specialization in relation to prey availability and quality. We collected 103 ducklings and aquatic invertebrates from 27 wetlands 2010–2012 across the YFNWR. To assess diet we are using duckling gut contents and stable isotope analysis. To address prey quality we will measure the spatiotemporal variation in protein and lipid content in potential food items. Work is still in progress; however, we anticipate that Scaup ducklings are relative generalist consumers with amphipods as an important prey item because of their relative higher abundance and quality. Understanding duckling prey selection will aid in identifying wetlands for protection that provide adequate food sources in the face of potential ecosystem 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

In-Kind Support: ADFG provided equipment and vehicles 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. This project completed the final year of field data collection (4 years total) in spring 2013. Data collection and analysis are ongoing. Fawn survival rates were 54%, 16%, and 52% for 2010, 2011, and 2012, respectively, and adult female survival rates during the same period were 90%, 86%, and 95% for those years. Analysis currently underway includes effects of habitat and weather on deer population dynamics, evaluation of relative importance of vital rates for different age classes, development of resource selection functions and risk functions in different habitat types, quantification of deer-bear predator-prey relationship, and modeling of deer population response to future climate and habitat-alteration scenarios. We recently submitted a manuscript for publication detailing age-dependent fawn survival rates. Understanding how habitat and winter weather variability affect deer population dynamics will allow us to project possible effects of different timber and hunting management scenarios on the deer population, as well as to factor in potentially

interacting effects of changing climate. This will help managers ensure adequate supplies of deer for subsistence and recreational harvest in the future.

Climate-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)



Research technician Jared Milhous uses a D-frame sweep net to collect aquatic invertebrates in shallow wetlands on the Arctic Coastal Plain. Understanding the hydrologic factors that affect aquatic invertebrate communities is an important part of the Changing Arctic Ecosystems research program. Chipp North study site, approximately 50 miles southeast of Barrow, July 7, 2011. Photos by Kirsty Gurney.

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 examine several mechanisms that are hypothesized to be responsible for variation in wetland invertebrate communities. Specifically, we will determine how invertebrate biomass, phenology, and community structure respond to changes in nutrient flux and temperature. We are using a series of field-based wetland observations and manipulations to assess changes in wetland invertebrate communities in response to increases in temperature and nutrient concentrations. Fieldwork for this research program is now complete, all samples have been processed, and preliminary data assessments suggest that biomass and counts of key invertebrate taxa are elevated in fertilized ponds. Stable isotope analyses indicate that fertilization may also shift the trophic status of key aquatic invertebrate groups. Seasonal patterns of invertebrate biomass, however, do not appear to change in response to fertilization. Pending analyses will evaluate these patterns more closely by including key covariates in statistical models. 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)

In-Kind Support: School of Fisheries and Ocean Sciences provided Teaching Assistantship



Ross Dorendorf captures the first Arctic grayling of the season in a highly connected North Slope lake, July 2013. Photo by Sarah Laske.



Constance Johnson successfully captures zooplankton from a shallow Arctic lake, August 2012. Photo by Sarah Laske.

The rapid rate of climate warming in the Arctic requires understanding of baseline conditions in freshwater aquatic 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 differ 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 on the North Slope. Water bodies varied in size and degree of surface water connectivity to surrounding water bodies. Fish communities differed depending on degree of surface water connection. It appears that fish community differences affect invertebrate assemblages through top down processes. The 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 aquatic systems respond to changes in climate.

Trophic Pathways Supporting Arctic Grayling (*Thymallus arcticus*) in a Beaded Stream on the Arctic Coastal Plain, Alaska

Student Investigator: Jason J. McFarland, MS Biology

Advisor: Mark Wipfli

Funding Agency: Bureau of Land Management (BLM) (RWO 179)

In-Kind Support: Teaching assistantship, Department of Biology and Wildlife

Aquatic ecosystems on the Arctic Coastal Plain (ACP) in Alaska are threatened by rapidly increasing oil and gas activities and climate change. The ACP is an ecologically and biologically poorly understood area, particularly with the food webs that support fishes. Understanding the structure and function of these lotic systems is paramount to understanding how the future Arctic aquatic habitats and ecosystems will be influenced by changes in land use and climate. The ACP is comprised of a water-dominated landscape consisting of complex networks of interconnected lakes, rivers, and streams. The small size of these streams makes them potentially very susceptible to impacts from land use and climate change. These understudied, yet abundant waterways provide habitat for multiple species of fish, with Arctic grayling being the most common and widespread. To evaluate how potential habitat changes may affect Arctic grayling, we must first understand the basic ecology of these aquatic habitats and of the fishes that inhabit them. Objectives of this study were to (i) identify and quantify prey ingested by Arctic grayling in a beaded stream on the Arctic Coastal Plain, Alaska, (ii) determine if prey type ingested is a function of predator size, (iii) quantify invertebrate drift and terrestrial invertebrate infauna into stream reaches within prevailing aquatic-riparian habitats, and (iv) contrast ingestion of terrestrial invertebrates in stream reaches among common riparian plant community types. We examined prey consumption in nearly 500 fish diets, estimated terrestrial invertebrate prey inputs to streams with differing riparian plant community types, and measured invertebrate drift throughout the growing season during June, July, and August 2011 and 2012. Results indicate aquatic invertebrates are more common food items in Arctic grayling diets than terrestrial prey. Arctic grayling are not commonly known to be piscivorous, although the larger size classes preyed heavily upon ninespine stickleback. Riparian vegetation type affected terrestrial prey subsidies to streams; however, we did not detect differences in terrestrial invertebrate prey consumption by fish according to vegetation type. The findings of this study are expected to help guide future management of small streams on Alaska's North Slope, particularly in the face of climate change.

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

Student Investigator: Daniel P. Govoni, PhD Biological Sciences

Advisor: Mark Wipfli

Funding Agency: Rannsóknamiðstöð Íslands (Icelandic Centre for Research – RANNIS)

In-Kind Support: Hólar University, Freshwater Fisheries Institute of Iceland, Blönduós Academic Center

Food webs and invertebrate communities have been 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. Data have not been analyzed yet, but we expect invertebrate assemblages in thermally stable spring-fed hyporheic and surface stream habitats to be stable and influences from seasonality or annual variations to be minimal. We also expect invertebrate assemblages in hyporheic and surface habitats with variable thermal regimes to vary by season and temperature. 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.



Dan Govoni collects a Surber sample from Varmá geothermal stream in Hveragerði, Iceland in May 2013. Photo by Mark Wipfli.



Mark Wipfli hammers a hyporheic sampling pipe into the substrate of Varmá geothermal stream in Hveragerði, Iceland in May 2013. Photo by Dan Govoni.

Effects of Climate and Landscape Change on Chinook Salmon Rearing Habitats in the Kenai River Watershed

Student Investigator: Courtney Pegus, PhD Fisheries

Advisor: Mark Wipfli

Funding Agency: Support from Alaska EPSCoR NSF award #OIA-1208927 and the State of Alaska

In-Kind Support: Kenai Watershed Forum provided personnel, lab space, and logistics

Declines of Chinook salmon have occurred throughout Alaska over the last decade, and currently show no signs of recovery. Although declines have coincided with large-scale changes in climate throughout the state, the actual causes of declines

remain unknown. Diminished habitat quality or quantity (i.e., from drying, increased temperatures, altered food supply) from climate change in juvenile salmon rearing habitats could be contributing to declines. Chinook salmon management requires understanding and evaluating salmon habitat, knowledge about how landscape and climate change may be affecting and changing freshwater rearing habitats for juveniles, and how juveniles respond to habitat change. The objectives of this study are to (1) determine how landscape and climate change are affecting Chinook salmon rearing habitats, and (2) predict future habitat changes and potential impacts on salmon populations, on the Kenai River. Habitat features (e.g., temperature trends, prey dynamics, surface water distribution and abundance) will be collected for habitat and bioenergetic models. Existing, historical data sets on climate patterns (temperature, precipitation) and streamflow will be used to model and predict long-term changes in rearing habitats. Preliminary data from the 2013 pilot season suggest that water temperatures in selected rearing streams and habitats can exceed optimal ranges during summer periods of high air temperatures and low streamflow. Results from this study will help inform stakeholders and managers on current and future freshwater rearing habitat changes within the Kenai River Watershed, and are expected to help guide landscape planning and resource management on the Kenai Peninsula.

Interactions of Fire and Thermokarst Affecting Ecological Change in Alaska

Student Investigator: Dana Nossov, PhD Biological Sciences

Co-Advisors: Knut Kielland

Funding Agency: USGS (RWO 189)

In-Kind Support: BNZ-LTER, DoD

Permafrost underlies much of the Alaskan boreal region, strongly influencing ecosystems, vegetation, hydrology, habitat, and land use. Climate change and wildfire may cause permafrost to degrade, but the vulnerability of permafrost to long-term thawing, and the ecological effects thereof, are influenced by many interacting factors and can vary widely within a region. A better understanding of the interactions between fire and permafrost in the context of a heterogeneous environment is needed to be able to predict and plan for future ecological changes. This study addresses the environmental and biological controls over the response of permafrost to fire across different landscape types in Interior Alaska. We compared vegetation, soil, and permafrost characteristics in burned and unburned stands across topographic positions, soil textural types, and over time. We monitored soil temperatures, thaw depths, and thaw settlement, and will use thermal modeling to test the findings of field-based studies. Future study will utilize remote sensing and GIS to develop spatially explicit models of fire effects on active layer thickness. High-severity fires caused permafrost degradation due to the increase in heat flux after the reduction of organic layer thickness. Among rocky upland, silty upland, and sandy lowland soil landscapes, the vulnerability of permafrost to long-term degradation was greatest in coarse-textured soils due to the effects of increased drainage after initial permafrost thaw on soil thermal regimes. Landscape position also influenced the microclimate and permafrost sensitivity to fire. Future planning should consider the interactions between climate, permafrost, topography, soil properties, vegetation, and disturbance that drive the spatial heterogeneity of ecological change.

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	U.S. Bureau of Land Management
BOEM	U.S. Bureau of Ocean Energy Management
DBW	Department of Biology and Wildlife, UAF
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
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
NASA	U.S. National Aeronautics and Space Administration
NDEP	Nevada Department of Environmental Protection
NFWF	National Fish and Wildlife Foundation
NPS	U.S. 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	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey