Alaska Cooperative Fish and Wildlife Research Unit

Annual Research Report Ñ 201 7

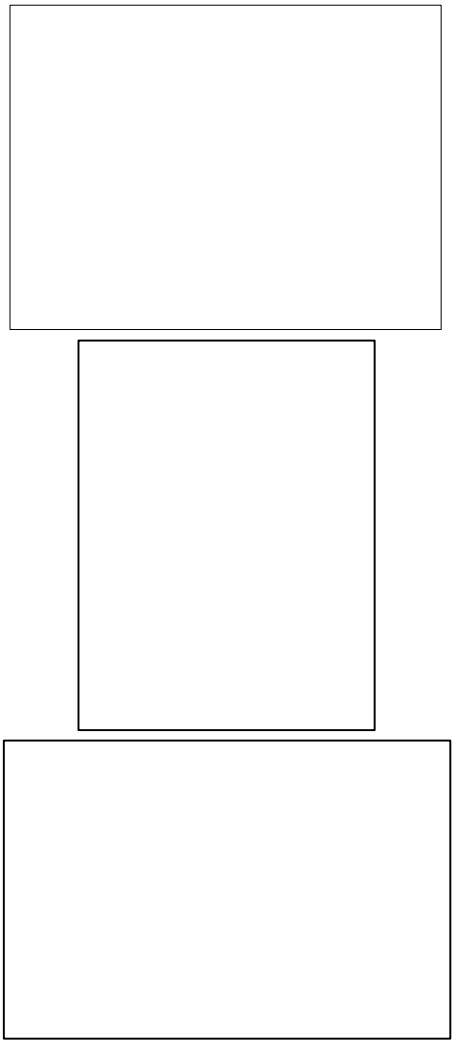

Photo by J R Ancheta UAF

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Photo 1: Skiffs loaded with gear for a nest - searching trip down the ice - laden Beaufort Sea coast, field season 2017. Photo by Elyssa Watford.

Photo 2: Schoen, E., M. Wipfli, and 15 other coauthors. 2017. F uture of Pacific Salmon in the f ace of environmental c hange: Lessons from o ne of the w orld's r emain ing p roductive salmon r egions. Fisheries 42(10): 538- 553.

Photo 3: Fisheries research technicians preparing to examine large woody debris in the Chena River, fie ld season 2017. Photo by JR Ancheta, UAF.

Unit Roster

Federal Scientists

¥ Brad Griffith: Leader
¥ Jeff Falke: Assistant Leader - Fisheries
¥ Dave McGuire: Senior Scientist
¥ Mark Wipfli: Assistant Leader - Fisheries

University Staff

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

Unit Students and Post -Doctoral Researchers

Current

¥ Megan Boldenow, MS Biological Sciences Candidate (Powell)
¥ Chelsea Clawson, MS Fisheries Candidate (Falke)
¥ Dan Govoni, PhD Biological Sciences Candidate (Wipfl i)
¥ Jess Grunblatt, PhD In terdisciplinary Studies Candidate (Wipfli and Adams)
¥ Joelle Hepler MS Wildlife Biology and Conservation Candidate (Griffith and Falke)
¥ Cha se Jalbert, MS Fisheries Candidate (Falke)
¥ Philip Joy, PhD Fisheries Candidate (Wipfl i)
¥ Sarah Laske, PhD Fisheries Candidate (Wipfli and Rosenberger)
¥ Jason Leppi, PhD Fisheries Candidate (Wipfli)
¥ Ben jamin Meyer, MS Fisheries Candidate (Wipfli)
¥ Kristin Neuneker, MS Fisheries Candidate (Falke)
¥ Kelly Overduijn, MS Wildlife Biology a nd Conservation Candidate (Powell)
¥ Vijay Patil , PhD Biological Sciences Candidate (Griffith and Euskirchen)
¥ Matt Sexson, PhD Biological Sciences Candidate (Powell and Peterson)
¥ Eric Torvinen, MS Fisheries Candidate (Falke)

Post - D octoral Researchers

¥ Charlotte Gabrielsen (Griffith)
¥! Erik Schoen (Wipfli)

Graduated in CY 201 7

¥ Chelsea Clawson, MS Fisheries (Falke)
¥! Sarah Laske, PhD Fisheries (Wipfli and Rosenberger)
¥! Kristin Neuneker, MS Fisheries (Falke)
¥! Eric Torvinen, MS Fisheries (Falke)

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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 Alas ka 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 large r and even older program, the US Department of the Interior's Cooperative Research Unit Program. Established in 1935, Cooperative Research Units were created to fill the vacuum of wildlife management information and the shortage of trained wildlife biologists. In 1960, the Unit Program was formally san ctioned by Congress with the enactment of the Cooperative Units Act. Each u nit is a partnership among the Ecosystems Discipline of the US Geological Survey, a State fish and game agency, a host university, and the Wildlife Management Institute. Staffed by Federal personnel, Cooperative Research Units conduct research on renewable natural resource questions; participate in the education of graduate students destined to become natural resource managers and scientists; provide technical assistance and consulta tion 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 AlaskaÕs 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 emphasi ze 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 o f 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: 4 (advised by Unit faculty)
Presentations: 37
Scientific and Technical Publications: 20

Courses Taught

Jeff Falke: Physical Processes in Freshwater Ecosystems (3 credits, Fall 2017)

Honors and Awards

Chelsea Clawson (MS Fisheries candidate advised by Jeff Falke) received a Eugene Maughan Scholarship for $2500 from the Western Division, American Fisheries Society. She also received 2nd place for Best Long Talk at the March 2017 Student Symposium, Fairbanks.

Jeff Falke, December 2017, Annual Performance Award, Cooperative Research Unit Program, USGS, Reston, VA.

Chase Jalbert (MS Fisheries candidate advised by Jeff Falke) received Best Student Poster at the annual meeting of the Alaska Chapter, American Fisheries Society, March 2017.

Dave McGuire, March 2017, Unit Award for Excellence of Service, Department of Interior

Clawson, C., J. Falke, J. Rose, A. Martin, and A. Prakash. 2017. A remote sensing and occupancy estimation approach to quantify spawning habitat use by fall Chum Salmon (*Oncorhynchus keta*) along the Chandalar River, Alaska. Alaska Chapter American Fisheries Society Annual Meeting, Fairbanks, AK. 19- 23 March 2017. (Contributed Oral)

Clawson, C., J. Falke, J. Rose, A. Martin, and A. Prakash. 2017. A remote sensing and occupancy es timation approach to quantify spawning habitat use by fall Chum Salmon (*Oncorhynchus keta*) along the Chandalar River, Alaska. Western Division American Fisheries Society Annual Meeting, Missoula, MT. 22 -25 May 2017. (Contributed Oral)

Euskirchen, E.S., S. Serbin, T. Carman, C. Iversen, V. Salmon, H. Genet, and A.D. McGuire. 2017. Predicting c hanges in A rctic t undra vegetation: Towards an understanding of plant trait u ncertainty. Fall Meeting American Geophysical Union, New Orleans, LA. 11 -15 December 2017. (Contributed Poster)

Falke, J.A., B.M. Huntsman, E.R. Schoen, and K.E. Bennett. 2017. Growth potential of juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) across a boreal riverscape. Alaska Chapter American Fisheries Societ y Annual Meeting, Fairbanks, AK . 20- 24 March 2017. (Invited Oral)

Falke, J., M. Sparks, E. Torvinen, and P. Westley. 2017. Climate vulnerability and salmonids in Alaska: Hind - and forecasting freshwater growth and phenology across species and habitats. Western Division American Fisherie s Society Annual Meeting, Missoula, MT. 23 - 25 May 2017. (Invited Oral)

Laske, S., A. Rosenberger, M.S. Wipfli, and C. Zimmerman. 2017. Surface water connectivity among Arctic lakes drives patterns of fish species richness and composition, and food web structure. American Water Resources Association Spring Specialty Conference 2017, Snowbird, UT. 30 April -3 May 2017. (Invited Oral)

Li, Z., J. Xia, A. Ahlstrom, A. Rinke, C. Koven, D.J. Hayes, D. Ji, G. Zhang, G. Krinner, G. Chen, J. Dong, J. Liang, J .C. Moore, L. Jiang, L. Yan, P. Ciais, S. Peng, Y. -P. Wang, X. Xiao, Z. Shi, A.D. McGuire, and Y. Luo. 2017. Recent slowdown of atmospheric CO2 amplification due to vegetation -climate feedback over northern lands. Fall Meeting American Geophysical Union, N ew Orleans, LA. 11 -15 December 2017. (Contributed Poster)

Lynch, A.J., B.J.E. Myers, T.J. Krabbenhoft, R.P. Kovach, T.J. Kwak, J.A. Falke, C. Chu, D.B. Bunnell, and C.P. Paukert. 2017. Global synthesis of the projected and documented effects of climate cha nge effects on inland fishes. 50th Anniversary Symposium of the Fisheries Society of the British Isles. Exeter, UK. 3 -7 July 2017. (Contributed Oral)

Lyu, Z., H. Genet, Y. He, Q. Zhuang, A.D. McGuire, A. Bennett, A. Breen, J. Clein, E.S. Euskirchen, K. Johnson, T. Kurkowski, N. Pastick, T.S. Rup p, B. Wylie, Z. Zhu. 2017. The role of d riving factors in historical and projected carbon dynamics in wetland e cosystems of Alaska. Fall Meeting American Geophysical Union, New Orleans, LA. 11 -15 December 2017. (Cont ributed Poster)

Meyer, B., M. Wipfli, D. Rinella, E. Schoen, and J. Falke. 2017. Growth and foraging patterns of juvenile Chinook and Coho Salmon in three geomorphically distinct sub -basins of the Kenai River. Alaska Chapter American Fisheries Society Annu al Meeting, Fairbanks, AK. 19- 23 March 2017. (Contributed Oral)

Meyer, B., M. Wipfli, D. Rinella, E. Schoen, and J. Falke. Growth and foraging patterns of juvenile Chinook and Coho Salmon in three geomorphically distinct sub -basins of the Kenai River. 2017. Western Division American Fisheries Society Annual Meeting, Missoula, MT. 22 -25 May 2017. (Contributed Oral)

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Meyer, B., M. Wipfli, D. Rinella, E. Schoen, and J. Falke. 2017. Growth and foraging patterns of juvenile Chinook and Coho Salmon in three geomorphically distinct sub -basins of the Kenai River. Society for Freshwater Science Annual Conference, Raleigh, NC. 4 -8 June 2017. (Contributed Oral)

Neuneker, K., J. Falke, J. Nichols, and P. Richards. 2017. Mig ration patterns of adult C23nd Sa lmon in two Southeast Alaska transbn22o3ean fn72(e)2(r)4(.53(b)). Claska t te52(r)4(.53(C)-(l)7m(e)-4(

American Fisheries Society Annual Meeting, Fairbanks, AK. 19 -23 March 2017. (Contributed Oral)

Shafte l, R., S. Mauger, J. Falke, D. Rinella, J. Davis, and L. Jones. 2017. Characterization of thermal regimes in the Mat -Su Basin. MatSu Science Symposium, Palmer, AK. 8-9 November 2017. (Contributed Oral)

Timm, K., J. Reynolds, J.S. Littell, K. Murphy, E.S. E uskirchen, A.L. Breen, S.T. Gray, A.D.

Jiang, Q. Zhang, and Y. Luo. 2017. Terrestrial ecosystem model performance in simulating productivity and it vulnerability to climate change in the nor thern permafrost

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

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

Post - doctoral Researcher : Erik Schoen (IAB) R
Advisor: Mark Wipfli
Funding Agencies : ADFG and USFWS
In

Note: Chelsea Clawson graduated from the University of Alaska Fairbanks in August 2017 . Her thesis abstract follows:

Abstract: Groundwater upwellings provide stable temperatures for overwinter salmon embryo development and this process may be parti cularly important in cold, braided, gravel - bed Arctic rivers where rivers may freeze solid in the absence of upwellings. Aerial counts and remote sensing were used during 2013 -

occupancy in lentic habitats. On low - relief tundra, permafrost processes and climate are chiefly responsible for lake forma tion and s urface water dynamics, such as the timing, durat(..244 Td [(ch)-2(i)h)5(a)1 Td nd(a)1 Td vRs.lntis5(i)5(of)2(e)1(r)3( )5(dy)1(na)1(m)-5(i)imdyÑbitafec5(dy)5(i)5(f)5

periods of high flows, were slower for fish in the Taku River, and were slower in both systems in 2016 compared to 2015. Migration rates were faster for fish with spawning sites farther upstream when compared to those that spawn ed closer to the river mouth, but these rates decreased over time as fish swam farther upriver. Chinook Salmon (N = 129) sampled for energetic status at the beginning of their freshwater spawning migration had higher total percent lipid than those near the spawning grounds (ANOVA: F = 202.1, df = 3, P < 0.001), and total percent lipid and water were precisely predicted based on BIA measurements (R "! = 0.82, RMSE = 5.33; R "! = 0.78, RMSE = 2.43 respectively). The BIA model was tested to determine if it could b e generalized between similar species, but this was found to be less precise than species -specific models. The! BIA measurement technique was also easily implemented into an existing study on a remote Chinook Salmon population. Given threats from climate ch ange and mining activities, this information will be useful for fisheries researchers as a benchmark for understanding migration behaviors in these Chinook Salmon populations, and indicates that integration of BIA into population monitoring may be a useful tool for creating management practices targeted at facilitating successful migration behaviors and increasing or maintaining energetic status for these fish. !

Lake Trout (Salvelinus namaycush) Otoliths as Indicators of Past Climate Patterns and Growth i n Arctic Lakes

Student Investigator: Eric Torvinen, MS Fisheries
Advisor: Jeff Falke
Funding Agency: USGS Alaska Climate Science Center

Note: Eric Torvinen graduated from the University of Alaska Fairbanks in May 2017. His thesis abstract follows:

Abstract: The effects of climate change on freshwater ecosystems are amp lified in high -latitude regions; however, Alaska climate data are limited due to the remote location of the Arctic. Predictions have indicated that warming temperatures owing to climate ch ange could increase fish growth, but the magnitude and factors influencing these changes remain uncertain. Here I investigated the relationship between Lake Trout *Salvelinus namaycush* growth and physical and biological characteristics, fish community struc ture and climate patterns. I applied biochronology techniques to predict recent climate patterns from annual growth increments recorded on Lake Trout otoliths. Growth increments were also used to perform length -at -age back -calculations and to estimate the growth coefficient *K*, as described by a von Bertalanffy growth model. Lake Trout were captured from 13 climate -sensitive lakes in the Fish Creek watershed in Arctic Alaska during 2014 and 2015. Individual Lake Trout (*N* = 53) ranged from 471 Ð903 mm fork len gth (FL; mean = 589.3 mm) and their readable annuli, representative of age, ranged from 9 -55 annual growth increments. I constructed a growth chronology for the period 1977 Ð2014 and used model selection to identify the best predictive model of relative Lak e Trout growth (ring width
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biochronology techniques to estimate past climate patterns in remote regions, and provided valuable knowledge regardin g growth - environment relationships for Lake Trout. In turn, this information can be used to better understand the effects of a changing environment in sensitive Arctic lake ecosystems.

Ongoing Aquatic Studies

Marine - Derived Nutrient Effects on Chinook an d Coho Salmon Productivity

Student Investigator: Philip Joy, PhD Fisheries
Advisor: Mark Wipfli
Funding Agencies : Alaska Sustainable Salmon Fund; ADFG, Sport Fish Division; Norton Sound Economic Development Corporati on

Marine derived nutrients (MDN) impo rted to freshwater eco

populations using a genotyping-by-sequencing approach to generate multilocus genotype datasets. We will use NetMap to characterize and rank habitat suitability for Northern Pike within the MatSu Basin. Presence-absence data will be used to parameterize and evaluate the accuracy of the habitat suitability model. Additionally, we will quantify habitat connectivity throughout the MatSu Basin to predict areas were Northern Pike are likely to invade. Finally, our habitat suitability model and connectivity estimates will be compared to known distributions of juvenile salmonid rearing habitats. We expect to detect a significant degree of genetic differentiation between native and introduced populations. We will produce maps of salmon population vulnerability to Northern Pike invasion by species and provide these to ADFG. Objective 1: We characterized genetic diversity among three native and six invasive populations collected from lakes and streams in the MatSu Basin and the species native range in Alaska -k(7a)-2(e)3( )1(A)ror6-5(e)-5(p)-y3(i)4(n)-2(

environmental variables including temperature and food availability contribute to juvenile salmon growth rates will help inform us on how these fish may fare in a changing landscape . Objectives were

Completed Wildlife Studies

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

Post -doctoral Researcher : Cristina Hansen , Department of Veterinary Medicine
Principal Investigator : Karsten Hueffer , Department of Veterinary Medicine
Funding Agency: USGS (RWO 214)
In -Kind Support: Transportation, logistics, and field sampling provided by USGS

Microbial infections cause embryo mortality in birds and may represent a threat to populations. The bacteria that we have associated wit h embryo mortality in greater white -fronted geese are either novel or have not been associated with bird eggs previously. Route(s) of infection, infectious dose, geographic extent, and the characterization of bacterial species involved in embryo infection in greater white -fronted geese in Arctic and subarctic settings have not been characterized. The objectives of this research are to further assess bacterial infection of avian embryos in Alaska. This study expanded the geographic scope of monitoring by coo perating with field camps in Alaska and Canada. Additionally, we aimed to determine the source of infection by testing environmental samples and tissue samples from nesting white -fronted geese. We also aim to determine whether infection by the most common bacteria isolated (a *Neissera* species) is vertical or horizontal. 1(l) hiWit-y3(g)-2( )3(p)-2(e)

Compl eted Ecological Studies

Figure 1. Bog and fen wetlands cover large areas of low elevation Yukon River terraces near Circle, Alaska.

The poorly drained conditions of these features cause the development of peatlands, which store large amounts of carbon in thick surficial peat layers, but also produce substantial methane emissions. At the regional level, the climate warming effects of methane emissions from the newly formed wetlands could be greater than the climate cooling effects of increased soil carbon sequestration. These changes in hydrological regimes will also influence river discharge and lateral exports of dissolved carbon. Changes in wetland distribution will also impact habitat for plant and animal species, including important subsistence species such as waterfowl. The geomorphological changes associated with thermokarst disturbance will also likely have local impacts on infrastructure. This project is building upon a modeling framework to represent the key-processes that will help improve our understanding of the impacts of thermokarst disturbance on ecosystem structure and function in the Yukon Flats National Wildlife Refuge. We are improving an existing process-based ecosystem model to represent key landcover types and processes associated with themokarst disturbance. We are then using this improved model framework to predict thermokarst dynamics in the Yukon Flats National Wildlife Refuge (YFNWR), and quantify its impact on landcover and carbon dynamics from 2010 to 2100 by applying the coupled model. Finally, we will develop and apply an impact model to assess how thermokarst dynamics affect wildlife habitat. Thermokarst-related land cover change was simulated from 2000 to 2100 across the Yukon Flats. By 2100, the model predicts a mean decrease of 7.4% (sd 1.8%) in permafrost plateau forests associated with an increase in TK lakes and wetlands. The model projections will be used as a baseline by the resource managers of the YFNWR to integrate future ecosystem changes into an adaptive management strategy.

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

Faculty: Brad Griffith, EugŽnie Euskirchen, and A. David McGuire
Funding Agency: Alaska Climate Science Center, USGS (RWO 212)

In winter, caribou rely on low stature lichens for food while moose rely on deciduous shrubs that protrude above the snow. Fire favors deciduous shrubs at the expense of lichens, and caribou movement is impeded by shallower snow than moose. Rain-on-snow may restrict access to lichens but not shrubs. As a result, effects of climate change are expected to be different between the species. Moose and caribou are the most important terrestrial species to subsistence and sport hunting economies in Alaska. Our objective is to use output from the Integrated Ecosystem Model (IEM) to project the differential effects of climate change (e.g., vegetation dynamics, snow and rain, fire frequency/severity, and successional trajectories) on the quantity of food available to these two species throughout most of Alaska and parts of Canada, ~1970-2100. We will refine IEM output to be relevant to ungulate forages. IEM NPP output will be restricted by winter weather (snow depth and icing events) derived from a dynamically downscaled daily climate dataset. Regression models will be used to estimate spatial and temporal trends in habitat value. Preliminary dynamically downscaled winter weather projections and NPP outputs from the IEM model will be obtained in spring 2018; computational requirements will necessitate sampling the study domain rather than inventorying it. Maps and models of spatial and temporal trends in habitat value will be stratified by land ownership and explicitly tailored to stakeholder needs. Maps can be used to inform conservation plans and management actions.

Development of an Alaska-based Research Framework for Migratory Waterfowl

Faculty: Brad Griffith and Abby Powell
Funding Agency: Alaska Climate Science Center, USGS (RWO 218)

The direction and magnitude of climate effects on the seasonal ranges of migratory species are unlikely to be consistent. Thus, the cumulative effects across annual life cycles and decades will be difficult to predict without a coordinated and focused effort to integrate research across the entire annual range. A multi-regional framework is needed to efficiently integrate management-focused research among seasonal ranges and focus limited resources on the most critical season-specific links between climate change and waterfowl population trends. Our objective is to identify and prioritize the most critical cross-seasonal information needs regarding climate effects on the factors (e.g., habitat, species interactions, distribution and phenology, among others) most likely to affect waterfowl demography. We will use a literature review; a questionnaire survey of waterfowl researchers and managers representing state, federal, and non-governmental organizations; and a panel discussion at an international conference to identify and prioritize research needs. Results from a preliminary literature review have been used to develop a questionnaire survey which was administered during fall 2016 and spring 2017. This prioritization of management-focused research needs will be used to more efficiently and effectively allocate limited resources and will enable researchers and managers from widely separated ranges to communicate in common terms.

Effects of Large-

Model simulations indicate t he IEM region was a small sink for carbon during the historical time period and becomes a much stronger sink for carbon in the future. Future changes in permafrost indicate that, by the end of the 21st century, late Hol ocene permafrost in Alaska and northw est Canada will be actively thawing at all locations and that even some Late Pleistocene permafrost will begin to thaw. The projections produced by the IEM are

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