Alaska Cooperative Fish and Wildlife Research Unit

Annual Report—2005

July 2006

Contents

Linking Chinook Spawner Density to Habitat Limitations 22
Alternative Escapement Goals for Unuk River Chinook Salmon
(

Migration Strategies and Winter Movements of King Eiders in the Bering Sea 37
The Common Raven (*Corvus corax*) on Alaska's Coastal Plain and its Relationship to Oil and Gas Development 37
Development of a Bird Collision Risk Model 38
Wildlife Habitat Modeling in the Toklat Basin Study Area, Denali National Park and Preserve 39
Calving and Post-Calving Habitat Selection of the Teshekpuk Caribou Herd 39
Assessing Population Status and Habitat Use in a Southeast Alaskan Moose Population 40
Interrelationships between Brown Bears and Chum Salmon at McNeil River, Alaska 42
Completed Ecological Studies 44
Fate of Carbon in Alaskan Landscapes .... **Error! Bookmark not defined.**
Carbon Exchange and Permafrost Collapse: Implications for a Changing Climate 44
Forest Sector Outcomes with/without Climate Change and Carbon Sequestration Management (RWO 135, completed), Carbon Dynamics of the US Forest Sector with/without Climate Change and Carbon Sequestration Management (RWO 144, ongoing), and Impact of Climate Change on Vegetation and Water Supply (RWO 150, ongoing) 44
Quantifying the Relative Importance of Different Secondary Succession Processes in the Alaskan Boreal Forest 45
Ongoing Ecological Studies 46
Ecosystem Management and Regional Dynamics in Response to Global Change: Three Case Studies from the Tongass National Forest and Southeastern Alaska 46
Snow Cover and Biology in the Arctic 46
Modeling the Contribution of Belowground Carbon Allocation and Productivity to Net Carbon Storage in the Upper Great Lakes Region 47
Fire-mediated Changes in the Arctic System: Interactions of Changing Climate and Human Activities 48
Synthesis of Arctic System Carbon Cycle Research Through Model-Data Fusion Studies Using Atmospheric Inversion and Process-Based Approaches 49
Carbon Responses along Moisture Gradients in Alaskan Ls L

Unit Roster

Federal Scientists

- Brad Griffith: Assistant Leader-Wildlife
- F. Joseph Margraf: Leader
- A. David McGuire: Assistant Leader-Ecology
- Abby Powell: Assistant Leader-Wildlife
- Mark Wipfli: Assistant Leader-Fisheries

University Staff

- Michelle Das: Travel Coordinator
- Karen Enochs: Fiscal Technician
- Kathy Pearse: Administrative Assistant

Unit Students

Current

- Stacia Backensto, PhD Biology (Powell)
- Michael Balshi, PhD Biology (McGuire)
- Colin Beier, PhD Biology (McGuire)
- Elizabeth (Baney) Benolkin, MS Fisheries (Margraf)
- Meagan Boltwood, PhD Biology (Wipfli)
- Jeremy Carlson, MS Fisheries (Margraf)

- Brad Wendling, MS Wildlife (Griffith)
- Heather Wilson, PhD Biology (Powell)

Graduated (during CY)

- Rachel Jones, MS Wildlife (Griffith)
- Julie Morse, MS Wildlife (Powell)

- Kate Martin, MS Wildlife (Lindberg)
- Brandt Meixell, MS Biology (Lindberg)
- Susan Oehlers, MS Wildlife (Bowyer/Huettmann)
- Morgan Peterson, MS Biological Oceanography (Finney)
- Joy Ritter, MS Wildlife (Rexstad/Huettmann)

Graduated (during CY)

- Bryce Lake, MS Wildlife (Lindberg)
- David Safine, MS Wildlife (Lindberg)

Cooperators

- Brian Barnes–Director, Institute of Arctic Biology, University of Alaska Fairbanks
- Robert Davison–Northwest Representative, Wildlife Management Institute
- McKie Campbell–Commissioner, Alaska Department of Fish and Game
- Rowan Gould–Director, Region 7, US Fish and Wildlife Service
- Michael Tome-Unit Supervisor, Cooperative Research Units, US Geological Survey

Introduction

This is the Annual Report for the Alaska Cooperative Fish and Wildlife Research Unit, highlighting activities for calendar year 2005. 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

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

- Dave Gregovich, MS (Margraf)
- Ron Heintz, PhD (Wipfli)
- Dawn Magness, PhD (McGuire)
- Kate Martin, MS (Powell)
- Bruce Medhurst, MS (Margraf)
- Kevin Petrone, PhD (McGuire)
- Miranda Plumb, MS (Wipfli)
- Brian Riordan, MS (McGuire)
- Shann Jones, MS (Wipfli)
- David Shaw, MS (Powell)
- Garrett Staines, MS (Margraf)
- Mark Stichert, MS (Wipfli)
- Tumi Traustason, PhD (McGuire)
- Jason Vogel, PhD (McGuire)
- Johann Walker, MS (Powell)
- James Walton, MS (McGuire)
- Sherri Wall, PhD (McGuire)
- Heidi Weigner, PhD (Margraf)
- Lijie Zhu -PhD (McGuire)

Courses Taught

- Research Design (GriffitG

- Member, Technical Advisory Team for Fisheries for U.S. Fish and Wildlife Service, Region 7, Refuges Technical Advisory Team (Margraf)
- Member, Science Steering Committee for the Arctic Community-wide Hydrological Analysis and Monitoring Program (Arctic-CHAMP), a program supported through the Arctic System Science (ARCSS) Activity of the National Science Foundation (McGuire)
- Member, Science Steering Committee for the Study of Environmental Arctic Change (SEARCH), a research activity supported through several federal agencies (McGuire)
- Member, Science Steering Committee for the Community Arctic Modeling Project (CAMP), a project operated through the International Arctic Research Center (IARC), as part of a cooperative agreement between the University of Alaska Fairbanks and the

terrestrial carbon sequestration. Annual Meeting, Ecological Society of America, Montreal, Canada.

Knoche, M., A. N. Powell, P. Barboza, M. Wooller, and L. Quakenbush. January 2005. New insights into the molt migration of female King Eiders from stable carbon and nitrogen isotope analyses. Annual Meeting, Pacific Seabird Group/Waterbird Society Meeting, Portland, OR.

Lake, B., M. Lindberg, J. Schmutz, C. Ely, M. Anthony, W. Eldridge, and F. Broerman. January 2005. Spatial and temporal variation in body mass of prefledging emperor geese in relation to habitat use, grazing lawn availability. NorthAmerican Arctic Goose Conference, Reno, NV.

Lindberg, M. S. March 2005. Modeling nest survival. Annual Meeting, Ecological Society of America, Montreal, Canada.

McGuire, A. D. and the IGBP High Latitude Transect Working Group. April 2005. Responses of high laitude ecosystems to global change: Potential

Phillips, L. M. and A. N. Powell. October 2005. Use of the Beaufort Sea by king eiders. Twenty-ninth Waterbird Society Meeting, Jeckyll Island, GA.

Phillips, L. and A. N. Powell. January 2005. Large-scale movements and habitat use of King Eiders throughout the nonbreeding season. Annual Meeting, Pacific Seabird Group/Waterbird Society Meeting, Portland, OR.

Phillips, L., A. Powell, E. Taylor. March 2005. Use of the Beaufort Sea by King Eiders. Tenth Annual MMS Information Transfer Meeting, Anchorage, AK.

Phillips, L. M., A. N. Powell, and E. Taylor. November 2005. Use of the Beaufort Sea by king eiders. Second North American Sea Duck Conference, Annapolis, MD.

Phillips, L.M., A. N. Powell, and R. JB11(d)7751.9(t)1.28171(i)M1e(l)0.9NR.6A JB11m(f)34(b2(u)8)4

Safine, D. E. and M. S. Lindberg. November 2005. Breeding ecology of white-winged scoters on the Yukon Flats National Wildlife Refuge, Alaska. Second North American Sea Duck Conference, Annapolis, MD.

Smikrud, K. M. and F .J. Margraf. September 2005. A remote sensing approach to detect potential salmon rearing habitat in the Unuk River, Southeast Alaska. Annual Meeting, American Fisheries Society. Anchorage, AK.

Scientific Publications

Apps, M. A. and A. D. McGuire. 2005. Climate-Disturbance Interactions in Boreal Forest Ecosystems. Peer-reviewed papers selected from the International Boreal Forest Research Association Conference, Fairbanks, AK, May 3-6, 2004. Canadian Journal of Forest Research 35:2073-2293.

Beringer, J., F. S. Chapin, C. C. Thompson, and A. D. McGuire. 2005. Surface energy exchanges along a tundra-forest transition and feedbacks to climate. Agricultural and Forest Meteorology 131(3-4):143-161.

Calef, M. P., A. D. McGuire, H. E. Epstein, T. S. Rupp, and H. H. Shugart. 2005. Analysis of vegetation distribution in interior Alaska and sensitivity to climate change using a logistic regression approach. Journal of Biogeography 32:863-878.

Cameron, R. D., W. T. Smith, R. G. White, and B. Griffith. 2005. Central Arctic caribou and petroleum development: Distributional, nutritional and

Zhuang, Q., V. E. Romanovsky, and A. D. McGuire. 2001. Incorporation of a permafrost model into a large-scale ecosystem model: Evaluation of temporal and spatial scaling issues in simulating soil thermal dynamics. Journal of Geophysical Research--Atmospheres 106:33,649-33, 670.

Technical Publications of Federal Staff

Powell, A. N., L. M. Phillips, E. A. Rexstad, and E. J. Taylor. 2005. Importance of the Beaufort Sea to king eiders (*Somateria spectabilis*). Final Report, Coastal Marine Institute, University of Alaska Fairbanks.

Powell, A. N., R. Suydam, and R. L. McGuire. 2005. Breeding biology of king eiders on the coastal plain of northern Alaska. Final Report MMS #2005-060, Coastal Marine Institute, University of Alaska Fairbanks.

Theses and Dissertations of Unit Graduate Students

Jones, Rachel R. 2005. Daily heterogeneity in habitat selection by the

Research Reports

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

Completed Aquatic Studies

Environmental and Evolutionary Differences in Population Dynamics and Life History Traits of Western and Interior Arctic Grayling

Student Investigator: Jenny Neyme, MS Fisheries
Advisor: F. Joseph Margraf and Nicholas Hughes
Funding Agency: Sport Fish Division/ADFG, Region III
In-Kind Support: Vehicle, technical assistance and equipment provided by ADFG during field season

Note:

Ongoing Aquatic Studies

Ecological Factors Influencing Fish Distribution in a Large Subarctic Lake System

Student Investigator: Miranda Plumb, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: USFWS (RWO 111)

The coastal climate in southwest Alaska creates an atypical thermal environment (non-stratified in summer) in the remote Ugashik Lakes. The objective of this study was to determine how lake trout *Salvelinus namaycush,* Arctic char *S. alpinus,* Dolly Varden *S. malma,* Arctic grayling *Thymallus arcticus,* round whitefish *Prosopium cylindraeceum,* and pygmy whitefish *P. coulterii* were distributed according to depth, substrate particle size, food habits, length, and age given the absence of strong thermal structure. Sample sites were randomly chosen within sampling strata, and a gill net was set at each site. Lake trout and round whitefish were most abundant in my collections and had the oldest individuals. In more typically thermally stratified lake systems, lake trout and Arctic char usually move to colder, deeper water in the summer. However, in the Ugashik Lakes both species were abundant in shallow water all summer. Prior to this study pygmy whitefish were undocumented in this system. The Ugashik Lakes salmonids were opportunistic feeders, consuming abundant organisms such as isopods and amphipods. Fish in the Ugashik Lakes were found in locations different from what one would expect from predominant literature; fisheries managers may need to take this into account in their fisheries management.

A Spawning Habitat-Based Escapement Goal for Chum Salmon in the Tuluksak River, Southwestern Alaska

Student Investigator: John O'Brien, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: USFWS (RWO 112)

Due to diminishing returns of salmon and years of poor commercial and subsistence fishing in western Alaska, fishery management strategies are being reevaluated and new techniques are being sought. Management tools that recognize intricate life histories and incorporate environmental conditions at each particular life stage are needed. Toward that goal a study of spawning habitat for chum salmon *Oncorhynchus keta* was conducted from June 2002 to January 2005 on the Tuluksak River in western Alaska. Large-scale river features related to channel morphology were identified by aerial photographs, satellite images (LANDSAT-7), and synthetic aperture radar

moderate current velocity and stream strata that had a sinuosity greater than 1.5 but less than 2.5. Principal components analysis (PCA) suggested a

Assessment of Fish Condition in Two Arctic Lagoons using Bioelectrical Impedance Analysis, Kaktovik, Alaska

Student Investigator: Jeremy Carlson, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: USFWS (RWO 137)
In-Kind Support: Vehicle, bunkhouse and technical assistance provided by Arctic National Wildlife Refuge/USFWS

Arctic nearshore habitats are important for many fish species to feed and grow. Warming trends in the Arctic and the threat of development could directly impact fish populations. Healthy fish populations are important to subsistence users and the arctic ecosystem in general. The object of this study is to develop a model that relates fish condition as a measure of lipid content to bioelectrical impedance analysis measurements. The model will be developed to include both immature and mature Arctic cisco, Arctic cod, Arctic flounder and Dolly Varden. Fish were captured in five fyke nets set in Jago and Kaktovik lagoons. Bioelectrical impedance analysis measurements were taken on sampled fish. These fish were then euthanized, homogenized and will be sent to the laboratory for proximate composition analysis. Proximate analysis results will be used to calibrate the model. It is expected that bioelectrical impedance analysis will provide researchers with a quick, minimally invasive technique to evaluate fish condition in the field. The prospect of oil development and the increase in arctic temperatures may cause problems for fish species that use the nearshore waters for feeding and growth. Reduction in the ability of fish to forage efficiently may directly affect subsistence users and the many arctic species that utilize them.

Geomorphology and Selection of Spawning Habitat by Inconnu: A Heuristic Model

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Linking Chinook Spawner Density to Habitat Limitations

Student Investigator: Sam Decker, MS Fisheries
Advisor: F. Joseph Margraf
Funding Agency: ADFG (RSA Base Supplement)

Habitat models for determining carrying capacity are gaining interest in fisheries. Currently, research is focused on statistical models with mixed results. This study focuses on determining what processes limit the upstream range of Chinook salmon spawning habitat in the Chena River. River conditions that are required for egg survival will be measured: available oxygen, resistance to freezing, and accumulated thermal units for development. We will track use of the habitat through the arrival timing of the run. We predict that habitat suitable to chinook salmon spawning is spatially limited and will shift temporally by conditions that promote egg survival. Understanding the processes that limit the suitable spawning habitat will provide a firm foundation for future development of habitat models and predictions of change in spawning habitat range with changing climate regimes.

Alternative Escapement Goals for Unuk River Chinook Salmon (*Oncorhynchus tshawytscha*)

Student Investigator: Christie Hendrich, MS Fisheries
Co-Advisors: Gordon Kruse and F. Joseph Margraf
Funding Agency: Sport Fish Division/ADFG, Region I
In-Kind Support: Field accommodations, logistical assistance, and riverboat provided by ADFG

In Alaska, management of chinook salmon is based on harvest or escapement goals designed to ensure spawning abundance that produces maximum sustainable yield. These goals have historically been determined using spawner-recruit relationships. Intensive stock-assessment and many years of data are required to construct a robust model through this approach. Establishing a measurable relationship between a river system's spawner carrying capacity and fish production could provide an alternative means for setting management goals, while adding insight into the stock's population dynamics. The intent of this study is to explore habitat-based approaches to setting escapement goals for chinook salmon on the Unuk River in Southeast Alaska. The Unuk River provides a good study site in that it has been the location of a full stock-assessment program by the Alaska Department of Fish and Game for chinook salmon since 1997. Additionally, the department has been doing habitat assessment on the Unuk's spawning tributaries since 2001. This and other available habitat information are being investigated for potential use in a habitat-based model. Three years of spatially documented spawner densities have been recorded for this study. The task of structuring these data into analyses is ongoing. By spring 2006, new stock-assessment analyses should be complete and a traditional biological escapement goal

Spatial Subsidies from Headwater Streams to Fish-Bearing Habitats across Climatic and Disturbance Gradients in the North Cascade Mountains

track MDN and measure effects in stream and riparian environments at the watershed scale. Our approach was to link stream chemistry, stable isotope, and fatty acid measures along a longitudinal gradient from headwaters to mouth in nine streams (six with salmon and three without) in three regions of the Kenai Peninsula. Large fluxes of dissolved nutrients (nitrogen and phosphorus) coincided with salmon spawning and increased in a downstream direction. In salmon streams, macroinvertebrates and riparian plants generally (but not always) showed isotopic enrichment that increased in a downstream direction, but isotope ratios were highly variable and did not appear to be a reliable predictor of MDN inputs. Dolly Varden fatty acid signatures and lipid levels suggest that increased energy storage is associated with MDN consumption and that larger Dolly Varden disproportionately capitalized on MDN subsidies. Our data suggest that stream-resident fishes are the most reliable integrators and indicators of MDN at watershed scales. Forthcoming effort will focus on relationships between spawning salmon abundance and stream-resident fish growth and fitness as a tool for guiding ecologically-based salmon escapement goals.

Completed Wildlife Studies

Breeding Ecology of White-Winged Scoters on the Yukon Flats, Alaska

Student Investigator: David Safine, MS Wildlife Biology
Advisor: Mark Lindberg
Funding Agencies: Yukon Flats National Wildlife Refuge/USFWS (RWO

Alaskan-breeding King Eiders (*Somateria spectabilis*) disperse from nesting areas on the Arctic Coastal Plain and move through the Beaufort Sea to wing molt and winter locations in remote areas of the Bering Sea. Knowledge of King Eider distribution outside the breeding period is critical to provide regulatory agencies with opportunities to minimize potential negative impacts of resource development. To characterize the nonbreeding distribution of King Eiders, we collected location data of 60 individuals over two years from satellite telemetry. During post-breeding migration, male King Eiders had much broader use areas in the Alaskan Beaufort Sea than females.

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Population and Habitat Analyses for Dall's Sheep (*Ovis dalli*) in Wrangell-St. Elias National Park and Preserve

Student Investigator: Miranda Terwilliger, MS Wildlife
Advisor: Brad Griffith
Funding Agencies: U.S. National Park Foundation, Safari Club International, and Ted McHenry Scholarship
In-Kind Support: Wrangell-St. Elias National Park and Preserve/NPS

Note: Miranda Terwilliger graduated from the University of Alaska Fairbanks in August 2005. The abstract of her thesf Fa nroilv

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production in the boreal forest and provide estimates of breeding parameters for comparison with other regions. We will estimate hen survival, breeding

Pre-migratory shorebirds depend on resources found in coastal areas on the North Slope of Alaska to acquire fuel for southward migration, yet little information exists on how shorebirds use these areas or what sites are most important in preparing birds for migration. Such information is critical for evaluating potential impacts of energy development along Alaska's North Slope. One relevant testable question is how shorebirds make decisions regarding site choice and timing of use while staging on the North Slope. We

to have information on the reproductive parameters of King Eiders in both an undisturbed and a disturbed area.

Migration Strategies and Winter Movements of King Eiders in the Bering Sea

Student Investigator: Steffen Oppel, PhD Biology
Advisor: Abby Powell
Funding Agencies: MMS and NSB

Little is known about the timing and distance of migratory and non-migratory

Wildlife Habitat Modeling in the Toklat Basin Study Area, Denali National Park and Preserve

Student Investigator: Joy Ritter, MS Biology
Advisor: Eric Rexstad and Falk Huettmann
Funding Agency: Denali National Park/NPS (RWO 129)

Increasing visitor numbers in our national parks place a burden on existing facilities and thoroughfares. Park managers must decide if and where expansion can take place without damaging or destroying that which our park system was designed to preserve. A better understanding of landscape characteristics associated with the resources that organisms select can help managers make such decisions. The time and effort required to obtain data at a park-scale often make this type of study cost-prohibitive. However, the potential exists for the development of resource selection models using opportunistic data, or data that were collected for another use. The objective of this study is to explore the use of opportunistic data to model the habitat selection of four species common to Denali National Park: caribou, moose, grizzly bear, and wolf. Multiple years of radiolocation data for these species representing used habitat were obtained from park biologists. A geographic information system was used to obtain landscape characteristics associated

post-development distribution and habitat use studies, as well as for the development of any disturbance mitigation measures. The purpose of this study is to estimate the geographic areas, habitat features, and diet components that are selected by female caribou during the summer period. We radio-tracked marked female caribou every two weeks from mid-June until the rut in 2002–04. We estimated diet composition through microhistological analysis of fecal pellets. We analyzed habitat selection using logistic regression at two spatial scales, comparing used and available or unused habitat features such as air temperature, terrain ruggedness, remotely sensed vegetation class, and remotely sensed green-up patterns

Interrelationships between Brown Bears and Chum Salmon at McNeil River, Alaska

Student Investigator: Joshua Peirce, MS Wildlife
Co-Advisors: Mark Wipfli and Erich Follmann
Funding Agency: ADFG, GKW Foundation, NPS, the Wildlife Society
In-Kind Support:

per sheep within sequential periods was used as a covariate in all analyses. Sheep movement rates, home range size, habitat use and selection differed among study area, years within study areas and sequential time period within years within study area, but did not vary in relation to military overflight intfliga2fosasT0h51(d s)0.4(e0 -1)0zu mcrve51intfccfi

Completed Ecological Studies

Carbon Exchange and Permafrost Collapse: Implications for a Changing Climate

Student Investigator: Isla Myers-Smith, MS Biology
Advisors: A. David McGuire and F. Stuart Chapin
Funding Agency: Geologic Division/USGS (RWO 97)

Note: Isla Myers-Smith graduated from the University of Alaska Fairbanks in

and management in the forest sector relative to climatic change. The second study adds another objective to the first study: to compare the results of US forest sector carbon dynamics simulated by two different models, one of which is the model implemented in Dr. McGuire's lab (the Terrestrial Ecosystem Model) and the other of which is a model implemented by the USDA Forest Service (FORCARB). The third study will analyze the estimates of leaf area index and water yield simulated by the model implemented in Dr. McGuire's lab. These studies are part of two USDA Forest RPA Special Studies that have been granted to Dr. Linda Joyce of the USDA Forest Service Rocky Mountain Forest and Range Experiment Station. In collaboration with Dr. Joyce, Dr. McGuire's lab has completed research on the first study, and the results have been incorporated into a Forest Service General Technical Report devoted to the RPA Special Studies. The simulations for the second and third studies are currently being designed and will be run in Dr. McGuire's lab this summer. The comparison of the carbon dynamics results of TEM with a Forest Service Model, FORCARB, will provide a measure of uncertainty relevant to policy decisions on carbon sequestration management. The analysis of water yield simulated by TEM will provide information relevant to policy discussions on water management in the face of climate change. This research will contribute to developing a more comprehensive approach to risk assessment and management in the forest sector relative to climatic change.

Quantifying the Relative Importance of Different Secondary Succession Processes in the Alaskan Boreal Forest

Student Investigator: Thomas A. Kurkowski, MS Natural Resource Management
Advisors: Scott Rupp and Daniel Mann
Funding Agency: Joint Fire Science Program/BLM (RWO 116)
In-Kind Support: Logistical support including helicopter and fixed-wing transportation from BLM and USFWS

Secondary succession after fires is arguably the most important ecological process occurring in the boreal forest. Post-fire forest succession in Interior Alaska occurs in two different ways, but their relative importance is unclear. Self-replacement (SR) occurs when pre-fire dominant tree species immediately replace themselves after fire as the canopy dominants. Species-dominance relay (SDR) involves the simultaneous establishment of deciduous and coniferous tree species after fire, followed by shifts in the dominant overstory species over time. The goal of this study is to quantify the relative importance of SR and SDR on a representative, hilly landscape near Fairbanks, Alaska. SR implies a relatively unchanging vegetation distribution that is equilibrated with environmental parameters, while SDR predicts stand composition is a function of time-since-last-fire. We tested these hypotheses by building a statistical model that relates stand type to environmental variables including solar insolation during the growing season, site altitude, and size of the hydrological catchment uphill. In addition, we tested the

season and the associated rates of terrestrial productivity. Changes in productivity will influence the ability of these ecosystems to sequester atmospheric CO_2. We use the Terrestrial Ecosystem Model (TEM), which simulates the soil thermal regime, in addition to terrestrial carbon, nitrogen and water dynamics, to explore these issues over the years 1960-2100 in extratropical regions (30˚-90˚N). Our model simulations show decreases in snow cover and permafrost stability from 1960 to 2100. Decreases in snow cover agree well with NOAA satellite observations collected between the years 1972-2000, with Pearson rank correlation coefficients between 0.58-0.65. Model analyses also indicate a trend towards an earlier thaw date of frozen soils and the onset of the growing season in the spring by approximately 2-4 days from 1988-2000. Between 1988 and 2000, satellite records yield a slightly stronger trend in thaw and the onset of the growing season, averaging between 5-8 days earlier. In both the TEM simulations and satellite records, trends in day of freeze in the autumn are weaker, such that overall increases in growing season length are due primarily to earlier thaw. Although regions with the longest snow cover duration displayed the greatest increase in growing season length, these regions maintained smaller increases in productivity and heterotrophic respiration than those regions with shorter duration of snow cover and less of an increase in growing season length. Concurrent with increases in growing season length, we found a reduction in soil carbon and increases in vegetation carbon, with greatest losses of soil carbon occurring in those areas with more vegetation, but simulations also suggest that this trend could reverse in the future. Our results reveal noteworthy changes in snow, permafrost, growing season length, productivity, and net carbon uptake, indicating that prediction of terrestrial carbon dynamics from one decade to the next will require that large-scale models adequately take into account the corresponding changes in soil thermal regimes.

Modeling the Contribution of Belowground Carbon Allocation and Productivity to Net Carbon Storage in the Upper Great Lakes Region

Postdoctoral Researcher: Eugénie Euskirchen
Faculty: A. David McGuire
Funding Agency: USDA Forest Service

It is important to quantify carbon (C) pools and fluxes across different vegetation types and successional stages in order to gain a better understanding of the processes that control the uptake, storage, and release of CO_2 in forest ecosystems. However, one ambiguity in our understanding of the forest carbon cycle in managed landscapes is the partitioning of C between roots and stems and belowground productivity over successional stages and across forest types. Recent empirical studies of commercial and

valuable insights to the current debate on effectiveness of fire suppression in the boreal forest.

Synthesis of Arctic System Carbon Cycle Research Through Model-Data Fusion Studies Using Atmospheric Inversion and Process-Based Approaches

Postdoctoral Researcher: Daniel Hayes
Faculty: A. David McGuire
Funding Agency: NSF

A large release of carbon dioxide and methane from high latitude terrestrial and marine systems to the atmosphere has the potential to affect the climate system in a way that may accelerate global warming. To improve our ability to predict the dynamics of carbon in high latitudes, this project will comprehensively analyze the carbon cycle of the arctic system, guided by the following two general questions: (1) What are the geographic patterns of

^{1} (12.67 g C m^{-2} yr^{-1}). Our analysis suggests that CO_2, climate, and fire each play important roles in carbon dynamics across the pan-boreal region. It also shows that it is important to incorporate fire in a temporally and spatially explicit manner when estimating the effects of fire on carbon dynamics for the boreal forest region. Our next step in this study is to develop a fire model that can be coupled to TEM to evaluate carbon dynamics across the boreal forest for future scenarios of climate change. We expect to extend the model framework to the conterminous U.S. and to the tropics. Successful development and coupling of a prognostic fire model to global biogeochemical models will allow climate assessments to consider the response of wildfire to projected climate change and to evaluate how that response will influence global terrestrial carbon storage.

Magnitude, Rate, and Heterogeneity of Lake Drying in Wetlands on National Wildlife Refuges in Alaska

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

The full extent, magnitude, and heterogeneity of climate-induced lake drying in Alaskan National Wildlife Refuges is not known. Wetlands are the dominant land-cover type on Alaskan refuges and provide critical habitat for waterfowl and moose which are important subsistence resources. Understanding the magnitude and mechanisms behind changes in surface water area will be essential to predicting the potential effects on the abundance and distribution of these species. The objectives of this study are to (1) fully characterize the magnitude and rate of lake drying in Alaskan Refuge wetlands, (2) identify potential mechanisms behind lake drying, and (3) estimate the effects of lake drying to waterfowl and moose populations. The above objectives will be addressed by (1) comparison of remotely sensed imagery from 1950s to

USDA U.S. Department of Agriculture

USFWS U.S. Fish and Wildlife Service

USGS U.S. Geological Survey
BRD Biological Resources Discipline