Department of the Interior

U.S. Geological Survey

Annual Report Fiscal Year 2013

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Introduction

The Northwest Climate Science Center (NW CSC) was established in 2010 as one of eight regional Climate Science Centers created by the Department of the Interior (DOI). The NW CSC encompasses Washington, Oregon, Idaho, and western Montana and has overlapping boundaries with three Landscape Conservation Cooperatives (LCCs): the Great Northern, the Great Basin, and the North Pacific. With guidance from its Executive Stakeholder Advisory Committee (ESAC), the NW CSC and its partner LCCs are addressing the highest priority regional climate science needs of Northwest natural and cultural resource managers.

Climate Science Centers tap into the scientific expertise of both the U.S. Geological Survey (USGS) and academic institutions. The NW CSC is supported by an academic consortium[1] with the capacity to generate climate science and tools in a coordinated fashion, serving stakeholders across the Northwest region. This consortium is primarily represented by Oregon State University (OSU), the University of Idaho (UI), and the University of Washington (UW). The academic consortium and USGS provide capabilities in climate science, ecology, impacts and vulnerability assessment, modeling, adaptation planning, and advanced information technology, all necessary to address and respond to climate change in the Northwest. University members also recruit and train graduate students and early-career scientists.

This Annual Report summarizes progress for the goals set out in the NW CSC Strategic Plan for 2012-2015 (http://www.doi.gov/csc/northwest/upload/Northwest-CSC-Strategic-Plan.cfm) and the NW CSC Workplan for Fiscal Year (FY) 2013 (October 1, 2012 through September 30, 2013). The report follows the structure of the Strategic Plan, which describes the five core services (Executive, Science, Data, Communications, and Education and Training) provided by the NW CSC in support of the stated vision:

[1] Institutions that participate in the NW CSC academic consortium include: Boise State University, Idaho National Laboratory, Idaho State University, Montana State University, Oregon Health and Science University, Oregon State University, Pacific Northwest National Laboratory, Portland State University, University of Idaho, University of Montana, University of Oregon, University of Washington, Washington State University, and Western Regional Climate Center.

Our Vision

To become nationally recognized as a best-practice model for the provision of climate science and decision support tools to address conservation and management issues in the Pacific Northwest Region

Major NW CSC Accomplishments in Fiscal Year 2013

1. Executive Services

The objective of Executive Services is to provide leadership, guidance, and support for climate-related activities through coordination and engagement with relevant stakeholders. Establishing a significant and effective leadership presence in the Northwest is essential to developing a comprehensive climate science portfolio and coordinated response to climate-related resource management challenges.

1.1. Shared Leadership Responsibility

The NW CSC works closely with many regional partners to seek guidance, coordinate efforts, and plan for an effective distribution of functions and responsibilities. Two primary groups participate in the shared leadership of the NW CSC: the Executive Stakeholder Advisory Committee (ESAC) and the Leadership Team (LT).

The ESAC ensures broad participation by regional stakeholders and provides guidance for the NW CSC by identifying and prioritizing needs for research, monitoring, data management, and additional skills and capacities in the Northwest. It is composed of 23 executives from federal and state agencies, tribal organizations, and LCCs (Appendix 1). The ESAC convened in Portland, Oregon, on September 17-18, 2013, and has interacted through quarterly conference calls and group emails throughout FY 2013.

The LT was established to allow for open and frequent communication between the USGS and the primary academic consortium partners. Members of the LT are the NW CSC Director, the USGS Regional Director for the Northwest, and the University Direc-

tor and Consortium Leads from the primary academic consortium partners (Appendix 2). The LT addresses operational issues arising from the implementation of the NW CSC through quasi-monthly conference calls and face-to-face meetings.

1.2. Staffing

In December 2012, Dr. Nate Mantua stepped aside from his role as NW CSC Consortium Lead from the University of Washington and began a position with the NOAA Fisheries Service. Nate was replaced by Dr. Eric Salathé, Assistant Professor in the School of Science Technology Engineering and Mathematics at the University of Washington, Bothell. Eric conducts research on regional climate change and climate impacts in collaboration with the UW Climate Impacts Group (CIG) with a primary focus on the Pacific Northwest.

After serving the NW CSC in a temporary detail position in FY12, Dr. Nicole DeCrappeo was hired as the permanent Research Coordinator for the NW CSC in FY13. Nicole manages the NW CSC science portfolio and helps coordinate the regional climate science effort by inventorying current research projects in the region, communicating with regional LCC partners, and working with NW CSC-funded scientists to ensure that research products are tailored to the needs of resource managers and other stakeholders.

In March 2013, Tribal Liaison and Communications Coordinator Marijke van Heeswijk completed her part-time detail with the NW CSC. Marijke helped develop the NW CSC Tribal Engagement Strategy for 2012-2015 (section 1.3) and the NW CSC Communication Strategy (section 4.1), created an official USGS brochure about the work of the NW CSC (http://www.doi.gov/csc/northwest/upload/NW-CSC-FEB2013-brochure.pdf), and helped accomplish work associated with the FY 2014 Request for Proposals (section 2.3).

1.3. Engaging Northwest Tribes

The geographic area covered by the NW CSC is home to 52 federally recognized tribes. Northwest tribal communities are especially vulnerable to climate change because they are place-based and depend on natural resources to sustain their economies and traditional way of life. Blending of traditional ecological knowledge (TEK) and western science brings a unique opportunity for understanding linked social, cultural, and natural resource impacts from climate change.

The NW CSC puts a high priority on engaging Northwest tribes and, as a result, developed and adopted the NW CSC Tribal Engagement Strategy for 2012-2015. This Strategy describes the many opportunities for collaboration between the NW CSC and the tribes within its geographic area and relates these opportunities to the NW CSC's five core services. The Strategy can be downloaded here: (http://www.doi.gov/csc/northwest/news/northwest-csc-adopts-tribal-engagement-strategy-for-2012-2015.cfm)

In addition to adopting the Tribal Engagement Strategy, the NW CSC and Northwest tribes worked together in substantive and meaningful ways in FY 2013. There was strong tribal participation in ESAC conference calls and the annual in-person ESAC meeting, and members of the NW CSC participated in regular conference calls with the Pacific Northwest Tribal Climate Change Network. The NW CSC awarded funding to researchers at Oregon State University to (1) study the effects of climate change on plants of key cultural significance to tribes on the Olympic Peninsula and (2) understand Native American cultural responses associated with climate change (Appendix 3). In addition, the NW CSC, Alaska CSC, and North Pacific LCC jointly funded four research projects focused on assessing the vulnerabilities of important tribal resources to climate change (Appendix 3, http://www.doi.gov/csc/northwest/news/nw-csc-announces-fy-13-tribal-project-portfolio.cfm). The NW CSC also created opportunities for tribal students and instructors to participate in the Third Annual NW CSC Climate Boot Camp (section 5.1).

1.4. National Leadership

USGS center directors, university PIs, and staff from the eight regional CSCs and their parent organization, the National Climate Change and Wildlife Science Center (NCCWSC), stay connected via in-person meetings, conference calls, and frequent email exchanges throughout the year. University PIs from the NW CSC provide enthusiastic leadership to this established network. Four of five cross-CSC Working Groups are led or co-led by NW CSC PIs. Dr. Philip Mote, NW CSC University Director from Oregon State University, leads two working groups: Climate Scenarios, which focuses on technical aspects of cli-

mate data development and application, and the Council of Lead PIs, a group which includes the eight lead PIs from all CSCs and serves to coordinate the university-based activities and leadership across CSCs. Dr. Steven Daley-Laursen, University of Idaho Consortium Lead for the NW CSC, co-chairs the Data Management working group, which establishes data storage, data quality, and metadata standards for the CSC network. He also chairs the Congressional Relations working group; this group visited congressional offices in Washington, DC, in May 2013, to discuss the work and future of the CSC network.

2. Science Services

The objective of Science Services is to develop and implement a comprehensive Science Agenda to address current and emerging climate priorities in the Pacific Northwest. Science Services include the design of a long-term (4-year) Science Agenda and ensuing Annual Workplans that provide guidance for the progressive implementation of the broad Science Agenda. Both products rely heavily on the input by stakeholders regarding Northwest climate science needs. Ultimately, this statement of regional climate science needs is combined with similarly identified needs of CSCs throughout the United States to articulate a national program for climate science.

2.1. Science Agenda

In FY 2013, the NW CSC continued implementing the Northwest Climate Science Agenda that was established by the ESAC in 2011 (http://www.doi.gov/csc/northwest/Climate-Science-Agenda.cfm). This broad agenda is composed of seven themes, each with several sub-themes, that outline the science needed to support sound resource management decisions in the Northwest in the face of climate change. The seven themes are:

1. Climate science and modeling
2. Response of physical systems to climate change
3. Response of biological systems to climate change
4. Vulnerability and adaptation
5. Monitoring and observation systems
6. Data infrastructure, analysis, and modeling
7. Communication of science findings

2.2. Funded Science

To date, the NW CSC has invested nearly $3.5M in climate science research projects funded in FY 2011 through FY 2013. New projects funded in FY 2013 can be found in Appendix 3, and the full NW CSC research portfolio can be viewed at https://nccwsc.usgs.gov/display-csc/4f8c64d2e4b0546c0c397b46.

All science projects funded in FY 2011 are nearing completion. The following were completed and closed in FY2013:

- Climate change threats to fish habitat connectivity: Growth and predation
- Contribution of landscape characteristics and vegetation shifts from global climate change to long-term viability of greater sage-grouse

In addition, products from projects that were funded in FYs 2011 and 2012 began to come to fruition in FY 2013, as a number of scientific articles were published in peer-reviewed journals (Appendix 4).

2.3. DEPTH database and web portal

In our quest to provide state-of-the-science climate research and decision management tools for the Northwest, the NW CSC, with help from the ESAC, has built a database of projects funded by regional federal and tribal agencies that address the NW CSC Science Agenda. The database can be accessed through a web portal known as DEPTH (Data Entry for Project Tracking and Highlighting; https://my.usgs.gov/depth/#/). DEPTH allows users to search climate research projects by organization, project PI, keywords, or by NW CSC Science Agenda theme and sub-themes. DEPTH is a tool that will help avoid duplication of research efforts, build opportunities for collaboration, and help assess when the portfolio of regional climate-related products satisfies specified resource management needs.

2.4. FY 2014 Request for Proposals

The NCCWSC coordinated the FY 2013 and FY 2014 request for proposals (RFP) for the entire CSC network (see Appendix 5 for timeline of RFP process). Because the NW CSC science budget for FY 2013 was committed to fund the second year of projects started in FY 2012, the NW CSC invited statements of interest (SOIs) for research projects beginning in FY 2014 only. Eligible applicants for the RFP were institutions participating in the NW academic consortium

and USGS science centers, field stations, and laboratories. Applicants were asked to address the following five science priority needs identified by the ESAC:

1. Response of hydrologic systems to future climate
2. Threats to habitat connectivity and potential fragmentation
3. Changes in fire regimes
4. Changes in phenology and related monitoring needs
5. Vulnerability of species, populations, and ecosystems to climate

Sixty-five SOIs were received, twenty applicants were selected to submit full proposals, and eight proposals were recommended to be funded in FY 2014. An independent review panel of federal and university climate science professionals evaluated the SOIs and proposals based on their relevance and applicability to management needs, transfer value, scientific design, feasibility, and ability to leverage funds and build climate science capacity in the region. Projects that aimed to produce resource management-relevant information and products and/or actively engage with the intended users of the scientific output were highly encouraged and ranked higher in the SOI and proposal review process.

3. Data Services

The objective of Data Services is to collect and secure climate data, while providing timely access, analytical functions, and interpretive services. Data Services provide a core business function to Northwest stakeholders by linking data owners and providers to users. This high-level function includes developing data-administration standards and procedures, conducting data processing and validation, and providing technical tools, risk management, security and user-friendly data access. Our view of the value of data as a resource permeates all stages of the project cycle.

Research Data Management Plans (DMPs) are required and used as a selection criterion for all submitted proposals, and the NW CSC and NCCWSC provide data management services to project PIs during the life of a funded project and indefinitely. The University of Idaho (UI), in partnership with the IT program of the NCCWSC, is the lead institution for data management and cyberinfrastructure programs of the NW CSC.

3.1. ScienceBase

ScienceBase (www.sciencebase.gov) serves as the official repository for NW CSC projects and associated products. For each project, a geospatial footprint of the study area is captured and added to enable spatial searching by project. Project details (timeline, investigators, an abstract, topic keywords, etc.) are also captured to provide readers with information about CSC-funded projects. As projects release datasets or publications, ScienceBase is used to record these products.

During FY 2013, nearly all projects funded by the NW CSC in FYs 2011 and 2012 added spatial footprints to their records and had all project details confirmed. Projects were linked to peer-reviewed publications for a number of projects (Appendix 4), and DMPs were created for all FY 2012 projects following compliance requirements for the NCCWSC. The DMPs are stored in ScienceBase in restricted access areas.

4. Communication Services

The objective of Communication Services is to provide professional communication and outreach services that support the exchange of information among regional stakeholders (including scientists), and effectively raise awareness of climate issues in the Pacific Northwest. The key role of Communication Services is to provide logistical and technical support for effective outreach and community involvement in the activities of the NW CSC. Promoting communication between researchers and stakeholders and the communication of science findings are considered so important that they were used as selection criterion for proposals submitted under the FY 2014 RFP.

4.1. Communication Strategy

A significant achievement for FY 2013 was the development of the NW CSC Communication Strategy. This document was officially adopted by the ESAC on March 20, 2013 (http://www.doi.gov/csc/northwest/nw-csc-communication-services.cfm). The goals of the NW CSC Communication Strategy are to:

1. Facilitate development and dissemination of Northwest climate-related science, information,

and tools to support management of natural and cultural resources under changing climate conditions, and

2. Increase access to and understanding of Northwest climate-related science and data.

The communications program recognizes four specific audiences: (1) scientists, (2) resource managers (including tribes and federal and state agencies), (3) legislators, policy makers, and administrators, and (4) the general public. To achieve these goals, the communications strategy is organized according to seven general objectives, each targeted to one or more of the four key audiences. Maintaining a dialogue with these different audiences regarding their needs for information can help foster relationships between the NW CSC and the community and ensure the communications program is responsive to region-wide needs.

4.2. Staffing

In order to implement and maintain the communications efforts outlined in the NW CSC Communication Strategy, the NW CSC initiated the recruitment process for a communications coordinator who will be based at the University of Washington. We expect that the hiring process will be complete and the new communications coordinator will begin work in FY 2014. The duties of this position include:

- Develop and manage the NW CSC communications program;
- Write synthesis reports based on published papers;
- Research, write, edit, and publish web articles about NW CSC;
- Develop materials for public presentations;
- Work with other NW CSC staff to prepare and edit documents;
- Evaluate the effectiveness of the communications program, and
- Finalize and post web content to keep online information up-to-date.

5. Education and Training Services

The objective of Training and Education Services is to promote broad participation by and support education of diverse young scientists in the work of the NW CSC. The NW CSC provides Education and Training Services to deliver science-based knowledge and informal educational programs to the larger community. These services also aim to develop and sustain a revolving corps of young researchers by elevating the priority of student and post-doctoral opportunities in budget planning. Training and education of young scientists carries such importance that it was included as a selection criterion for proposals submitted under the FY 2012 RFP.

The NW CSC supported nine graduate student fellows in FY 2013; these students worked on a broad range of climate science topics through various academic departments at Oregon State University, the University of Idaho, and the University of Washington. A full list of NW CSC graduate student fellows' project descriptions and progress can be found in Appendix 6.

5.1. Climate Boot Camp

The NW CSC Climate Boot Camp (CBC) is a unique, annual, week-long interdisciplinary training program organized, staffed and supported through the collaborative efforts of the NW CSC and university partners (Oregon State University, University of Idaho, and University of Washington). Its mission is to prepare graduate students and early-career professionals for successful careers by providing knowledge and abilities in climate science, science communications, knowledge integration and the science-policy interface, all in a climate change and adaptation context, through a concentrated session of formal and non-formal education, skill development, and interaction with practicing professionals.

The 2013 CBC was held July 28–Aug 2, 2013, in McCall, Idaho at the McCall Outdoor Science School (MOSS) Campus. Steven Daley-Laursen (NW CSC Consortium Lead, University of Idaho), Erin Corwine (Coordinator), and Josh Foster (NW CSC University Program Manager) ably led and organized the 2013 CBC. Twenty-four Fellows participated, including graduate students from all 8 regional CSCs and early-career professionals from several Northwest tribes, agencies, and non-profit organizations.

The one week course included field trips, skill-building exercises, and presentations by leading climate scientists, communications experts and resource managers to give participants an all- encompassing view of the workings of climate impacts science. More information about the 2013 Climate Boot Camp can be found at http://bootcamp.nkn.uidaho.edu/.

A valuable outcome of the CBC has been the development of the Early Career Climate Forum (ECCF), a network of early career scientists, managers, and others working at the science-management interface on climate changes issues. The ECCF website (http://eccforum.csc.alaska.edu/) provides a space for those affiliated with the Climate Science Centers to interact, discuss topics, and find resources. The ECCF also strives to be an accessible outlet where the general public can learn about climate science from early career professionals intimately involved with studying climate change and its implications for ecosystems and people.

NW CSC Funding in Fiscal Year 2013

Funding for the NW CSC comes from the U.S. Department of the Interior through the U.S. Geological Survey (a summary budget sheet can be found in Appendix 7). The total funding allocation for the NW CSC in FY 2013 was $2,360,881. Despite the sequestration order imposed on the federal budget in FY 2013, the NW CSC was able to honor all second year funding requests as originally contracted without having to apply any cuts to our existing projects. The effects of sequestration were largely absorbed centrally by the NCCWSC. Operational adjustments by the NW CSC also contributed to savings and reprograming that helped offset the outlay reductions that would have been necessary otherwise.

The largest share of the NW CSC FY 2013 budget was dedicated to supporting academic operations and research (60.85%). This allocation included the third year installment ($763,881) of the basic Cooperative Agreement with the primary academic consortium partners (OSU-UI-UW) and other research awards provided to institutions within the academic consortium on a competitive basis ($672,730). The second-largest share of NW CSC funds (15.43%, or $364,279) supported research projects designed and led by USGS Science Centers.

In FY 2013, the partnership initiated last year between the NW CSC and the North Pacific LCC to jointly fund tribal climate research projects was expanded to include the Alaska CSC. This collaboration between the two CSCs and the LCC is intended to assist tribes in being better prepared to anticipate, monitor, and adapt to climate change. Whether funding tribal research projects alone or in partnership with others, the NW CSC invested some $281,658 (11.93%) of its budget to promote research on tribal themes. This allocation brings substance to the commitments articulated in the NW CSC Tribal Engagement Strategy and our pledge to work with tribal communities to assess how culturally-important resources will be affected by changing climate and related environmental stressors. NW CSC operational costs, including salaries and benefits, facilities, and other non-personnel expenditures reached $209,790 (8.9%). A balance of $68,543 (less than 3%) was carried over to the NW CSC budget for FY 2014.

Appendix 1: Executive Stakeholder Advisory Committee (ESAC)

(23 agencies and organizations: 13 federal agencies, 4 state agencies, 3 tribal organizations, 3 Landscape Conservation Cooperatives)

Federal Agencies

U.S. Army Corps of Engineers, Northwestern Division
Bonneville Power Administration
Bureau of Indian Affairs
Bureau of Land Management, Oregon/Washington
Bureau of Reclamation, Pacific Northwest Region
U.S. Environmental Protection Agency, Region 10
Federal Highway Administration, Western Federal Lands Highway Division
National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center
National Park Service, Pacific West Region
Natural Resources Conservation Service, National Water and Climate Center
U.S. Fish and Wildlife Service, Pacific Region
U.S Forest Service
U.S. Geological Survey, Northwest Region

State Agencies

Idaho Department of Fish and Game
Montana Department of Natural Resources and Conservation
Oregon Department of Fish and Wildlife
Washington State Department of Ecology

Tribal Organizations

Affiliated Tribes of Northwest Indians
Columbia River Inter-Tribal Fish Commission
Northwest Indian Fisheries Commission

Landscape Conservation Cooperatives

Great Basin Landscape Conservation Cooperative
Great Northern Landscape Conservation Cooperative
North Pacific Landscape Conservation Cooperative

Appendix 2: NW CSC Leadership Team (LT)

Gustavo Bisbal, Director, Northwest Climate Science Center
Philip Mote, University Director, Oregon State University
Steven Daley-Laursen, Consortium Lead, University of Idaho
Eric Salathé Jr.[2], Consortium Lead, University of Washington
Nancy Lee, Chair of the ESAC and Deputy Director, U.S. Geological Survey Northwest Region

[2] Dr. Salathé replaced Dr. Nathan Mantua as the University of Washington Consortium Lead for the NW CSC.

Appendix 3: NW CSC Projects Funded in Fiscal Year 2013

Lead principal investigators, their affiliations, and titles for projects funded by the Northwest Climate Science Center (NW CSC) in FY 2013. For project summaries, visit http://www.doi.gov/csc/northwest/news/nw-csc-announces-fy-13-tribal-project-portfolio.cfm.

SCIENCE PROJECTS

Projects funded solely by the NW CSC

- Vulnerability of traditional women's foods to climate change on the Olympic Peninsula, WA: Management projections and implications for tribal perspectives on Usual and Accustomed gathering areas (Jesse Ford, Oregon State University)
- Understanding Native American cultural response associated with climate change (Phil Mote, Oregon State University)

Projects funded jointly with the Alaska CSC and North Pacific LCC

- A coupled (ocean and freshwater) assessment of climate change impacts on Pacific lamprey and Pacific eulachon (Rishi Sharma, Columbia River Inter-Tribal Fisheries Commission)
- Klamath Basin traditional ecological knowledge and climate change science internship (Kim Mattson, Quartz Valley Indian Reservation)
- Berry risk mapping and modeling of native and exotic defoliators in Alaska (Nathan Lojewski, Chugachmiut Tribal Consortium)
- Identifying climate vulnerabilities and prioritizing adaptation strategies for eulachon populations in the Chilkoot and Chilkat Rivers and the application of location monitoring systems (Brad Ryan, Chilkoot Indian Association)

INFORMATION-MANAGEMENT/WORKSHOP-SUPPORT PROJECTS

- Support for the 4th Annual Pacific Northwest Climate Science Conference (Philip Mote, Oregon State University)

Appendix 4: NW CSC-funded Project Publications in FY 2013

Benjamin, J., L. Wetzel, K. Larsen, and P. Connolly. Accepted. Spatio-temporal variability in movement, age, and growth of mountain whitefish (Prosopium williamsoni) in a river network based upon PIT tagging and otolith chemistry. Canadian Journal of Fisheries and Aquatic Sciences, doi:10.1139/cjfas-2013-0279.

Bohn, T.J., B. Livneh, J.W. Oyler, S.W. Running, B. Nijssen, and D.P. Lettenmaier. 2013. Global evaluation of MTCLIM and related algorithms for forcing of ecological and hydrological models. Agricultural and Forest Meteorology 176:38-49.

Livneh B., E. Rosenberg, C. Lin, B. Nijssen, V. Mishra, K. Andreadis, E. Maurer, and D. Lettenmaier. 2013. A long-term hydrologically based data set of land surface fluxes and states for the conterminous U.S.: Update and extensions. Journal of Climate 26:9384-9392.

Rupp, D.E., Abatzoglou, J.T., Hegewisch, K.C., and Mote, P.W. 2013. Evaluation of CMIP5 20th century climate simulations for the Pacific Northwest USA. Journal of Geophysical Research: Atmospheres 118:10884-10906.

Shirley, S.M., Z. Yang, R.A. Hutchinson, J.D. Alexander, K. McGarigal, and M.G. Betts. 2013. Species distribution modeling for the people: unclassified landsat TM imagery predicts bird occurrence at fine resolutions. Diversity and Distributions 19:855-866.

Wenger, S.J., N.A. Som, D.C. Dauwalter, D.J. Isaak, H.M. Neville, C.H. Luce, J.B. Dunham, M.K. Young, K.D. Fausch, B.E. Rieman. 2013. Probabilistic accounting of uncertainty in forecasts of species distributions under climate change. Global Change Biology 19:3343-3354.

Appendix 5: Timeline for NCCWSC FY13/14 Request for Proposals

February 1, 2013 – Deadline for submission of Statements of Interest (SOIs)

February 25, 2013 – Applicants notified and full proposals requested

March 25, 2013 – Invited full proposals due

May 1, 2013 – Final candidate projects identified

May 2013 – Cross-project and cross-CSC reviews

June 1, 2013 – Applicants notified of intent to award funding

(Note: Projects recommended for funding will begin in FY 2014)

Appendix 6: NW CSC Graduate Student Fellows' Projects in FY 2013

Collette Gantenbein, University of Idaho - Disaggregating climatology, climate variability, and disturbance influences on land cover change in the Pacific Northwest

Pervasive changes in land cover pattern within the past several decades express the effects of climate change and the increased abundance of landscape scale disturbance within susceptible ecosystems. The disturbance of fire is of particular concern as even slight changes in climate can significantly alter wildfire regimes; this is especially apparent in fire prone environments such as the Pacific Northwest. Recent studies have addressed the issue of climate induced land cover change through bioclimatic envelope modeling founded by the ecological niche theory. However, bioclimatic envelope models are static in nature and do not include variability of climate or disturbance. By excluding the complex and non-linear dynamics of land cover change, predictive mapping produced by such models are not relevant to actual land cover. The goal of this study is to improve the accuracy of bioclimatic envelope modeling by incorporating climate variability and the disturbance of fire into bioclimatic envelope models.

Progress: Over the course of the last year, land cover and climate data were acquired for building bioclimatic envelope models to predict land cover patterning for the Pacific Northwest region. Preprocessing steps were conducted in preparing data for analysis generating predictor variables for modeling by means of time series analysis and classification tree analysis (CTA). Three splitting algorithms for the CTA were tested for the best accuracy including the gain ratio, entropy, and Gini algorithms along with different pruning levels. A literature review and proposal was written and is in the process of being reviewed.

Isabel Guerrero, Oregon State University - The economics of climate change for possible impacts on the Pacific Northwest and evaluation of mitigation and adaptation strategies

Initial research questions are focusing on adaptation and mitigation strategies for land use practices, specifically: 1) What are the costs and benefits for threatened species and biodiversity if public and private lands are managed to adapt to and mitigate climate change? 2) How does adaptation and mitigation impact biodiversity conservation in selecting protected areas?

Progress: Fellow met in February 2013 with Tom Miewald, Landscape Ecologist for the National Wildlife Refuge System and the North Pacific Landscape Conservation Cooperative; and David Patte, Climate Change Coordinator (Senior Advisor on Ecosystem Change) - US Fish and Wildlife Service, to discuss the possibility of cooperation with the ongoing project: "Piloting a strategic approach to conservation planning and design for the National Wildlife Refuge System in the Columbia Plateau Ecoregion." The Fellow also met in April 2013 with academic advisors (Dr. Christian Langpap and Dr. Susan Capalbo) on how to cooperate with the Columbia Plateau project. Readings were suggested on reserve site selection and crowding out of private conservation and public reserves. The Fellow will make a presentation summarizing the readings. The Fellow as will present on a possible research niche and how it will contribute to the Columbia Plateau project as soon as possible with the goal of creating a research concept paper in fall 2013.

Sarah Hadley, Oregon State University – Climate, land cover, and the distribution of forest birds

The Fellow's research is exploring the relative contributions of microclimate, vegetation cover type, and species interactions in determining bird distributions in complex terrain at Oregon State University's H. J. Andrews Experimental Forest (HJA) with emphasis on identifying drivers of spatiotemporal patterns in microclimates. Understanding how temperature varies across a mountainous landscape at small scales is crucial to understanding the direct implications of climate change impacts on biodiversity as well as a current conservation interest in understanding the potential of complex mountainous landscapes to buffer species from macroclimate changes. In particular, research will be able to identify potential 'micro-refugia' and their role in buffering species from regional warming.

Progress: A targeted selection of relevant system response variables were collected and analyzed from 184 sites (e.g., mean June temp, mean temp of coldest month, growing degree days above 5°C). A boosted regression tree technique was used to understand the influence on microclimate of other environmental variables (e.g., forest structure and composition, topography, etc.) at multiple spatial scales (5-, 25-, 50-, and 250-m radii). Using this technique the research was used to relate bird distribution to fine spatiotemporal patterns of microclimate on the landscape. Preliminary indications are that at least some bird species distributions are connected with temperature; and the sites which warmed more over the breeding season (i.e., less buffered) had higher rates of vacancy by the hermit warbler.

Brittany Jones, University of Washington – Spatially-explicit assessment of natural adaptation and restoration of tidal wetlands under the influence of future climate change throughout Puget Sound

The overall goal of this novel project is to conduct a spatially-explicit assessment of the adaptive capacity of tidal wetlands to future climate change in order to plan for strategic conservation and restoration of tidal wetlands in Puget Sound. Research will use the Puget Sound Nearshore Ecosystem Restoration Project's (PSNERP) change analysis geodatabase and the Sea Level Affecting Marshes Model (SLAMM 6.0.1 beta) to: (1) assess variation in the ability of tidal wetlands to transgressively migrate landward under future climate change as a function of controlling processes, such as eustatic sea level rise, vertical land movement, and hydrological alterations; (2) analyze the adaptive capacity of tidal wetlands to naturally increase in vertical elevation due to sediment accretion from climate changed induced variability in sediment delivery; and, (3) evaluate conservation and restoration potential of current and future tidal wetlands by ranking their adaptive capacity and ecosystem service value.

Progress: Data layers have been compiled and processed for SLAMM inputs, including wetland inventory, elevation, slope, the presence or absence of dikes, and percent impervious surface. Historical and current variability of sediment accretion rates among Puget Sound deltaic and non-deltaic estuarine wetlands will be determined. The sediment accretion data will be used to re-run SLAMM with a focus on certain river deltas and estuaries. The changes in tidal wetland area, type, and distribution due to inundation, transgressive migration, and surface elevation change generated by SLAMM outputs will be utilized in conjunction with ecosystem service value to evaluate conservation and restoration potential using a weighted ranking system.

Jesse Langdon, University of Washington – Forecasting the impact of climate change and land use on terrestrial animals in the Pacific Northwest

Protected areas are a fundamental component of many conservation strategies. They safeguard some of the best examples of unfragmented natural landscapes in many regions, provide important habitat for many rare and threatened species and communities, and serve as a refuge from a human-dominated world. As temperatures continue to rise and precipitation patterns shift due to anthropogenic climate change, vegetation systems and species communities are expected to undergo substantial changes. The research summarizes projected changes in future temperature and precipitation, shifts in major vegetation systems, and species turnover for the study area.

Progress: Research first determined a species turnover rate for by modeling future changes in habitat suitability for 366 terrestrial vertebrate species. Temperature and precipitation, shifts in major vegetation systems, and species turnover were calculated for the entire study area, and then summarized by protected areas. Similar geographic variations were found for all three measures, with areas in close proximity to the Pacific Coast exhibiting the most moderate changes, compared to increasingly greater changes projected along a longitudinal gradient toward the continental interior. Moderately strong correlations were found between vegetation change and species turnover, longitude and species turnover, climate change and longitude, and climate change and elevation. The resulting spatial variations in these measures underscore the importance of developing appropriate climate adaptation strategies in response to disparate trends in future environmental change. Thesis research was completed in May 2013. Currently, two manuscripts (one for each thesis chapter) are being prepared for submittal to two peer-reviewed journals for publication.

David Lawrence, University of Washington – Contemporary controls and future predictions of non-native smallmouth bass range expansion into salmon-rearing habitat

Research examines the range expansion of non-native predatory smallmouth bass in Pacific Northwest streams where juvenile salmon rear. Smallmouth bass can cause lethal and sub-lethal effects on juvenile salmon when these species overlap, but no studies to date have documented the contemporary degree of bass invasions in headwater streams where salmon develop. Bass are anticipated to move farther upstream into salmon-bearing streams as climate and land use alteration cause stream warming. Overall, research will: (1) provide insight into the contemporary controls on the distributions of non-native bass in Pacific Northwest river systems; (2) determine the extent that bass are moving into salmon habitat presently; and (3) provide management relevant tools to anticipate and prevent the future range expansion of bass.

Progress: A field observation dataset was combined with correlative and mechanistic models to determine the contemporary controls on non-native bass distribution and predict the future range expansion of predatory bass into salmon-bearing streams. In the John Day River, upstream expansion of bass into salmon rearing areas was largely water temperature controlled. Distributional surveys revealed that bass overlap with juvenile Chinook salmon in a considerable amount of their early summer rear-

ing habitat. The thermal regime of the John Day River under climate change conditions was predicted using a series of linked models indicating how bass and juvenile Chinook salmon distributions are likely to respond to climate-induced stream warming. The results suggest that bass will occupy an increasingly large portion of juvenile Chinook salmon rearing habitat in the future across the PNW. The first results from this study were accepted for publication in the journal Ecological Applications.

Sihan Li, Oregon State University – Regional climate modeling with large ensembles using volunteer computing: Regional Climate Prediction Dot Net (REGCPDN)

Research under Climateprediction.net for the PNW uses large ensembles of global climate simulations sufficient to explore model uncertainties of regional climate by perturbing initial conditions, boundary conditions, and physical parameter values.

Progress: A limiting factor in the reliability of climate predictions is the need for parameterization of processes occurring at scales smaller than those resolved by the model, leading to uncertainties in how to relate such processes to large scale prognostic variables. To be useful to policy makers and strategists of adaptation and mitigation, these uncertainties much be incorporated in the predictions of future climate. Perturbed physics ensembles (PPE), i.e., ensembles of model simulations that differ in the value of one or more model parameters, can best highlight uncertainties in predictions due to these parameter settings. This research has focused on the question: what are the dominant model parameter changes, and how do they relate to the major regional scale prognostic variables, i.e., trying to relate the macroscopic variation in global/regional response to the subgrid scale parameterization. The results so far indicate that different parameter combinations did not show much difference from the unperturbed model or from each other, suggesting that many of the parameter combinations explored have relatively little effect on regional variables. Possible reasons: the relevant processes may in fact have only a limited impact on regional response; the parameter ranges used may be too small to influence substantially the response in this model; and/or multiple perturbations may have mutually compensating effects when averaged on regional scales.

Ronda Strauch, University of Washington – Transportation impacts and adaptation to climate change on federal lands in north-central Washington

Research goals are to examine the climate change elements relevant to transportation, assess potential impacts to access, and contribute to integrating this information into adaptation efforts of national parks and national forests in north-central Washington. Specific objectives include: (1) geo-spatial analysis of projected changes in climate on hydrologic processes, and resulting stress on transportation infrastructure; (2) advancing the understanding of landslide risks, including as affected by climate change and its consequences for travel management; and (3) communicating this analysis to managers within national parks and national forests through workshops and publications.

Progress: Three climate and hydrology pathways directly influence access in mountain landscapes including changes in (1) snowpack and rate and timing of snowmelt; (2) flooding regime and extreme flows, and (3) elevated winter soil moisture that enhances landslide risk. Warmer temperatures are projected to drive shifts in hydrologic regime that will alter the timing and magnitude of stream flows increasing damage to roads and trails adjacent to or crossing streams, disrupting travel, and increasing maintenance and repair costs. Reductions in snow cover will allow earlier access, but may necessitate adjustments to management. Projected higher winter soil moisture may lead to elevated landslide risks. Recent efforts have focused on using a geo-spatially-based slope stability index mapping tool to identify areas of differential stability classes. Mapping tool results have then been incorporated with site-specific features (e.g., observed landslides), topographic features (slope, curvature, drainage area), geology, and soil texture. Additionally, research has used linear programming to identify and explore optimization of essential roads and trails to principal destinations and integrate future climate change constraints.

Lindsey Thurman, Oregon State University – A metacommunity framework for evaluating amphibian response to climate change at high elevations

The amphibian 'meta-community' is a conceptual model that can be used to identify priority areas and species based on the direct and indirect effects of climate change. Research goals are to: (1) explain current amphibian species distributions in the Cascade Mountain range using environmental and climatic variables and identify discontinuities and presently isolated populations; (2) experimentally quantify phenotypic plasticity in larval development in a subset of strategically selected communities in response to climate change variables (e.g. temperature and hydroperiod) and concurrent biological interactions (e.g., competition); and (3) integrate objectives to model potential shifts in species distributions and assess the likelihood of species persistence.

Progress: An experiment was conducted that quantified the degree of phenotypic plasticity in larval development among three high elevation amphibian species in response to climate warming: the Western toad, Pacific chorus frog, and Cascades frog. Final results indicate a significant loss in fitness as a result of sensitivity to climate warming for the Cascades frog, a species of conservation concern. It showed the lowest acceleration in larval development under the warmed scenario with the greatest reductions in body size at metamorphosis. The other two have potential for rapid adaptation given warmed temperature treatment caused them to emerge approximately two weeks before their control treatment counterparts with relatively minimal consequences to body size at metamorphosis.

Appendix 7: NW CSC Funding and Expenses in FY 2013

FY 2013 NW CSC Funding	**$2,360,881**

Center Operational Costs	
Salaries and awards	$197,018
Travel, supplies, miscellaneous expenses	$12,772
Subtotal	**$209,790**

Allocation to academic institutions	
OSU/UI/UW – Basic NW CSC Co-op	$763,881
University research	$672,730
Subtotal	**$1,436,611**

Research dedicated to tribal themes	
Subtotal	**$281,658**

Research by USGS Science Centers	
Subtotal	**$364,279**

TOTAL EXPENSES	**$2,292,338**

Carryover into FY14	**$68,543**