

Northwest Climate Adaptation Science Center Funding Year 5 Annual Report

1 June 2022

SUBMITTED TO:

U.S. Department of the Interior & U.S. Geological Survey

SUBMITTED BY:

University of Washington, on behalf of the Northwest Climate Adaptation Science Center & University Consortium (University of Washington, Western Washington University, Washington State University, Oregon State University, Boise State University, University of Montana)



ADMINISTRATIVE

Award Recipient

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Hosting the Northwest Climate Science Center

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PURPOSE AND OBJECTIVES

The Northwest Climate Adaptation Science Center (NW CASC) delivers science to help fish, wildlife, water, land and people adapt to a changing climate. The Center combines academic expertise with federal resources to advance climate science development and delivery for managers and policy makers across Washington, Oregon, Idaho and Western Montana.

This report provides a summary of the NW CASC University Consortium activities during the Year 5 reporting period, i.e., months 49-60 of the cooperative agreement between the University of Washington and the U.S. Geological Survey. The Consortium completed the agreed-upon deliverables for its fifth year, which are described throughout this report and include accomplishments in science; education, training and capacity-building; and communications.

Highlights from Year 5 include:

- Funding 13 research projects in support of the NW CASC's *Science Agenda*, involving NW CASC fellows and a diverse suite of partners from federal, state and tribal resource management agencies;

- Providing 13 NW CASC fellows with actionable science skills through a capacity-building curriculum developed and coordinated by the University Host;
- Planning and hosting a *Deep Dive* into the science and practice of managing stream drying in the Northwest that brought together ~100 natural resource managers and scientists to identify actionable science and co-production priorities. In response to continued COVID-19 pandemic restrictions, we used the same *Deep Dive* approach we designed in 2020, involving a months-long virtual working group process;
- Strengthening relationships and deepening participation of members of the University Leadership Team and other stakeholder partners in NW CASC activities through the *Deep Dive* process;
- Developing and delivering six actionable science skills-building webinars, garnering over 300 registrants;
- Conducting in-depth and collaborative Consortium strategic-planning efforts across NW CASC programs;
- Strengthening cross-CASC collaborations through: participating in the implementation of the Climate Adaptation Postdoctoral Fellows Program; facilitating regular network-wide meetings of the CASC University Directors and Deputy/Assistant Directors; leading efforts to develop collaborative, cross-CASC, university, USGS and tribal working groups; and facilitating cross-CASC communications collaboration; and
- Bringing on former NW CASC fellow Dr. Kendra Kaiser as a NW CASC co-PI at Boise State University. Kendra has helped promote the NW CASC Research Fellowship Program at BSU, launching proposal-writing workshops and information sessions to help increase the pipeline of students interested in and pursuing opportunities to conduct actionable science.

ORGANIZATION

The NW CASC University Consortium is led by a University Leadership Team (ULT) composed of the University Director, Deputy Director and co-PIs from each of the Consortium universities (Tables 1 and 2). The ULT collaboratively develops and advertises the Consortium's call for research proposals; evaluates and selects projects for funding in consultation with the NW CASC USGS Director; and oversees award and sub-award administration. The ULT meets roughly every other month by video conferences convened by the University Director and is in frequent contact via email and phone regarding Consortium operations, strategic opportunities and Consortium-member specific management issues. The University Director and Deputy Director oversee, manage and supervise NW CASC-funded ("core") personnel at the University of Washington (Table 1).

Table 1. Individuals funded by the NW CASC USGS award at the host institution (UW) and sub-award institutions. FTEs relative to 12 months unless noted.

INSTITUTION	PERSONNEL
<i>Core NW CASC Personnel</i> – Oversee and complete NW CASC consortium activities.	
University of Washington	Amy Snover (University Director, 2.54 FTE), Meade Krosby (University Deputy Director, 3.01 FTE), Mary Ann Rozance (Actionable Science Postdoctoral Fellow, 1.96 FTE), Darcy Widmayer (Communications Manager, 10.12 FTE), Laura Davis (Awards Manager, 3.25 FTE), Hana Sawanobori (Awards Specialist, .81 FTE), Jenny Dettmann (Program Coordinator, 5.40 FTE), Guillaume Mauger (Planning Committee Member - Deep Dive 0.60 FTE), Ryan Hasert (Research Scientist, 0.6 FTE)
<i>NW CASC Fellows (Consortium partner universities)</i> – Selected through a competitive RFP process to conduct research that aligns with NW CASC science priorities (NW CASC fellows at UW are listed in Table 3). Note: Reported FTEs reflect total support provided by the NW CASC, including support projected for summer/fall 2022.	
Western Washington University	Sydney Jantsch (1 FTE for 1.5 months)
Washington State University	Sky Button, (0.5 FTE for 4.5 months), Dylan Quinn (.5 FTE for 9 months)
University of Montana	Timber Burnette (1 FTE for 2 months), Celina Gray (1 FTE for 2 months)
Boise State University	Fiona Noonan (0.5 FTE for 4 months)
Oregon State University	Risa Askerooth (.05 FTE for 6 months), Kyle Hogrefe (0.5 FTE for 9 months), Jordan Ortega (1 FTE for 6 months)

NW CASC Social Science Lead – Contracted by the host institution to support evaluation of NW CASC programs.	
University of Arizona	Alison Meadow (0.08 FTE)
NW CASC Personnel (Consortium PIs and Fellows) supported for contributing to the 2021 Deep Dive process.	
Boise State University	Kendra Kaiser and Lejo Flores (\$11,753)
Oregon State University	Rosemary Pazdral (\$1,104)
University of Washington	Michelle Agne (\$2,731)
Washington State University	Katherine Swensen (\$3,012)
Western Washington University	James Robinson (\$2,811)

Table 2. Contributed service not funded by award: NW CASC University Leadership Team and NW CASC Fellow Advisors.

INSTITUTION	PERSONNEL
<i>NW CASC University Leadership Team (Consortium Co-PIs)</i> – Provide strategic leadership, act as NW CASC liaisons to consortium institutions and administer sub-awards.	
Western Washington University	John Rybczyk
Washington State University	Jan Boll, Julie Padowski
University of Montana	Solomon Dobrowski
Oregon State University	Selina Heppell
Boise State University	Alejandro Flores, Kendra Kaiser
<i>NW CASC Fellow Advisors</i> – Advise NW CASC fellows on research projects, support administration and compliance of award.	
University of Washington	Sarah J. Converse, Brian J. Harvey, Emily Carrington, Phil Levin
Western Washington University	James M. Helfield
Washington State University	Jonah Piovia-Scott, Kevan Moffett
University of Montana	Anna Sala, Libby Metcalf
Oregon State University	Sally Hacker, Robert E. Kennedy, Jonathan Armstrong
Boise State University	Megan Cattau

Table 3. Formal cost-share: UW climate science.

INSTITUTION	PERSONNEL
<i>NW CASC fellows</i> – Selected through a competitive RFP process to conduct research that aligns with NW CASC science priorities (fellows at consortium universities listed in Table 1). <i>Note:</i> Reported FTEs reflect total support provided by the NW CASC, including support projected for summer/fall 2022.	
University of Washington	Abby Bratt (0.5 FTE for 6 months), Michele Buonanduci (0.5 FTE for 12 months), Robin Fales (0.5 FTE for 9 months), Olivia Zimmerman (0.5 FTE for 12 months)

RESULTS

PARTNERSHIPS

The NW CASC's goal is to respond to high priority natural and cultural resource management challenges and foster substantive, sustained engagement between scientists and managers. During Year 5, the Consortium focused on enhancing partnerships between the NW CASC and NW CASC stakeholders, between the NW CASC and host institution programs and between the NW CASC and other federal programs.

NW CASC STAKEHOLDERS. NW CASC Advisory Committee: During Year 5, NW CASC personnel continued to participate in the USGS-organized NW CASC Advisory Committee meetings, which provide an opportunity to build new and deepen existing relationships with both the agencies and individuals represented on the Committee.

HOST INSTITUTION PROGRAMS. Climate Impacts Group: During Year 5, the NW CASC continued its partnership with the Climate Impacts Group at the University of Washington. The NW CASC provides Climate Impacts Group staff with information about NW CASC activities, products and funding opportunities for distribution to their scientific partners and stakeholders. In turn, Climate Impacts Group personnel deliver insights about regional science needs to NW CASC leadership.

Doris Duke Conservation Scholars Program (DDCSP): The NW CASC partners with the DDCSP to support climate adaptation internships with DOI-relevant partners (e.g., state natural resource management agencies, tribes) for students and recent graduates from underrepresented groups. In Year 5, NW CASC-supported interns worked with the Tulalip Tribes to support its climate adaptation efforts.

OTHER FEDERAL PROGRAMS. Washington Cooperative Fish and Wildlife Research Unit: The Washington Cooperative Fish and Wildlife Research Unit is a partnership among the USGS, University of Washington, Washington State University, Washington Department of Ecology, Washington Department of Fish and Wildlife and Washington Department of Natural Resources. In Year 5, the NW CASC supported its first NW CASC fellow associated with the Washington Coop Unit (*Mediating impacts of climate change on streaked horned larks through prairie-oak management*). **NOAA Regional Integrated Science and Assessment (RISA) Program:** During Year 5, the NW CASC maintained its strong linkage with the Western Water Assessment (University of Colorado, Boulder), through NW CASC University Director Snover's participation on the WWA Advisory Board, and established ties to the new, Climate Impacts Group-hosted Northwest RISA, *The Northwest Climate Resilience Collaborative (NCRC)*, through NW CASC University Director Snover's participation as NCRC PI and University Deputy Director Krosby's participation as NCRC Co-PI.

SCIENCE

NW CASC FELLOWS' RESEARCH. In Year 5, the University Consortium finished supporting 13 research projects that began in Year 4 and began funding 13 new research projects. These 26 projects collectively supported each of the six Management Priorities and two of the Human Dimensions Goals identified in the *NW CASC Science Agenda (2018-2023)*. Details and deliverables for the thirteen Year 4 projects were reported in the Year 4 Annual Report. Science highlights for the thirteen projects funded in Year 5 include:

Mediating impacts of climate change on streaked horned larks through prairie-oak management.

NW CASC Science Agenda Priorities: 2.1.1., 2.2.1. Interim Research Highlights: This project aims to understand the impacts of climate change stressors on streaked horned larks. The research fellow has been developing population models based on over 10 years of intensive monitoring data, using them to test whether climate change is driving inter-annual differences in nest success. Results of these analyses will be used to predict future nest success and population abundance in order to inform management of streaked horned larks in a changing climate.

The role of wildfire, vegetation interactions, and climate dynamics in Great Basin plant species distributions.

NW CASC Science Agenda Priorities: 5.1.1, 2.1.1., 2020 Deep Dive (Managing Post-fire Vegetation Change in a Warming Climate). Interim Research Highlights: A NW CASC fellow has built models that account for the effects of fire histories, restoration treatments, drought and vegetation interactions on three key species in the Northern Great Basin: big sagebrush, juniper and cheatgrass. Results indicate that co-occurrence of sagebrush, juniper and cheatgrass—a proxy for vegetation interactions—most strongly influence these species' respective distributions. Drought conditions and the number of historical fires both drive species distributions as well, while restoration treatments exhibit more mixed success.

Potential impacts of future fires in the western Cascades: insights from spatial metrics of burn severity.

NW CASC Science Agenda Priorities: 2018 Deep Dive (Managing Western Washington Wildfire Risk in a Changing Climate). Interim Research Highlights: A NW CASC fellow has been examining the spatial patterns of contemporary fires (1985-2020) that have occurred across the forested ecoregions of the Northwest US, developing an atlas of scaling relationships that relate high-severity patch size and structure to overall fire size. They are evaluating whether and where contemporary fires in western Cascadia fall within this atlas of scaling law. Results will help quantify the anticipated future range of ecological impacts that may be expected from wildfire in the western Cascades, to inform both pre- and post-fire management strategies.

Climate change, salmon recovery, and environmental justice in Washington State floodplains.

NW CASC Science Agenda Priorities: 1.2.1., 1.3.1., 2.1.1. Interim Research Highlights: A NW CASC fellow interviewed Tribal natural resource managers to assess the degree to which they felt Floodplains By Design – an integrated floodplain management and habitat restoration program – was supporting their community's needs. They found that while the integrated approach of Floodplains By Design was driving solutions in some realms, Indigenous cultural needs and the biological factors that support them were systematically under-supported in regional floodplain management.

Impacts of a novel, invasive beachgrass hybrid on biodiversity and climate change-induced flooding risk in Pacific Northwest coastal dunes. NW CASC Science Agenda Priorities: 2.2.1., 3.1.1., 6.1.2. *Interim Research Highlights:* A NW CASC fellow has been working with community members to map a novel, invasive hybrid beachgrass and its parent species, and to measure its growth, morphology and ability to capture sand. Results indicate that the hybrid is much more abundant than previously anticipated and displays hybrid vigor in its stem height and density, two traits that are linked with the sand capture ability of vegetation. Results suggest that this new plant may modify dune landscapes in the future, with consequences for coastal protection, species diversity and other dune services.

Kelp in the Salish Sea: A comparative study of responses to climate change and marine heatwaves. NW CASC Science Agenda Priorities: 2.2.1, 2.2.2, 1.2. *Interim Research Highlights:* Habitat-forming kelp species and the communities that they support are at risk due to global change. A NW CASC fellow is working to understand the responses of kelps across the Salish Sea to warming and nutrient limitation through comparative thermal tolerance studies that compare kelp responses from a cool and warm region in an experimental marine heatwave.

Identifying and managing seeps as climate refugia. NW CASC Science Agenda Priorities: 1.1.1, 2.1.3, 2.2.2. *Interim Research Highlights:* A NW CASC fellow developed a tool that predicts locations of cliff-face seeps in the Pacific Northwest, making these important amphibian and mollusk habitats much easier to study. A major discovery of this project is that the spatial distribution of cliff-face seeps – long considered cryptic habitats – can be predicted using 1x1km-scale climate and 10x10m-scale landscape variables; this makes it possible to predict where cliff face seeps should occur in a given area simply by inputting raster layers containing environmental data and running their model. Now that they better understand where these habitats occur, they are researching which characteristics maximize their value as climate refugia for amphibians and mollusks.

Use of engineered log jams to promote hyporheic upwelling and cool-water refuge for chinook salmon in a thermally impaired river. NW CASC Science Agenda Priorities: 1.2, 1.2.4. *Interim Research Highlights:* A NW CASC fellow has been assessing the effectiveness of engineered log jam construction as a means of promoting upwellings of shallow subsurface (i.e., hyporheic) water to create cool-water refuge habitat allowing chinook salmon (*Oncorhynchus tshawytscha*) to persist in rivers affected by climate change. The results of this work will guide future habitat restoration and climate adaptation strategies for at-risk salmon populations.

Can we improve seedling handling protocols for better post-fire restoration success? NW CASC Science Agenda Priorities: 2020 Deep Dive (*Managing Post-fire Vegetation Change in a Warming Climate*). *Interim Research Highlights:* How current reforestation standard operating procedures for seedling handling influence western larch physiology, growth and survival in a future hotter and drier world is unclear. A NW CASC fellow has been examining whether reduced carbohydrate storage impairs seedling water relations, limits growth and ultimately reduces survival in western larch, a major species for reforestation in the northwest USA.

Akaitapitsiniksinists Ais'stimattsookinaan Aatsimani "Our Stories Show Us, Connectedness" Stakeholder perspectives of culturally important species of the Blackfoot. NW CASC Science Agenda Priorities: 1.1.2., 1.2.3., 1.2.4., 2.1.1., 2.2.1., Human Dimensions Goals 1 & 2. Interim Research Highlights: A NW CASC fellow's project aims to understand culturally relevant wildlife management of culturally important species by stakeholders directly and indirectly connected to Blackfeet culture through qualitative research methods. Outcomes will support culturally relevant climate adaptations for wildlife and habitat management for the Blackfeet Nation.

Modeling the hydrological consequences of wildfire and climate change in the seasonal temperate headwater catchments of the Pacific Northwest. NW CASC Science Agenda Priorities: 4.1.1., 4.2.1., 4.2.3., 6.1.1., 6.1.2., 2018 Deep Dive (Managing Western Washington Wildfire Risk in a Changing Climate). Interim Research Highlights: A NW CASC fellow's research aims to bolster the capacity for predicting, comparing and weighing tradeoffs among the cascading consequences of fire on forest, water and soil resources. Through a combination of stakeholder needs synthesis and numerical hydrological modeling experiments, they are identifying locations where the intersection of climate change and increased wildfire frequency in Northwest headwater catchments will have the greatest impact on aquatic systems and water resources.

Identifying dissolved oxygen refuges for redband trout to guide restoration and climate adaptation in the Upper Klamath Basin, Oregon. NW CASC Science Agenda Priorities: 1.1, 1.2, 1.3. Interim Research Highlights: A NW CASC fellow is using remote sensing data and dissolved oxygen loggers to map riverscape patterns of dissolved oxygen on the Sprague River, Oregon, and relate them to patterns of fish occupancy.

Models to management: Enhancing adaptive capacity on northwest rangelands with a Community-Based Rangeland Assessment and Monitoring System (CBRAMS). NW CASC Science Agenda Priorities: 2.1.5., 2.2.1., 2.1.1., 5.1.3. Interim Research Highlights: A NW CASC fellow is conducting a case study of the Wallow County Rangeland Assessment and Monitoring System – a community-based, multi-model information system that produces weekly assessments of forage quantity – to produce scientific, locally relevant information that can help increase the adaptive capacity of NE Oregon ranchers and rangelands.

Future of Fire in the Northwest: Towards a National Synthesis of Wildland Fire Under a Changing Climate. NW CASC Science Agenda Priorities: 2020 Deep Dive (Managing Post-fire Vegetation Change in a Warming Climate). This project is focused on mapping the vulnerability of Northwest forests to fire-driven transformations and co-producing new knowledge about how management activities can be used to resist, accept or direct likely ecosystem trajectories. With the USGS Climate Adaptation Postdoctoral Fellows cohort, knowledge about the state of the science on fire in the Northwest will be integrated into a national-scope synthesis of strategies to adapt people and ecosystems to the future of fire.

CAPACITY BUILDING

The NW CASC's goal is to build a community of practice of researchers and managers engaged in climate-adaptation oriented work and to foster their leadership in science-based resource management. Efforts in Year 5 were designed to advance novel research and promote the use of existing knowledge in support of climate adaptation decision making. To enhance researchers' proficiency to co-produce knowledge, the Consortium facilitated professional development opportunities in the form of four education, training and capacity-building activities, described below.

NW CASC FELLOWS PROGRAM. In Year 5, the University Consortium supported 13 research fellows, selected through a competitive RFP process in Year 4. Fellows represent each of the six Consortium universities; their research, described in the Science section above, spans all four Northwest states (WA, ID, MT, OR). All 2021-2022 fellows participated in a University of Washington graduate seminar, *The Theory and Practice of Linking Knowledge with Action to Address Modern Environmental Challenges*. During the seminar, the fellows learn key theories and best practices for producing actionable science. They meet with practitioners from academic, government and non-government entities working on actionable science to ground their learning in real-world, applied contexts. Fellows participate in monthly video cohort training calls covering topics including career pathways, building networks for co-production, communicating science to policy makers and journalists, developing compelling scientific presentations and other activities.

Four fellows from across cohorts (years 2018-2020) participated as research assistants in the Year 5 *Deep Dive* described above. These fellows supported working groups of managers and scientists, building skills in collaborative, transdisciplinary research and synthesizing different types of knowledge (literature, survey responses, meeting summaries) into key findings and actionable science recommendations.

NW CASC ACTIONABLE SCIENCE POSTDOCTORAL FELLOWSHIP. In Year 5, the NW CASC Actionable Science Postdoctoral Fellow continued to help facilitate the Center's actionable science efforts. She supported the process of evaluating both the NW CASC Fellows Program and other NW CASC capacity-building efforts, such as the *Deep Dive*. Though she has now moved on to a permanent position with a climate adaptation consulting group, she is continuing to work with NW CASC staff and partners to complete a manuscript with science-administration recommendations for supporting co-production research and another manuscript based on findings from the 2020 *Deep Dive*.

SUPPORTING THE REGIONAL COMMUNITY OF PRACTICE IN ACTIONABLE SCIENCE. The University Consortium continued to develop and deliver Actionable Science Skills-Building Webinars (four in Fall 2021 and two in Spring 2022) to help build regional capacity for generating and applying actionable climate science.

Fall 2021: Tribal Perspectives on Cross-Cultural Fire Management

Due to scheduling difficulties and an early fire season, the final webinar of our spring 2021 series was held in November 2021. This series was co-developed and co-sponsored by the U.S. Forest

Service. Tribal members Dr. Frank Lake and Monique Wynecoop from the U.S. Forest Service co-planned and co-hosted this series. This webinar series supported key capacity-building needs identified in the 2020 *Deep Dive* actionable science agenda, including *elevating the experience and expertise of tribal Nations and developing opportunities for effective knowledge exchange and learning with Northwest communities and Tribal Nations to better incorporate diverse values, cultures and knowledges into practices and policies for managing post-fire vegetation transitions.*

November 2021: *Tribal Experiences in Collaborative Fire Management in the Northwest*

Fall 2021: *Practical Frameworks for Collaborative Climate Adaptation Research*

The goals of this webinar series were to increase exposure to new co-production literature and to offer practical recommendations for researchers and managers to consider in their work. The publications featured in this series were open access, included a strong equity lens and supported the NW CASC's mission and priorities.

November 2021: *Rethinking Authorship Guidelines to Recognize Diverse Contributions in Collaborative Research*

December 2021: *Promoting Collaboration Between Evolutionary Biologists and Conservation Practitioners to Help Species Adapt to a Changing World*

December 2021: *Decolonizing Ecology: Five Steps Towards More Inclusive and Ethical Research Practice*

Spring 2022: *Practical Frameworks for Collaborative Climate Adaptation Research (Part II)*

This webinar series is a continuation of the fall 2021 series, with the same goals and paper criteria.

May 2022: *Environmental Science with (not at) Society*

June 2022: *Meeting Today's Climate Challenges by Transforming Science Training*

SUPPORTING THE REGIONAL COMMUNITY OF PRACTICE IN ACTIONABLE SCIENCE. The University Consortium organized a Deep Dive virtual workshop that engaged ~100 participants from federal and state agencies, Tribal governments, universities, NGOs and other entities in a working group process to help create a community of practice for managing climate-driven changes in Northwest stream permanence.

COMMUNICATIONS

During Year 5, the NW CASC University Consortium communications program used multiple channels to promote NW CASC activities and facilitate information sharing, mutual learning and action within and beyond the NW CASC network.

COMMUNICATIONS CHANNELS & PRODUCTS. **Website Updates:** Continued to keep the NW CASC website up to date with most-recent projects, publications, webinars and announcements. Published a new *Introduction to Actionable Science* page, which walks users through the stages of a co-produced, actionable science research process and offers considerations for building effective partnerships along with curated lists of relevant literature and other resources.

Newsletter: Distributed five issues of the *NW CASC Connections* electronic newsletter, sent every other month, to connect NW CASC audiences with NW CASC science, products, opportunities and resources. **Actionable Science & Informational Webinars:** Hosted six Actionable Climate Science Skills-Building Webinars, designed to build capacity for effective engagement between research and management communities. Hosted a welcome call for new 2021 fellows and advisors and a Q&A webinar for graduate students and postdocs interested in applying for the NW CASC's 2022 Research Fellowship Program. **Social Media:** Continued to share relevant announcements through Twitter to connect NW CASC consortium partners with activities and opportunities within and outside of the network and to elevate the work of other CASCs.

COMMUNICATIONS SUPPORT. NW CASC Research Fellowship Program: Supported NW CASC research fellows by providing individual communications guidance; promoting their research through NW CASC channels; sharing relevant funding and training opportunities; and leading a cohort call about effective meeting planning and facilitation. **USGS-funded projects:** Supported several USGS-funded research projects through meeting with new PIs to discuss project-specific communication opportunities and sharing NW CASC science through various channels. Worked with project PIs to start developing an infographic to help communicate project findings to partners.

CASC NETWORK COMMUNICATIONS. USGS Highlights: Submitted routine highlights to inform USGS of upcoming, high-profile activities within the NW CASC network. **Climate Adaptation Insights Newsletter:** Provided regular submissions for consideration in the Climate Adaptation Insights newsletter. **CASC Network Collaboration Calls:** Communications Manager attended calls every other month to stay informed of activities and connect with communications staff across the network. **CASC Network Communication Calls:** Communications Manager led monthly cross-CASC communications calls to plan communication campaigns, reflect on cross-CASC communications goals (e.g. planned a Mural brainstorming session to set 2022 cross-CASC communication priorities and gather feedback from CASC communicators), and keep communications staff apprised of communications activities across the network (e.g. organized a Pecha Kucha-style virtual event in which all CASCs shared rapid presentations on their programs and upcoming events). These calls also provided a space to ask communications questions, share best practices and receive updates on communication guidance from the National CASC. After leading these calls since fall 2020, the National CASC has offered to start leading and coordinating these calls starting in June 2022.

COMMUNICATIONS STRATEGY. Consortium Strategic Communications Planning: Implemented the communications strategy developed in Year 4. This plan aligns with and supports the NW CASC's other programs and overarching mission. **Evaluation:** Conducted rigorous evaluation of communications channels and efforts, including the NW CASC website, Twitter, newsletter and webinars.

OUTREACH

PUBLICATIONS

Peer-Reviewed

Agne, M.C., J.B. Fontaine, N.J. Enright, S.M. Bisbing, and **B.J. Harvey.** 2022. Demographic processes underpinning post-fire resilience in California closed-cone pine forests: the importance of fire interval, stand structure, and climate. *Plant Ecology* 19:1-17.

Applestein, C., and M.J. Germino. 2021. Detecting shrub recovery in sagebrush steppe: comparing Landsat-derived maps with field data on historical wildfires. *Fire Ecology* 17:1-11.

**Published in February 2021 - including in this list as we did not report on it last year.*

Applestein, C., A.B. Simler-Williamson, and M.J. Germino. 2021. Weather and distance to fire refugia limit landscape-level occurrence of fungal disease in an exotic annual grass. *Journal of Ecology* 109:2247-2260.

**Published in March 2021 - including in this list as we did not report on it last year.*

Bell, D.A., R.P. Kovach, C.C. Muhlfeld, R. Al-Chokhachy, T.J. Cline, D.C. Whited, D.A. Schmetterling, P.M. Lukacs, and A.R. Whiteley. 2021. Climate change and expanding invasive species drive widespread declines of native trout in the northern Rocky Mountains, USA. *Science Advances* 7:1-11.

Bell, D.A., R.P. Kovach, Z. L. Robinson, A. R. Whiteley, and T.E. Reed. 2021. The ecological causes and consequences of hard versus soft selection. *Ecology Letters* 24:1505-1521.

**Published in May 2021 - including in this list as we did not report on it last year.*

Carter, S., **C.B. van Rees, B.K. Hand,** C.C. Muhlfeld, G. Luikart, and J.S. Kimball. 2021. Testing a generalizable machine learning workflow for aquatic invasive species on rainbow trout (*Oncorhynchus mykiss*) in Northwest Montana. *Frontiers in Big Data* 7:34990.

Emmet, R.L., R.A. Long, and B. Gardner. 2021. Modeling multi-scale occupancy for monitoring rare and highly mobile species. *Ecosphere* 12:e03637.

Healy, S.M., and **A.L. Khan.** 2022. Mapping glacier ablation with a UAV in the North Cascades: A structure-from-motion approach. *Frontiers in Remote Sensing* 2:764765.

Howard, L., **C.B. van Rees,** Z. Dahlquist, G. Luikart, and **B.K. Hand.** 2022. A review of invasive species reporting apps for citizen science and opportunities for innovation. *NeoBiota* 71:165-188.

Robinson, Z. L., **D.A. Bell,** T. Dhendup, G. Luikart, A. R. Whiteley, and M. Kardos. 2021. Evaluating the outcomes of genetic rescue attempts. *Conservation Biology* 35:666-677.

**Published online in March 2021 - including in this list as we did not report on it last year.*

Vadeboncoeur, Y., M.V. Moore, S.D. Stewart, S. Chandra, K.S. Atkins, J.S. Baron, K. Bouma-Gregson, S. Brothers, S.N. Francoeur, **L. Genzoli,** S.N. Higgins, S. Hilt, L.R. Katona, D. Kelly, I.A. Oleksy, T. Ozersky, M.E. Power, D. Roberts, A.P. Smits, O. Timoshkin, F. Tromboni, M.J. Vander Zanden, E.A. Volkova, S. Waters, S.A. Wood, and M. Yamamuro. 2021. Blue waters, green bottoms: benthic filamentous algal blooms (FAVS) are an emerging threat to clear lakes worldwide. *Bioscience* 71:1011-1027.

Van Rees, C. B., B. K. Hand, S. C. Carter, C. Barger, T. J. Cline, W. Daniel, J. A. Ferrante, K. Gaddis, M. E. Hunter, C. S. Jarnevich, M. A. McGeoch, J.T. Morissette, M. E. Neilson, H. E. Roy, M. **A. Rozance,** A. Sepulveda, R. D. Wallace, D. Whited, T. Wilcox, J. S. Kimball, and G. Luikart. 2022. A framework to integrate innovations in invasion science for proactive management. *Biological Reviews* (page numbers not yet available).

Peer-Reviewed: In Process

Barrett, H.S., and J.B. Armstrong. Move, migrate, or tolerate: quantifying three tactics for coldwater fish coping with warm summers in a large river. *Ecosphere*. *Accepted*.

Davis, K., M.A. Rozance, and M. Krosby. Managing climate-driven, post-fire ecosystem transformation: Science, capacity and coordination needs for proactive landscape management. *Manuscript in preparation*.

Elmstrom, E. The climate sensitivity of water quality in the Pacific Northwest: Linking anticipated shifts in hydrologic regime to riverine nitrogen sources in Puget Sound watersheds. *Manuscript in preparation*.

Malison, R. Tolerance of alpine stoneflies to a changing climate: Local adaptation and gene flow in mountaintop environments. *Manuscript in preparation, targeting PNAS*.

McClure, M., B. Ward, N. Stevenson-Molnar, and G. Howe. A new climate-based seed zone system for the Pacific Northwest. *Manuscript in preparation*.

Rozance, M.A., M. Krosby, A.K. Snover, A. Meadow, and G. Garffin. Mobilizing science to support ambitious climate adaptation. *Manuscript in preparation*.

Sorel, M.H., A.R. Murdoch, R.W. Zabel, C.M. Kamphaus, E.R. Buhle, M.D. Scheuerell, and **S.J. Converse.** Effects of population density and environmental conditions on life-history expression in a migratory fish. *Ecology*. *In Review*.

Sorel, M.H., A.R. Murdoch, R.W. Zabel, J.C. Jorgensen, C.M. Kamphaus, and **S.J. Converse.** Juvenile life history diversity is associated with lifetime demographic heterogeneity in a migratory fish. *Ecosphere*. *In Review*.

Reports

Agne, M.C., and **B.J. Harvey.** 2022. The race between fuels and fruits: testing mechanisms of serotinous forest resilience to short-interval severe reburns. Joint Fire Science Program Final Report (Project ID: 19-1-01-16). 31 pp.

Mauger, G.S., Rozance, M.A., Agne, M., Pazdral, R., Robinson, J., Swensen, K., Kaiser, K.E., Pitt, P., Glenn, B. 2021. A Deep Dive into Shallow Waters: Understanding and Responding to Climate-Induced Impacts on Stream Permanence in the Northwestern US. Northwest Climate Adaptation Science Center, University of Washington, Seattle.

PRESENTATIONS

In Year 5, NW CASC Consortium personnel delivered 26 presentations on NW CASC-funded research to diverse audiences including academic departments, academic society meetings, non-profit organizations, regional conferences and working groups, including: University of Washington School of Aquatic and Fishery Sciences, Pacific Estuarine Research Society, The Nature Conservancy, Cascadia Innovation Corridor Conference, and the Puget Sound Kelp Research and Monitoring Workgroup Meeting. Additionally, eight webinars (six actionable science webinars and two informational webinars) were given to broader Northwest audiences that included a mix of resource managers, researchers and students.

MEDIA COVERAGE

Media coverage featuring the NW CASC University Consortium-funded University Leadership Team (*) and fellows (+), UW cost share-funded fellows (++) and climate science affiliates (^):

Bell, Donovan.+ Feb 2022. Climate change and invasive species are driving native trout declines in Montana. Newsbreak.

Bell, Donovan.+ Feb 2022. Guest column: Climate provisions belong in the Build Back Better bill. Bozeman Daily Chronicle.

Bell, Donovan.+ Jan 2022. Anglers are seeking a solid climate policy. Missoulian.

Bell, Donovan.+ Jan 2022. Opinion: Man-made energy better for Montana. Missoulian.

Bell, Donovan.+ Jan 2022. Climate change is helping invasive species take over trout habitats in Montana, study says. The Independent.

Bell, Donovan.+ Jan 2022. Climate change contributes to native trout declines. Azocleantech.com.

Bell, Donovan.+ Jan 2022. Study: Climate change, invasive species drive native trout declines. Daily Inter Lake.

Bell, Donovan.+ Jan 2022. Study: Climate change, invasive species drive native trout declines. EurekAlert!.

Bell, Donovan.+ Jan 2022. Climate change, invasive species drive native trout declines. Mirage News.

Bell, Donovan.+ Jan 2022. Climate change, invasive species found to drive native trout declines. Phys.org.

Bell, Donovan.+ Jan 2022. Climate change, invasive species drive native trout declines. Science Daily.

Bell, Donovan.+ Jan 2022. Study: Climate change, invasive species drive native trout declines. Bioengineer.org

Bell, Donovan.+ Jan 2022. Study: Climate change, invasive species drive native trout declines. ScienMag.

Fales, Robin.++ Nov 2021. How heat waves warp ecosystems. High Country News.

Fales, Robin.++ Dec 2021, PNW scientists find ruin and resilience after summer heat wave. Crosscut.

Greenler, Skye.+ Sept 2021. Centering Indigenous fire stewardship. Oregon State University.

Krosby, Meade.* Mar 2022. New infrastructure package could help reduce damage to wildlife. Newsy.

Krosby, Meade.* Feb 2022. Northwestern farmers are losing crops to hungry elk. NPR.

Krosby, Meade.* Jan 2022. Floods cut off Seattle from the rest of the US. Reuters.

Krosby, Meade.* Jan 2022. Evacuations, search for missing persons continue after flooding in Washington. MyNorthwest.

Krosby, Meade.* Dec 2021. For the Northwest, climate change was hard to ignore in 2021. KUOW.

Krosby, Meade.* Dec 2021. Famously soggy Seattle sees its wettest fall on record. Associated Press.

Krosby, Meade.* Nov 2021. Big Northwest floods a 'dress rehearsal' for a hotter climate. KUOW.

Malison, Rachel.+ Nov 2021. From alpine to aquifer: stoneflies in strange places. National Park Service.

Nelson, Laura.++ Jun 2021. Scientists in action: Laura Nelson. The Nature Conservancy, Washington.

Ortega, Jordan.+ Nov 2021. Warm-water habitat 'pays the bills,' allowing cold-water fish to fuel up. Oregon State Newsroom.

Pradhan, Kavya.++ Jun 2021. Scientists in action: Kavya Pradhan. The Nature Conservancy, Washington.

Snover, Amy.* Feb. 2022. Valley Life: Winthrop. Column, Methow Valley News.

Snover, Amy.* Nov. 2021. With climate models predicting less snow, local ski areas look to adapt. The Spokesman-Review.

Snover, Amy.* Nov. 2021. WA's frontline communities face the brunt of climate change. Crosscut Op-Ed.

Snover, Amy.* Sept. 2021. Changing climate, changing health. Methow Valley News.

Snover, Amy.* Aug. 2021. Climate Change & the future of outdoor adventuring. Crosscut Event.

Snover, Amy.* Aug. 2021. Climate change and the future of outdoor recreation. Crosscut Live: Northwest Newsmakers.

Snover, Amy.* Aug. 2021. Unequivocal. Unprecedented. Extreme. Irreversible. But not hopeless. The Daily Sentinel.

Snover, Amy.* Aug. 2021. Climate change and its impact on hunting, angling, and other recreational pursuits. Washington Department of Fish and Wildlife.

Snover, Amy.* Aug. 2021. In a summer of smoke, a small town wonders: 'How are we going to do better than survive? The Washington Post.

Snover, Amy.* Aug 2021. Reconsidering outdoor travel in the West, as wildfires burn. The New York Times.

Snover, Amy.* July 2021. Critters search for shade during Washington's heat wave, possible harbinger of future climate conditions. The Spokesman-Review.

Snover, Amy.* June 2021. Carbon in Earth's atmosphere reaches highest mark in modern history, scientists say. KOMO News.

STAKEHOLDER ENGAGEMENT

Research supported by the NW CASC in Year 5 was conducted in close partnership with natural resource managers. Partner engagement was supported by the actionable science skills-building activities and cohort calls provided by the NW CASC Research Fellowship Program. In Year 5, the 13 newly funded projects culminated in numerous project meetings and workshops led by the fellows, specific to co-producing science with resource managers, stakeholders and other scientists from 27 agencies and organizations. Fellows reported having weekly, biweekly or monthly meetings with their natural resource management partners. Partnering organizations included tribal, federal, state and county governments and NGOs, including: the Klamath Tribes, Lummi Nation, Nez Perce Tribe, National Park Service, Bureau of Land Management, Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, King County and The Nature Conservancy and others. Some fellows partnered with existing multi-partner collaborative efforts, for example, Floodplains By Design.

Fellows communicated extensively with resource managers and other partners through regular meetings, organized workshops, presentations and consultations through one-on-one meetings, phone conversations and email communications. This collaboration with resource agencies has shaped research questions, methodologies and analysis and given fellows first-hand experience collaborating with resource managers outside their university setting. The 2021 *Deep Dive* (described under 'Science', above) engaged a diverse group of ~100 stakeholders – both resource managers and scientists – whose work relates to changes in stream permanence in a warming climate. Scientists participated from universities and agencies including the University of Washington, Boise State University, U.S. Geological Survey and U.S. Forest Service. Natural resource managers participated from tribal, federal, state and other agencies, including Yakama Nation, Nez Perce Tribe, Columbia River InterTribal Fisheries Commission, U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, Washington Department of Natural Resources and Oregon Department of Fish and Wildlife, as well as non-governmental organizations such as Conservation Science Partners and the Upper Columbia Salmon Recovery Board. Participants examined the state of knowledge around biophysical, practice and human dimensions of the issue. Knowledge syntheses were supported by four NW CASC fellows who acted as research assistants. Participants convened monthly between June-August to review progress towards knowledge syntheses and identify remaining knowledge gaps and capacity needs, culminating in a fall *Deep Dive* workshop.

OTHER PRODUCTS FROM NW CASC-FUNDED RESEARCH PROJECTS

During Year 5, in addition to peer-reviewed publications and reports, NW CASC Consortium-funded research projects also produced:

PRODUCTS. Draft maps, including spatial predictions of species distribution model outputs for juniper, sagebrush and cheatgrass in the Northern Great Basin. Additional maps may be provided to the BLM upon request. Datasets, including the cleaned data frame of covariates used in all models and an adjacency matrix required for constructing conditional autoregressive models with grazing allotments as an areal unit. **RESEARCH PROJECT:** The role of wildfire, vegetation interactions, and climate dynamics in Great Basin plant species distributions.

PRODUCTS. Dataset: Locations of all 117 currently known hybrid patch points. Datasets in progress: the distribution and abundance of the hybrid beachgrass; the growth of the hybrid beachgrass compared to its parent species; the growth form and morphology of the hybrid beachgrass compared to its parent species; the sand capture of the hybrid beachgrass compared to its parent species. Map of currently known hybrid patch locations: a shareable version on Google My Maps as well as a map intended for presentations. **RESEARCH PROJECT:** Impacts of a novel, invasive beachgrass hybrid on biodiversity and climate change-induced flooding risk in Pacific Northwest coastal dunes.

PRODUCTS. A dataset of seep occurrences. Maps for management partners (following project completion): (1) a map of species observations, (2) a map of observed seep locations, (3) maps showing predicted seep occurrences in Mount Rainier and Olympic National Parks, (4) maps showing current and predicted future habitat suitability for seep-associated species detected in this study, and (5) maps showing predicted patterns of seep thermal and hydrologic stability. A tool that allows managers to plug raster layers for any area in the PNW into R and receive a map of predicted seep locations across the landscape as an output (in progress). **RESEARCH PROJECT:** Identifying and managing seeps as climate refugia.

PRODUCTS. A soft launch of a workshop to train wildlife scientists, policymakers and students about working with Indigenous People. The workshop will be held at The Wildlife Society national conference in Spokane in November 2022. **RESEARCH PROJECT:** Akaitapitsiniksini Ais'timattsookinaan Aatsimani "Our Stories Show Us, Connectedness" Stakeholder perspectives of culturally important species of the Blackfoot.

PRODUCTS. Community-Based Rangeland Assessment and Monitoring System: WC-LEWS initially draws on weekly datasets produced by the PHYGROW/LEWS model that forecast forage at field survey locations. Forecasts are based on plant response to available soil moisture (i.e. rainfall after the model accounts for soil and terrain types) and then offtake by livestock and wild ungulates. This information is available at the Global Livestock Early Warning System (GLEWS) website:

<https://cnrit.tamu.edu/glews/>. At the core of the PHYGROW/LEWS model is a series of datasets that the model uses to make its forage forecasts. These datasets detail plant species composition and biomass production at PHYGROW survey sites, 15 years of grazing effort data (for USFS, TNC and other private pastures), and grazing preference by plant species for cattle, sheep, elk and deer. The

initial site-based PHYGROW/LEWS forecasts are mapped across Wallowa County using a random systematic distribution of site-specific estimates as associated with NRCS Ecological Site Description data. These maps are available in interactive format on the WC-LEWS website/dashboard: <https://arcg.is/0DfefD0>. These maps are also made available in PDF format via bi-weekly WC-LEWS email notifications. **RESEARCH PROJECT:** Models to management: Enhancing adaptive capacity on northwest rangelands with a Community-Based Rangeland Assessment and Monitoring System (CBRAMS).

CONGRESSIONAL OUTREACH

During Year 5, the NW CASC continued to participate in the cross-CASC effort to provide outreach and education to Congressional offices about the role and activities of the CASCs and the expressed science and capacity needs of CASC stakeholders regarding climate adaptation for natural and cultural resources.

CROSS-CASC CONTRIBUTIONS

In Year 5, the NW CASC collaborated with working groups across the CASC network on a range of initiatives. The NW CASC Communications Manager continued to lead the cross-CASC communications calls. Through these calls, the communications manager led a reflection and work prioritization activity as well as a virtual event for CASCs to share overviews of their communication programs and activities in the upcoming year.

The NW CASC University Director facilitated coordination of CASC network university leadership through monthly meetings of all regional CASC university directors, monthly meetings for university directors and NCASC leadership and quarterly meetings for all regional CASC university directors and deputy/assistant directors. With the University of Oklahoma (SC CASC) and the NE CASC USGS Director, the NW CASC/UW coordinated a collaborative cross-CASC visioning effort to develop and discuss ideas for advancing climate resilience work across our network and the nation. Working groups focused on the topics of Climate Adaptation Technical Services (CATS) and developing cross-CASC collaborative processes to achieve high-impact, actionable science.

NEXT STEPS

During Year 6 of the NW CASC award, we anticipate engaging in the following activities:

CENTER & CONSORTIUM OPERATIONS. We will continue regular meetings and communication among NW CASC University and USGS staff and with the NW CASC University Leadership Team.

HOST INSTITUTION PROGRAMS. The NW CASC will continue to partner with the Doris Duke Conservation Scholars Program to support climate adaptation internships for undergraduate students and program alumni from underrepresented groups.

TRIBAL ENGAGEMENT. During Year 6 we intend to restart the coordination meetings for the NW CASC, the NW tribal liaison and the Affiliated Tribes of Northwest Indians, which have been on hold because of Covid-related impacts on our tribal partners during Year 4 and changes in tribal partner leadership during Year 5. We will continue to work collaboratively to support tribal adaptation work in the NW.

SCIENCE FOR MANAGEMENT. Year 5 Consortium-funded science projects will be completed during summer/fall 2022. Year 6 science projects have been identified and will begin during summer/fall 2022. The NW CASC Climate Adaptation Postdoctoral Fellow will begin their second year of work in the cross-CASC *Future of Fire* postdoctoral cohort. We will scope, plan and implement the 2022-2023 *Deep Dive*, likely focused on issues related to management and adaptation of coastal ecosystems and the communities they support in response to sea level rise. The NW CASC will support planning and preparation for the 12th Annual NW Climate Conference, which will be held in Boise, Idaho, in Fall 2022 and hosted by Boise State University under the leadership of Lejo Flores, NW CASC co-PI.

NW CASC FELLOWS. Our sixth cohort of NW CASC fellows will begin cohort activities during fall 2022. This cohort includes five MS candidates, five PhD candidates and one postdoctoral fellow spread across all six consortium universities. Fellows will participate in monthly cohort training calls, Actionable Science Skills-Building Webinars, the Actionable Science Graduate Seminar and the NW Climate Conference.

CAPACITY-BUILDING ACTIVITIES. During Year 6, the NW CASC will convene our 2022 *Deep Dive* workshop. The *Deep Dive* workshop will review the state of knowledge synthesis and enable participant co-development of an actionable science agenda for addressing climate impacts on coastal processes. During Year 6, we also anticipate hosting two series (fall/spring) of skills-building webinars.

COMMUNICATION. During Year 6, the NW CASC will continue to connect its audiences to NW CASC-funded science, resources and opportunities through up-to-date, clear and accessible communication channels. We will continue implementing our communications plan and evaluating the efficacy of new and existing communications efforts. This includes exploring ways to better collate and highlight NW CASC science products through various channels.

NATIONAL NETWORK. During Year 6, the NW CASC will participate in CASC network university leadership collaborations. NW CASC leadership will continue to advise NCASC on development and implementation of the Climate Adaptation Postdoctoral Fellows Program through participation on the CAP fellows leadership committee. The NW CASC Communications Manager will participate in the monthly cross-CASC communications calls and the bimonthly network collaboration calls.

CONGRESSIONAL OUTREACH. During Year 6, the NW CASC will continue to participate in the cross-CASC effort to provide outreach and education to Congressional offices about the role and activities of the CASCs and the expressed science and capacity needs of CASC stakeholders regarding climate adaptation for natural and cultural resources.

BUDGET

Table 4. NW Climate Adaptation Science Center Budget Summary. Award and cost-share spending each represent the sum of actual spending through 30 April 2022 and projected spending for May-July 2022. See notes in budget below for budget spending variances.

APPENDIX: PRESENTATIONS

Formal presentations delivered by the NW CASC University Consortium-funded University Leadership Team (*) and fellows (+), UW cost share-funded fellows (++), Tribal Liaison (~), climate science affiliates (^) and NW CASC Fellow Advisors (#) include:

Askerooth, R.+, M. Mostow, H. Ly, R. Antaki, and **S. Hacker.#** 2021. *Discovery that a novel invasive beachgrass hybrid (*Ammophila arenaria* x *A. breviligulata*) is widespread across Oregon and Washington coastal dunes*. State of the Coast Annual Meeting.

Askerooth, R+, H. Ly, M. Mostow, R. Antaki, and **S. Hacker.#** Apr 2022. *Investigating the distribution and abundance of a new, invasive beachgrass hybrid (*Ammophila arenaria* x *A. breviligulata*) across Oregon and Washington coastal dunes*. The Cascadia Coastlines and Peoples Hazards Research Hub Annual Meeting.

Askerooth, R.+, R. Edgell, R. Mostow, H. Ly, R. Antaki, P. Ruggiero, and **S. Hacker.#** Mar 2022. *Playing dune detective with UAV-based imagery: Mapping the density and location of a new, invasive hybrid beachgrass (*Ammophila arenaria* x *A. breviligulata*)*. 2022 Pacific Estuarine Research Society Annual Meeting. *First place student award

Buonanduci, M.,++ D.C. Donato, J.S. Halofsky, M.C. Kennedy, and **B.J. Harvey.#** May 2022. *Western Cascadia wildfire: spatial patterns of burn severity and implications for future ecological impacts*. University of Washington School of Aquatic and Fishery Sciences Quantitative Seminar Series.

Buonanduci, M.,++ D.C. Donato, J.S. Halofsky, and **B.J. Harvey.#** Nov 2021. *Potential impacts of future fires in western Cascadia: scaling spatial patterns of burn severity*. International Fire Ecology and Management Congress.

Fales, Robin.++ May 2022. *Bull kelp thermotolerance across the Salish Sea: understanding temperature and nutrient stressors*. Puget Sound Kelp Research and Monitoring Workgroup Meeting.

Greenler S.,+ F. Lake, S. Prichard, P. Hessburg, C. Dunn, W. Tripp, W. Harling, and J. Bailey. Mar 2022. *Collaboratively mapping cultural fire regimes in Northern California: Co-production to advance landscape fire modeling*. International Association for Landscape Ecology - North America Annual Meeting.

Greenler S.,+ F. Lake, S. Prichard, P. Hessburg, C. Dunn, W. Tripp, W. Harling, and J. Bailey. Nov 2021. *Burning for people, wildlife, and landscapes: Modeling cultural fire regimes in the California Klamath Mountains*. International Fire Ecology and Management Congress.

Huffman M., W. Harling, **S. Greenler,+** and S. Thrower. Nov 2021. *Support from non-Indigenous partners panel discussion: Advances and challenges for Indigenous fire stewardship*. International Fire Ecology and Management Congress.

Greenler, Skye.+ Nov 2021. *Integrating cultural fire regime characteristics into fire and climate modeling*. Northwest Climate Adaptation Science Center Advisory Committee Meeting.

Greenler, Skye.+ Oct 2021. *Collaborative development of culturally informed, landscape-scale fire models in Northern California*. Oregon State University Board of Trustees.

King, Kelsey.+ May 2022. *Management under climate change: Understanding how phenological shifts may alter floral resources for Fender's blue butterfly*. USFWS Science of the Service Conference.

Krosby, Meade.* Sept. 2021. *Co-producing the tribal climate tool*. National Tribal Resilience Data Workgroup.

Krosby, Meade.* Oct. 2021. *Climate change impacts on natural hazards in the West*. Integrating Climate Change into Hazard Mitigation Plans Workshop, Institute for Tribal Environmental Professionals and Bureau of Indian Affairs.

Krosby, Meade.* Mar. 2021. *Key consideration for climate adaptation planning*. Olympic Coast National Marine Sanctuary.

Malison, R.L.,+ J. Giersch, T. Cosart, S. Hotaling, J. Kelley, H.A. Woods, C. Muhlfeld, J.A. Stanford, G. Luikart, and **B.K. Hand.**# May 2022. *Local adaptation, gene flow, physiological tolerance, and population vulnerability to climate variation among stoneflies in mountaintop environments*. Joint Aquatic Sciences Meeting.

Noonan, Fiona.+ Dec 2021. *The role of wildfire, restoration, and climate in the distributions of Northern Great Basin plant species*. Idaho EPSCoR Genes by Environment: Mapping, Modeling, and Mechanisms (GEM3) 2021 Annual Meeting.

Noonan, Fiona.+ Apr 2022. *The role of wildfire, restoration, and vegetation dynamics in the distributions of Northern Great Basin plant species*. International Association for Landscape Ecology - North America 2022 Annual Meeting.

Pradhan, Kavya.++ Jun 2022. *Addressing the challenge of applying climate change refugia in forest management*. 2022 International Biogeography Conference.

Rockweit, Jeremy,+ Katie M. Dugger, Damon B. Lesmeister, Alan B. Franklin, Raymond J. Davis, and J. Mark Higley. Oct 2021. *Historical effects of wildfire on an old forest species and its potential to inform climate change impacts*. Annual meeting of The Wildlife Society.

Snover, Amy.* Feb 2022. *Creating a climate resilient Northwest*. Brighton Jones Community Impact Circle.

Snover, Amy.* Nov 2021. *Facing climate change in Cascadia*. Cascadia Innovation Corridor 2021 Conference.

Snover, Amy.* Oct 2021. *Climate risk in the Northwest*. Washington State Office of the Insurance Commissioner Climate Summit 2021.

Snover, Amy.* May 2021. *Motivating local action to address climate impacts and build resilience*. National Academies' Applied Research Topics for Hazard Mitigation and Resilience Workshop, Panel 2: Translating Data for Motivating Local Resilience Action.

Sorel, Mark.++ Nov 2021. *Asynchrony, tradeoffs, and climate drivers: evaluating demographic rates of spring Chinook salmon juvenile life history pathways*. American Fisheries Society Annual Meeting.

Zimmerman, O.,++ and T. Eison. May 2022. *Centering Indigenous perspectives in floodplain management*. The Nature Conservancy Lunch and Learn Series.