Oregon State University
College of Forestry

Fish and Wildlife Habitat in Managed Forests Research Program

Progress Reports

Nov 18, 2022

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Fish and Wildlife Habitat in Managed Forests

Final Report

Title: Biodiversity in Natural and Managed Early Seral Forests of Southern Oregon

Investigators: Meg Krawchuk, Matthew Betts, James Rivers, A.J. Kroll, Jake Verschuyl, Mark Swanson

Objectives: Our objective for this project is to document how plantation forestry alters biodiversity and temporal characteristics of the early seral period in comparison to its primary natural counterpart, stand-replacing wildfire. At the same time, we investigate the extent to which active management may support species and communities traditionally associated with natural disturbance.

To address our objectives we conducted a large-scale retrospective study of biodiversity in early seral Douglas-fir forest types of southwestern Oregon.

Our biodiversity metrics include:

- plant community and forest structure
- carabid beetle communities
- invertebrate pollinator communities, particularly bees
- bird communities, specifically songbirds and woodpeckers

We are comparing responses to 1) community development, structure, and biodiversity after stand replacing fire on public lands (*SRFire*), 2) after wildfire and timber salvage/management on public lands (*FSalvage*), and 3) managed regeneration plantation forestry on private lands (*IFM*). We stratified our sampling across three different periods of early stand development: *young* (1 to 5 years since disturbance), *adolescent* (6 to 12 years), and *old* (13 to 20 years) periods.

Field data were successfully collected over three seasons (2019, 2021, 2022), led by College of Forestry PhD candidate Graham Frank. The field season in 2020 was cancelled due to COVID-19, but still collected data across a three-year period as described in the proposal.

FWHMF funding supported Graham Frank for his PhD program from September 2018-September 2022, including an extra year of funding due to the loss of the 2020 field season. NCASI funding supported field costs and is now supporting Graham in the final year of his PhD (2022/2023) during which analysis and final results are being developed for Graham's dissertation. Accordingly, this FWHMF final report summarizes initial results from the work but cannot provide a synthetic quantitative product – this will be available in Summer/Fall 2023.

Summary of Accomplishments toward Objectives:

We are excited to have successfully completed all field data collection for the project and to be heading into the final year of work with a focus from PhD candidate Graham Frank on data analysis, writing, outreach, and eventually dissertation defense. We plan to tackle datasets and dissertation chapters for individual taxa sequentially, focusing on birds, then ground beetles, and finally bees as the year progresses. Below, we summarize our data collection for all taxa and some initial results demonstrating findings of the work.

<u>Stand Characteristics</u>

Across three field seasons, we sampled a total of 69 early seral forest stands. As much as possible, we attempted to maintain similar distributions of key biophysical characteristics among disturbance-age categories to avoid confounding sources of variation (Table 1).

Table 1: Count of stands sampled in each disturbance-age category, as well as mean (sd) values for stand age (years), elevation (meters), and heat load index (HLI, 0-1). We completed observations of 1/3 of stands in each field season, for a total of 69 early seral forest stands.

	SRFire			IFM			FSalvage
	Young	Adolescent	Old	Young	Adolescent	Old	Adolescent
n	10	10	9	10	10	9	11
Stand age	3.2 (1.2)	7.4 (1.2)	18.9 (1.2)	3.7 (0.9)	7.3 (1.3)	18.2 (1.3)	7.5 (1.1)
Elevation	656 (172)	680 (137)	807 (442)	710 (140)	689 (121)	637 (121)	767 (177)
HLI	0.75 (0.17)	0.69 (0.20)	0.74 (0.15)	0.77 (0.17)	0.72 (0.15)	0.75 (0.12)	0.66 (0.17)

Bird communities

Our final dataset of avian communities contains nearly 3,000 detections of 71 distinct species, 64 of which were detected more than once. We are currently in the process of refining occupancy models that will allow us to estimate community-level responses while accounting for imperfect detection, including species richness and species dissimilarity (i.e., amount of overlap in composition). We are also partitioning comparisons by functional guild, focusing on groupings we expect to respond to the key structural and compositional differences among different forms of early seral, including leaf-gleaners, ground-foragers, and cavity-nesters. Preliminary results suggest that species richness is higher in *SRFire* early seral than *IFM* in the years immediately following each disturbance event, but eventually converges (Figure 1). Community composition appears to follow a similar trend, with the least overlap between disturbance types occurring in the most recently disturbed stands. Our initial results indicate that richness in adolescent *FSalvage* stands is comparable to *SRFire* stands of the same age, but with fewer cavity nesting species and more ground foragers. As we continue to drill into this dataset, we are also examining how bird communities vary across gradients in snag abundance, vegetation structure, and vegetation composition, with an additional focus on covariates that explain fine-scale habitat use for individual species.

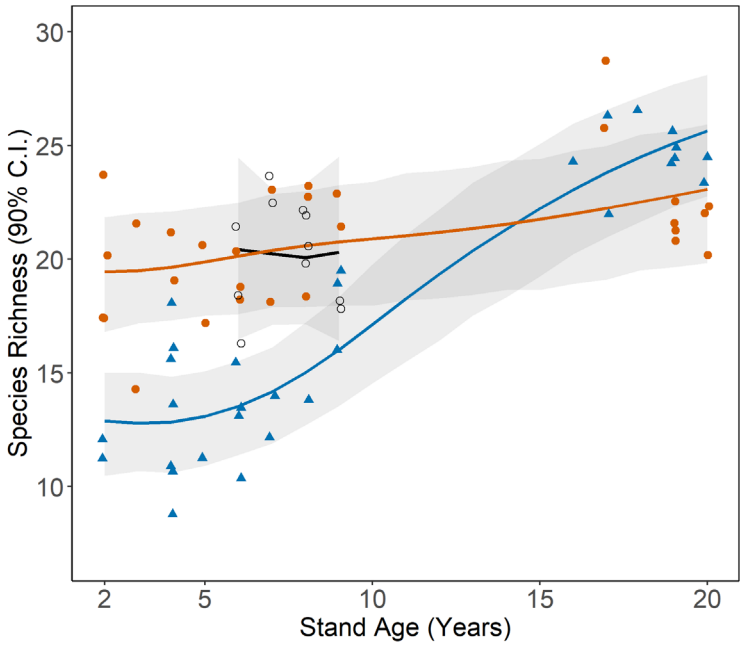


Figure 1. Estimated avian species richness among early seral forest sites generated by *SRFire* (orange dots), *IFM* (blue triangles), and *FSalvage* (black circles) across a chronosequence of stand age. Points represent estimates of species richness for individual stands after accounting for imperfect detection. Lines are average values for a given disturbance-age combination, and shading represents a 90% Bayesian credible interval around this estimate.

Ground beetle communities

We used pitfall trapping to collect ground beetles (family Carabidae) during six weeks in the spring of each field season. We have completed taxonomic work on pitfall trap samples, with a final dataset of 5858 individual ground beetles representing 40 species across 22 genera.

Ground beetles have a wide array of different life history strategies that we expect will help explain contrasts between different types of early seral. Particularly, past studies in other locations have suggested that fire and harvesting result in distinct ground beetle communities in part because of differences in direct mortality, and consequently the relative importance of dispersal ability. Different aspects of carabid morphology, such as leg length, elytra width, and mandible width:length tend to be correlated with dispersal ability as well as foraging niche. Morphological trait measurements, rather than categorical descriptions of species functional traits, allow us to analyze functional traits as continuous variables and avoid uncertainty associated with poorly understood species (Figure 2). Through the College of Forestry's Mentored Employment Program, undergraduate Lucinda Boyle worked to measure morphological traits on most of our species in early 2022, with only a few new species from this past field season left to measure.

Figure 2. Illustration of some key morphological traits we are measuring for all carabid beetle species in our dataset. These include mandible width relative to length, which is predictive of foraging guild, as illustrated by the omnivorous *Amara conflata* (a), the generalist predator *Omus dejeani* (b), and the specialist predator *Scaphinotus rugiceps* (c). Additional traits shown include elytra width, which is typically associated with flight ability, as illustrated by the flight-capable *Amara conflata* (a); and leg length, which is associated with running ability, as illustrated by the fast-running *Scaphinotus rugiceps* (c).

Bee communities

We sampled bee communities using blue vane traps, left open for two days during each of two distinct sampling periods (late spring, mid-summer) for each field season. Although our original proposal focused specifically on bumblebees (*Bombus* spp.) and *Xylocopa* we have expanded our scope to include all bees in order to better capture differences among types of early seral that might not be reflected by these large-bodied genera. In our first season, approximately 90% of the 101 species and 80% of the 3881 individual bees captured belonged to genera other than *Bombus* or *Xylocopa.* Preliminary analyses with this first season of data (23 stands) suggested similar bee richness between *SRFire* and *IFM* stands of comparable ages, but considerably lower richness in *FSalvage* stands compared with adolescent early seral stands of either other disturbance. Bees from the remaining two field seasons are currently being identified by taxonomist Lincoln Best, and we expect the dataset to be ready for analysis by the end of the year or January 2023. In total, we collected nearly 10,000 bees.

Forest composition and structure

We measured standing snags, residual live trees, and downed dead wood to quantify key elements of forest conditions and habitat structure. *IFM* stands contained very little residual live trees or standing deadwood (mean snag volume across all stand ages: 1.5 m^3/ha, sd: 4.5 m^3/ha). Volume of standing

deadwood was highest in young *SRFire* stands (mean: 571 m^3/ha, sd: 138 m^3/ha), lower in adolescent *SRFire* stands (mean: 475 m^3/ha, sd: 202 m^3/ha), and lower still in old *SRFire* stands (mean: 178 m^3/ha, sd: 203 m^3/ha), likely reflecting processes of snag decomposition, fracture, and fall over time. Adolescent *FSalvage* stands contained more standing deadwood than *IFM* clearcuts, but relatively little compared to *SRFire* stands (mean: 42.8 m^3/ha, sd: 46.3 m^3/ha). Total volumes of downed dead wood were more similar among disturbance types than standing deadwood volumes, but still slightly lower across *IFM* stand ages than in adolescent or old *SRFire*. Adolescent *FSalvage* stands contained the highest downed deadwood volume of any disturbance-age category (mean: 217 cm^3 m^{-2}, sd: 50 cm^3 m^{-2}).

Plant communities

We estimated cover for each vascular plant species within 12 circular 25m^2 plots in each stand, separated into four height strata to account for variability in the vertical structure of vegetation. By the end of sampling, our dataset included over 320 identified species. Focused analyses and an associated manuscript on this dataset will be a priority in the second half of 2023, once Graham has defended his dissertation. In the meantime, these data provide valuable habitat covariates for analyses of wildlife taxa for Graham Frank's three dissertation chapters (birds, beetles, bees), and have been the focus of an Honors College thesis from Natural Resources major Sarabeth Pearce-Smith mentored by Frank and Krawchuk.

Sarabeth Pearce-Smith's thesis focused on the presence and abundance of exotic plant species across the different types of early seral forests in our study design, utilizing the first two years of field data. For both *IFM* and *SRFire,* exotic species were more abundant in the youngers stands than in older early seral that has better-developed woody vegetation, and this trend was far more pronounced for *IFM* stands. Notably, analyses revealed a lower probability of exotic species presence with increasing overhead (>2m) vegetation cover, and that trend was weaker or even reversed in sites with hotter, drier topographic positions, supporting the stress-gradient hypothesis.

This rich dataset of biodiversity in early seral stands will provide important information for scientists and forest professionals understanding heterogeneity of young forests through space and time, generated from three common disturbance types in the region. Delivery of research outcomes will be accomplished through scientific publications and academic presentations, as well as through basic outreach products to land managers of the region. We aim to expand the synthesis and extension work for this project to fully leverage the data and findings from the research through a funding proposal to FWHMF FY24 focused on synthesis and application of the science, and including collaborations with OSU FNR Extension.

Problems and Barriers:

Field season was cancelled in Spring/Summer 2020 due to COVID-19.

Planned Work: n/a – final report

List of names and brief overview of graduate and/or undergraduate engagement in project: [e.g., thesis, research experience for UG, etc.]

Graham Frank. PhD candidate in FES (Krawchuk lab) recruited for this project, 2018-2023

Skye Greenler, PhD. Recruited into FERM starting Fall 2018 (with Bailey), who worked as a field technician on the project in summer 2018.

Daniel Spence. College of Forestry Mentored Employment Program protégé, Fall 2019/Winter 2020.

Haley Weir. College of Forestry GUMP protégé, Summer 2020

Sarabeth Pearce-Smith. College of Forestry Honors College thesis and MEP protégé, defended Spring 2022.

Lucinda Boyle. College of Forestry Mentored Employment Program protégé, Fall 2021/Winter 2022

Summer field research assistants: Kaitlyn Wright, Rya Rubenthaler, Ken Burton, Cara Kildall, Cassidy Lee, Carolyn Coyle, Alan Moss, Helen Payne, Emma Tate, Meghan Sullivan, Jordan Pow, Logan Bradley, Brycen Rogers

List of Presentations, Posters etc.:

Frank, G.S. (Guest), Grand, L. (Host). 2022. Podcast episode. Early seral forests (Episode 25). *In The Woods*. OSU Forestry & Natural Resources Extension. September 17. https://inthewoodspodcast.com/2022/09/17/episode-25-early-seral-forests/

Frank, G.S., Krawchuk, M.A. 2022. Presentation. Does forest harvest emulate natural wildfire disturbance for early seral bird assemblages in the Pacific Northwest? North American Forest Ecosystems Workshop. June 20-24 (remote)

Frank, G.S., Krawchuk, M.A. 2022. Presentation. Is all early seral created equal? Biodiversity comparisons among natural and managed early seral habitats. South Gifford Pinchot Collaborative Meeting. May 19 (remote)

Frank, G.S., Krawchuk, M.A. 2022. Presentation. Diversity and composition of early seral forest bird assemblages: Does disturbance type matter? Northwest Scientific Association Annual Meeting. March 16-17 (remote)

Frank, G.S., Krawchuk, M.A. 2021. Presentation. A beetle's-eye view of early seral forests: Does forest harvest emulate wildfire disturbance for ground beetle communities in the Pacific Northwest? 9th International Fire Ecology and Management Congress. December 3 (remote)

Frank, G.S., Krawchuk, M.A. 2021. Presentation. Does timber harvest emulate natural disturbance for Oregon's early seral forest birds? Willamette Valley Bird Symposium, January 23, 2021 (remote)

Frank, G.S., Krawchuk, M.A. 2020. Presentation. The birds and the bees… and plants. Cross-taxon congruence of early successional forests of the Klamath-Siskiyou. Western Forestry Graduate Research Symposium (WFGRS), April 30- May 6 2020 (remote)

Frank, G.S., Krawchuk, M.A. 2019. Poster. Comparing early-successional biodiversity between clearcutting and wildfire: Initial results from the Klamath-Siskiyou region of southwest Oregon. 8th International Fire Ecology and Management Congress, Tucson Arizona, November 18-22nd 2019

List of Publications, Thesis Citations: [published or anticipated]

None completed at this time.

At minimum expecting one PhD dissertation (Graham Frank), and anticipating four journal publications.

Fish and Wildlife Habitat in Managed Forests

Final Report

Title: Black-Backed Woodpecker Vital Rates in Unburned and Burned Forest Within a Fire-Prone Landscape

Investigators: James Rivers (OSU), Jake Verschuyl (NCASI)

Objectives: Our core study objectives are focused on comparing woodpecker vital rates between burned and green (i.e., unburned) forest, and include: (1) conducting breeding surveys for woodpeckers; (2) quantifying nest survival and post-fledging survival of Black-backed Woodpeckers (BBWOs); (3) evaluating nest survival of non-focal woodpeckers; (4) measuring vegetation at nest-sites and post-fledging BBWO locations; and (5) assessing whether past management actions support successful BBWO nesting. In addition to our core objectives, we aim to leverage tagging efforts to collect pilot data on natal dispersal of BBWOs to expand our research on this species.

Summary of Accomplishments toward Objectives: During summers 2018, 2019, and 2021 we made significant progress towards our study objectives. In 2018, we undertook >180 surveys for woodpeckers, as well as their potential predators during the nest (e.g., squirrels) and fledgling stage (e.g., *Accipiter* hawks); these survey locations were established in the Fremont-Winema National Forest (n=50 points) and the Sun Pass State Forest (n=12 points). Surveys consisted of passive listening counts for all aforementioned groups, followed by targeted call playback surveys for BBWOs only. A total of 8 woodpecker species were detected during surveys which include the six species shown in Table 1, as well as the Downy Woodpecker and Pileated Woodpecker. Nearly 3x as many BBWOs were detected via playback surveys than passive counts (44 vs. 15 individuals, respectively). We also detected Northern Pygmy-Owl, Cooper's Hawk, Common Raven, Steller's Jay, chipmunk sp., and squirrel sp. as potential predators during the course of surveys.

Table 1 | *Number of nests located for woodpecker species during targeted searches for the Black-backed Woodpecker. Field crews spent more time focused on our focal species in 2021, resulting in fewer nests of other species.*

Species	2018	2019	2021
Black-backed Woodpecker	19	32	45
Hairy Woodpecker	21	15	4
Northern Flicker	13	4	1
Williamson's Sapsucker	7	2	0
White-headed Woodpecker	6	2	1
Red-breasted Sapsucker	4	0	0
American Three-toed Woodpecker	1	3	1
Red-naped Sapsucker	0	0	1
Total	**71**	**58**	**53**

During the summers of 2018, 2019, and 2021 we compiled >1100 person-hours searching for nests and located 96 active BBWO nests, with 35 nests in green forest and 61 nests in burned forests. Across all years, apparent nest survival was relatively high in both green (80.5%) and burned forests (83.9%), with all nests that failed due to natural causes being a result of apparent predation. We also obtained nesting data on an additional 86 nests representing 7 additional woodpecker species during the course of focal work on BBWOs (Table 1). From nests that we located we captured, color-banded, measured, and obtained blood samples from 133 BBWO chicks that originated from the 59 nests that were accessible and safe enough to support tree climbing. From this sample, we attached radio-tags to 33 juvenile woodpeckers in green forest and 31 individuals in burned forests and spent >1000 person-hours tracking these individuals. Confirmed mortalities throughout the course of the study suggested raptor predation was the primary cause of mortality, although at least one tag was tracked to an underground location which was suggestive of predation by a small mammal or snake. Vegetation at

nest sites and at locations where fledglings were found alive were also quantified to assess whether variation in habitat measures may be linked to survival rates.

In addition to our focal work, we have leveraged this project beyond our original objectives in four significant ways. First, we have obtained ~155 hours of nestling provisioning video data from 58 BBWO nests during the peak of nestling growth (ca. nestling day 10) that will allow for evaluating whether food provisioning behavior differs between BBWOs nesting in green and burned forest. To our knowledge, this is the largest database of BBWO nestling feeding footage available and we expect it to serve as a separate, stand-alone manuscript published in a peer-refereed scientific journal.

Second, we expanded field data collection to include second-order habitat selection data to allow us to draw inference about where BBWO home ranges are selected from potential locations that are available across our study area. This involved the measurement of 240 additional random vegetation plots for comparison with measurements already being taken in the vicinity of BBWO nest sites.

Third, we shifted from using traditional "beeper" telemetry radio tags to using so-called connectivity tags for tagging all fledglings in 2021. Those tags were in a battery conserving mode during the winter until becoming active in the following spring which allowed us to determine where young birds settled for their first breeding opportunity (i.e., natal dispersal) in collaboration with LightHawk Conservation Flying, which provides aerial telemetry flights free of charge to track individuals across the burned forest mosaic. Examining natal dispersal, in turn, has allowed us to expand beyond looking at vital rates of woodpeckers in green and burned forests and obtain information about BBWO population connectivity between the two forest types in the broader landscape. From 2019-2020, we had a pilot season with 4 birds tagged using the connectivity tags, with 3 being relocated, and we successfully relocated 12 of the 20 birds still alive at the end of the summer 2021 sampling period in the 2022 breeding season. Of the 15 birds we have assessed for natal dispersal, 6 of 9 burned forest birds were confirmed nesting, with another 2/9 having unconfirmed pair status. Meanwhile, only 2 of 6 green forest birds were found nesting with the other 4 being unpaired. Preliminary analysis has found that green forest birds dispersed 3-4× times further, on average, than burned forest birds and both green forest birds found nesting had dispersed to new burn areas. In 2022 we were able to tag 5 adults and 13 more nestlings with refurbished connectivity tags that are expected to lead to obtaining natal dispersal data on more individuals in summer 2023.

Finally, in summer 2022 we initiated a field study to evaluate whether potential food resources constrained BBWO use of green forests. Our study incorporates a use vs. availability experimental design that allows us to determine whether the abundance and diversity of wood-boring beetles (the primary prey of BBWOs) can predict where BBWOs select nest sites within green and burned forests. Our field sampling efforts were particularly successful, and we are now seeking funding from the FWHMF program and ODF to obtain support to hire students to help us with processing and identify specimens. When combined with data collected from our two students, we will be able to provide a strong test of the factors thought to constrain BBWO breeding in green forest which, in turn, will delineate the management actions that may be taken to support BBWO populations in green forest.

Problems and Barriers: COVID-19 constrained nearly all field work during summer 2020; we were only able to get into the field for a short (<4 day) trip to attempt to relocate a sample of birds tagged with connectivity tags in summer 2019. However, we were able to move field work to summer 2021 and continue data collection as we would have in 2020, and we ended up having a particularly successful season.

Planned Work: Mark Kerstens has joined our research group as a M.S. student in fall 2020 and has been leading the completion of the project. Mark's M.S. thesis work – a comparison of nest survival, reproductive output, and juvenile survival between BBWOs in burned and green forest – was reviewed favorably in the scientific journal *Ornithological Applications* and is currently being revised for resubmission. He successfully defended his M.S. thesis in August 2022 and is staying on as a Ph.D.

student, and he will be using the data obtained from this study as the focus of his dissertation project. Project components include examining BBWO breeding habitat selection, quantifying movement and habitat use of juvenile BBWOs, comparing parental provisioning behaviors, and quantifying constraints on BBWO breeding in unburned forest; each of these are expected to lead to at least one peer-refereed each (see below).

List of names and brief overview of graduate and/or undergraduate engagement in project: In addition to graduate training (Mark Kerstens), nine young professionals have worked as full-time research assistants on this project to date: Amanda Holland (OSU alum, 2018–2019), Brett Howland (2018–2019), Cameryn Brock (2018), Meredith Kuzel (2018), Victoria Green (2019), Cory Ross (2019), Nate Quatier (2021), Elaine Bee (2021), and Jo Ford (2021). All have interest in pursuing graduate school in the future and gained experience with a number of methods needed for working with breeding birds; at least two are in graduate programs as of the time of this writing. In addition, we have actively recruited undergraduate volunteers from the Louis Stokes Alliance for Minority Participation (LSAMP) Program at OSU, and we were able to provide Mateo Garcia, a student in the program, with a research experience with tracking birds and quantifying habitat use of fledgling woodpeckers in summer 2018. We have also provided a demonstration of wildlife telemetry techniques to the LSAMP Bridge Program at OSU at the start of the fall 2018 and 2021 terms, which included outreach to ~150 underrepresented minority STEM students. Students were instructed on the use of wildlife telemetry and were provided with hands-on experience to use telemetry equipment to locate hidden radio tags to simulate field work with this technique. Finally, we are actively mentoring undergraduates with ongoing project work, including those in the URSA Engage Program and the STEM Leaders Program at OSU, to assist with obtaining data from parental provisioning videos and assisting with preparation of beetle specimens. Kate Hassett (URSA) and Katja Erringer (volunteer intern) have both committed many hours over the past year to coding nestling provisioning footage, as well as assisting with fieldwork in 2022. Additionally, we are bringing on Weylin Crouch (STEM Leaders Program) in January 2023 to assist with the provisioning footage, and we anticipate providing three students in the URSA Engage program with research experiences related to examining beetle abundance and diversity in BBWO nest-sites and non-use areas.

List of Presentations, Posters etc.:

1. Kerstens, M. E. 2022. Black-backed Woodpecker vital rates do not differ between unburned and burned forests within a pyrodiverse landscape. Oral presentation for The Wildlife Society National Conference.

2. Hassett, K. 2022. Black and green: analysis of parental provisioning of Black-backed Woodpeckers in burned and unburned forests. Summer Undergraduate Research Symposium, Oregon State University.

3. Kerstens, M. E. 2022. The Birds and the Burns: Woodpeckers and Wildfire in a Pyrodiverse Landscape. Invited guest speaker for Birds of Oregon and General Science.

4. Kerstens, M. E. 2022. Is green the new black? No difference in Black-backed Woodpecker vital rates between unburned and burned forests in a pyrodiverse landscape. Oral presentation for the National Council of Air and Stream Improvement Annual Conference.

5. Kerstens, M. E. 2022. An Assessment of Black-backed Woodpecker (*Picoides arcticus*) Vital Rates in Green and Burned Forests within a Pyrodiverse Landscape Mosaic. Master's Thesis Defense, Oregon State University.

6. Kerstens, M. E. 2022. Demographics and Dispersal of Black-Backed Woodpeckers (*Picoides arcticus*) in a Pyrodiverse Landscape Mosaic: A comparison of green and burned forest. Oral presentation for the Oregon Chapter of The Wildlife Society Annual Conference.

7. Kerstens, M. E. 2022. Demographics and dispersal of juvenile Black-Backed Woodpeckers (*Picoides arcticus*): A comparison of green and burned forest. East Cascades Audubon Society Birder's Night Guest Speaker <virtual>.

8. Kerstens, M. E. 2021. Dispersal and Survival of Juvenile Black-backed Woodpeckers (*Picoides arcticus*) in Burned and Unburned Klamath Basin Forests. Oral presentation for the Klamath Basin Audubon Society <virtual>.

9. Rivers, J. W. 2021. Assessing Black-backed Woodpecker vital rates in a fire mosaic landscape. Oral presentation for the National Council for Air and Stream Improvement Forestry Program Webinar <virtual>.

10. Kerstens, M. E. 2021. Moving between green and black: Natal dispersal and survival of juvenile Black-backed Woodpeckers (*Picoides arcticus*). Western Forestry Graduate Research Symposium <virtual>.

11. Kerstens, M. E. 2021. Moving between the green and black: Black-backed woodpecker habitat selection in a fire-prone landscape. Willamette Valley Bird Symposium <virtual>.

12. Rivers, J. W. 2019. Black-backed Woodpecker vital rates in green and burned forest within a fire-prone landscape: update from the 2019 field season. Oral presentation for the summer meeting of the National Council for Air and Stream Improvement, Tillamook, OR.

13. Rivers, J. W. 2018. Black-backed Woodpecker vital rates in green and burned forest within a fire-prone landscape: update from the 2018 field season. Oral presentation for the annual meeting of the National Council for Air and Stream Improvement, Vancouver, WA.

List of Publications, Thesis Citations:

1. Kerstens, M. E. 2022. Vital rates and nest-site selection of the Black-backed Woodpecker in a fire mosaic landscape. M.S. thesis, College of Forestry, Oregon State University.

2. Kerstens, M. E., and J. W. Rivers. Is green the new black? Black-backed Woodpecker vital rates do not differ between unburned and burned forests within a pyrodiverse landscape. Submitted to *Ornithological Applications* (in revision).

3. Black-backed Woodpecker habitat selection within a fire mosaic landscape. Submission planned to *Forest Ecology and Management*.

4. Post-fledging movement and habitat use by Black-backed Woodpeckers in burned and green forest of western North America. Submission planned to *Global Ecology and Conservation*.

5. Parental provisioning in divergent forests: Black-backed Woodpecker feeding in burned and green forests. Anticipated for submission to *Avian Conservation and Ecology*.

6. Evaluating the constraints on breeding by the Black-backed Woodpecker in unburned forest. Submission planned to *Ecological Applications*.

Fish and Wildlife Habitat in Managed Forests

Progress Report

Title: Development of native bee identification keys for the Pacific Northwest

Investigators: James W. Rivers and Lincoln R. Best

Objectives: The overall objective of this project is to develop user-friendly materials that can be used by non-specialists to quickly and accurately identify wild bees of the Pacific Northwest (PNW, covering Oregon and Washington). Available identification aids used for bees in the PNW are specific to other areas and thus include groups that are irrelevant to this region and confuse identification, rely heavily on arcane taxonomic jargon unfamiliar to novices, and make use of idealized drawings to highlight features that are often unrepresentative of what is observed on real-world specimens. Therefore, our approach is to take existing information regarding bees and create identification materials that leverage ongoing work and expertise from the Oregon Bee Project to develop (1) a generic-level key for all bee species that are found within the PNW region, and (2) sex-specific species-level keys for all bumble bee (*Bombus*) species that are found within the PNW region.

Summary of Accomplishments toward Objectives: During the last calendar year we have made significant progress towards our study objectives. The recent discovery of the rare, floral-specialized Rophitine bee genus *Micralictoides* in the state by Oregon Bee Atlas Master Melittologists has been added to the state and regional checklists of genera, and couplets added to the expanded draft key to genera for the PNW by Best. On a recent visit to Canada's oldest entomological collection at the University of Guelph (DEBU), Best obtained a loan of the genera *Augochlora*, *Augochlorella*, and *Augochloropsis*. These specimens are necessary to illustrate the couplets diagnosing the tribe Augochlorini, and the three respective genera. Additionally, Best obtained a private loan of the genus *Macrotera* from J. Sharkey (University of Toronto).

Best has produced a third set of drafts for:

a) Key to the female *Bombus* species of the PNW; 27 couplets. (Modified from Williams *et al* 2014. Bumble bees of North America: An identification guide)
b) Key to the male *Bombus* species of the PNW; 25 couplets (Modified from Williams *et al* 2014. Bumble bees of North America: An identification guide)
c) Key to the bee genera of the PNW; 76 couplets (Modified from Michener, McGinley, and Danforth 1994. The bee genera of North and Central America.)
All three keys have had improvements made to their architecture and language.

Imaging:
Four rounds of specimen imaging have been completed by Best and Joshua Dunlap (ODA). Dunlap has produced 119 edited stacked images. These images satisfy the key to genera through to couplet 54, making it nearly 70% complete. The key to female *Bombus* has the first 3 couplets illustrated by 15 stacked images which will improve users' diagnosis of cheek (malar) length, a common source of error among *Bombus* determinations. The bumble bee keys rely significantly on the color form templates which we have received from world bumble bee expert Paul Williams (NHM, London, UK).

Problems and Barriers: Complications arising from COVID-19 produced significant barriers that initially impeded progress to our initial timeline. Although we were able to make progress developing bee identification keys, we were unable to access specimen materials on campus at the OSU Arthropod Collection until June 2021 due to university closures. This led to a delay in compiling the hundreds of specimens of bumble bees and representative bee genera and delivering them to the Oregon Department

of Agriculture (ODA) for imaging. Although that backlog has finally been alleviated, it has necessitated additional time to complete the original project. Therefore, we have requested and been granted a no-cost extension with a new end date of September 30, 2023.

Planned Work: Our planned work remains as outlined in our project proposal with respect to our original study objectives, albeit on an extended timeline. In the coming year Best and Dunlap will produce the remaining images for couplets 54-76 of the key to genera, and couplets 4-25 for the key to bumble bee species. We will produce a fourth version of the keys with minor revisions to the architecture, further simplified language, and fully illustrated which will be reviewed by August Jackson (Mount Pisgah Arboretum; Oregon Bee Project) the project graphic designer. Jackson will collaborate with Best, and Dunlap to deliver the final design of the keys available in print, and online .pdf format. Jackson will design and deliver a landing page on the Master Melittologist website (https://extension.oregonstate.edu/bee-atlas). Once materials are tested and finalized, we will work to disseminate and publicize identification keys through ongoing partnerships with ODA, Oregon Forest Resources Institute, Oregon Department of Forestry, and OSU Extension so that these products are shared as broadly as possible with all target audiences, which includes researchers, bee population surveyors, amateur entomologists, and small woodlot owners.

List of names and brief overview of graduate and/or undergraduate engagement in project: No graduate or undergraduate students are directly engaged in the project at the current time.

List of Presentations, Posters etc.: No presentations have been given on this work at the current time.

List of Publications, Thesis Citations:

1. A user-friendly identification guide in to bees cover 56 genera of the Pacific Northwest in digital and hard copy formats (anticipated).
2. A user-friendly identification guide to the bumble bees (*Bombus* spp.) of the Pacific Northwest in digital and hard copy formats (anticipated).

Fish and Wildlife Habitat in Managed Forests

Final Report

Title: Assessing the response of aquatic biota to alternative riparian management practices

Investigators: Dana Warren and Ashley Coble

Objectives:

Our study goal is to determine how water quality and stream biota respond to three alternative riparian management options (buffer gaps, thinning, and variable retention) relative to standard fixed-width buffers and to a wholly unharvested unit. To meet this overarching goal, we had the following objectives:

- *Quantify bottom-up factors, including algal standing stocks, primary production, and macroinvertebrate abundances, that may affect growth, abundance, and overall production of fish and salamanders in headwater streams*
- *Quantify the short-term (<3 yr) responses of fish and salamander abundance, total biomass, and summer growth across prescription alternatives.*
- *In each stream, determine how temperatures vary by treatment and whether significant temperature responses can be linked to other watershed or stream features such as stream size, water residence time, or substrate embeddedness.*

Summary of Accomplishments toward Objectives:

In the first three years of this study, we selected six replicate blocks of 5 streams per block for our experimental treatments (Figure 1). Considerable effort was put into selecting a number of sites that were impacted wildfires and/or logistical constraints associated with COVID; however, by the end of year 3, we had identified all of our study streams and collected at least one summer of data from all 6 blocks (30 streams). At four blocks, we collected one year of pre-treatment data (with plans for a second year of pre-treatment data collection in summer 2022 and post-treatment data collection in 2023 and 2024). At one block (Walton), we collected two years of pre-treatment data during this 3-year grant period, and at one block (Valsetz) we collected two years of pre-treatment data and one year of post-treatment data over the duration of the grant.

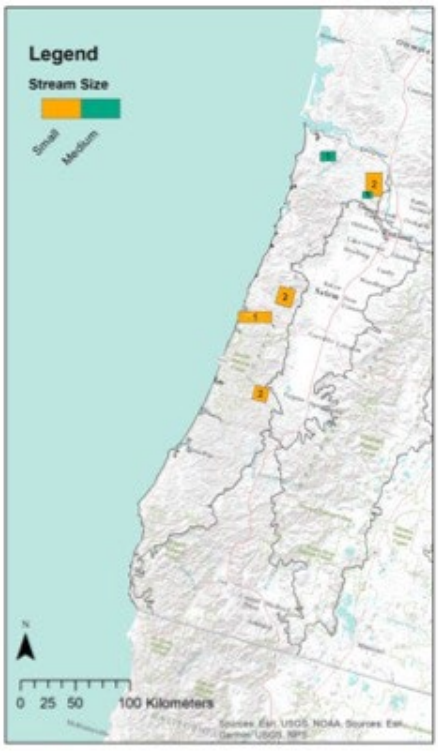


Figure 1. Locations of the six study blocks (5-streams per block) for the riparian alternatives research program in western Oregon. Color of the block on the map indicates whether study streams in that block are classified as small or medium fish streams.

At each site, we collected data on stream habitat, water chemistry (during summer low-flow), stream temperature, stream light,

dissolved oxygen levels, benthic biofilm standing stocks, macroinvertebrate communities, and stream vertebrates (including trout, salmon, sculpin and salamanders). Figure 2 illustrates the range of data collection using stream vertebrate population estimates from the lower sections of each reach.

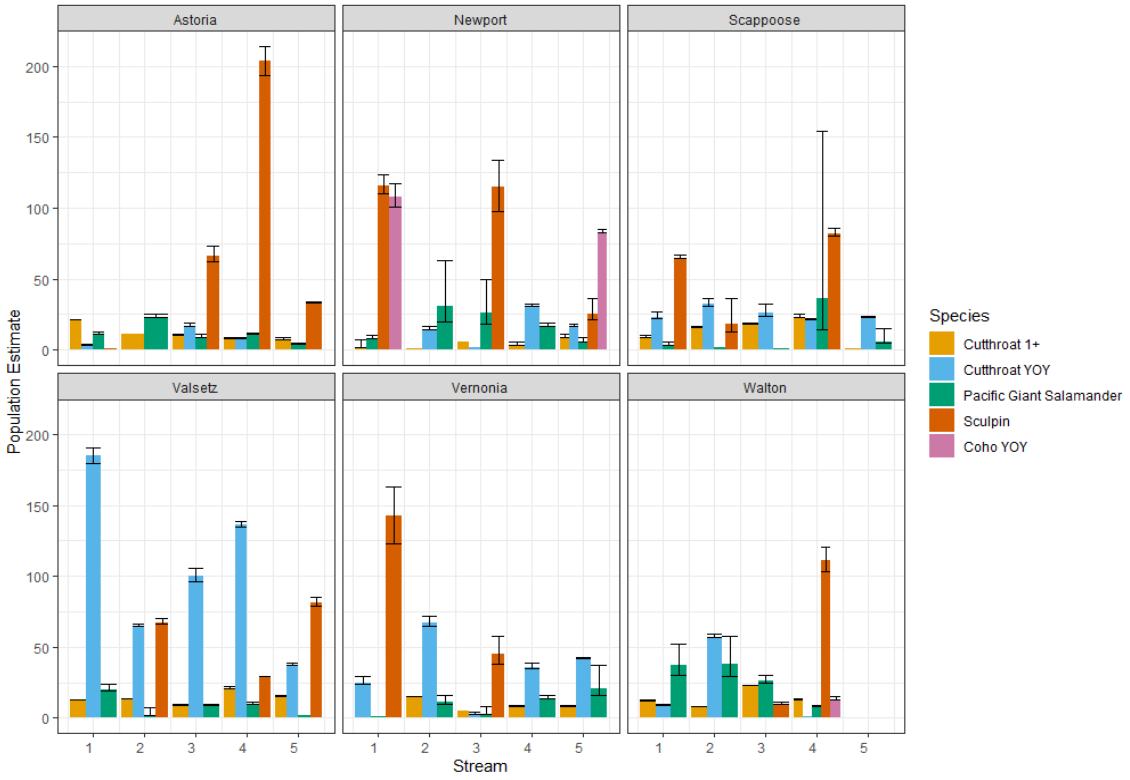
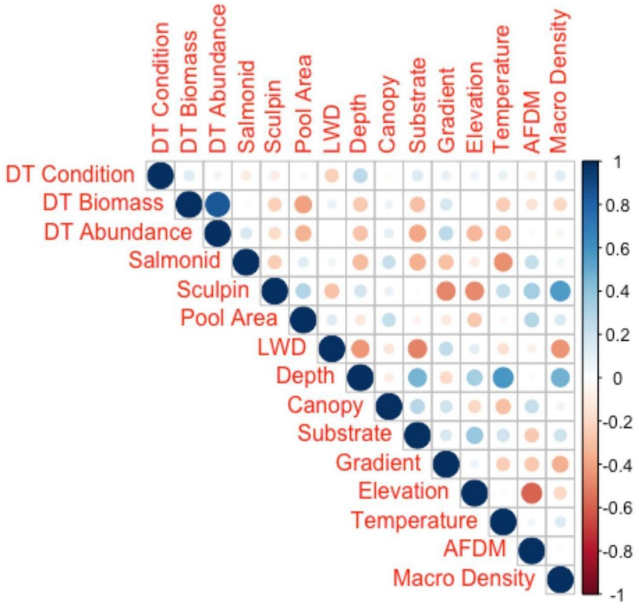


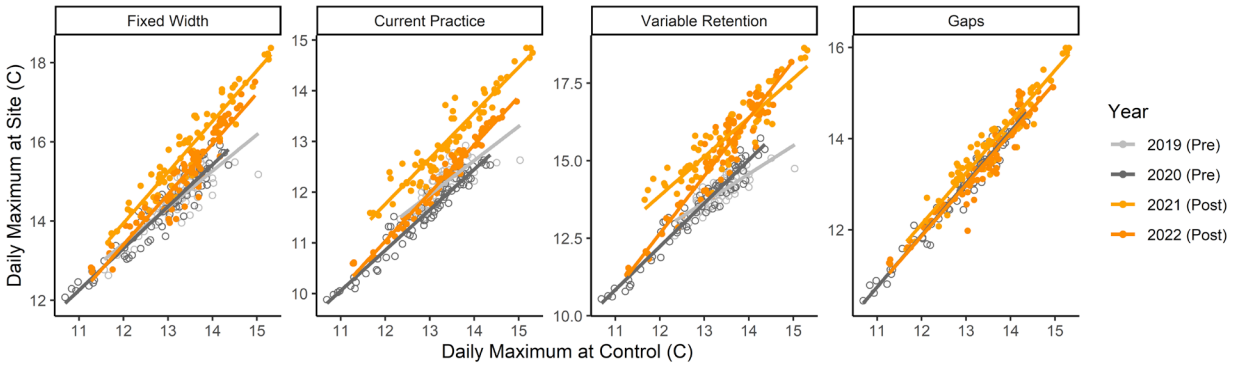
Figure 2. Fish and salamander population estimates across study sites surveys in summer 2022.

The observational data from the pre-treatment sites in 2021 were used by OSU undergraduate student, Nate Neal, in an analysis of stream salamanders. This study included a correlation matrix which explored relationships among a wide range of stream biotic and abiotic characteristics across 24 unmanipulated sites in summer 2021 (Figure 2). This analysis ultimately suggested that for salamanders, habitat features rather than biotic characteristics of the stream had a dominant influence on salamander abundance and biomass in streams.



In the Valsetz block where we had pre- and post-treatment data, we evaluated relative temperature trends in response to alternative riparian buffer treatments through summer by looking at changes in the relationship in daily stream temperatures between unmanipulated reference sites and those with a range of riparian treatments. In general, preliminary data indicate that there was a slight increase in temperature in treatment reaches

relative to the control in the first year after the treatments (Figure 4). However, 2021 was an unusually warm year and in 2022, a year with temperature closer to the long-term mean, temperature changes were substantially smaller. It should be noted that two of these riparian buffers were subjected to blowdown (Current Practice and Variable Retention) that caused more light at the stream level than anticipated.



Overall, despite setbacks (see problems and barriers below), with support from this FWHMF grant we made substantial progress toward our study objectives.

A final notable accomplishment from this project was a study derived from the sites that were impacted by the 2020 wildfires. Although fire-impacted sites ultimately needed to be removed from the riparian alternatives study, we had loggers in burned over sites as the fire moved through. This allowed us to quantify changes in temperature and dissolved oxygen in streams as fire burned the nearby riparian forest. In a recently published manuscript (Sanders et al. 2022), we analyzed these data to document the responses of stream temperature paired with air temperature, light availability (as PAR), and dissolved oxygen during the fires. We found short-term temperature increases when fire burned directly adjacent to streams but temperatures returned to pre-fire levels soon after the fire moved through. The more persistant and widespread temperature effect was actually a decline due to smoke cover creating shade throughout the Willamette valley for a few weeks. We also saw immediate declines in dissolved oxygen (DO) in the most severely burned sites, but as with temperature, overall shading from smoke was more pervasive affecting a broader region for longer duration on DO. This paper was led by the graduate student funded by FWHMF on this project, Ashley Sanders.

Problems and Barriers:

Problems and barriers to work on this phase of the project were extensively articulated in the 2021 progress report. There have been no notable changes or updates in regard to challenges faced by this first phase of the project between when the 2021 progress report was submitted and June 30 2022, when this award was finished. I have therefore included below text on challenges and impacts from the 2021 report (in italics below) with few changes.

Site selection challenges

Cascades: in 2019 and 2020 we encountered challenges in regard to site selection associated with fishless sites in the smaller streams. Overall there are few small fish-bearing streams that meet our criteria for inclusion in the study. We identified two additional replicate blocks in the Cascades in spring/early-summer 2020 with all sites categorized as medium fish bearing streams. However, the September 2020 wildfires removed a number of existing sites and also many potential

future/alternative sites for this region, complicating efforts to find new/replacement blocks in the Cascades.

<u>Coast:</u> Salmon, Steelhead, & Bull Trout (SSBT) streams are prevalent along the coast, and we had difficulty finding enough suitable non-SSBT small fish-bearing streams in the Coast Range. We were not able to sample the SSBT streams in the first pre-treatment year because of the long lead-time needed for SSBT collection permits in the state of Oregon. However, in September 2020 we obtained the requisite permits to collect SSBT fish in Oregon Coast Range streams for all subsequent years.

<u>Overall:</u> During site selection in 2019 and 2020, we found that one-sided units are prevalent across the landscape, and that it was not possible to incorporate two-sided units everywhere. We therefore incorporated both one-sided and two-sided units into the study design. To be consistent in our study designs, all treatments in an experimental block have the same management regime (e.g., five streams with two-sided buffers or five streams with a single-sided buffer). Notably the first two blocks, which were a primary focus of this funding, were both two-sided buffers.

September 2020 wildfires

In September 2020, three large wildfires occurred in the western Cascades mountains of Oregon. These fires impacted a number of our study sites, disrupting our experimental plans. While these fires clearly impacted our study, the events created a natural experiment which were able to explore the acute and short-term impacts of fire and smoke on stream temperature and dissolved oxygen patterns..

Planned Work:

This is the final report for this phase of the study, but the FWHMF program has supported continued work on this project and we will provide details on progress/data/plans for continued work on this effort in that progress report.

List of names and brief overview of graduate and/or undergraduate engagement in project: [e.g., thesis, research experience for UG, etc.]

The technician on this project, Ashley Sanders, transitioned to being an MS graduate student in the Department of Forest Ecosystems and Society in the College of Forestry starting in September 2021. Ashley's thesis is focused on how changes in canopy cover translate to changes in light at the stream level, and furthermore, how those changes in light affect stream temperature, biofilm standing stocks, and trout demographics.

<u>Undergraduate field technicians:</u>

- Rory Corrigan – Ecological Engineering, Oregon State University (2021)
- Jacqui James – Natural Resources, Oregon State University (2021)
- Nate Neal – Biology, Oregon State University (2021)

- Maya Greydanus – Forestry, Oregon State University (2021)
- Zowie DeLeon – Natural Resources, Oregon State University (2020)
- Rylee Rawson – Natural Resources, Oregon State University (2020)
- Nathanial Maisonville – Biology, Oregon State University (2020)
- Annika Carlson – Fisheries and Wildlife, Oregon State University (2020)
- Molly Hamilton – Natural Resources, Oregon State University (2019)
- Alex Boe – Natural Resources, Oregon State University (2019)

List of Presentations, Posters etc.:

Within the last 12 months, we have made the following presentations related to this project:

Sanders, A. M., A. A. Coble, and D. W. Warren. "Light-Driven Changes in Headwater Stream Thermal Regimes Following Alternative Riparian Buffer Treatment," *OSU Western Forestry Graduate Research Symposium* in Corvallis, OR April 2022.

Sanders, A. M., A. A. Coble, and D. W. Warren. "Light-Driven Changes in Headwater Stream Thermal Regimes Following Alternative Riparian Buffer Treatment," *NCASI Quarterly Meeting 2022*, virtual, April 2022.

Sanders, A. M., A. A. Coble, and D. W. Warren. "Light-Driven Changes in Headwater Stream Thermal Regimes Following Alternative Riparian Buffer Treatment," *OSU Pacific Northwest Water Research Symposium* in Corvallis, OR, April 2022.

Sanders, A. M., A. A. Coble, A. G. Swartz, M. River, P. James, D. W. Warren. "Fire and smoke effects on headwater stream temperature, dissolved oxygen, and light during the Holiday Farm Fire," *Oregon Chapter of the American Fisheries Society*, virtual, March 2022.

List of Publications, Thesis Citations:

(^ indicates student author)

Sanders, A.M.^, A.A. Coble, A.G. Swartz^, M. River, P. James, and D.R. Warren. **2022**. Effects of fire and smoke on water temperature and dissolved oxygen in headwater streams. *Freshwater Science*

Neal, N.^ 2022. Abiotic and biotic predictors of coastal giant salamander (*Dicamptodon tenebrosus*) in headwaters of the Oregon Coast Range. Oregon State University Honors College Thesis

Fish and Wildlife Habitat in Managed Forests

Progress Report

Title: Multi-scale Habitat Value of Slash Piles for Conserving Rare Carnivores

Investigators: Dr. John Bailey, Dr. Katie Moriarty **Master's Student**: Jordan Ellison

Objectives:

1. Document martens and fishers visiting slash piles. Due to the previously documented avoidance of openings by both martens and fishers (Moriarty et al. 2015, Moriarty et al. 2016, Martin et al. 2019), our first goal is to establish whether martens or fishers will enter clear cuts to visit slash piles, and evaluate whether those visits have any relationship to the time since the stand was harvested, how much vegetation cover is present in the stand, or the distance from the forest edge.
2. Generate estimates of small mammal abundance, diversity, and energetic biomass at slash piles and in the surrounding landscape. One possible benefit of slash piles for martens and fishers is the potential for slash piles to increase habitat for small mammals, which constitute a large proportion of marten and fisher diets (Golightly et al. 2006, Slauson and Zielinski 2017, Eriksson et al. 2019, Parsons et al. 2020). If small mammal populations are increased by the presence of slash piles, piles may represent a year-round foraging resource for martens and fishers.
3. Model effects on surface fire behavior with the occurrence of slash piles. Creation and subsequent removal of slash piles is used as a fuel reduction treatment in recently harvested stands. There may be wildlife value in retaining piles, but that value may not be a long-term benefit if piles considerably increase the risk of severe wildfire. We will assess the degree to which pile size, composition, and distribution influence the likelihood of more intense wildlife behavior.

Summary of Accomplishments toward Objectives:

We have surveyed in 69 stands in coastal northern California and 9 stands southern Oregon. Our focal efforts were in northern California because piles were largely not removed over a period of 15 years, allowing us to evaluate both pile size and age.

During the 2020 and 2021 season, field teams deployed 354 remote cameras in 69 stands in northern California (Figure 1), collecting >1.6 million images. Fishers were detected in 59 stands with detections at slash piles in 35 of those stands. Martens were detected in 8 stands, including one detection at a slash pile. Following the completion of remote camera surveys, we proceeded with a team of undergraduate students in an effort to review all images using the photo-tagging software Timelapse. We completed photo-tagging all images as of October 2022.

Scat detection dog teams surveyed 45 stands in northern California and collected 99 scats. Of those scats, 60 were identified in the field as possible marten or fisher scats. Extending to surveys in northern California, the dog teams collected 300 scats, 79 verified as fisher and 16 as marten with some processing left to be completed. We conducted vegetation and woody debris sampling in all surveyed stands.

To address the objective of small mammal use of piles, we conducted 18 trapping replicates with 3 trap 'webs' per replicate, capturing 946 individual small mammals. Our trap webs had an approximately equal number of Sherman, Tomahawk, and Longworth traps with an average of 75 traps per web. A replicate consisted of:

1. A pile stratified by size and age
2. A geographically independent stand without piles or region within the same larger stand away

from piles.

3. A forest stand >20 years that shares a border with the stand that contains the slash pile

In addition to the vegetation and woody debris sampling completed in all stands, a detailed pile and fuel transect sampling effort was undertaken in a subset of the surveyed stands in California and southern Oregon (funded by fisher CCAA) for modeling surface fire behavior. We recorded the size on all piles (or up to ten piles where more than ten piles were present); piles were randomly selected from aerial imagery prior to the start of field work.

In southern Oregon, we completed vegetation, woody debris, and slash pile sampling in 9 stands on recently harvested private ownerships in the range of both fishers and martens (Figure 2). Oregon stands were additionally surveyed by scat detection dog teams.

Problems and Barriers:

Opportunities to survey slash piles within Oregon are limited given that landowners remove piles shortly following harvest, in some cases within the same year that they were created. This practice is common in Oregon but is a sharp contrast with survey opportunities in our California study area, where piles have largely been retained over time. Due to this difference in practices, we will be unable to fully examine how slash pile conditions change over time in Oregon.

Additionally, to meet our objectives regarding fisher and marten use, our surveys were limited to within or near to their current known distributions. Much of the area most likely to contain both slash piles and be occupied by martens or fishers in southwest Oregon are on private lands, and thus we were additionally limited by the willingness of landowners to collaborate in the study. We thank Green Diamond Resource Company and Rayonier for their collaboration.

Planned Work:

We expect to complete fire behavior modeling and data analysis in the coming months. Jordan's thesis defense is anticipated during Winter term 2023.

List of names and brief overview of graduate and/or undergraduate engagement in project:

Jordan Ellison, MS student in Forest Engineering and Resource Management, will be completing her thesis using the data from this project.

We received a scholarship for a Cal Poly Humboldt undergraduate to intern on the project as a field technician (Shalom Fletcher). Jordan has trained and remotely mentored 6 additional undergraduates (Sandy Diaz, Alanna Garcia, Kelly Johnson, Sabrina Ott, Anna Schwecke, Louis Salas) to process the photographs from the 2020 field season. Two of these individuals (Alanna Garcia and Shalom Fletcher) have completed undergraduate senior theses using these data.

List of Presentations, Posters etc.:

J.L. Ellison, K.M. Moriarty, A. Larsen-Gray, J.D. Bailey. 2021. Conservation value of slash piles for Pacific martens (*Martes caurina*) and Pacific fishers (*Pekania pennanti*). 68th Annual Meeting of the Western Section of The Wildlife Society. Virtual, recorded.

J.L. Ellison, J.D. Bailey, K.M. Moriarty, A. Larsen-Gray. 2021. Investigating the conservation value of slash piles for Pacific martens and fishers. Western Forestry Graduate Research Symposium. Oregon State University, College of Forestry.

J.L. Ellison, K.M. Moriarty, A. Larsen-Gray, J.D. Bailey. 2022. A research update investigating the conservation value of slash piles for Pacific martens (*Martes caurina*) and fishers (*Pekania pennanti*). Annual Meeting of the Oregon Chapter of The Wildlife Society. Newport, Oregon.

J.L. Ellison, K.M. Moriarty, A. Larsen-Gray, L.M. Ellsworth, J.D. Bailey. 2022. Conservation value of slash piles for Pacific martens and fishers. Annual Meeting of the Wildlife Society. Spokane, Washington.

List of Publications, Thesis Citations:

Literature cited

Eriksson, C. E., K. M. Moriarty, M. A. Linnell, and T. Levi. 2019. Biotic factors influencing the unexpected distribution of a Humboldt marten (*Martes caurina humboldtensis*) population in a young coastal forest. PLoS One **14**:e0214653.

Golightly, R. T., T. F. Penland, W. J. Zielinksi, and J. M. Higley. 2006. Fisher diet in the Klamath/North Coast bioregion. Humboldt State University, Arcata, CA.

Martin, M. E., K. M. Moriarty, and J. N. Pauli. 2019. Forest structure and snow depth alter the movement patterns and subsequent expenditures of a forest carnivore, the Pacific marten. Oikos **129**:356-366.

Moriarty, K. M., C. W. Epps, M. G. Betts, D. J. Hance, J. D. Bailey, and W. J. Zielinski. 2015. Experimental evidence that simplified forest structure interacts with snow cover to influence functional connectivity for Pacific martens. Landscape Ecology **30**:1865-1877.

Moriarty, K. M., C. W. Epps, and W. J. Zielinski. 2016. Forest thinning changes movement patterns and habitat use by Pacific marten. The Journal of Wildlife Management **80**:621-633.

Parsons, M. A., J. C. Lewis, J. N. Pauli, T. Chestnut, J. I. Ransom, D. O. Werntz, and L. R. Prugh. 2020. Prey of reintroduced fishers and their habitat relationships in the Cascades Range, Washington. Forest Ecology and Management **460**.

Slauson, K. M., and W. J. Zielinski. 2017. Seasonal specialization in diet of the Humboldt marten (*Martes caurina humboldtensis*) in California and the importance of prey size. Journal of Mammalogy **98**:1697-1708.

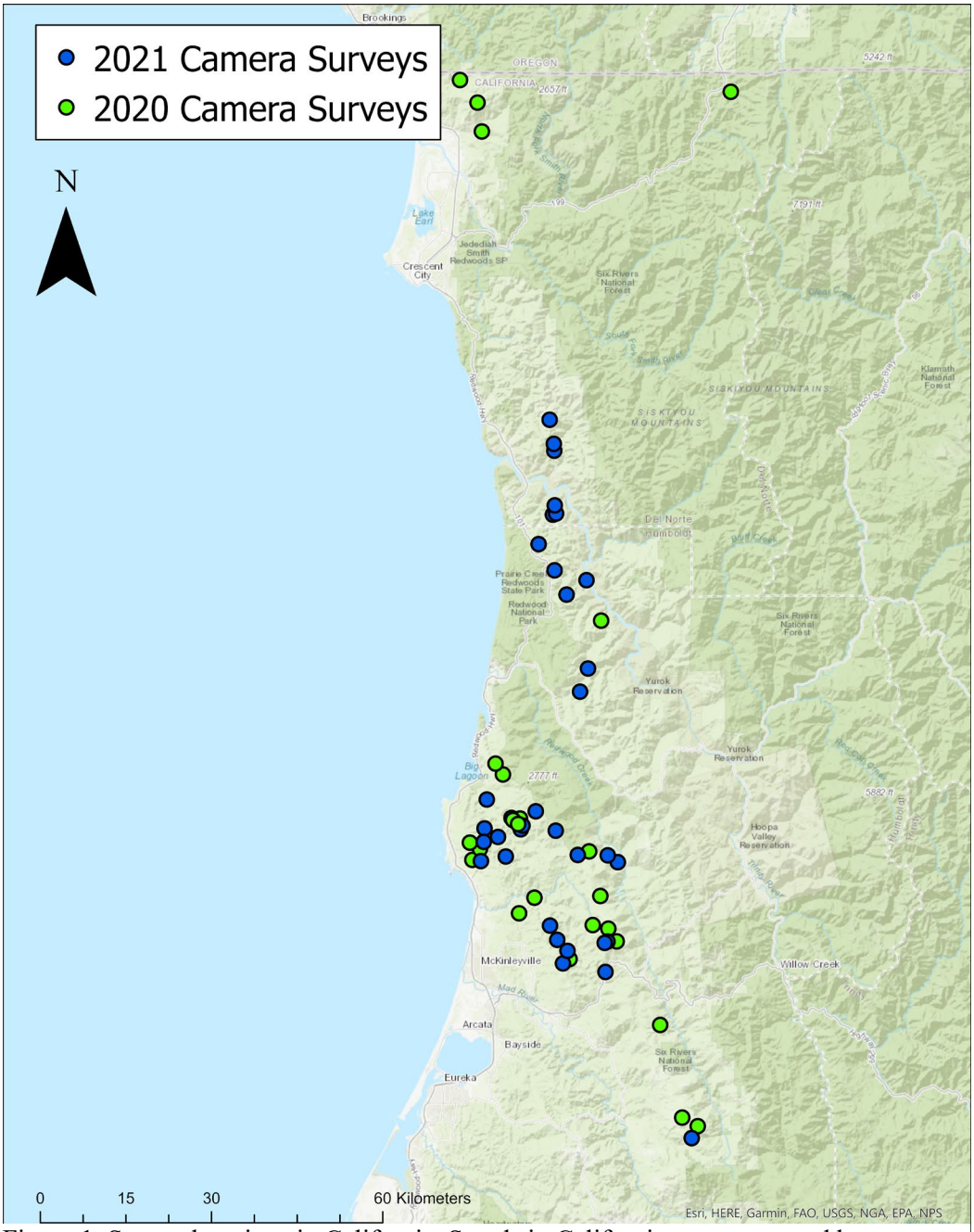


Figure 1. Survey locations in California. Stands in California were surveyed by remote cameras and detection dogs, and data was recorded for slash pile dimensions and composition and at vegetation and woody debris sampling plots.

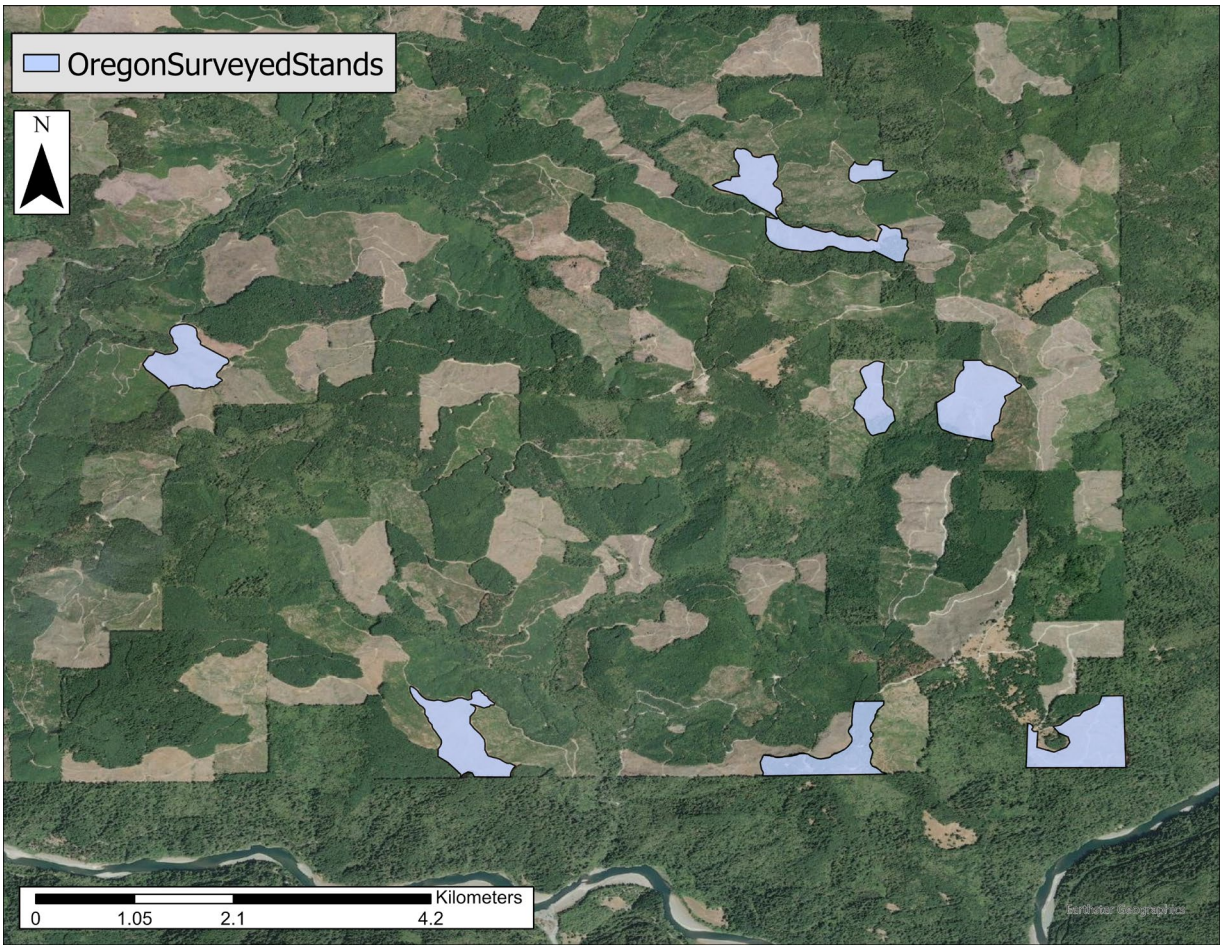


Figure 2. Stands surveyed in SW Oregon, about 20km northeast from the town of Gold Beach. Oregon stands were surveyed by scat detection dog teams, and field crews collected data on pile dimensions and composition, woody debris, and vegetation sampling plots.

Fish and Wildlife Habitat in Managed Forests

Progress Report

Title: Red Tree Voles in Working Forests

Investigators: John Bailey, Katie Moriarty

Objectives:

- Quantify relative abundance of red tree vole nests across stand ages and distance from old forest
- Quantify detection rates of red tree vole nests across a range of stand ages
- Estimate nest density within stands that differ in age and distance from older forests
- Estimate red tree vole nest status (e.g. old, occupied, recently occupied) and use by other arboreal mammals
- Estimate nest survival during the study; create framework for long-term evaluation (e.g., 10 years)
- Quantify red tree vole local colonization and extirpation rates across stand age

Summary of Accomplishments toward Objectives:

During the 2022 field season we resurveyed 40 stands from 2019-2021 and surveyed 15 new stands to address data gaps and assess detectability in old forest stands. We climbed and collected data on 934 nests and installed a total of 77 nest cameras to monitor activity of red tree voles and other arboreal species. Our final sample size was 63 stands, with stratification across age class and distance from old forest as shown in Table 1.

Table 1: Stand stratification with younger stands split by distance from old forest (OF), with old forest defined as trees estimated to be older than 80 years & in patches >20ha as derived by LiDAR information in GIS.

	Age Class					
	20-29	30-39	40-49	50-59	60-79	80+
0-1km from OF	13	11	6	6	2	9
1-5km from OF	4	4	3	3	2	
Total	**17**	**15**	**9**	**9**	**4**	**9**

In 2022 we recorded signs of red tree vole activity (both old and recent) in 40 stands and observed colonization and extirpation of red tree vole nests in 20 stands. Tree vole nests in young forest (<80 years) were typically large in size and constructed in broken tops, split trunks, and sometimes in association with nests constructed by other arboreal species such as Humboldt's flying squirrel (Figure 1). Tree vole nests in old forest (>80yr) were typically small in size, constructed mainly in cavities and under moss mats, and were not found in association with nests of other arboreal species (Figure 2).

Figure 1: Large tree vole nest in a broom defect. Stand age: 27 years

Figure 2: Small tree vole nest under a moss mat. Stand age: 320 years

We confirmed the presence of occupied nests via remote camera and/or live capture in 17 stands during the time period between 2021 and 2022 surveys. Tree vole occupancy follows a bimodal distribution and is largely concentrated in stands between 20-40 years old that are within 1.3km of the nearest old forest patch and alsoinstands >100 years old. Occupancy dropped off to near zero in stands between 60-80 years old (Figure 3). Proportional density, as shown in Figure 3, was defined as an index of proportion of recently occupied nests that accounts for nest density in a given stand.

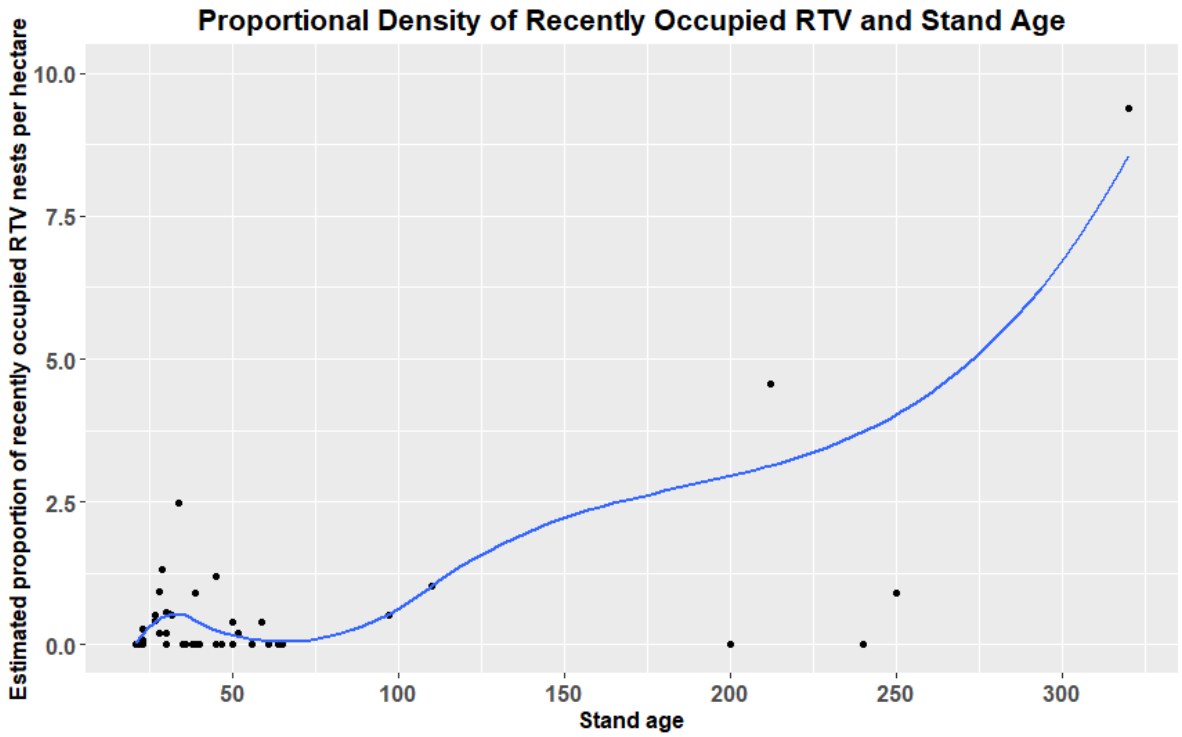


Figure 3: Red tree vole occurrence across stand age. Data from 2021 survey year. We included only stands within 1.3km from nearest old forest patches. Proportional density (y axis) was a calculated index of proportion of recently occupied nests, which accounted for nest density in a given stand. (from Piasecki et al. 2022 USFWS Report)

We successfully implemented our protocol for live capturing and marking red tree voles to determine tree vole density in young forests. We captured 28 voles across 8 stands primarily in the 20 and 30 year age classes with one opportunistic capture in the >80 year age class. We found pregnant females and both pre- and post-dispersal juvenile voles at nests in young forest (Figure 4). We interpret these findings as red tree voles successfully mating and reproducing in younger stands, although questions surrounding survival and juvenile dispersal remain unanswered. We used unique fur clip patterns identify individuals in the nest using images taken by remotely-triggered nest cameras images (Figure 5).

Figure 4: Juvenile tree vole with fur clip

Figure 5: Nest camera photo of fur clipped adult female tree vole

Problems and Barriers: Because of their dependency on the forest canopy and cryptic nesting behavior, red tree voles were difficult to study. Obtaining reliable information required both ground surveying and tree climbing to confirm tree vole activity. Our work employed multiple survey methodologies to locate, identify, and collect data on red tree vole nests and nests of other arboreal species. Another difficulty we will focus on is describing colonization events in stands. It is almost impossible to determine when and where a tree vole will build/colonize a nest within a forest. Despite this challenge, we have been fortunate enough to capture nest camera footage of red tree voles colonizing pre-existing nests. The amount of effort to accurately assess colonization through our methods is substantial - of the 111 cameras installed in 2021, only 2 captured tree vole colonization events (1.8%).

Planned Work: We plan to process data and conduct analysis over the coming months with an anticipated thesis defense in June 2023.

List of names and brief overview of graduate and/or undergraduate engagement in project: Jason Piasecki – Thesis research

List of Presentations, Posters etc.:

Quarterly Red Tree Vole Working Group Updates 2019, 2020, 2021, 2022

Piasecki, J., K. M. Moriarty, and J. D. Bailey. 2021. Red tree voles (*Arborimus longicaudus*) - Exploring forest occupancy, *abstract within:* Conference Western Section of the Wildlife Society. Virtual.

Piasecki, J., K. M. Moriarty, and J. D. Bailey. 2021. Red tree voles (*Arborimus longicaudus*) - Exploring forest occupancy. Conference Western Forestry Graduate Research Symposium. Virtual.

Scoresby, S., J. Piasecki, and K. M. Moriarty. 2022. Multi-species presence in red tree vole nests, *Poster abstract within:* Conference Western Section of the Wildlife Society. Reno, Nevada.

McCoy, M., K. M. Moriarty, and J. Piasecki. 2022. Red tree vole nesting preferences and use of interspecific nests in stands that differ in age, *Poster abstract within:* Conference; Oregon Chapter of the Wildlife Society. Newport, Oregon.

McCoy, M., K. Webb, K. M. Moriarty, and J. Piasecki. 2022. Red tree vole nest platform availability and interspecific competition with Humboldt's flying squirrel, *Poster abstract within:* Conference; The Wildlife Society. Spokane, Washington.

Shriner, I., J. Piasecki, and K. M. Moriarty. 2022. Biodiversity of arboreal mammals in the north-central coast range, Oregon, *Poster abstract within:* Conference; The Wildlife Society. Spokane, Washington.

Scoresby, S., J. Piasecki, and K. M. Moriarty. 2022. Red tree vole nest density and stand age, *Poster abstract within:* Conference; The Wildlife Society. Spokane, Washington.

Piasecki, J., J. D. Bailey, K. Dugger, and K. M. Moriarty. 2022. Arboreal nest survival and red tree vole use in forests that differ in age, *abstract within:* Conference; The Wildlife Society. Spokane, Washington.

List of Publications, Thesis Citations: Piasecki et al. 2022 – USFWS research report

Fish and Wildlife Habitat in Managed Forests

Progress Report

Title: Where is it the most effective to restore streams? Salmon Habitat Restoration using Large Wood: Linking Stream Geomorphic Change and Restoration Effectiveness

Investigators: Catalina Segura, FERM (PI), (Co-Pi), Erik Suring, ODWF (Co-Pi), and Christopher Lorion, ODFW (Co-Pi)

Objectives:

1. Assess the stability/resilience of the fish habitat changes observed one-year post LW restoration to changes observed 6-yrs post restoration.
2. Investigate the geomorphological changes triggered by LW restoration in three reaches based on the comparison of annual topographic surveys conducted 1-yr pre- to 5-yrs post-restoration.
3. Assess the stability of LW structures at the basin scale by comparing a wood survey conducted in 2016 to a new 2022 survey.
4. Investigate the relationship between local and basin scale habitat/geomorphic metrics and fish populations response after the restoration in the context of long-term fish population data.

Summary of Accomplishments toward Objectives:

1. Assess the stability/resilience of the fish habitat changes observed one-year post LW restoration to changes observed 6-yrs post restoration: We have made progress towards the modeling of hydraulic conditions during high flows (bankfull flow) around wood pieces in the three study reaches. It is important to recall that these reaches have been investigated by our group since 2014. Specifically:

- We processed the topographic data collected at the three sites into surfaces with sub-meter resolution. These surfaces are used as the boundary condition in the hydraulic model.
- We measured stream velocity and stage data to build rating curves in the three sites. Special emphasis has been given to high flows considering we are particularly interested in modeling peak flows (Fig. 1). The stage data collected at different flow sizes was used to generate water surface elevation across each reach for the model calibration (Fig 2).
- We have modeled bankfull conditions in the larger site (Site 1). The modeling has been conducted under the same modeling framework used in the 1-year post restoration study conducted at the same sites (Bair et al., 2018). The model, Nays2DH, is an unsteady quasi-3-dimensional hydraulic model (Fig. 3). We compared spatial velocity distribution in this site for 2014 (before the wood was added), 2016 (immediately after wood was added) and 2021 (5 years after the LW introduction). Although the size of the flow model in 2021 is smaller than the size of the flows modeled in 2014 and 2015, the distributions of velocity indicate that the created habitat in 2016 is still present in 2021. Indeed, the distributions of velocity across these 3 flows indicate similar shapes between 2016 and 2021 (not shown here for brevity but available). The percentage of the channel that is blue or light blue increased from 29.2 to 65.2% between 2014 and 2016. According to the preliminary run we have for 2021, the percentage of the channel that is blue or light blue increased by 80%. This would indicate that habitat has continued to increase as the channel adjusts to the wood introductions.

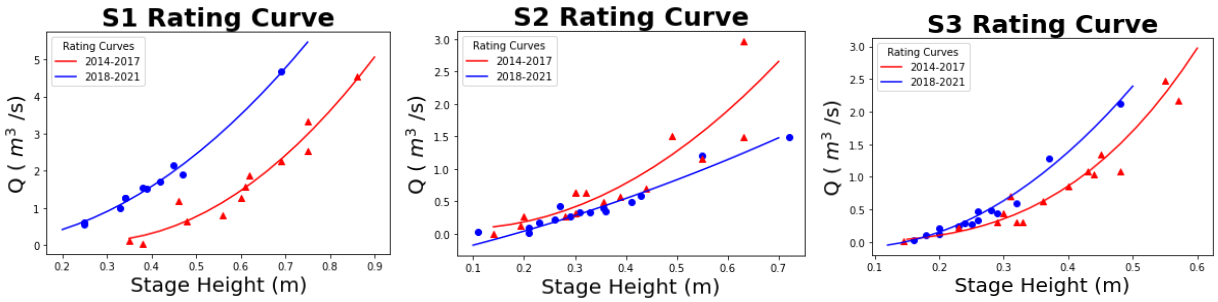


Fig. 1: Rating Curves developed for each study site. The blue points indicate the most recent data collected.

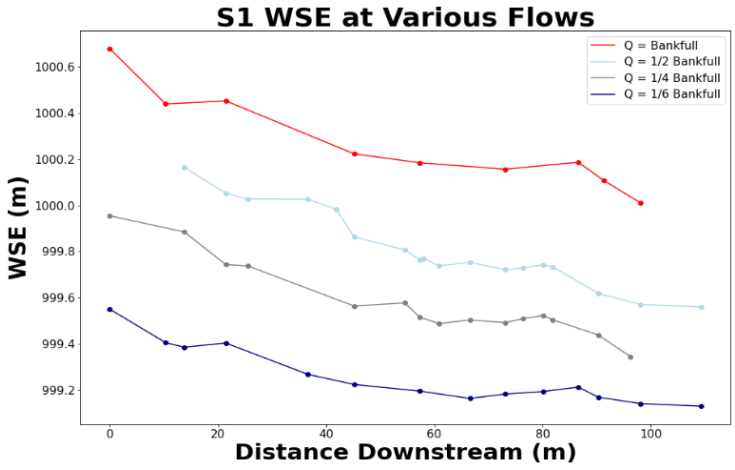


Fig. 2. Water surface elevation (WSE) values derived from field measurements during various flow regimes in Site 1.

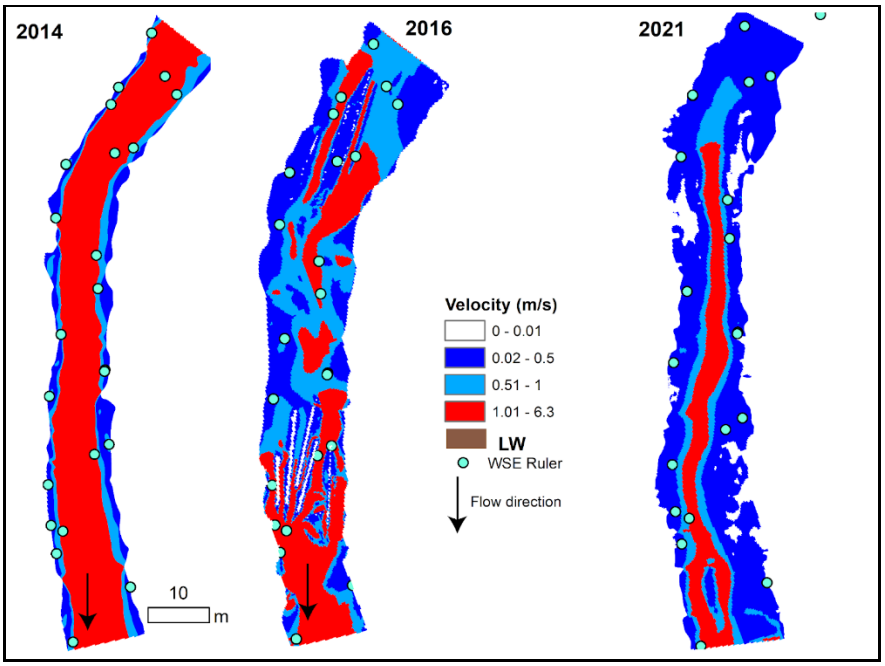


Fig.3: Velocity distributions for near bankfull conditions in Site 1. Modeled flows are 8.7 m^3/s (2015); 12 m^3/s (2016); 7.2 m^3/s (2021). Colors correspond to thresholds of velocity relevant to the ability of juvenile coho salmon to maintain position in the stream: dark blue: v<v-crit, where v-crit = 0.5m/s, light blues: v-cri<v<v-burst where v-burst = 1 m/s, and red: v>v-burst.

2. Investigate the geomorphological changes triggered by LW restoration in three reaches based on the comparison of annual topographic surveys conducted 1-yr pre- and 5-yrs post-restoration. We have begun the analysis of the cross-sectional survey data collected since 2014 in the three study reaches. Geomorphic changes have been quantified annually from detailed topographic surveys taken. In fulfillment of this objective, we have:

- Conduct annual geomorphic analysis of scouring, deposition, and total change within each of the three reaches (Fig 4 and 5 show examples for Site 1).
- Analyzed annual changes to site characteristics such as average width, depth, cross sectional area.
- Examined changes in LW locations in relation to each of the geomorphic changes.

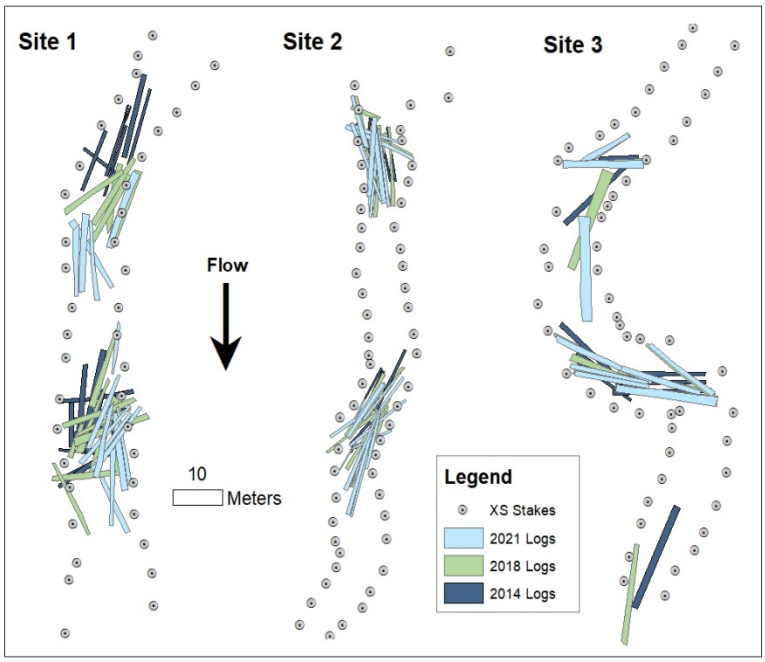


Fig. 4. Location of LW pieces in the three study reaches in 2914, 2918 and 2021.

According to Fig. 4 most of the scouring has occurred around XS6. This cross-section is located near the downstream LW jam in this site. From the temporal perspective it is evident that most changes occurred 2020–2021 (Fig. 5).

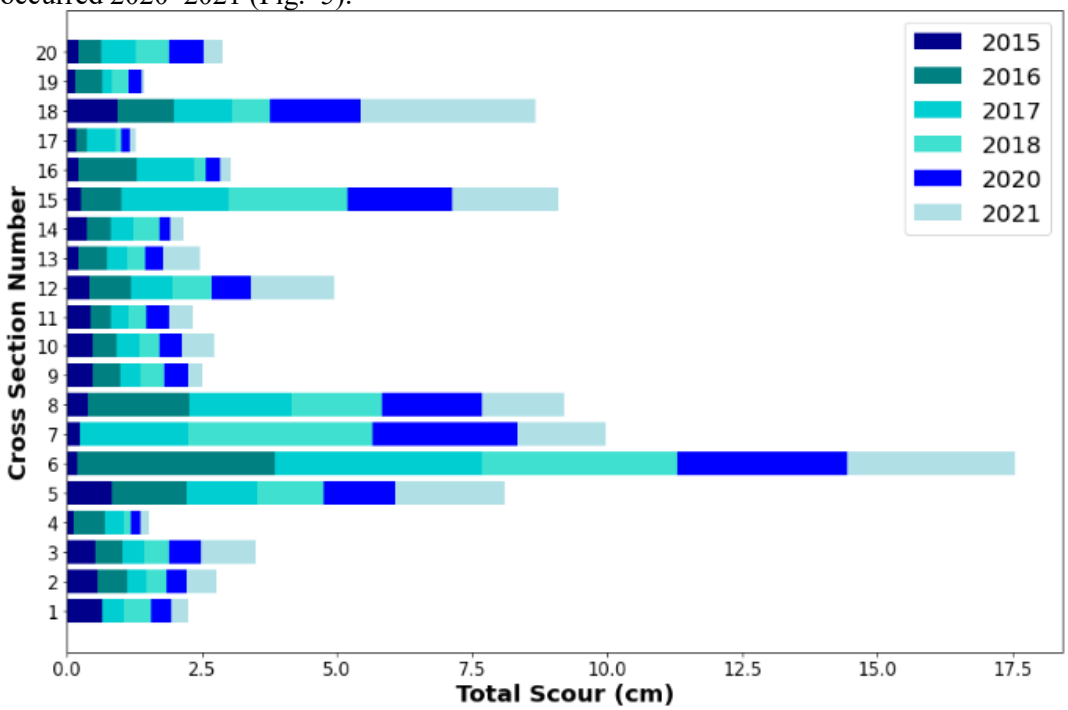


Fig. 4. Annual amounts of total scour per cross-section in Site 1, relative to the prior year.

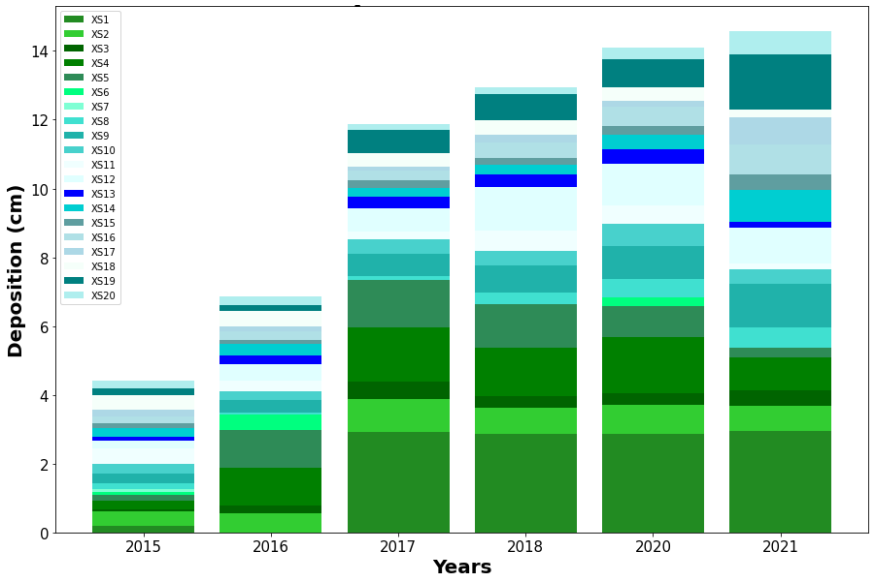


Fig. 5. Changes in cross sectional deposition from 2014 to 2021, relative to the prior year.

3. Assess the stability of LW structures at the basin scale by comparing wood surveys conducted in 2016 and 2020. An investigation of large wood stability in each reach will reveal the residence time of the structures and longevity of the restoration effort. Surveyed locations of each individual wood piece from 2014 to 2021 show the fate of the jam configurations as they relate to characteristics and flow magnitudes at each site. Efforts towards quantifying the stability of the LW structures at each site consists of:

- Mapping the location of each large wood structure in 2014, 2018, and 2021 (Fig. 6).
- Examining the relationship between log and stream dimensions in relation to their movement.

Fig. 6 shows significant movement for log jams that are oriented parallel to the flow or situated in straight reaches. Log jams that were configured perpendicular to the flow or near locations of meandering appear to reveal increased stability.

4. Investigate the relationship between local and basin scale habitat/geomorphic metrics and fish populations response after the restoration in the context of long-term fish population data. We have complete:

- A basin wide assessment of all LW structures introduced included information such as individual log length, diameter, volume below bankfull depth, and orientation. Information regarding valley confinement and floodplain connectivity were additionally collected at 100-meter intervals across 8.6 km of total stream length. These data will be used to assess the changes promoted by the LW addition and infer possible trajectories of channel adjustment as they relate to the creation and maintenance of fish habitat. For example, the degree of channel confinement is relevant to the creation of off-channel habitat.
- Analysis of long-term fish data to assess fish response at the basin scale and at the tributary scale. So far, we have preliminary results of the basin wide fish response (Fig. 6) indicate increases in Mill Creek after the restoration in 2016.

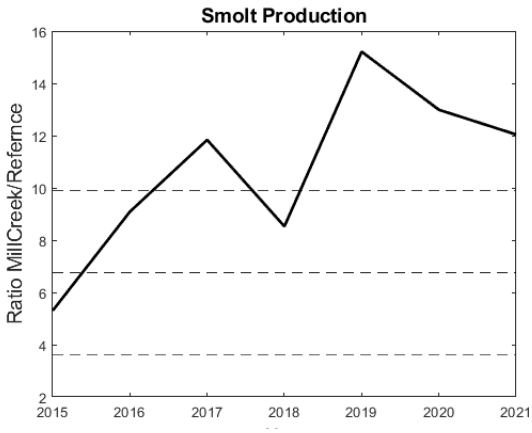


Fig. 6: Fish production ratio of restored Mill Creek to unrestored Lobster Creek.

Problems and Barriers:

The focus on peak flow events presents numerous challenges in terms of equipment and safety. In-stream equipment is thoroughly anchored to prevent destruction or washing away, however, the nature and magnitude of storm events is unpredictable. Desired peak flow data requires instream flow measurements which presents a large risk for the students. Since safety is a prioritization in the Segura Lab, data collection is not always feasible during the large storm events. The temporal scale of this research project has additionally created unforeseen difficulties. Data collection from numerous cohorts of students have prompted problems in understanding file notation, data locations, etc.

Planned Work:

- Complete hydraulic modeling at bankfull flow in 2021 for the three sites. We need to improve mesh resolution for the depiction of the LW in the model.
- Continue the analysis of 7 years of geomorphic information pre- (2014) and post (2015–2021) restoration at three reaches. We will incorporate into the analysis the streamflow variability.
- Based on the field data collected last summer we will develop metrics of geomorphic response to orientation and volume of log jams to extrapolate data to the basin scale. We will compare wood surveys conducted by Weyerhaeuser with the survey we conducted last summer.
- Investigate the relationship between geomorphic metrics derived and fish populations at the tributary and basin scales.

List of names and brief overview of graduate and/or undergraduate engagement in project:

Madelyn Maffia is a second year Master's student in the Water Resources Science Program, working on this project as her thesis. Melissa Mauk, Sydney Anderson, and Will Potter are field technicians that have assisted Madelyn with the field portion of this project and all study under the College of Forestry (CoF) at OSU. Additional graduate students, Jonah Nicholas, and Jaime Ortega in the CoF, have assisted with peak flow velocity and depth measurements during the Fall of 2021. Michal Tutka, a graduate student in the department of Biological and Ecological Engineering advised by Dr. Desiree Tullos, is additionally partnering with us to investigate LW impact on flow depth and velocities of varying log jam orientations in the same sites where we have been working. Madelyn secured additional funding from the CoF SUGAR Program to hire and fund an undergraduate technician, Christopher Neihoff, to assist with the basin-wide relocation survey during the summer of 2022.

List of Presentations, Posters etc.:

A poster contribution to the American Geophysical Union Fall Meeting, December 12–16, 2022 will be presented by Madelyn Maffia.

List of Publications, Thesis Citations: We anticipate two papers:

- Maffia, Yager, Bair, Segura: Channel geometry adjustment to LW introduction over 7 years; to be submitted to Geomorphology or Earth Surface Process Dynamics in 2022.

- Maffia, Segura, Suring. LW restoration success as a function of channel size; to be submitted to Geomorphology in 2023.

Fish and Wildlife Habitat in Managed Forests

Progress Report

Title: Quantifying the effects of wildfire on water quantity, water quality, and fish: The Hinkle Creek Watershed Study revisited

Investigators: Kevin D. Bladon, Dana Warren, and David Roon

Objectives: Our research is addressing the following objectives:

O1. Quantify effects of wildfire on bioavailable nutrient concentrations and relate these to primary productivity, fish, and amphibian populations across nested sub-catchments.
O2. Quantify streamflow to enable quantification of wildfire effects on nutrient yields (fluxes), water supply, and habitat quality and availability for fish and amphibians across nested sub-catchments.
O3. Relate water quantity and water quality responses across the nested sub-catchments to spatial data on catchment and wildfire characteristics to identify drivers of variability in post-fire responses.
O4. Leverage data from the original Hinkle Creek Watershed Study to compare effects of wildfires on streamflow, chemical water quality, and fish and amphibians to effects from forest harvesting.

Summary of Accomplishments toward Objectives:

Toward O1, we collected water samples every month during the summer low flow period from ten sites through the stream network, as planned. Those samples were filtered and sent to the lab for analysis of nitrate (NO_3^-), total nitrogen (TN), orthophosphate (PO_4^{3+}), total phosphorus (TP), and dissolved organic carbon (DOC), as planned. We have also re-established automated water samplers (ISCOs) at the six sites in preparation for fall and winter storm flows. These samplers will capture daily composite water samples for suspended sediment analysis. We have also developed a strategic plan for the coming fall and winter to manually collect water samples approximately every 7–14 days for nutrient analysis.

Toward O2, we removed the Montana flumes that were destroyed by the Archie Creek fire and replaced them with the new flumes during summer 2022. This infrastructure will be critical to providing reliable and accurate measurements of streamflow, which will enable us to compare the post-fire hydrological response to the original Hinkle Creek Watershed Study data. Related to this, we continued to maintain stilling wells and pressure transducers that we installed prior to installation of the flumes to capture preliminary stage data. We have downloaded this data and begun QA/QC analysis. Once we have established flow data from the Montana flumes, this preliminary stage data will enable us to develop relationships with the stage sensors to back-calculate streamflow. We also quantified streamflow each month during the summer low flow period at each of our larger, downstream reaches on the mainstem Hinkle Creek to facilitate development of rating curves for quantification of continuous streamflow on the larger streams.

Toward O4, we have compiled and begun preliminary analysis on much of the original Hinkle Creek Watershed Study data. This data was poorly organized across network drives; however, we now have most of the data in hand and organized to facilitate completion of this objective once we quantify the post-fire effects.

Problems and Barriers:

- We were not able to make any demonstrable progress toward completion of O3. This will require us to fulfill our plans for sample and data collection over this upcoming year. We have a strategic

plan developed to fulfill this objective, as planned.

- Coordination for transport of the flumes to the Hinkle Creek research sites, removal of the old flumes, and installation of the new flumes required a substantial effort. Work with the contractor to install the flumes was greatly delayed due to differences in expectations for quality of the work. However, this was fortunately resolved in September 2022 and we are now quantifying streamflow as planned.

Planned Work:

List of names and brief overview of graduate and/or undergraduate engagement in project: [e.g., thesis, research experience for UG, etc.]

- Kate McCredie (MS student): She has been primarily responsible for collection of the water samples through the summer and deployment of the ISCO water samplers across the study catchments. She has started processing samples to quantify turbidity and suspended sediment. Kate has also led the effort to capture the depth integrated water samples of water to provide some preliminary quantification of nitrogen, phosphorus, and carbon in the streams. She has also collected soil samples, which will also be analyzed for nitrogen, phosphorus, and carbon to link the terrestrial processes to the in-stream response.

- Jansen Ivie (MS student): Completed his first summer working on the project in Summer 2022. Jansen's MS research is focused explicitly on expanding the preliminary research on the fish and trying to relate those observations to physical water quality parameters and the original Hinkle Watershed Study. In summer 2022, Jansen and field assistants completed numerous important tasks, including: (a) reestablishment of yellow cards through the stream network to demark stream distances, (b) stream habitat surveys, (c) three-pass depletion fish surveys along SF Hinkle in July and September to quantifying fish density, biomass, and growth (via installation of PIT tags), (d) longitudinal pool sampling to quantify fish density and biomass via single-pass electrofishing in pool habitats along SF Hinkle and major fish-bearing tributaries during August, with an emphasis on locations sampled during the Original Hinkle Watershed Study, and (e) estimations of summer benthic algae abundance with a BenthoTorch (fluorometer to estimate total benthic algae concentrations) and deployment of ceramic tiles. Periphyton was scraped from half of tiles in August and half in September to quantify ash free dry mass and chlorophyll-*a*. Measurements occurred at quantitative fish sites (4 sites * 5 reps = 20 total) and at temperature sensor locations (n = 17).

- Alessandra Bertucci, Bailey Brockamp, Brenna Cody, India Gerhardt, Samuel Ogle, Casey Warburton (Undergraduate field technicians): Our undergraduate field technicians have gained broad field, laboratory, and data analysis skills associated with quantifying fish biomass, fish populations, primary productivity, aquatic habitat, canopy closure, stream temperature, suspended sediment, nutrients, precipitation, and streamflow. These students worked full-time through the summer and/or have worked for us through the current academic year.

List of Presentations, Posters etc.:

- Bladon, K.D., Cole, R.P., Donahue, D., Graham, E., Grieger, S., *McCredie, K., Myers-Pigg, A., Roebuck, J.A., *Roon, D.A., Scheibe, T., *Wampler, K.A., and Warren, D. 2022. Wildfire effects on catchment hydrology and biogeochemical processes. American Geophysical Union Fall Meeting. Dec. 12–16, 2022, Chicago, IL. (Invited)

- *McCredie, K., Bladon, K.D., and DeLuca, T.H. 2022. Disentangling pre- and post-fire forest management effects on water quality and soil health in the Hinkle Creek Watershed, Western Oregon. American Geophysical Union Fall Meeting. Dec. 12–16, 2022, Chicago, IL.
- Bladon, K.D., Warren, D.R., Roon, D.A., Swartz, A., *McCredie, K., and Ivie, J. 2022. Wildfire and post-fire management effects on water quantity, water quality, and aquatic ecology: The Hinkle Creek Watershed Study revisited. Nov. 3, 2022. Umpqua Hydro Breakfast, Roseburg, OR. (Invited)
- Roon, D.A., Bladon, K.D., Warren, D.R., Swartz, A., *McCredie, K., and Ivie, J. 2022. Wildfire and post-fire management effects on water quantity, water quality, and aquatic ecology: The Hinkle Creek Watershed Study revisited. Sep. 28, 2022. National Council for Air and Stream Improvement Fall Meeting, Vancouver, WA. (Invited)
- Warren, D.R., Roon, D.A., Swartz, A., Bladon, K.D. 2022. Cold-water fish persist in a stream system with elevated summer temperatures after a severe wildfire. Sustainable Forestry Initiative, Oregon State Implementation Committee Meeting. Sep. 21, 2022. Virtual.

- Field tour: Hinkle Creek Watershed Study Revisited: Wildfire effects on water quantity, water quality, and aquatic ecology. September 15, 2022, Hinkle Creek Watershed, OR. OFIC and NCASI members. (17 attendees)

- Media: Timber Fires and High-Water Temperatures Didn't Impact an Oregon Trout Stream Population. Sport Fishing. Oct. 17, 2022. https://www.sportfishingmag.com/news/timber-fires-high-water-temperatures-didnt-impact-oregon-trout-stream-population/.
- Media: Warmer stream temperatures in burned-over Oregon watershed didn't result in fewer trout. PhysOrg. Oct. 4, 2022. https://phys.org/news/2022-10-warmer-stream-temperatures-burned-over-oregon.html.

List of Publications, Thesis Citations:

- Warren, DR., Roon, D., Swartz, A., and Bladon, K.D. 2022. Cold-water fish persist in a stream system with elevated summer temperatures after a severe wildfire. Ecosphere. 13(9): e4233. doi: 10.1002/ecs2.4233.

Fish and Wildlife Habitat in Managed Forests

Progress Report

Title: Post-wildfire resurvey of terrestrial salamanders on managed forests

Investigators: Tiffany Garcia, Jessica Homyack, Claudine Reynolds, Meg Krawchuk, Andrew Kroll

Objectives: Compare pre- and post-fire changes in salamander occupancy and abundance on managed timberlands.

Summary of Accomplishments toward Objectives:

The start date for this project was July, 2022, thus we are in the early stages of research implementation. The first field survey is scheduled for spring 2023. In preparation, we have focused on 1) site selection, 2) field housing, 3) permissions, 4) personnel, and 5) communication.

1. Site selection- Stands included in this resurvey effort were all part of the 2013-19 project to quantify harvest impacts on terrestrial salamanders. We have selected 60 stands out of the 88 original stands, all of which were fit the original criteria of being >10 acres in size and located below 2500ft in elevation, and the new criteria of being in or near the 2020 Beachie Creek and Riverside wildfire perimeters, with all burned sites located in high burn severity areas.

Our 4 treatments include: **1**. Stands that were harvested post-2015 and subsequently burned in the 2020 fires (Harvested/Burned; # Resurvey plots = 15), **2**. Mature stands that did not burn (Unharvested/Unburned; # Resurvey plots = 15) **3.** Mature stands that burned in the 2020 fires and were subsequently salvage-logged (Burned/Salvaged; # Resurvey plots = 7, # new plots = 8), and **4.** Stands that were harvested post-2015 and did not burn (Harvested/Unburned; # Resurvey plots = 15). All 60 sites are located on Weyerhaeuser and Port Blakely plantations.

In an effort to fully explore the role of fire on salamander occupancy, we are expanding the study to include a treatment of mature forests that burned but were not salvage logged (Unharvested/Burned). These stands are rare on the landscape as most of the commercially viable trees in burned stands were salvaged. However, we are in communication with Oregon Department of Forestry and Port Blakely to assess new sites that would fit our criteria. If included, this would expand the survey to 72 sites with site sampling occurring in both 2023 and 2024.

2. Field housing- Surveys will take place in the Molalla, OR region, primarily on Weyerhaeuser and Port Blakely ownership. We have investigated federal agency bunk house options and local campgrounds. No bunkhouse vacancies are expected, and due to the expected precipitation in spring, camping is less than ideal. As such, we are exploring private rentals that would 1) keep the crew near the sampling sites to limit drive time, and 2) provide 12 weeks of housing in an effort to more effectively and inclusively recruit a diverse field crew.

3. Permissions- A research agreement with Weyerhaeuser Timber Holdings was established from 15 April 2022 to 1 April 2025. This agreement outlines data contributions (ex. GIS data on stand history), safety, access, liability, and reporting expectations. Specific site access and gate keys will be provided at the beginning of the field seasons (March, 2022 & 2023) for Weyerhaeuser and Port Blakely. Oregon state collection permits and Oregon State University IACUC permits will be submitted in January, 2023.

4. Personnel- Jasmine Williamson, a MS student in the Department of Fisheries, Wildlife, and Conservation Sciences, will act as crew lead and the person managing data collection, storage, and analysis. She will also assist in the communication of the results in the form of peer-reviewed publications and scientific conference presentations. We are writing the position description for two field technicians which will be advertised in December 2022 and aimed at recruiting a diverse applicant pool.

We aim to hire both techs by 15 January 2023, with an anticipated start date of 1 March 2023. Each field season will be 12 weeks long.

5. Communication. Quarterly updates for all PIs and project participants are planned, with the first update scheduled for Fall 2022. Jessica Homyack and Claudine Reynolds are directly involved in access and site selection processes, and Jasmine Williamson is establishing relationships with Weyerhaeuser operations personnel (Mike Rochelle and Josh Johnson) and Oregon Department of Forestry resource managers and biologists (Nick Palazzotto and Vanessa Petro).

Problems and Barriers:

No problems or barriers have been detected thus far. The lack of field housing in the area is a minor impediment.

Planned Work: We plan on two field seasons, with the first starting in March 2023. Over the following 12 months, we will:

- Complete site selection- Dec. 2022
- Build GIS database for stand-level characteristics- Dec. 2022
- Purchase field supplies and instrumentation, such as soil moisture and ambient temperature probes, and densiometers.
- Advertise and hire Year 1 field crew- Jan. 2023
- Finalize housing for Year 1 survey- Jan. 2023
- Submit state animal collection and OSU animal handling permit applications- IACUC and Scientific Collection- Jan. 2023
- Schedule site surveys and construct appropriate maps- Feb. 2023
- Conduct Year 1 Survey- March-June 2023
- Establish database of salamander detection and habitat data for all sites

List of names and brief overview of graduate and/or undergraduate engagement in project: [e.g., thesis, research experience for UG, etc.]

Jasmine Williamson, a MS student in the Department of Fisheries, Wildlife, and Conservation Sciences, College of Agricultural Sciences, Oregon State University.

List of Presentations, Posters etc.:

N/A

List of Publications, Thesis Citations: [published or anticipated]

N/A

Fish and Wildlife Habitat in Managed Forests

Progress Report (year 1)

Title: Responses of Fish to Forest Management: Evaluating How Different Riparian Reserve Configurations Affect Fish and Food Webs in Headwater Streams

Investigators: Dana Warren, Ashley Coble

Objectives:

The core objectives of this proposed project were to:

(1) Continue data collection across all sites for a large-scale before-after control-impact study quantifying the response of habitat, ecosystem processes and biota to 4 different riparian reserve configurations (and relating those to an unmanaged control) in 6 replicated blocks.

(2) Synthesize, analyze, and contextualize results from the first two blocks in regard to changes in (1) temperature, (2) light, (3) benthic biofilms, and (4) fish density, biomass and growth in a master's thesis that will ultimately be developed into one or two peer-reviewed publications.

Summary of Accomplishments toward Objectives:

In this first summer of the second phase of this study, we have made progress on multiple aspects of this project.

- We completed another field season collecting data at 28 sites (2 were removed for logistical reasons)
- A new crew lead was hired in spring 2022 and was trained in summer 2022 to conduct field work, lab work, and data management for the remaining years of the project.
- The MS student on the project trained the new full-time technician and made progress on her thesis.
- Four undergraduate field technicians were hired and trained to conduct field work
- One manuscript has been published
- The graduate student on the project, Ashley Sanders, presented at an OSU research forum for aquatics (Monday Morning meeting) in October 2022
- We organized logistics for the location and configuration of riparian alternative treatments for 14 sites (the final 4 blocks) where harvest is set to occur this fall and winter.

Field work (June - September 2022)

Sites in the Valsetz block (2 years post-treatment) resembled conditions in year 1 post-treatment, except much more understory brush has grown in and there were slight geomorphological changes in the channel at the Current Practice site. At this site, there were more pools in the fishing reach, likely creating more habitat, resulting in more adult trout biomass (Figure 3). These data also show that while the YOY response from year 1 post-treatment was short-lived, it may have contributed to elevated adult cutthroat biomass in year 2 (2022) post-treatment as the cohort aged. Sampling was conducted similar to pre-treatment years with the addition of trout diet sampling (2 events) to use in fish bioenergetics models for Ashley Sanders' MS work.

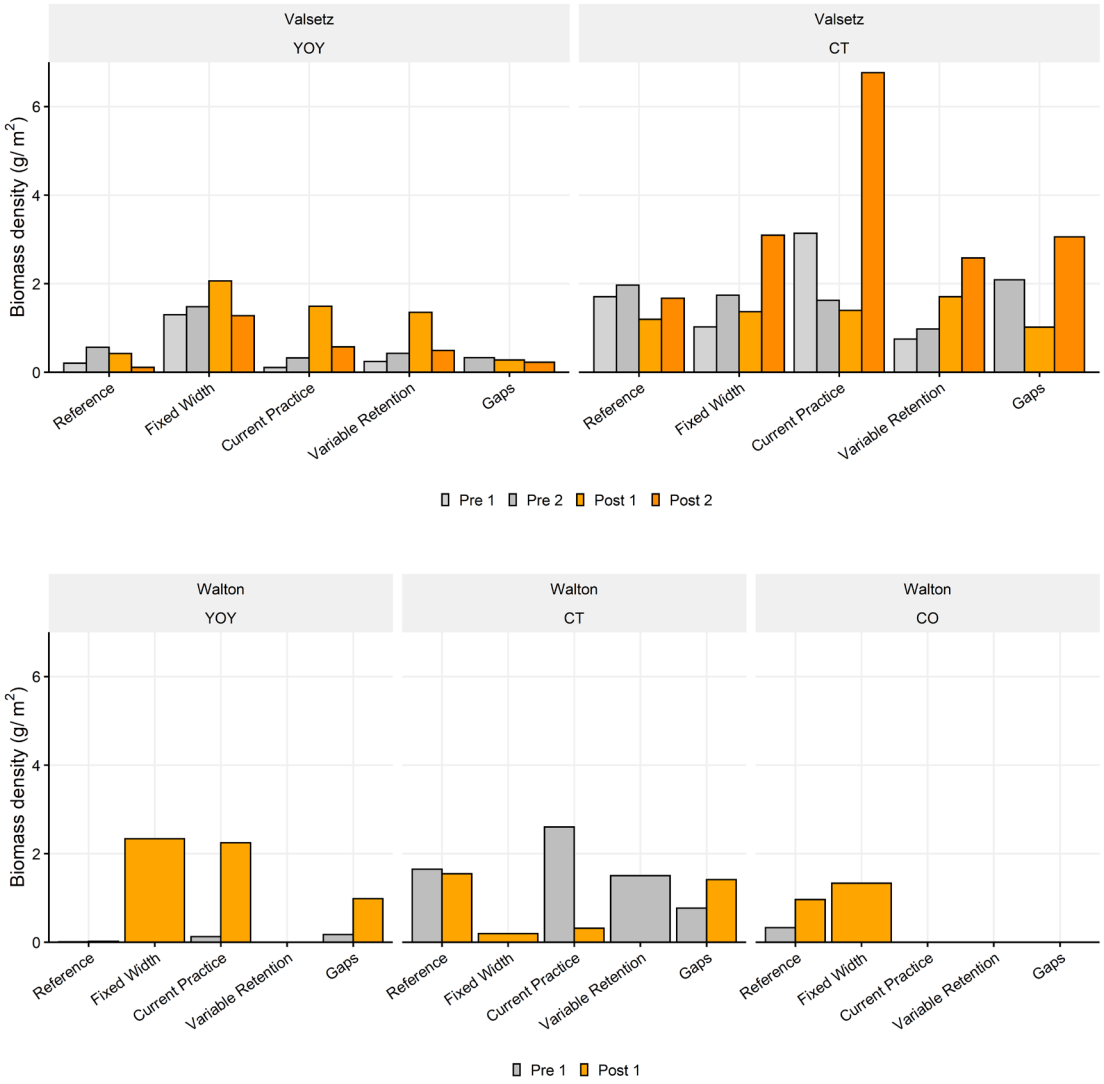


Figure 1. Biomass density of cutthroat trout (g/m^2) at the Valsetz and Walton blocks pre- and post-treatment. CT refer to adult cutthroat trout, YOY refer to young-of-year (juvenile) cutthroat trout, and CO refer to juvenile coho salmon captured during triple-pass depletion surveys using a backpack electrofisher. Pre-treatment data at the Walton block was only available for one year at 4 sites, and post-treatment was also only available for one year at 4 sites.

At a few sites, contractors started harvest early so equipment needed to be retrieved before the end of the summer. Pre-treatment drone footage (LiDAR) was captured at 2 replicate blocks by the landowner, with plans to return post-treatment, allowing us to quantify canopy cover change more precisely there.

New research assistant and 4 field technicians hired

In June 2022 we welcomed Alex Foote to the NCASI team as a new research assistant overseeing the project for the remaining 2 years of the study. He assisted with pre-season field equipment preparation, technician training, and leading field crews during sampling events. This fall he will take the lead on data management and preparation for data analysis of all replicate blocks.

We interviewed, hired, and trained 4 undergraduate students from the Biology, Ecological Engineering, and Marine Biology programs at OSU to assist with field work. For most, it was their first field season and through their work they gained first-hand experience following standardized protocols to sample streams, working collaboratively as a group, and better understanding timber management rules and regulations on private land in the Coast Range of Oregon.

Problems and Barriers:

Newly harvested sites (Walton block, Siuslaw basin) were visited at the beginning of the field season and we observed that fine logging debris and blowdown had affected the Variable Retention and Gaps sites to the point of disrupting stream sampling (Figure 2). We proceeded with as much of the data collection at these sites as possible (physical habitat, light, stream temperature, dissolved oxygen, canopy cover, periphyton, macroinvertebrates), but we were not able to collect vertebrates in the last half of the Gaps fishing reach or in any of the Variable Retention fishing reach. We are seeking resources to assist in removing some of this debris to access the stream for sampling next year. The Fixed Width and Current Practice sites were not as affected by logging debris and sampling was conducted similar to pre-treatment years. This was likely the result of steep slopes that required cable yarding across the stream corridors (gaps). We do not anticipate similar issues in remaining 4 blocks because they will be 1-sided buffers and will not require yarding across the stream.

Figure 2. Photos of logging slash in the stream following harvest at the Variable Retention and Gaps sites in the Walton block (Siuslaw basin). Fine logging debris covered the channel and prevented crews from sampling for stream vertebrates.

Planned Work:

Over the next year, we plan to complete the following:

- We will continue to organize and manage data in an accessible, cloud-based database.
- Ashley Sanders, a MS student, will begin data analysis for her thesis and present those findings at conferences in winter and spring 2023.
- We will clean, refurbish, and calibrate equipment and field instruments to maintain consistent data collection for the duration of the study.
- We will process periphyton samples in the lab and for chlorophyll a and ash-free dry mass
- We will receive results of macroinvertebrate taxonomy and water chemistry (N, P, C), which were already sent to an external taxonomist and the NCASI lab.
- We will communicate with landowners regarding progress of harvest operations.
- We will organize logistics for removing slash in the fishing reaches at the Variable Retention site in the Walton block to continue vertebrate sampling there next summer.

List of names and brief overview of graduate and/or undergraduate engagement in project:

OSU undergraduate field technicians for the 2022 season were Brenna Cody, Tyler Parr, Nicole Miller, and Ciana Carr. Field technicians assisted with data collection from June to September, learning a wide variety of stream ecology protocols and traveling to sites across the Coast Range. Toward the end of the season, they contributed to a significant volume of data entry which allowed for a quick transition to data analysis in the fall. They were also involved in many conversations with crew leads about forest management, DEI in ecology, and professional development.

Undergraduate Nicole Miller will be working with the project PI's and graduate student (Ashly Sanders) in conducting her OSU Honors thesis based on data she helped to collect as a field technician in summer 2022.

Ashley Sanders (MS student) continued work managing logistics for data collection, entry, and analysis for the larger project and the components used in her thesis.

List of Presentations, Posters etc.:

Sanders, A. M., A. A. Coble, and D. W. Warren. "Rethinking fixed-width: Light-mediated ecosystem responses to implementing alternative riparian buffers on small headwater streams," OSU Dept of Fisheries, Wildlife and Conservation Sciences Monday Morning Meeting, in person, October 2022.

List of Publications, Thesis Citations:

The following paper supported by FWHMF for the first phase of this project was accepted in June 2022 and will be published in December 2022.

Sanders, A, A.A. Coble, A.G. Swartz, M. River, P. James, and D.R. Warren. 2022. Effects of fire and smoke on water temperature and dissolved oxygen in headwater streams. *Freshwater Science*