Oregon State University
College of Forestry

Fish and Wildlife Habitat in Managed Forests Research Program

Progress Reports

Nov 8, 2021

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Fish and Wildlife Habitat in Managed Forests

Progress 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 is to document how plantation forestry alters biodiversity and temporal characteristics of the early seral period from its primary natural counterpart, stand-replacing wildfire. At the same time, we will investigate the extent to which active management may support species and communities traditionally associated with natural disturbance.

To address this objective we are conducting 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 are stratifying 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.

The majority of FWHMF funds support PhD Graham Frank's academic program. The majority of field costs are supported by NCASI funding.

Summary of Accomplishments toward Objectives:

Our 2021 field season (season two of three) was a success, which was a bit boost after the required cancellation of the 2020 field season due to COVID-19 health concerns. Highlights from the year include:

1. Spring/summer 2021 field data collection: Following the relaxation of OSU COVID-19 travel restrictions, we were able to successfully complete a second field season from April – August 2021. At 24 sites across southwest Oregon, we completed six weeks of pitfall trapping for ground beetles, two rounds of pollinator and floral resource sampling, and three separate visits for avian point counts, characterized plant communities, and took several measurements of forest structure. Together with sites sampled in 2019, we now have two-thirds of our anticipated data collected, allowing us to develop analytical techniques that can be applied to the full dataset and share some preliminary findings.
2. Taxonomic identification and functional trait measurements of ground beetles: Following training from carabidologist Jim LaBonte, Graham has identified over 4000 ground beetles from two years of pitfall trap collections, representing approximately 40 species. To facilitate the comparison of functional diversity and variation in functional traits among early seral forest types, we are developing a database of morphological trait measurements for each species. We have received funding from the OSU College of Forestry's Mentored Employment Program to bring on an undergraduate student to assist with this effort.
3. Taxonomic identification of bees: We are contracting out bee identification with Linc Best, and have decided to wait until the completion of 2022 sampling for him to identify our 2021 bees to make the process more efficient. Graham received a grant from the Northwest Scientific Association for materials needed to pin and safely store bee collections. BLM funding will cover ID costs.

4. Presentations: Graham Frank presented year one results from early seral bird communities at the Willamette Valley Bird Symposium in January 2021. Graham has also had an abstract accepted to present at the 9th International Fire Ecology and Management Congress at the end of the month, where he will present the first two years of ground beetle data.
5. Undergraduate honors thesis development: Sarabeth Pearce-Smith, a Natural Resources major and Honors College student at OSU, is working with plant community data collected as part of this project to develop an undergraduate honors thesis, which she will defend in Spring 2022. Her thesis focuses on questions about exotic plant species in early seral forests, how they vary among *IFM, FSalvage,* and *SRFire* and with stand age, and what environmental factors are associated with their abundance.
6. Graduate program progress: Graham is nearly finished with planned coursework, with only a single capstone class to complete a certificate in college and university teaching remaining. Qualifying exams to advance to PhD candidacy are planned for February 2022.

Problems and Barriers:

Cancellation of 2020 field season was a substantial set back. FWHMF generously contributed extra funds to support Graham Frank's academic program through an additional year, due to the global pandemic.

Planned Work:

This academic year Graham Frank will complete his PhD preliminary exams.

Graham Frank aims to attend and present at (remotely) the upcoming Association for Fire Ecology International Congress, in December 2021.

Summer 2022 will be our final full field season, and we anticipate visiting the final third of our total proposed sites. The field portion of this project is largely supported by funds from NCASI. We will be recruiting our summer field team and organized housing for the crew starting in December 2021.

Once Summer 2022 field season is complete, Graham will dive into analysis and writing of his PhD with anticipated defence in Fall 2023, with Winter 2024 as wiggle room. We have full funding for that time period.

We are pursuing funding for Science Applications and Synthesis work through the FY2023 FWHMF proposal call that would fund a small amount of manager outreach in the final year of Graham's PhD and support a 1-year postdoc to fully leverage and synthesize the rich dataset collected in this project.

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

Graham Frank. PhD student recruited for this project, 2018-2022 (2023)

Skye Greenler. PhD student 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, Fall 2020-ongoing.

Upcoming funded MEP protégé, Fall 2021+

List of Presentations, Posters etc.:

Frank, G.S., Krawchuk, M.A. 2021. 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. 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. 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:

None completed.

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

Fish and Wildlife Habitat in Managed Forests

Progress 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 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 doing so due to 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). Over both years, 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

were 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 three 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 rates differ between green and burned forest. To our knowledge, this is the largest database of nestling feeding database obtained by researchers and we expect it to serve as a separate, stand-alone manuscript to compare parental feeding rates and chick feeding behavior within green and burned forests.

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.

Finally, we moved from using traditional "beeper" telemetry radio tags to using so-called connectivity tags for tagging all fledglings in 2021. Those tags will be in a "sleep mode" over the winter and will turn on in late spring which allows us to determine where birds settle for their first breeding opportunity (i.e., natal dispersal) in collaboration with LightHawk Conservation Flying, which provides aerial telemetry flights free of charge. This allows us to move beyond looking at vital rates of woodpeckers in green and burned forests and collect pilot data for quantifying population connectivity between the two forest types.

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: We have collected the core data for the project in the field and our work plan is to obtain data from nestling provisioning videos, conduct data analysis, and commence the writing of manuscripts. Mark Kerstens has joined our research group as a M.S. student in fall 2020 and will be leading the completion of the project. In addition, he will be undertaking field work in May-June 2022 to relocated birds tagged in summer 2021 with connectivity tags to determine settlement patterns occurring during the course of natal dispersal.

List of names and brief overview of graduate and/or undergraduate engagement in project: In addition to Mark Kerstens, nine young professionals have worked as 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 but have experienced limited success to date. 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. Finally, we have 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 searching for undergraduates to assist with watching nest woodpecker provisioning videos, and we are targeting students involved with the OSU Honors College, STEM Leaders Program, and/or URSA Program.

List of Presentations, Posters etc.:

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

2. 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>.

3. 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>.

4. 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>.

5. 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.

6. 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. Black-backed Woodpecker nest site selection and reproductive output in burned and unburned forests of southern Oregon. Anticipated for submission to *Forest Ecology and Management*.
3. Post-fledging survival and movement of Black-backed Woodpeckers in a burned landscape mosaic. Anticipated for submission to *Ornithological Applications*.
4. Parental provisioning in divergent forests: Black-backed Woodpecker feeding in burned and green forests. Anticipated for submission to *Avian Conservation and Ecology*.

Fish and Wildlife Habitat in Managed Forests

Progress Report

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

Investigators: James Rivers (with Lincoln R. Best as key collaborator)

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 keys specific to the PNW that are focused on (1) a generic-level key for all bee species that are found within this region, and (2) a species-level key for all bumble bee (*Bombus*) species that are found within this region.

Summary of Accomplishments toward Objectives: We have developed bee genera checklists for the PNW and surrounding region. These checklists demonstrate that a key to the Oregon fauna will be inclusive of the entire northwest areas of the North American continent. In addition, we are working to source material for loan of male and female specimens of genera rare in the region such as *Oreopasites* (Apidae), and *Anthophorula* (Apidae). We have also received 473 bumble bee color templates from Dr. Paul Williams (Natural History Museum of London) that will allow for addressing within- and between-species variation in color pattern. We have discussed developing new templates with Williams for color morphs occurring in the region but that are not yet recognized. In addition, we have begun assembling specimens of within-species variability related to caste for some *Bombus* species. Finally, we have developed a *Bombus* species checklist for the PNW and surrounding region.

To date we have produced the second 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.)

These drafts provide the framework for the identification of 28 *Bombus* species and 55 genera. They require further refinement in order to meet the objective of avoiding the excessive use of technical terminology. This will be accomplished by reducing the descriptive component of the dichotomous couplets and leveraging high resolution macrophotographs and bumble bee color-form templates where applicable.

Problems and Barriers: Complications arising from COVID-19 has produced significant barriers have impeded expected progress. 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 during March 2020-May 2021 because the university was effectively closed. This meant that we were delayed 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.

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 we will continue to develop and refine keys, after which we will select exemplar specimens from the Oregon State Agricultural Collection (OSAC), Oregon Bee Atlas (OBA) and the OSU Forest Animal Ecology Lab for the genera and/or species represented in the identification keys. We will then work collaboratively with personnel at ODA to produce high-resolution images to illustrate species and key characteristics needed for identifying a specimen through the key. At the same time images are obtained, a graphic designer will develop a website that will be hosted by the Oregon Bee Project and used to house online keys. The graphic designer will also develop identification keys in printed form, as having both online and print materials will maximize dissemination to target audiences. Once materials are tested and finalized, we will work to disseminate and publicize identification keys through ongoing partnerships with ODA, 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, 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, but will seek opportunities for such interactions in the future.

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 to bees cover 55 genera of the Pacific Northwest (Anticipated).
2. A user-friendly identification guide to the bumble bees (*Bombus* spp.) of the Pacific Northwest (Anticipated).

Fish and Wildlife Habitat in Managed Forests

Progress Report

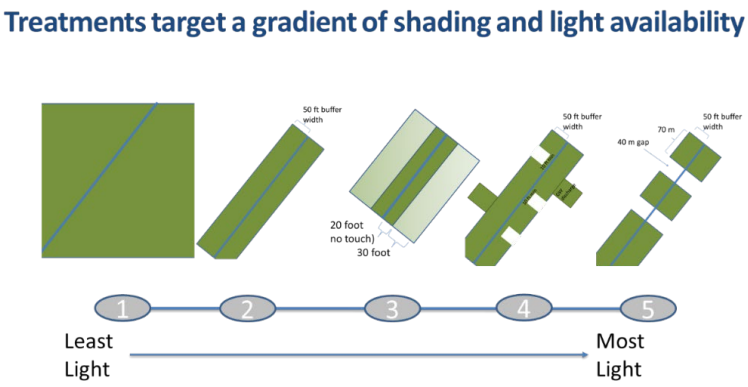
Title: Assessing the response of aquatic biota to alternative riparian management practices

Investigators: Dana Warren (OSU, FES); Ashley Coble (NCASI)

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 (Figure 1). To meet this overarching goal, we have 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*



- **Figure 1. conceptual diagram of treatments within a study block set along the hypothesized range of light availability in the reaches after treatments are applied.**

Summary of Accomplishments toward Objectives:

- In this funding cycle, we overcame setbacks in site selection imposed by the Labor day fires in September 2020 (which, eliminated three blocks from our study), and completed site selection for four new study blocks (of 5 streams each) in managed forests of the Oregon Coast Range. These four new blocks along with our two existing coast range block gave us our intended 6 full study bocks (30 streams) for the project. Our final network of sites included four blocks in which experimental treatments would be applied to "small-fish bearing streams" and two blocks in which experimental treatments would be applied to "medium fish-bearing streams". Three of the blocks had harvest on one side and three had harvest on both sides. (Figure 2)

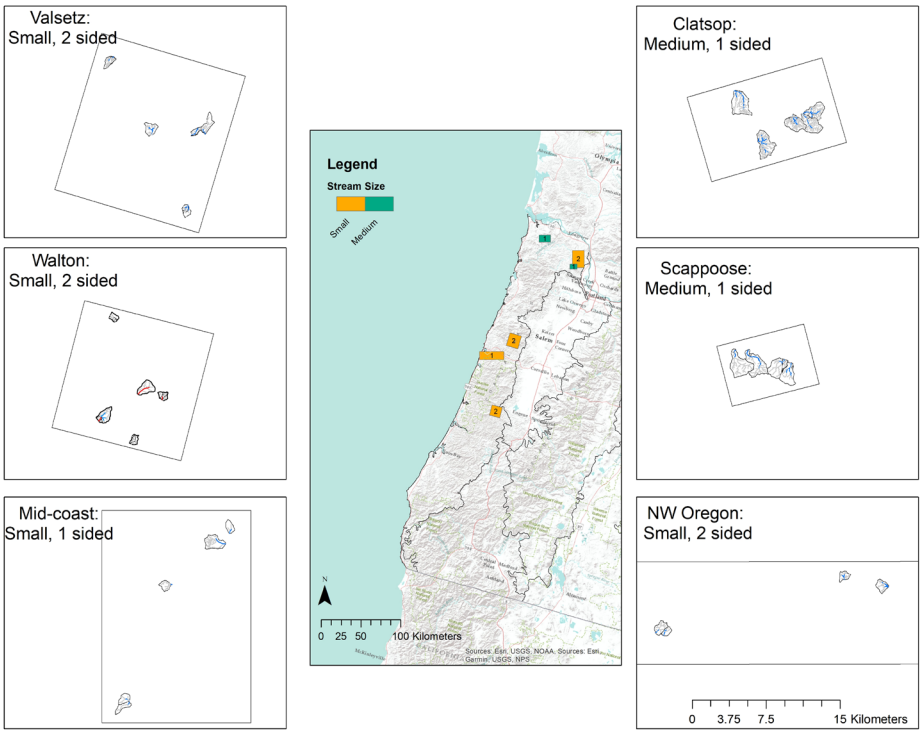


Figure 2. location of research blocks along the Oregon Coast Range mountains (large central map) and relative location of each study catchment within each block (in-set images on the sides).

- We instrumented all 30 streams to collect continuous data through summer 2021 on: light fluxes and light intensity, dissolved oxygen concentrations, and temperature (temperature was measured at 5 locations along each study stream).
- We quantified fish and salamander abundances in each of 29 streams in mid-summer 2021 (Figure 3). In one block (Valsetz), we marked fish with individual tags and returned to this site in late summer to quantify growth of marked individuals. We returned to most other sites in late summer to re-sample age 0+ salmonids to quantify their change in mean size (as a proxy for growth). If we captured very few 0+ salmonids in a given stream during our mid-summer survey, we did not return to that stream because we would not have the statistical power to determine a change in mean size.
- We collected the following data across sites
    - Three replicate aquatic macroinvertebrate samples in each stream (90 total)
    - Five replicate measurements of benthic biofilms in each stream (150 total)
    - Canopy cover at five locations along each stream (150 total measurements).
    - Stream widths, substrate sizes, and depths at 8 to 10 transects along each stream (~280 sample points)
    - Water for chemical analysis on time in mid-summer (low flow) at each site.
- We hired six undergraduate student field technicians who worked over summer 2021 (see below).
- In five of the six blocks we were collecting pre-treatment data. In one block, the riparian alternative treatments were implemented this year (in winter, spring and early summer 2021) (Figure 4).
- We conducted a preliminary analysis of changes in canopy cover (Figure 5) and of fish (Figures 6 and 7) responses in this site.
    - We did not see clear responses in adult cutthroat trout during this first year after treatment (Figure 6), but we did see notable relative increases in young of year trout in the two sites with the largest decline in canopy cover (Figure 7).
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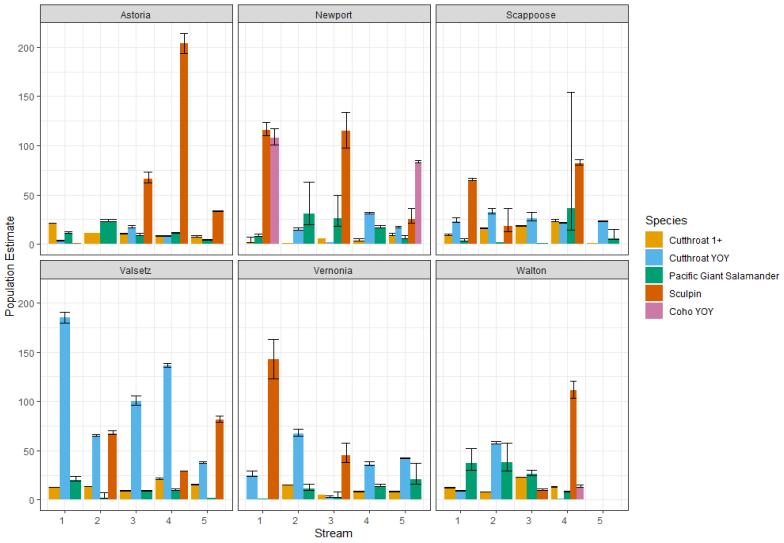

Figure 3. population estimates for cutthroat trout adults (1+), cutthroat trout young-of-year (age 0+), pacific giant salamander, sculpin, and juvenile (0+) coho salmon.

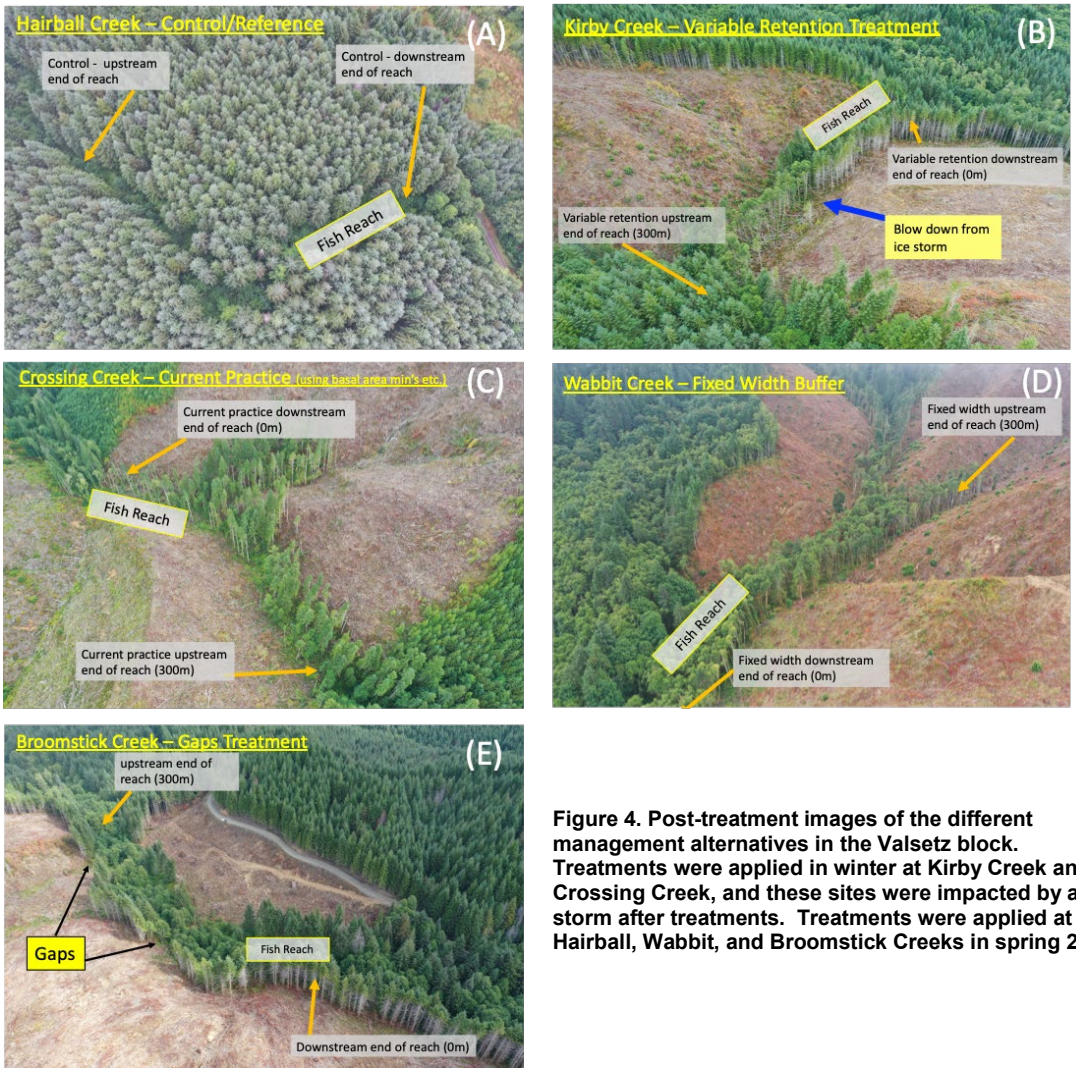

Figure 4. Post-treatment images of the different management alternatives in the Valsetz block. Treatments were applied in winter at Kirby Creek and Crossing Creek, and these sites were impacted by an ice storm after treatments. Treatments were applied at Hairball, Wabbit, and Broomstick Creeks in spring 2021.

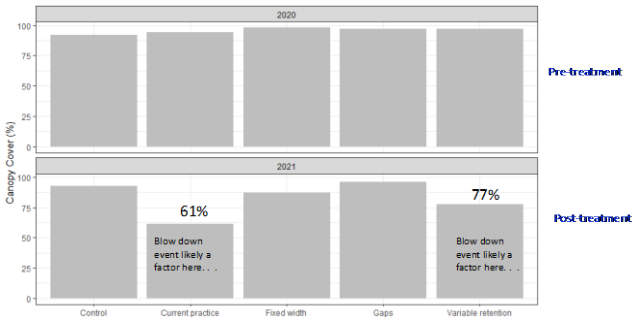

Figure 5. Canopy cover at Valsetz block sites before (2020) and after (2021) riparian alternative treatments. At the Variable retention and current practice sites (Kirby Creek and Crossing Creek, respectively – Figures 4B & 4C), an ice storm blow down event increased the loss of riparian trees and likely contributed to larger changes in cover.

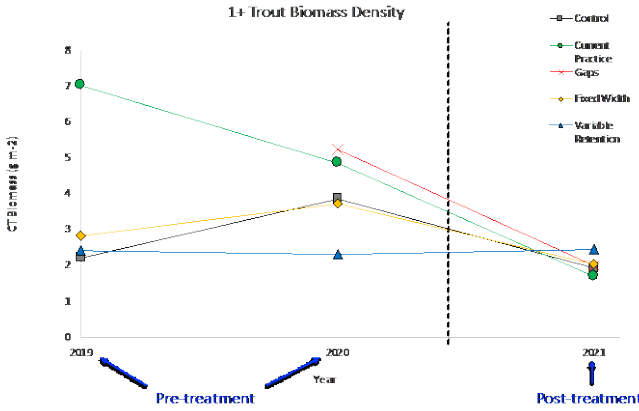

Figure 6. Changes in the biomass (g m^{-2}) of adult (1+ and older) cutthroat trout after treatment at all five streams in the Valsetz block.

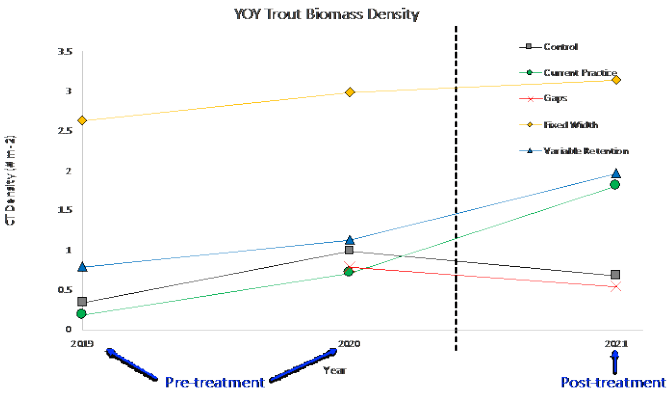

Figure 7. Changes in the biomass (g m^{-2}) of young-of-year (0+) cutthroat trout after treatment at all five streams in the Valsetz block.

Problems and Barriers:

- As noted in earlier progress reports, COVID impacted our work in 2020 and the labor day fires in 2020 eliminated 3 established blocks from our study. The effects of these earlier impacts carried over in that we have fallen behind our overall initial schedule plan, which was supposed to have two sites with post-treatment data coming online in summer 2021 with two more sites in which we would have conducted the second-year of pre-treatment data. As it stands we did have one site where we were able to get initial post-treatment data, but we did not have a second site and in

the next year, we will also be behind. Our success in selecting 4 additional blocks at the start of summer 2021 means that we will be able to complete the overall project as planned in the future, but the past impacts were a barrier to meeting our goals to this point.

Planned Work: [if progress report]

- Data management is a key part of any project, and we will spend time in fall 2021 and winter 2022 managing and organizing data collected in summer 2021.
- We will analyze initial responses in the Valsetz block and in so-doing we will develop a data analysis plan that can be applied to this block in future years and to future blocks.
- In winter and spring of 2022, we will impellent treatments at the Walton block.

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

We provided paid field experience for six undergraduate students this summer. Making these paid field experiences (rather than unpaid experience or having student only receive internship credits) is important, not only because we should be paying students for their time, but because if we do not pay competitive wages, we restrict these opportunities only to students who have the means to make no money (or less money) over the summer.

One of these students plans to use data collected in summer 2021 in his OSU Honors thesis, focusing on biotic and abiotic factors that account for salamander abundance in headwaters.

The full-time technician for this project, Ashley Sanders, who was funded by our project partner, NCASI, transitioned this fall to a Graduate student in the Dept. of Forest Ecosystems and Society. Ashley's MS thesis will focus on developing papers on the initial findings from this study. The data collected by this FWHMF project over the past three summers will therefore be foundational to her thesis.

Undergraduate student technicians supported in summer 2021

- Rory Corrigan – field technician
- Frank Graham – field technician
- Maya Greydanus – field technician
- Jacqueline James – field technician
- Cameron Naficy – field technician
- Nathaniel Neal – field technician
    - (Nathaniel will use summer 2021 data in his senior honors thesis assessing biotic and abiotic factors affecting pacific giant salamander abundances in coast range headwaters).

List of Presentations, Posters etc.:

Warren, D, A. Sanders, A. Coble, A Kroll. 2021. NCASI 2021 West Coast Regional Meeting, (Virtual) – *Assessing the response of aquatic biota to alternative riparian management practices.* (September 13-16, 2021)

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

None yet . . .

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 under what conditions they might do so.
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 surveyed in coastal northern California and 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 season, to assess fisher and marten occurrence field teams deployed 185 remote cameras in 35 stands in northern California (Figure 1). We obtained >1.1 million photographs and detected a fisher or marten in 26 of the 35 surveyed stands. Fishers were detected in 25 stands with detections at slash piles in 13 of those stands. Detection dog teams surveyed 30 stands 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 8 trapping replicates with 3 trap 'webs' per replicate, capturing 380 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

Our 2021 field season is ongoing with an anticipated end date of November 24th, 2021. We anticipate 35 stands surveyed by camera in coastal northern California (Figure 1), with vegetation, woody debris, and pile measurements completed in all surveyed stands. We have completed 9 replicates of small mammal trapping, with one more replicate anticipated. Detection dog surveys are also planned, anticipated to begin

October 31st, 2021 or after the current rain event.

In addition to the vegetation and woody debris sampling completed in all stands, a higher effort was undertaken in a subset of the surveyed stands in California and stands in 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 piles located by aerial imagery prior to the start of field work. We included three additional vegetation and woody debris sampling plots above our typical three plots per stand. In southern Oregon, we sampled 8 stands on recently harvested private ownerships in the range of both fishers and martens (Figure 2). Oregon stands will also be surveyed by scat detection teams this fall.

Problems and Barriers:

Opportunities to survey slash piles within Oregon are limited given that landowners remove piles shortly following a harvest, in some cases within the same year that they were created. This practice appears to be common 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 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. Response and participation from landowners in southern Oregon (e.g., South Coast) has been limited – if FWHMF representatives are aware of potential additional contacts, please let Jordan Ellison know.

Planned Work:

The 2021 field season will continue through November 24th and will include scat detection surveys with Rogue Detection Teams in Oregon (8-10 stands) and California (12-20 stands, funded by a California State Agricultural Research Fund acquired by collaborator Micaela Szykman Gunther, Humboldt State University).

Following the conclusion of field work, we will seek undergraduate assistance with photo-tagging.

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.

Jordan has trained 3 undergraduates and we anticipate involving an additional 6 members to the team. We received a scholarship for a Humboldt State undergraduate to intern on the project as a field technician (Shalom Fletcher). Jordan has been remotely mentoring 2 additional undergraduates (Alanna Garcia and Sabrina Ott) during the pandemic to process the photographs from the 2020 field season. At least two of these individuals (Alanna Garcia and Shalom Fletcher) will be independently working on their senior theses with these data. In addition, we expect a minimum of 1 million photos from the expanded 2021 season. Jordan will lead a crew of undergraduates at both Humboldt and Oregon State Universities to process these photographs in a timely manner.

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. (proposed)

List of Publications, Thesis Citations: N/A

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.

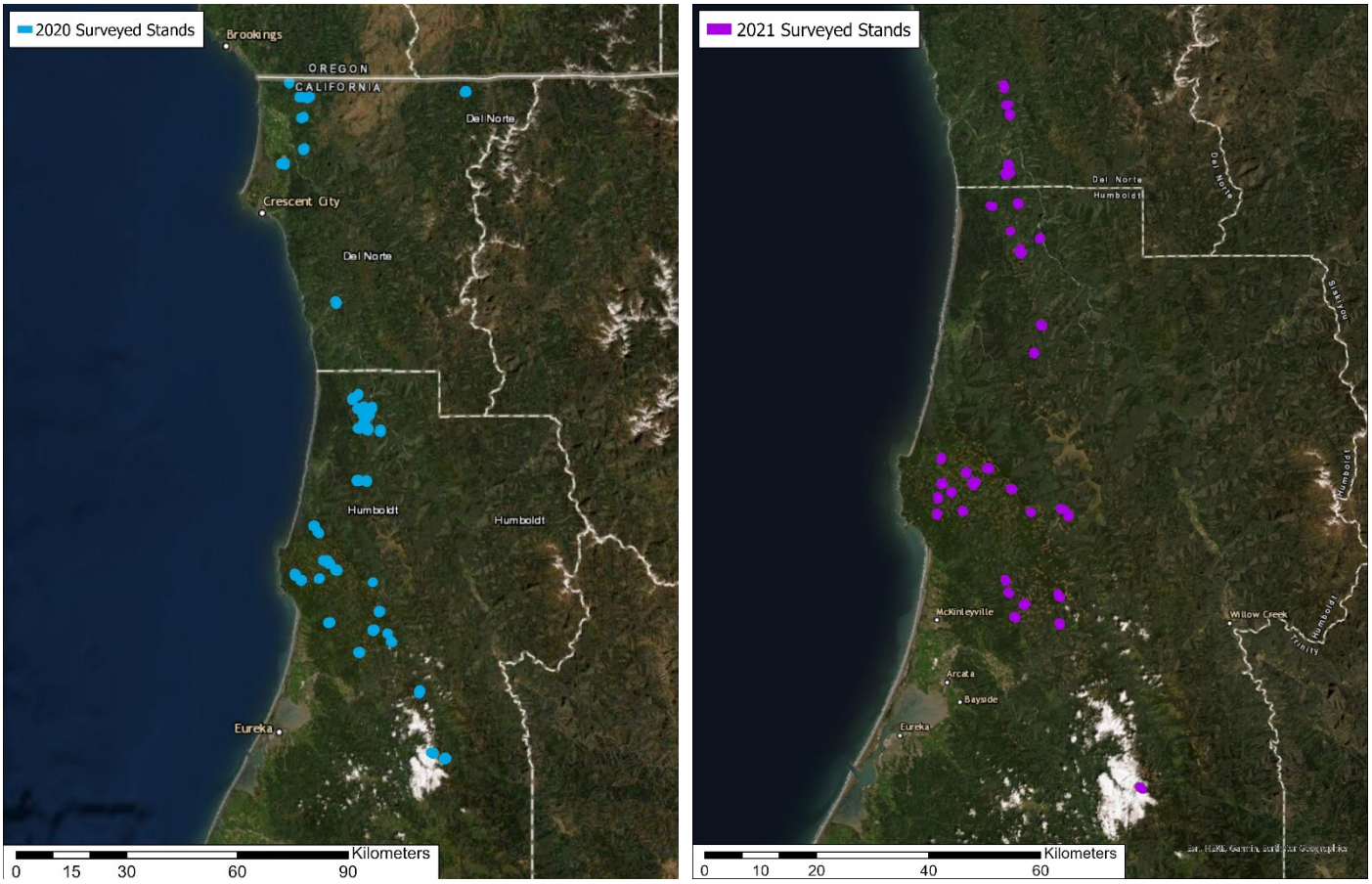

Figure 1. Survey locations in California during 2020 (left) and 2021 (right). Stands in California were surveyed by remote cameras and detection dogs, and data was recorded on pile measurements and at vegetation and woody debris sampling plots.

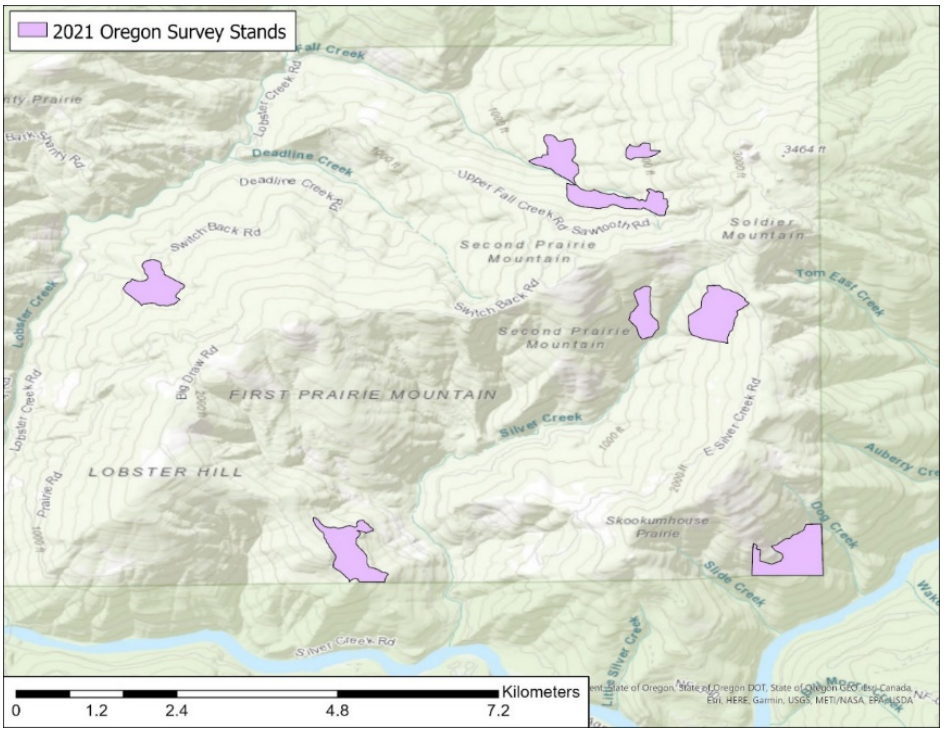

Figure 2. Stands surveyed in SW Oregon, about 20km northeast from the town of Gold Beach. Locating stand that contained piles was a challenge in our Oregon study area, as piles are not generally retained and often removed in the same year that they are created. This limited our surveys to those stands that had been harvested during 2021.

Figure 3. Setting traps in a burned stand. Field technician J. McBain in back is holding a Sherman live trap. Lead and master's student Jordan Ellison (front) is setting a Tomahawk live trap.

Fish and Wildlife Habitat in Managed Forests

Progress Report

Title: Red Tree Voles in Working Forests

Investigators: John Bailey, Katie Moriarty. **Master's student:** Jason Piasecki

Objectives:

- Quantify relative abundance of red tree vole (*Arborimus longicaudus*) 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:

Overall progress: During the 2021 field season we surveyed 45 stands. Of these, 12 stands were surveyed for 3 years (2019-2021), 25 were surveyed for 2 (2020 and 2021) and 8 were new stands surveyed without the intent of repeated sampling to address data gaps in the 60-79 and ≥80year age classes (Table 1). We climbed trees and collected data on 713 ground-identified nests, which doubled our sampling effort from 2020. This sampling increase was attributed to the high level of experience in returning field staff. During 2021, we installed 111 nest cameras across 31 stands to monitor activity of red tree voles and other arboreal species. Since 2020, we have used remote cameras to monitor 156 individual nests.

Table 1: Our study design strived to balance sampling across a gradient of distance from the nearest old forest (OF) patch designated as ≥80 years old and ≥20ha, and across age classes. During 2022 we will resurvey 37 stands and aim for new stands in the older age classes, but specifically the under-represented 60- to 79-year stage. This table represents the total number of stands sampled by distance from old forest (rows) and age classes (columns).

	Age Class					
	20-29	30-39	40-49	50-59	60-79	80+
0-1km from OF	9	7	3	4	2	5
1-5km from OF	4	3	3	3	2	
Total	**13**	**10**	**6**	**7**	**4**	**5**

Observations: Observations suggest recent red tree vole activity was most prevalent in 20, 30, 40, and 80+ year age classes. Recent vole sign was limited to stands within ~1km of the nearest old forest patch. We recorded sign of red tree vole activity (both old and recent) in 71% of stands (n = 45). We observed red tree vole nest colonization and extirpation in 54% of resurveyed stands (n = 37). Tree vole nests in young forest were typically large and constructed in broken tops, split trunks, and in association with nests constructed by other arboreal species such as Humboldt's flying squirrel (*Glaucomys oregonensis*, e.g., Figure 1). Tree vole nests in old forest (>80yr) were typically small, constructed mainly in cavities and under moss mats, and were not found in association with nests of other arboreal species (e.g., Figure 2).

Figure 1: Tree vole nest in split trunk with fresh cuttings piled on top

Figure 2: Tree vole nest under a moss mat with cuttings pulled into nest entrance

Next steps: We piloted a PNW protocol for live capturing and marking red tree voles, which will allow us identify individuals at nests to conduct future analysis to determine tree vole density in young forests. We captured 12 voles in 4 stands. Unique fur clip patterns were used to later identify individuals with nest camera footage (Figure 3). Camera data will be collected at the beginning of the 2022 field season to confirm that individual marking patterns were detected on nest cameras following (Linnell and Lesmeister 2020).

Figure 3: Adult red tree vole back with fur clip, showing the contrasting dark dorsal pelage.

Problems and Barriers: Because of their dependency on the forest canopy and cryptic nesting behavior, red tree voles are difficult to study and require both ground surveying and tree climbing to confirm tree vole activity. Our work employs multiple survey methodologies to locate, identify, and collect data on red tree vole nests and nests of other arboreal species. Another difficulty lies in capturing colonization events. This is extremely challenging because it is almost impossible to determine when and where a tree vole will build/colonize a nest. We are maximizing our opportunities to observe colonization events through the deployment of remote cameras on random subsets of nests regardless of vole activity.

Planned Work: We are planning for a full 6-month field season in 2022. We received additional funding from the Wildlife Conservation Initiative, a partnership between the U.S. Fish and Wildlife Service and the National Alliance of Forest Owners, to expand camera efforts and summarize nest composition. During the 2022 season we will focus on addressing data gaps in our sampling of stands, conducting live mark/recaptures of red tree voles to explore density in young forests, and recording measures of canopy complexity in all stands.

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

Jason Piasecki – Thesis research (ongoing), completed coursework in data programming and populations analysis and modeling, Teaching Assistant for FW599 Tree Climbing Methods (12 OSU students).

List of Presentations, Posters etc.:

Participation and presentations to the Red Tree Vole Working Group 2019, 2020, 2021

Piasecki, J., K.M. Moriarty, J.D. Bailey. 2021. Red tree voles (*Arborimus longicaudus*): Exploring forest occupancy. The Wildlife Society – Western Section Annual Conference, virtual. *Presentation

Piasecki, J., J.D. Bailey, K.M. Moriarty. 2021. Red tree voles in working forests. Western Forestry Graduate Research Symposium, virtual. *Presentation

McCoy, M., J. Piasecki, K.M. Moriarty. 2022. Red tree vole nesting preferences and use of interspecific nests in stands that differ in age. The Wildlife Society – Oregon Annual Conference, Newport, Oregon. *Poster (proposed)

Scoresby, S., J. Piasecki, K.M. Moriarty. 2022. Multi-species presence concurrent with red tree vole (*Arborimus longicaudus*) nest use in managed forests of the Oregon coast range. The Wildlife Society – Western Section Annual Conference, Reno, Nevada. *Poster (proposed)

List of Publications, Thesis Citations:

Not applicable yet. Thesis completion and publications expected during 2023.

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), Eric Suring, ODWF (Co-Pi), and Christopher Lorion, ODFW (Co-Pi)

Objectives: The objectives of this project are to:

1. Assess the changes in available fish habitat. We are curious if the introduced logs have had a positive impact on the available fish habitat, and what the ideal stream characteristics for the winter juvenile Coho populations are.
2. Examine long term topographic changes in the stream. We will look at how the channel's structure and composition are responding to the added large wood features.
3. Investigate the movement and stability of the large wood. We will assess how the water impacts the individual logs and log jam structures.
4. Investigate the relationship between the basins geomorphology and fish populations. We will look for correlations between the stream characteristics and the fish populations at the basin scale to conclude whether this was a success conservation effort.

Summary of Accomplishments toward Objectives:

Our ability to conduct field work in 2020 was limited given the COVID pandemic, we were however able to co collected topographic information in 20-28 cross-sections per site.

During the summer months of 2021, much field work progress was accomplished. For all three sites, topographic surveys were conducted on the cross sections, logjams, and stream banks to capture the elevational change in the basin structure. At each site, approximately 1800 to 2500 data points were collected with a Nikon total station (Figures 1–3). At each site, approximately 20–28 100-pebble counts were performed along cross sections with a gravelometer, contributing to data that will quantify bed material size, distribution, and habitat quality for the native Coho salmons. Cross section pins that were degraded were replaced and re-surveyed across all three sites. The last field component that took place this summer was the instrumentation of level loggers and staff gauges. Ten Solinst level loggers and 20 staff gauges were placed at each site, contributing to data on the flow depth and water surface elevation for hydraulic model calibration . The level loggers were placed into 5-foot PVC pipes with wire mesh on the bottom foot and connected T-posts pounded into the stream bed. Staff gauges were made by creating a 2-centimeter ruler along the entire span of a 5-foot rebar and pounded into the stream bed. Solinst level loggers and staff gauges were evenly distributed along the stream reach to capture the variation in stream depth across. Most of the level loggers have been anchored to the adjacent bank to make sure no strong flows carry the equipment downstream with Duckbill ground anchor apparatuses. Data collection and analyzation are in the preliminary stages, however the process of organizing and collecting records has begun.

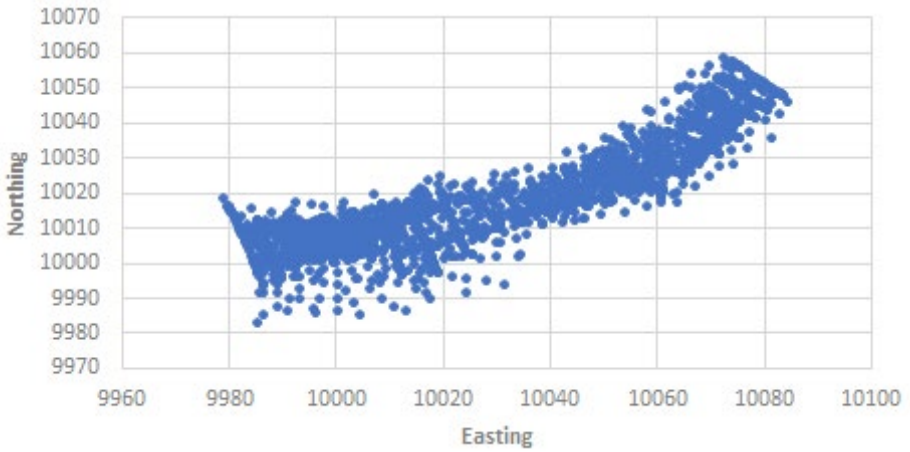

Figure 1. Shows that distribution of surveyed points for Site #1, Mill Creek in 2021. The survey points in represent all the points taken along the cross sections, logjams, stream bank, and middle cross-sectional areas.

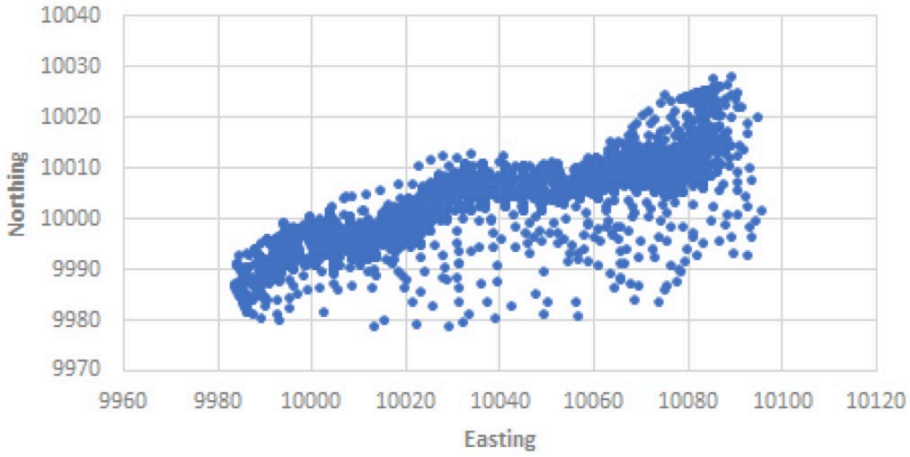

Figure 2. Represents the number of surveyed points taken at Site #2, Cerine Creek in 2021. The survey points in represent all the points taken along the cross sections, logjams, stream bank, and middle cross-sectional areas.

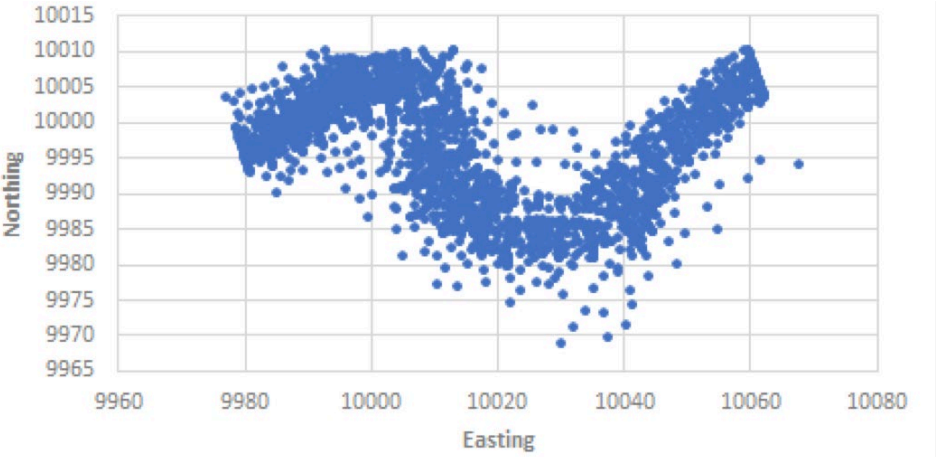

Figure 3. Represents the number of surveyed points taken at Site #3, South Fork Mill Creek in 2021. The survey points in represent all the points taken along the cross sections, logjams, stream bank, and middle cross-sectional areas.

Based on the topographic information collected over the last 7 years we have started the analysis of channel adjustment around the installed wood structures in the three sites. As an example. Figure 4 shows preliminary analysis of cross-sections at 3 XS in Site 3.

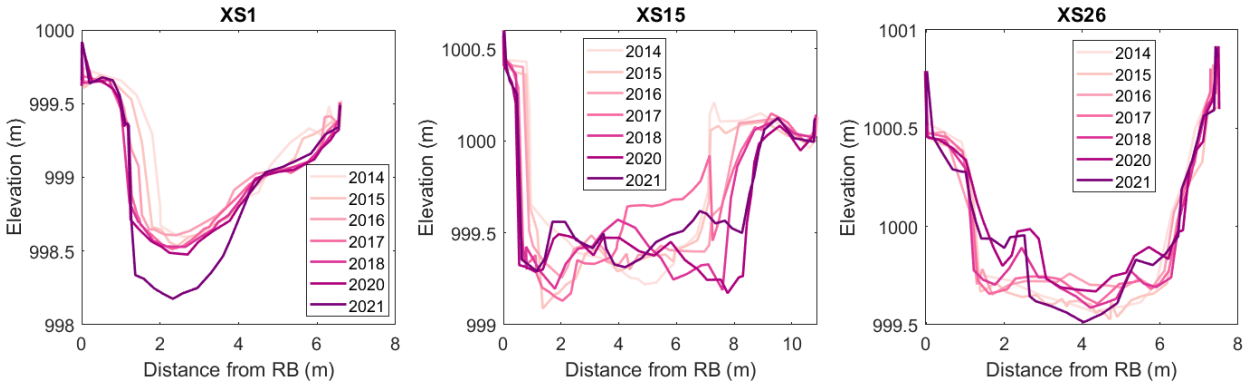

Figure 4: Topography of 3 cross-sections in Site 3 between 2014 and 2021. The large wood was added in 2015.

Problems and Barriers:

The main difficulties experienced so far for this project are primarily Covid-19 induced. The project had a later than anticipated start date due which put the timeline back by an entire year. Multiple delays from chain supply companies also complicated ordering supplies necessary for instrumentation. Equipment such as the level loggers and anchors were on backorder, which has extended the field instrumentation component to persist through the start of the rainy season. Even with the presented difficulties, the instrumentation will be completed in the coming weeks with the recent arrival of supplies. An additional barrier to the success of this project consists of the study sites size in comparison to the fish sampling sites performed by the ODFW. Extrapolation of both data sets will need to be performed to the basin size in order to accurately compare the data from both parties. We have not reached this point in the project's timeline, however, we are aware of this anticipated difficulty and look forward to tackling it when the time comes.

Planned Work

Stability/resilience of the fish habitat creation: The next steps of this project are to finish anchoring a few level loggers and start the process of field visits to collect stream flow data. Data organization and compilation are in the beginning phases for hydraulic modeling with Nays2DH at the three research sites. The goal is to compare the modeled flow filed in 2015 to the current conditions.

Long-term changes in channel morphology and fish habitat: We will analyze 7 years of geomorphic information pre- (2014) and post (2015–2021) restoration at three reaches. Field data collection has been completed. This information will be used to investigate geomorphological adjustment in the context of hydrologic variability in streams after the LW additions.

Basin scale monitoring of the stability of LW structures: We will quantify wood mobility based on the comparison of a basin scale wood survey conducted right after the wood was added in 2016 by Weyerhaeuser and a new survey that we will complete in 2022 in a subset of restoration sites representative of all treated reaches.

Investigate the relationship between geomorphic metrics derived and fish populations at different scales: We will analyze the geomorphic changes such as pool size and area and flow velocity and channel bed stability that have occurred since 2014 in each of the reaches . Given that the study reaches are representative of the variation present in the basin, we will be able to scale our results up to the treated river

segments using a channel classification system based in slope, channel confinement, and the wood surveys We will relate the expanded geomorphic changes to the changes observed in Coho Salmon overwinter survival in the treated reaches. *This information will get at the local-scale response*, which will allow for assessment of where in the basin the restoration effort has been most successful.

The reach scale geomorphic metrics can be integrated to the basin scale, and these results then will be compared to basin scale information about the fish population. Preliminary results indicate the project has had an effect on overwinter survival but we do not know how this relates to the geomorphic changes. *This information will get at the basin-scale response* which is something lacking in the literature

We have updated the timeline:

Objective	Activity	2020						2021												2022											
				Fall				Winter		Spring			Summer			Fall				Winter		Spring			Summer			Fall			
		7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
3.1 & 3.2	Topographic Surveys																														
3.3.	Basin wide wood survey																														
3.3 & 3.4	Geospatial analysis																														
3.1	High flow field observations																														
3.1	Hydraulic Modelling																														
3.1–3.4	Analysis of results																														
	Manuscript writing																														

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

Madelyn Maffia is a first-year Master's student in the Water Resources Science Program, working on this project as her thesis. As a graduate student at OSU, she spent the summer performing topographic surveys pebble counts, instrumentation, and data organization for all three sites. Melissa Mauk, Elle Luedloff, and Cedric Pimont are the three field technicians that have assisted Madelyn with the field work of this project and all study under the College of Forestry at OSU. All three technicians have assisted and gained experience with all aspects of the field work component. Additional technicians and graduate students from previous years have also collected annual data that will contribute to the objectives of this project.

List of Presentations, Posters etc.:

N/A - Still in the process of data collection.

List of Publications, Thesis Citations:

N/A - Still in the process of data collection.