Oregon State University
College of Forestry

Fish and Wildlife Habitat in Managed Forests Research Program

Progress Reports

March 4, 2021

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Fish and Wildlife Habitat in Managed Forests

Final Report

Title: Early Seral Habitat Longevity in Production Forests in the Oregon Coast Range

Investigators: Matthew Betts (PI), Scott Harris (CoPI)

Objective:

Our primary goal was to quantify the relationships between bird abundance/occupancy and stand-scale habitat variables in production forest stands aged 0 to 30 years, in the Oregon Coast Range. This age range encompasses vegetation development from stand initiation through canopy closure. Combining these species-specific "yield curves for birds" with management-relevant metrics of stand structure and composition (e.g., amount of hardwood, crop tree density) will be of high utility to forest managers and policy makers tasked with integrating biodiversity and timber production objectives.

Summary of Accomplishments toward Objectives:

We successfully accomplished our primary goal and additional objectives. We conducted 2 incident-free field seasons, analyzed data, provided outreach to landowners, and communicated our results through presentations and a peer-review journal article (Harris and Betts, 2021).

Our objectives were to examine the degree to which plantations affect biodiversity by 1) quantifying songbird abundance across a gradient in forest stand age (stand initiation through canopy closure), 2) estimating the duration of early seral habitat, and 3) test if forest structural and compositional elements prolong habitat availability. This approach is equivalent to the modeling of wood 'yield curves' common in forest management but applied to a biodiversity indicator.

We used a chronosequence sampling design to survey songbirds and vegetation in 283 tree plantations aged 0 to 30 years in the Oregon Coast Range. Study sites were on forest lands owned by the Weyerhaeuser Company, Hancock Forest Management, Starker Forests, and the State of Oregon. Stands were randomly selected within age strata and surveys were temporally replicated in order to use N-mixture models to estimate abundance after accounting for imperfect detection. Our chronosequence encompasses the assumed age of canopy closure, which we anticipated to be the point at which early seral biodiversity declines.

We detected 5,074 birds of 71 species during the 2018 and 2019 breeding seasons. **Canopy closure occurred approximately 12 years** following clearcut harvest and replanting. We found that **bird abundance changed dynamically during this short early seral stage**. Twenty species peaked in abundance either very early in stand development or with the approximate timing of canopy closure, and then subsequently declined to low levels by the end of the 30-year chronosequence. The estimated abundance of 3 species increased following canopy closure. We also found, contrary to our hypothesis, that **the amount of broadleaf cover increased habitat longevity for only one species - Wilson's warbler**.

To our knowledge, our study provides the first quantitative estimates for how bird species abundances change throughout the entire early seral stage in tree plantations in western North America – information that can be used to assess tradeoffs between timber production and biodiversity. We found that **the duration of early seral habitat in plantations is short and generally cannot be ameliorated by managing for higher levels of broadleaf cover**. This finding has important implications for early seral species in the rapidly shifting mosaic of tree plantation landscapes.

Problems and Barriers:

There were no significant problems or barriers.

Planned Work: [if progress report]

N/A

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

Under the advisement of Matt Betts, Scott Harris (graduate student) has been substantially engaged in all phases of project conceptualization, development, management, field data collection, analysis, and reporting.

Beavers were well-represented among our team. Of the 4 field technicians hired, 2 were recent graduates (B.S.) of the Oregon State University Fish and Wildlife Program and one was a recent graduate (M.S.) in soil science.

List of Presentations, Posters etc.:

Results from this project were included in the following presentations:

1. Early seral plantation forests: biodiversity and ecosystem services. Forest Health Conference. Corvallis, OR. 2020
2. Herbicides and biodiversity in managed forests. Pesticide Applicators Recertification Workshop. Portland, OR. 2019.
3. Early seral vegetation dynamics. Early Seral Biodiversity Science and Management Workshop. Corvallis, OR. 2019

List of Publications, Thesis Citations:

Harris, S.H., Betts, M.G., 2021. Bird abundance is highly dynamic across succession in early seral tree plantations. Forest Ecology and Management 483, 1–12. https://doi.org/10.1016/j.foreco.2020.118902

Harris, S.H. 2021 (Anticipated). Ch. 3. Bird abundance is highly dynamic across succession in early seral tree plantations, in *Biodiversity Conservation in Managed Forests of the Moist Pacific Northwest*. Dissertation. Oregon State University, Corvallis, OR.

Supplemental figures follow:

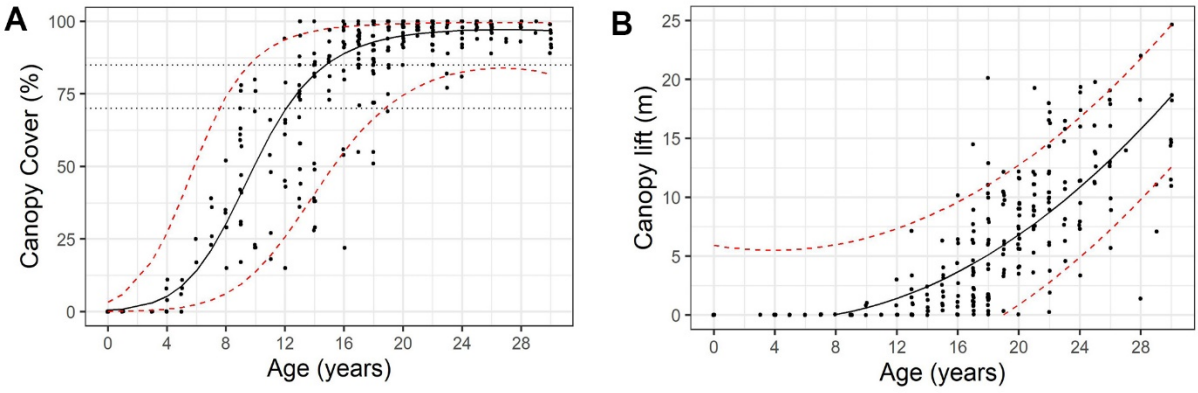

Figure 3. Canopy closure and lift begin at approximately 12 years post-harvest in tree plantations, Oregon Coast Range, USA, 2018-2019. **(A)** The relationship between overhead (> 2 m) canopy cover and age since harvest and replanting (n=283 sites). No sites were thinned. Points are raw data. The curve shows the linear regression estimate (adjusted r^2 = 0.75) with age as the quadratic explanatory variable. Dashed red lines encompass the 90% prediction intervals. It is estimated that the mean canopy cover will reach 70% (dotted horizontal line) at age 12 (90% prediction interval 8 to 19 years) and 85% (dotted horizontal line) at age 15 (90% calibration interval 10 to approximately 27 years). **(B)** The relationship between canopy lift (the height of the lowest live branches of conifer trees) and age since planting (n=276). No sites were thinned. Points are raw data. The curve shows the linear regression estimate (adjusted r^2 = 0.80) with age as the quadratic explanatory variable. Dashed red lines encompass the 90% prediction interval.

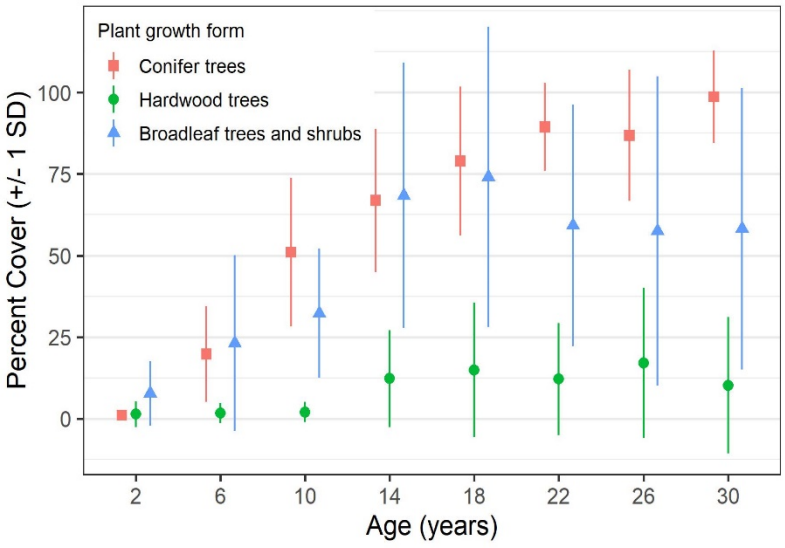

Figure 4. Stand composition in intensively managed tree plantations, Oregon Coast Range, USA, 2018-2019. Shown are mean percent cover values (+- 1 SD). Data are combined in 4-year age bins (e.g., "2" on the x-axis refers to stands aged 0 to 4 years old). Data are from plot cover estimates (n=283 sites) where cover for all species in each growth form are summed, so cover values may overlap and sum to greater than 100%. Broadleaf cover is the sum of the covers of hardwood trees, low and tall shrubs. See Appendix A for classification of plant species to growth

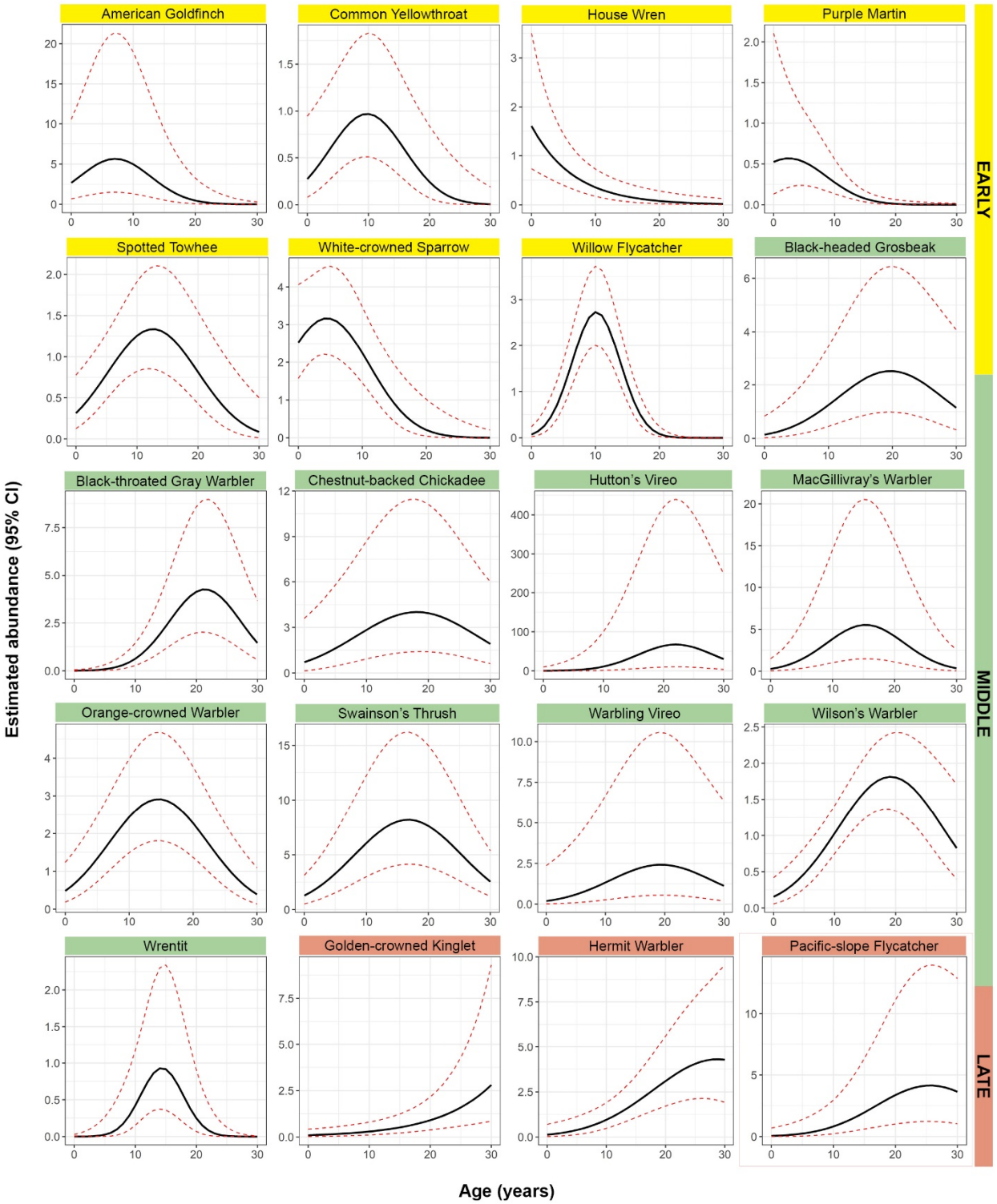

Fig. 5. Estimated abundances (and 95% confidence intervals) in 50 m radius point count plots as a function of age for 20 songbird species in tree plantations, Oregon Coast Range, USA, 2018-2019. Estimates shown are corrected for probability of detection using N-mixture models. All species showed dynamic changes in abundance over the 30 years following harvest. Three species (American Robin, Band-tailed Pigeon, and Cedar Waxwing) had excessive upper confidence intervals and are not plotted here.

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.

Summary of Accomplishments toward Objectives:

Our 2020 field season was cancelled due to COVID-19 health concerns. We are now looking forward to a successful 2021 field season. In 2020, PhD student Graham Frank has presented and defended his research proposal, is mentoring an Honor's College UG student in her thesis focused on the invasive plant communities from our 2019 dataset, and she is also supported by the MEP program. In summer 2020, Graham mentored a NR UG student internship focused on identification of carabid beetles. The following is a reminder of accomplishments from the 2019 season.

This summer and fall of 2019 put us on a good trajectory for the Early Seral Forest Biodiversity Project. This was our first full field season, and it went surprisingly well. PhD student Graham Frank demonstrated excellent organizational and leadership skills, not to mention quick skill and dedication with the botany and birding portion of the study. The field crew was top notch.

1. Field season summary. This summer, we completed sampling for all focal taxa at a total of 23 sites in the Klamath-Siskiyou. This effort included: two bouts of pitfall trapping for carabid beetles; three rounds of avian point counts; two bouts of bee sampling using blue vane traps, with floral resource sampling; species-level plant community cover estimates; sampling tree regeneration and vegetation structure; and quantification of live and dead structural legacies. We were able to bring on highly skilled seasonal technicians, each with several years of field experience, and were able to collect high quality data as a result. We benefited from a relatively cool summer and mellow fire season this year, but are confident that our goals for subsequent field seasons are realistic even in harsher conditions.

2. Taxonomic identification of bees. Bee samples have been identified to species/morphospecies by Dr. Lincoln Best. Contracting out bee identification will allow us to obtain greater resolution in both the taxonomic and functional diversity of our specimens than focusing strictly on bumblebees (Bombus spp.),

as we had originally proposed. This will also clarify any rare, species of concern.

3. Taxonomic identification of beetles. For the carabid beetles, we leveraged funds from the OSU College of Forestry GUMP program to hire and train an undergraduate student to assist with beetle sorting, pinning, and identification. Graham (PhD student) and Haley (GUMP undergraduate) worked with Dr. Jim LaBonte from the Oregon Department of Agriculture to develop processing and identification protocols and keys. Jim LaBonte will confirm all identifications.

Problems and Barriers:

Cancellation of 2020 field season was a substantial set back.

Planned Work:

This academic year Graham Frank will complete his PhD preliminary exams. Graham is leading a review paper for peer-reviewed publication, focused on temporal dynamics of early seral.

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

Summer 2021 will be our second full field season, and we anticipate visiting another third of our total proposed sites. The field portion of this project is largely supported by funds from NCASI. We have recruited our summer field team and organized housing for the crew.

We are pursuing funding for bee identification via BLM, Garden Club grants, NWSA fellowship.

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.

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), four journal publications.

Fish and Wildlife Habitat in Managed Forests

Progress Report

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

Investigators: Dana Warren, 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 (Figure 1). To meet this overarching goal, we are exploring 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:

Fieldwork and site selection Of the original 6 replicate blocks (5 streams each) planned for Oregon (2 initiated in 2019), we identified four additional replicate blocks and sampled all but one in summer 2020 (Fig. 1). All three replicate blocks in the Cascades Range are no longer likely capable to participate in the study because they were affected by the September forest fires. Of the remaining replicate blocks in the Coast Range, one is currently undergoing harvest, one will be harvested next year (2021-2022), and one will be harvested in 2022-2023. We are working with landowners to find additional sites in the Coast Range to fill out our initial plan of 6 OR blocks.

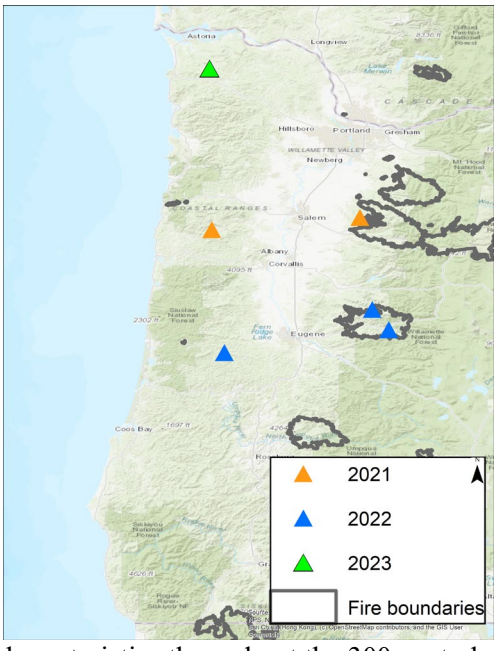

Figure 1. Approximate locations of originally selected replicate blocks in Oregon. Years denote planned harvest years: 2021 = harvest between fall 2021 and spring 2022, 2022 = harvest between fall 2022 and spring 2023, 2023 = harvest between fall 2023 and spring 2024. Fire boundaries are shown in dark gray, affecting study sites in the Oregon Cascades.

We collected pre-treatment data in each of the three Coast Range blocks. In two blocks, we collected year one data and in one block, we collected year 2 data. Sampling included measurements of physical, chemical and biological characteristics throughout the 300 m study reach in each stream (Fig. 2).

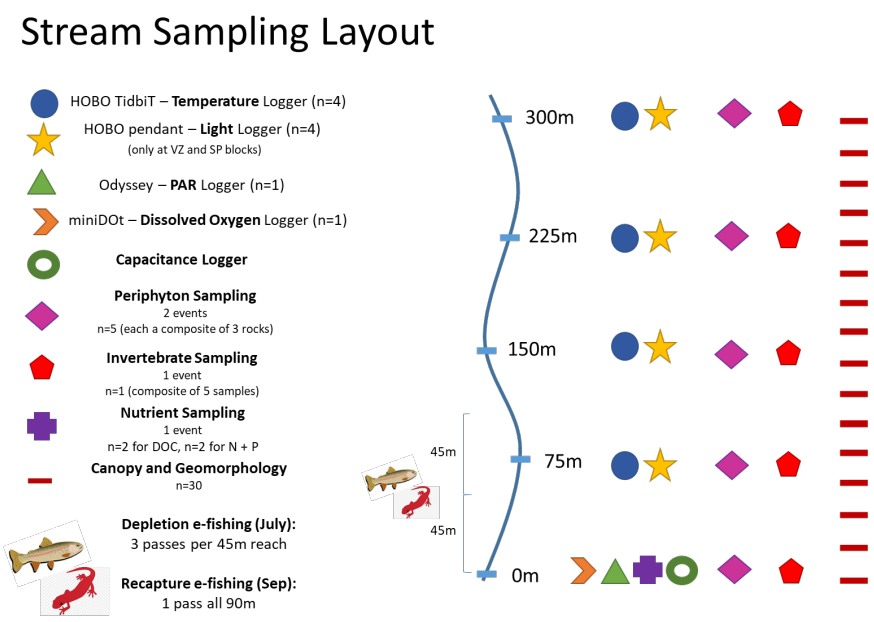

Figure 2. Sample location for each physical, chemical, and biological parameter within each 300 m study reach (n=5 streams/replicate block).

Additional funding

ARF: We secured supplementary funds for the project from the Oregon State University Agricultural Research Foundation (ARF). Project title: *Assessing the response of stream salmonids to alternative riparian management practices*. Funding: $14,644. This funding is primarily devoted to undergraduate field technicians' salary and travel and will be particularly helpful in ensuring that we have field crews that are large enough to complete our proposed work.

Preliminary results *(relevant figures are included at the end of this report)*

Temperature: High temporal frequency stream temperature data was collected in all streams across four replicate blocks throughout the summer. As an example, two years of pre-treatment stream temperature data for the first experimental block, which is currently undergoing harvest treatments, is shown in Figure 3. For comparison of stream temperature variability across replicate blocks we show mean stream temperature for all streams within a block (Figure 4).

Other abiotic characteristics: Across all study streams mean canopy cover is greater than 90% (Figure 5). As a pre-treatment measurement we collected hemispherical photography images at 20 m intervals in all five streams for the block that will undergo harvest this winter/spring (Figure 6). Hemispherical photography for additional replicate blocks will occur next summer prior to harvest. Streams located in the Oregon Coast Range are small fish-bearing streams, but streams located in the Cascades were medium fish-bearing streams due to a lack of suitable small fish-bearing streams for inclusion in the study (Figure 7). Differences in stream size (as mean depth, wetted width, and discharge) are shown in Figure 8.

Biota: Vertebrate biomass data across three blocks (Finn Rock, Valsetz, and Calapooia) were collected in 2020 (Figure 9). One block, which included salmon, steelhead, and bulltrout (SSBT) streams will be electrofished in summer 2021 when a federal permit will provide coverage. We provide an example of a preliminary analysis of cutthroat young of year (YOY) growth for one site in the Valsetz block (variable retention treatment) during the 2 pre-treatment years (Figure 10). We expect total length and weight of YOY individuals to increase over the course of the summer, as indicated by the dashed lines demarcating averages. The growth in 2020 is larger than 2019 because the fishing events were 53 days apart whereas in 2019, they were 27 days. For YOY growth comparisons across years, values will be corrected for time. We will also analyze growth of individual adult cutthroat trout that were marked and recaptured using PIT (passive integrated transponder) tags.

Problems and Barriers:

Site selection challenges

Cascades: As in 2019 we encountered challenges in summer 2020 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.

Coast: 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 because of the long lead-time needed for SSBT collection permits in the state of Oregon. However, in September 2020 we submitted our application to collect SSBT fish in Oregon Coast Range streams in the summer 2021 field so that we can integrate SSBT streams into the next year's fieldwork.

Overall: As in 2019, in selecting sites in 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 have 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).

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. The list of western Cascades streams within the region of the fire is listed in table 1. While these fires clearly impacted our study, the events created a natural experiment in which we have a rare set of pre-fire data for large number of streams. We plan to seek external funding to support a post-fire assessment in these systems in summer 2021, which utilizes the pre-treatment data collected in our summer 2020 sampling (Table 1).

Table 1. Study streams, their status following the September 2020 wildfires, and description of pre-treatment data collected across sites.

Site	Basin	Burn Status	Habitat				Chemistry				Light & Canopy			Primary producers		Animals									
																Invertebrates		Coastal Giant Salamander			Cutthroat trout				
		Burned/Unburned	LW abundance	Pool area	Pool depth	Summer temperature	[NO3-]	[PO4-3]	DOC/SUVA	Dissolved Oxygen	PAR (temporal)	Densiometer	Hemiphoto	biofilm [chl a]	biofilm AFDM	comm. composition	abundance	abundance	biomass	condition factor	abundance	biomass	condition factor	summer growth
Hands Crk	Calapooia	Unburned	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
WF of NF Calapooia	Calapooia	Burned	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Mill Crk	Mohawk	Burned	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Mill Crk trib	Mohawk	Burned	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Fawn Crk	Mohawk	partially burned	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Allen Crk	Mohawk	partially burned	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Ennis Crk	Mohawk	Burned	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Ennis Crk trib	Mohawk	Burned	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	

Planned Work:

In summer 2020, we plan to sample at 6 blocks (30 total streams). In this third summer, we hope to have a larger field crew so teams can split up and accomplish this intensive sampling effort. We will follow methods outlined above. COVID may impact plans in regard to vehcile needs and housing in particular. We were successful in summer 2020 in addressing these issues and so we are confident that we can maintain safety for our crews and for the communities we visit during our fieldwork.

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

Undergraduate field technicians:

- Zowie DeLeon – Oregon State University
- Rylee Rawsom – Oregon State University
- Nathanial Maisonvill – Oregon State University
- Annika Carlson – Oregon State University
- Molly Hamilton – Oregon State University
- Alex Boe – Oregon State University

List of Presentations, Posters etc.:

Sanders, A, D.R. Warren, A. Coble. 2020 Exploring relationships between stream characteristics and the relative abundance of trout and salamanders in forested headwaters of western Oregon. *Oregon Chapter of the American Fisheries Society Annual Meeting*. Bend, OR March

Coble, A. 2020. Virtual field tour: Assessing the effects of alternative riparian management practices on aquatic food webs and water quality. Oregon Society of American Foresters. October, 7, 2020

List of Publications, Thesis Citations:

We are still in pre-treatment data collection phase of this project. None so far. . .

Preliminary Results - Figures

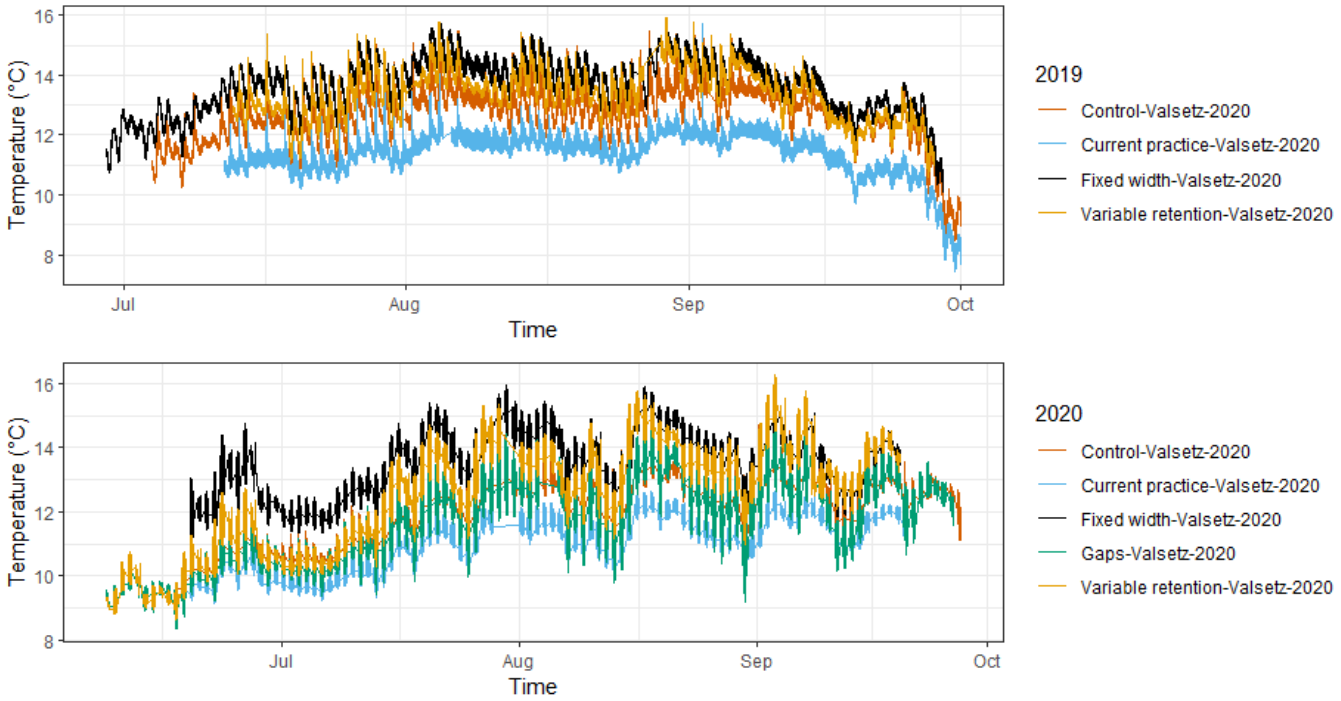

Figure 3. Stream temperature values through all sites in the Valsetz block(n=5) combining data from all sensors at each site (n=4-5). Temperature is measured with Onset Hobo TidbiTs deployed in housings secured to rebar in the center of the stream, with individual sensors redeployed at the same transect each year. Measurements are recorded each 30 minutes for the duration of the season.

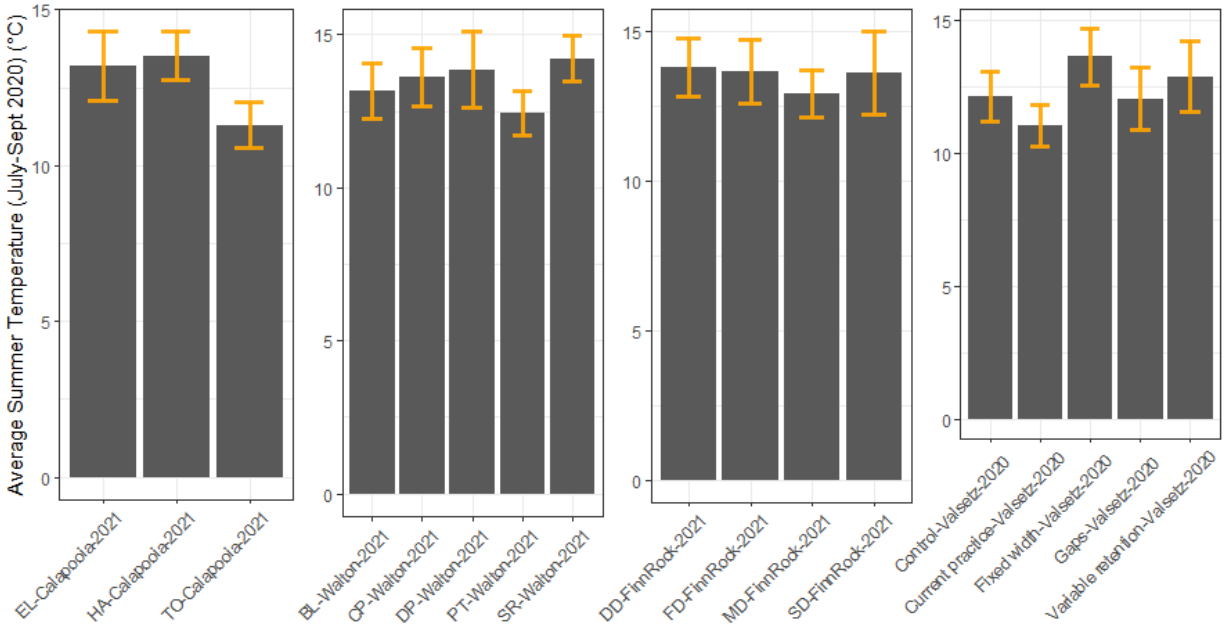

Figure 4. Stream temperature averaged in all sites (n=3-5) in each block. (Sensors still need to be retrieved at 2 Calapooia sites). Summer temperature was measured with Onset Hobo TidbiTs at 5 transects per site. Means were calculated by averaging all temperature values from July 1 to September 1, 2020. Error bars show 1 standard deviation from the mean

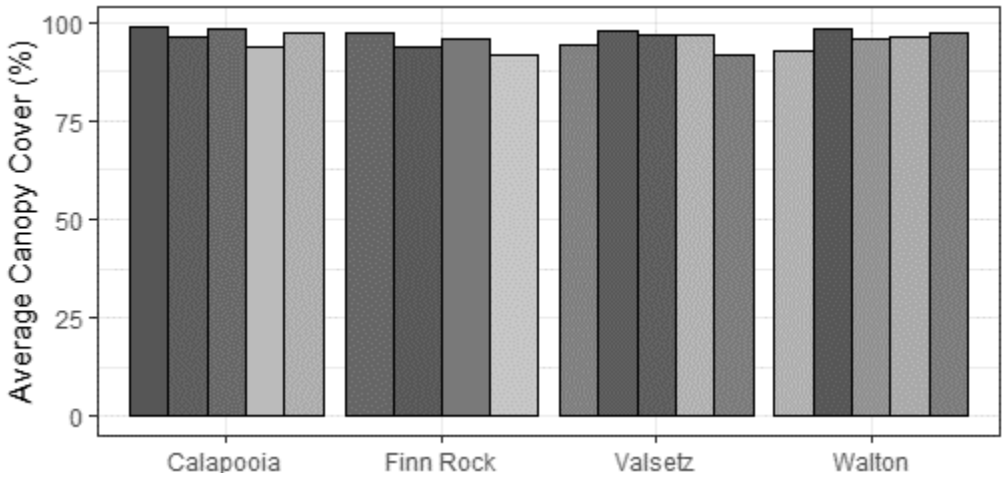

Figure 5. Canopy cover was measured using a spherical densiometer at 20 m intervals within the 300 m reach at each site. Values range from 91.8 to 99.1% cover.

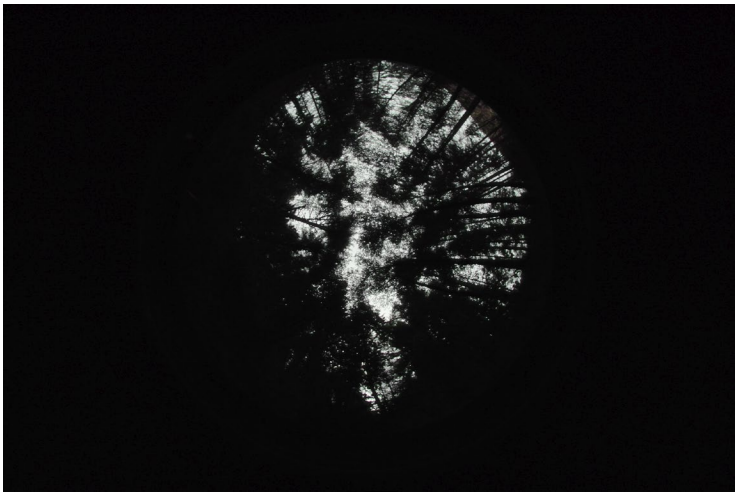

Figure 6. A pre-treatment hemispherical photo for a stream that will receive a gap treatment in the Valsetz block. Photos were taken by placing a camera on a tripod facing up in the stream, leveling the lens, then taking a photo of the canopy overstory.

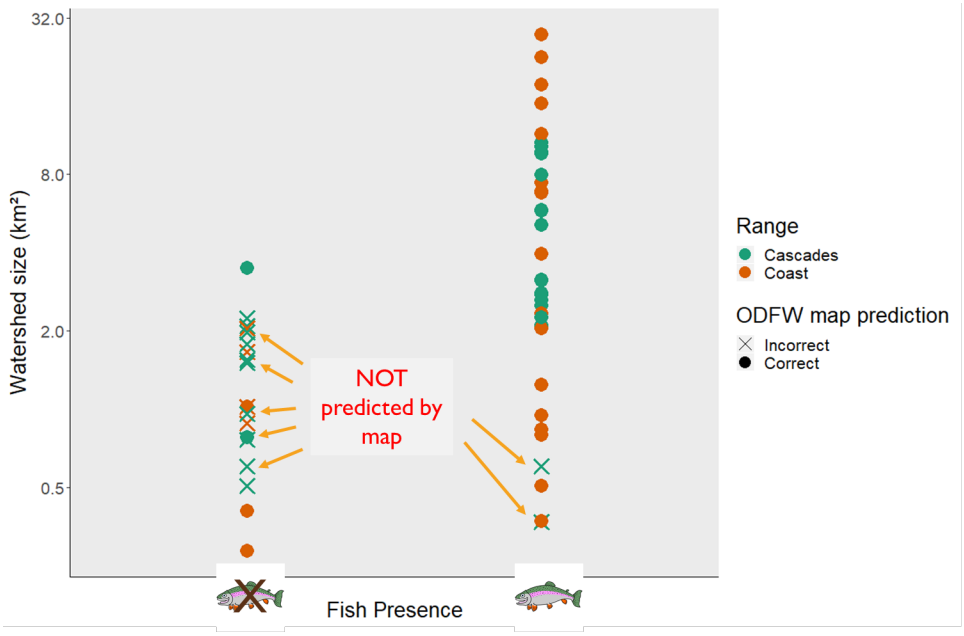

Figure 7. Fish presence plotted against watershed size for the Coast and Cascades site scouting trips from the first year of the study (2019) and presented at Oregon American Fisheries Society in Bend, Oregon. The ODFW map was used to determine fish presence, but consistently over-estimated fish presence at small watershed scales.

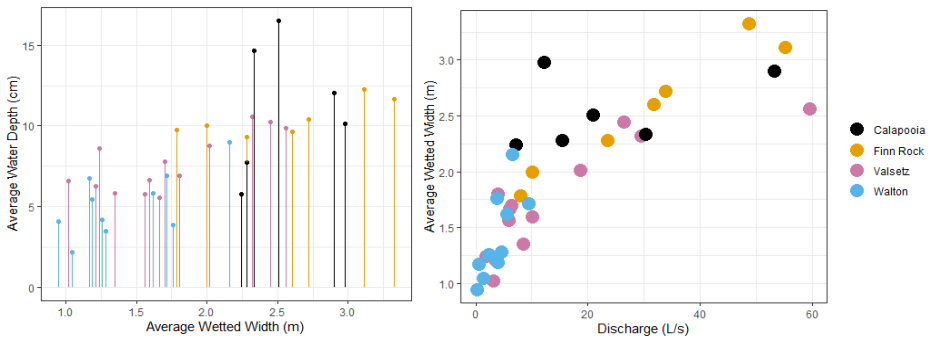

Figure 8. Average water depth, average wetted width, and discharge were measured periodically throughout the season at each site. Sites in the Finn Rock and Calapooia blocks are "medium" fish-bearing streams, while sites in Valsetz and Walton blocks are "small" fish-bearing streams.

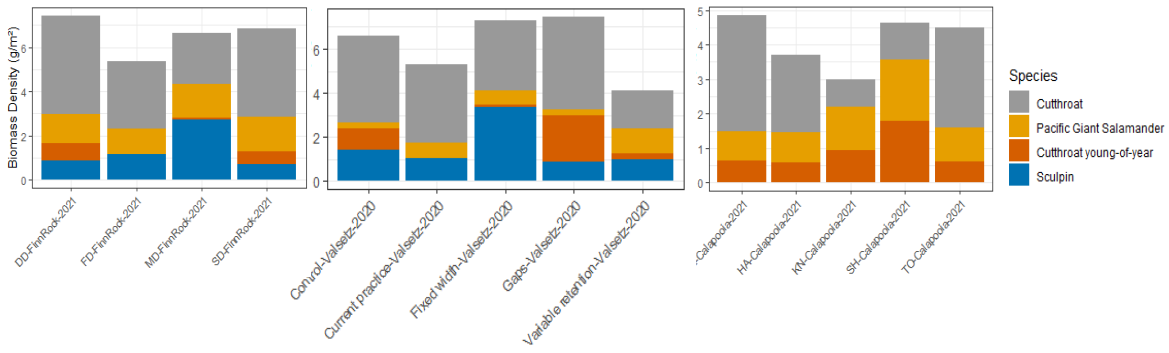

Figure 9. Total vertebrate biomass is compared across sites in each of the 3 blocks sampled in 2020. Vertebrates were sampled by 3-pass electrofishing in a 90 m reach. Biomass is calculated by multiplying the mean weight by the population estimate of each species. Population estimate is determined using the "Burnham" removal method in the FSA package in R.

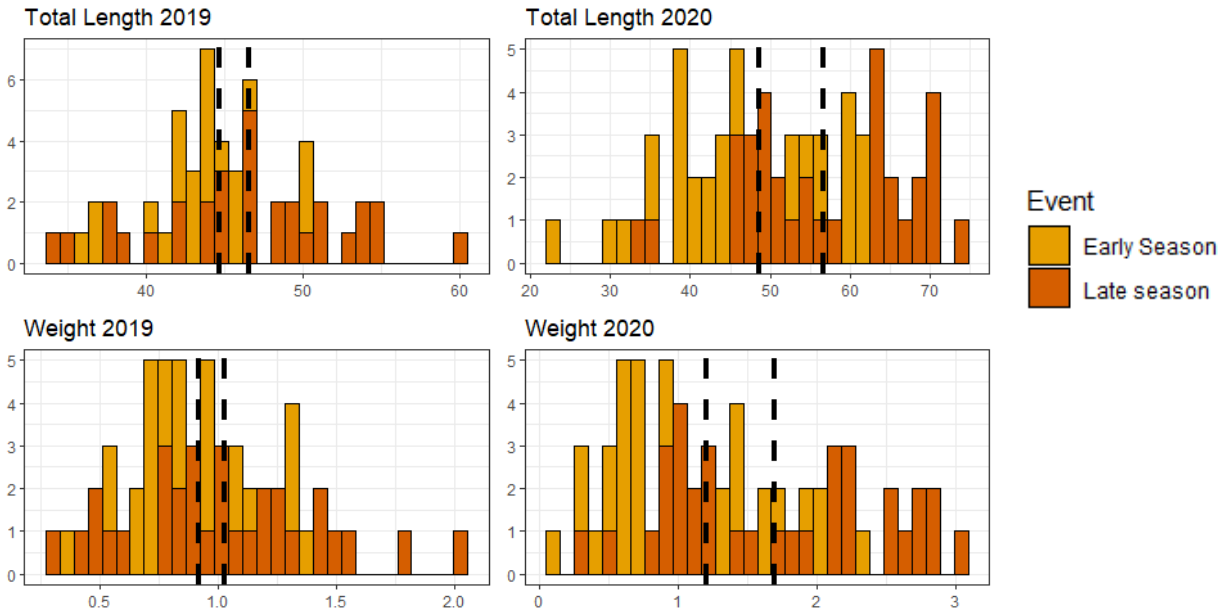

Figure 10. Young of year (YOY) length and weight distributions for the variable retention treatment in the Valsetz block. Dashed lines indicate the change in total length and weight averages in both 2019 and 2020. This site was fished on August 1 and August 28, 2019 (27 days), and on July 30 and September 21, 2020 (53 days).

Fish and Wildlife Habitat in Managed Forests

Progress Report

Title: Conservation Value of Slash Piles for Pacific Martens and Fishers in Managed Forests

Investigators: Dr. John Bailey, Dr. Katie Moriarty

Objectives:

1) Assess occurrence of martens and fishers at slash piles in stands within 15 years of harvest, as a function of pile size and composition, the placement of the pile on the landscape, and stand characteristics.

2) Assess spatial organization of small mammal communities in relation to slash piles and evaluate whether slash piles provide added prey diversity or abundance.

3) Assess potential for increased risk of wildfire and fire severity posed by retaining piles on the landscape, producing a "risk evaluation and concept paper" comparing the risks associated with retaining piles with the potential conservation benefits.

Summary of Accomplishments toward Objectives:

We have completed the first of two planned field seasons. We completed camera surveys, pile measurements, and vegetation and woody debris sampling in 35 stands, all in the northern California part of our study area. Of those 35 stands, we completed full small mammal trapping sessions (4 trap nights) in 8 stands. Following the field season, the preliminary results were compiled into a presentation for the Western Section of the Wildlife Society annual meeting, which was conducted virtually.

Problems and Barriers:

One challenge pertains to performing surveys in Oregon. One of our goals is to survey slash piles of different ages to assess whether age influences use by martens and fishers and how small mammal colonization of piles differs for piles of different ages. Because there are no forest management entities that we know of within Oregon that consistently retain piles over time, we have experienced difficulty in planning surveys in that part of our study area.

Another challenge has been acquiring an adequate sample size of stands aged 10-15 years. Often the roads to the stands in that age class have either been decommissioned or deteriorated from non-use, creating some difficulty in efficiently accessing those stands to survey, particularly for small mammal trapping. Stand selection is also limited by the ability to safely traverse the stands, which limits our options further. Filling in that data gap with be a primary focus in the upcoming field season.

Planned Work:

Work will continue with an additional field season in the summer of 2021, where the team will seek to increase sample size. We will review data from the 2020 field season to evaluate our methods and identify areas where protocols can be improved upon. Following the field season, we will proceed with data analyses, which will be reported in the thesis of the MS student working on the project.

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 their thesis using the data from this project.

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.

List of Publications, Thesis Citations: not yet

Fish and Wildlife Habitat in Managed Forests

Progress Report

Title: Red Tree Voles: Exploring Forest Occupancy

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:

We surveyed 16 stands in 2019 and 40 stands in 2020. Stands ranged in age class from 20 to 80+yrs and followed a gradient of distance to the nearest old forest patch up to 5km. We climbed and surveyed and photo-documented over 340 nests and installed 59 remote nest cameras to collect data on tree vole activity, nest survival, and capture any nest extirpation events. We recorded both red tree vole colonization and extirpation events across multiple stands. While our current dataset is fairly robust, we need to address gaps in our stand distribution to assess occupancy gradients across stand age and distance from old forest and continue to resurvey stands/nests to meaningfully develop timeseries data.

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 six month field season in 2021 to fill data gaps in stand distribution and resurvey 2019 and 2020 stands. The crew will spend approximately 1.5-2months surveying new stands, and approximately 4 months resurveying 2019 and 2020 stands. Existing nest cameras will be recovered/refreshed. Nest camera sample size will be increased and include randomly installed cameras as we attempt to record colonization events in 'real time'.

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

Jason Piasecki – thesis research

List of Presentations, Posters etc.: Red Tree Vole Working Group 2019, 2020**;** TWS-Western Section 2021

List of Publications, Thesis Citations: not yet