November 7, 2014

1. Title: Experimental Evaluation of Plethodontid Salamander Responses to Forest Harvesting

2. Investigators: Dr. Barbara Lachenbruch (CoF, OSU), Dr. Tiffany Garcia (Dept. of Fisheries and Wildlife, OSU), Dr. Andrew J. Kroll (Weyerhaeuser NR), and Dr. Blake Murden (Port Blakely Tree Farms LP)

3. Project duration: 2 years, beginning June, 2014

4. Objectives:

A. **Correlate Oregon slender salamander (OSS; *Batrachoseps wrightii*) and Ensatina salamander (ENS; *Ensatina eschscholtzii*) occupancy and abundance with CWD density and distribution at both the site and landscape scale.**

Summary of accomplishments towards First objective-

Site Selection- We selected 66 harvest units (>10 acres in size, <2500 ft. in elevation within western Cascade Range, OR) from ownership databases in two geographic blocks. Twenty-nine units occurred on the Clackamas Block and thirty-seven units occurred on the Snow Peak Block. Thirteen units on the Clackamas Block are owned by Port Blakely and 16 are owned by Weyerhaeuser; 6 units on the Snow Peak Block are owned by Oregon Department of Forestry (ODF) and 31 are owned by Weyerhaeuser. We sampled 55/66 harvest units in the 2014 season. We did not sample 12 units because they were being harvested. Harvested units will be sampled again beginning one year after harvest.

Sampling methods- We assigned a random starting point in each harvest unit for field crews to begin OSS/ENES sampling. This point served as the center for a single 9*9 m plot. Once the first plot was identified, a random azimuth was selected and six additional plots were established with a distance of 40 m between them. We searched plots in three sequential 10 minute intervals. Observers switched back and forth on every interval. As soon as both OSS and ENES were detected, sampling ceased. If OSS and ENES were not detected, all three intervals were completed. Observers followed a "light touch" sampling protocol in which cover objects were returned to their original position and in which disturbance to habitat features such as decayed logs was minimized. We sampled all seven plots in each harvest unit. During sampling, crews counted coarse woody debris based on length (1-5, 6-15, >15 m), width (large end; 25-50, >50 cm), and decay (none, Stage 1, and Stage 2) classes. Decay classes were based on those in Maser and Trappe (1984). In addition, crews recorded air temperature, soil moisture (at each of four points within each plot), and date.

We were interested in three quantities: ψ (probability that a harvest unit is occupied by OSS/ENES), θ (probability that a sampling plot is occupied by OSS/ENES), and λ (abundance in the sampling plot). We expect that forest harvesting will affect ψ, as harvest treatments are applied uniformly across units. However, our expectation is that θ and λ for OSS would be associated with distributions of coarse woody debris *within* the harvest units, regardless of whether the unit was assigned to the treatment or control group. Given the range of habitat associations for ENES, we did not expect to see a relationship between θ and λ and coarse woody debris. Our sampling design (three search intervals of each of seven plots within each of the 66 harvest units) allowed us to estimate these quantities. Details on the statistical models used to estimate these quantities (under different sampling designs) are provided in Royle and Nichols (2003), Nichols et al. (2008), Mordecai et al. (2011), and Pavlacky et al. (2012).

Results- We found OSS on sampling plots in 45/55 (82%) of the harvest units. In addition, we used non-random searching to determine that OSS occupied the remaining ten stands. Twenty-one of 23 units were occupied on the Clackamas block (9 Port Blakely and 12 Weyerhaeuser stands, respectively). Twenty-four of 31 units were occupied on the Snow Peak block (5 ODF and 19 Weyerhaeuser stands, respectively). We detected a total of 133 OSS: 74, 33, and 26 during the first, second, and third search intervals, respectively. Summary information for sampling covariates indicated that plots in the Snow Peak block contained ~50% more downed wood than plots on Clackamas (Table 1). Also, stands in the Snow Peak Block tended to be sampled later, on average, than stands in the Clackamas block.

We found ENES on sampling plots in 40/55 (73%) of the harvest units. In addition, we used non-random searching to determine that ENES occupied 9/15 remaining stands. Fourteen of 23 units were occupied on the Clackamas block (9 Port Blakely and 5 Weyerhaeuser stands, respectively). Twenty-six of 31 units were occupied on the Snow Peak block (3 ODF and 23 Weyerhaeuser stands, respectively). We detected a total of 83 ENES: 40, 23, and 20 during the first, second, and third search intervals, respectively.

Harvest unit occupancy was 1 for both OSS and ENES. In both models, we found a positive association between OSS occupancy and the number of pieces of downed wood per sampling plot (Figure 1). However, we did not find any relationships between ENES occupancy and the number of pieces of downed wood per sampling plot (Figure 1). Similarly, we found a positive association between OSS abundance and the number of pieces of downed wood per sampling plot, but no relationship for ENES (Figure 2). In addition, although we found a positive association between OSS detection probability and date (Figure 3, top), indicating that salamanders were more likely to be detected later in the sampling season, we found a slightly negative association between ENES detection probability and date (Figure 3).

Problems, barriers, proposed changes to First objective-

The analysis of the field data did not indicate a pressing need to expand the sample size of harvest units in the study. However, given that each harvest unit requires only one day for sampling per year, the addition of controls and treatment units to the study is worth considering in future field seasons.

B. Quantify relationship between Oregon slender salamander (OSS; *Batrachoseps wrightii*) and ensatina salamander (ENS; *Ensatina eschscholtzii*) occupancy and abundance with heartwood quantity.

Summary of accomplishments towards Second objective-

Justification- We hypothesize that heartwood content will be positively associated with both OSS and ENS occupancy and abundance, particularly as time since harvest increases.The Oregon slender salamander has a strong reliance on decayed coarse woody debris. A large portion of the geographic distribution of the Oregon slender salamander (OSS) occurs in forests managed intensively for wood production. In contrast, Ensatina salamanders (ENES) are associated with a broad range of habitat types. Reduced harvest rotation lengths can lead to lower input of total CWD and CWD heartwood at both the harvest unit and landscape scale (Bunnell and Houde 2010, Maguire and Batista 1996). Heartwood is more durable but has lower initial moisture content than sapwood, thus the overall effect of reduced heartwood on OSS or ENS habitat quality is unclear.

Sampling Status- We have pre-treatment sampling data on all units that include CWD length (1-5, 6-15, >15 m), width (large end; 25-50, >50 cm), sapwood width (none, <3 cm, > 3 cm), and decay class (none, Stage 1, Stage 2) (Maser and Trappe 1984). Once harvested units are sampled (one year after harvest) will begin to characterize the heartwood of CWD in each sub-plot, including moisture and density metrics. Twelve unites were harvested in 2014, thus data collection on heartwood characteristics will begin in 2015.

Problems, barriers, proposed changes to Second objective-

This component of the project has not started due to the absence of harvested treatment units up to this point in the project. As such, no issues or problems have presented themselves. We anticipate collection protocols will be seamlessly adhered to with outstanding results regarding heartwood characteristics.

7. Planned Work:

Site Selection- Our 2015 field season is anticipated to begin on April 1. We will hire 4 field technicians for 10 weeks to sample units within the two geographic blocks of this study. We estimate that 15 units have or will be actively harvested either after the 2014 sampling or during the 2015 sampling season. As such, we expect to perform pre-treatment sampling on 39 units and post-treatment sampling on 12 units.

Sampling methods- We will continue to use the 'light touch' sampling methods and occupancy analytical approaches to estimate Plethodon salamander occupancy and abundance in forested landscapes as a function of course woody debris abundance and distribution. We will continue to randomly generate a GPS point within each sampled unit to designate the center for a single 9*9 m plot; 6 additional plots will be assigned based on a random azimuth, each separated by 40m. Each plot will be sampled for 3 10-min intervals or until both a OSS and ENS are detected. All seven plots will be sampled. CWD data in post-treatment plots will include sampling methods used in pre-treatment units (CWD length, width, sapwood width, and decay class, and will be supplemented with additional information on heartwood width, moisture content, and density. Again, we will analyze presence and absence data to estimate three quantities: ψ (probability that a harvest unit is occupied by OSS/ENES), θ (probability that a sampling plot is occupied by OSS/ENES), and λ (abundance in the sampling plot). We will summarize our results over the 2013, 14 and 15 sampling years by treatment.

8. Comprehensive Summary: N/A

9. Graduate and/or undergraduate Engagement:

Carly Rathburn, an undergraduate student in OSU's Department of Fisheries and Wildlife (FW), participated in the 2014 sampling season and received 4 internship credits for her involvement. Carly was a member of the southern block sampling crew, working with one other field technician during the entirety of the 10 week sampling season. As part of the OSU FW Dept. internship requirements, Carly submitted a report outlining her experiences and accomplishments pertaining to this experience (available upon request). She detailed the scope of the research, the broader significance of the project, and the impact this opportunity had on her career goals. She gained significant experience in multiple skill set areas, including sampling techniques, animal identification, safety skills, and experimental design.

10. List of presentations, posters, etc.:

Garcia, T.S., A.J. Kroll, M. Rochelle, K. Dugger, J. Johnson, B. Murden and B. Lachenbruch. 2014. Oregon Forest Industries Council Board Meeting, June 17, 2014. Oregon State University, Corvallis, OR.

Garcia, T.S and T. Chestnut. 2014. Sampling techniques for terrestrial salamanders: The good, the bad, and the ugly. Society for Northwestern Vertebrate Biology Annual Meeting, Pasco, Washington.

Kroll, A.J., T. Garcia, J. Jones, B. Murden, J. Johnson, S. Peterman, and M. Rochelle. 2014. Multi-scale responses of Oregon slender and Ensatina salamanders to forest management. 21th Annual Conference, The Wildlife Society, Pittsburgh, PA.

Kroll, A.J. T.S. Garcia, J. Jones, B. Murden, J. Johnson, S. Peterman and M. Rochelle. 2014. Multi-scale responses of Oregon Slender salamander and Ensatina to forest management. North America Congress for Conservation Biology. Missoula, Montana.

Peterman, S., J. Johnson, M. Rochelle, T. Garcia, B. Murden, J. Jones, and A.J. Kroll. 2014. Experimental evaluation of Oregon Slender Salamander and Ensatina responses to forest management. 48th Annual meeting of the Oregon Chapter of The Wildlife Society, Bend, OR.

Kroll, A.J. 2014. Responses of terrestrial amphibians in production ecosystems. Joint Annual Meeting of the Society of Northwest Vertebrate Biologists and the Washington Chapter of The Wildlife Society , Pasco, WA.

11. List of publications, thesis citations: None

Table 1: Summary information for sampling covariates, Clackamas and Snow Peak blocks, Oregon Cascades, 2014.

	Clackamas (n=29)		*Snow Peak (n=37)*	
Covariate	**Average**	**SD**	**Average**	**SD**
Date	May 7	17 days	May 11	17 days
Downed wood (# of pieces)	2.4	2.2	3.6	2.7
Air temperature (°C)	9.3	3.7	12.1	5.5
Soil temperature (°C)	8	2.1	9.5	1.6
Elevation (m)	666	173	662	217

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Figure 1: Association between Oregon slender (OSS) and ensatina (ENES) salamander plot-level occupancy and downed wood (pieces per 81 m^2 sampling plot), Clackamas and Snow Peak blocks, Oregon Cascades, 2013-14. Estimates were averaged from 2013 and 2014 data. Two different statistical models, Royle and Nichols (2003) and Pavlacky et al. (2012), were used to produce estimates.

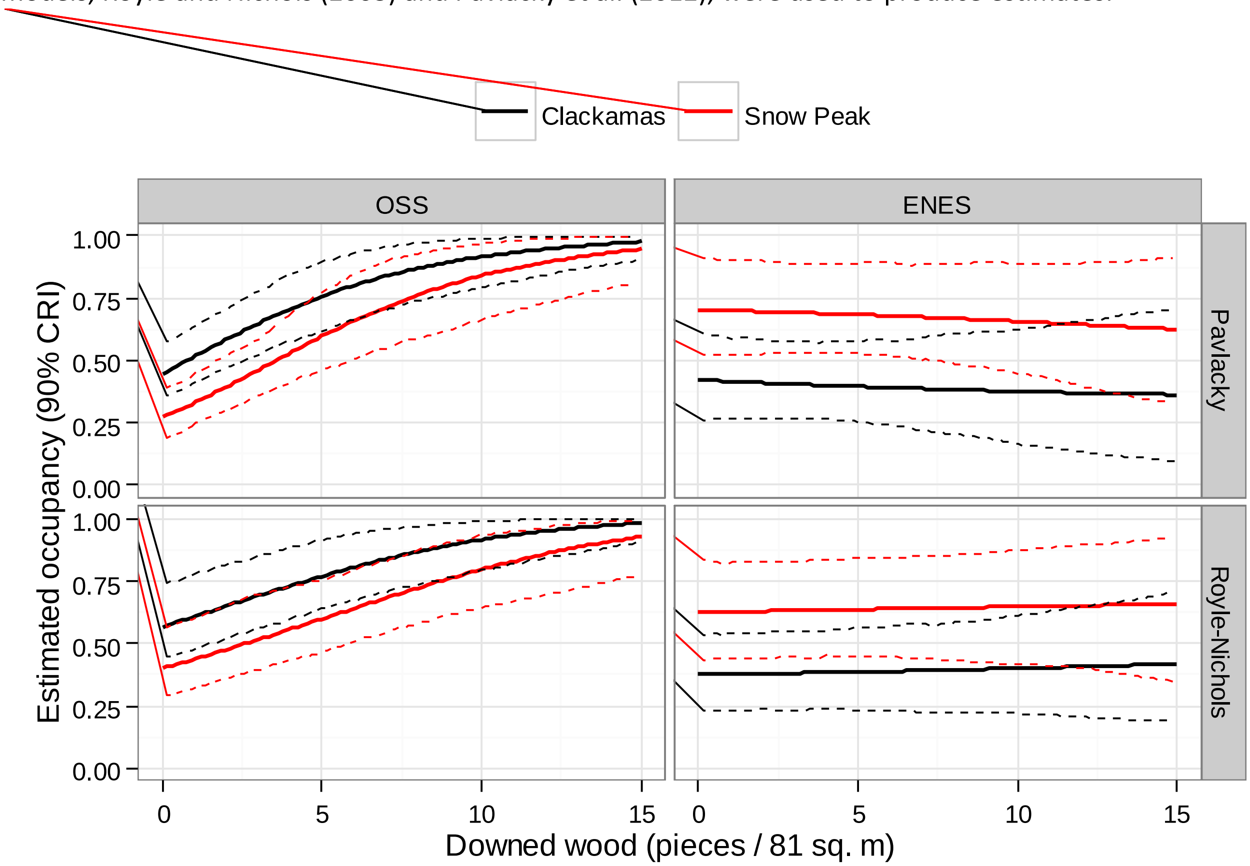


Figure 2: Association between Oregon slender (OSS) and ensatina (ENES) salamander abundance and downed wood (pieces per 81 m^2 sampling plot), Clackamas and Snow Peak blocks, Oregon Cascades, 2013-14. Estimates were averaged from 2013 and 2014 data.

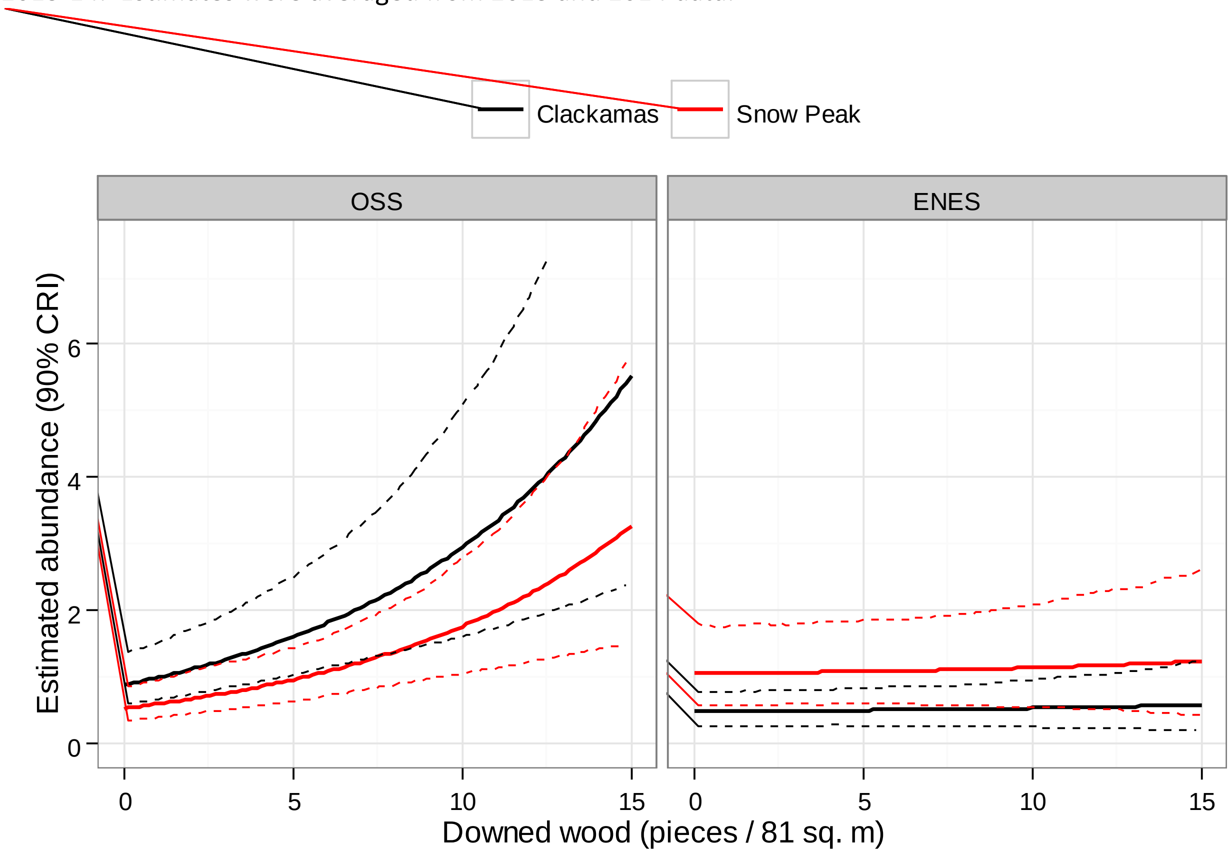
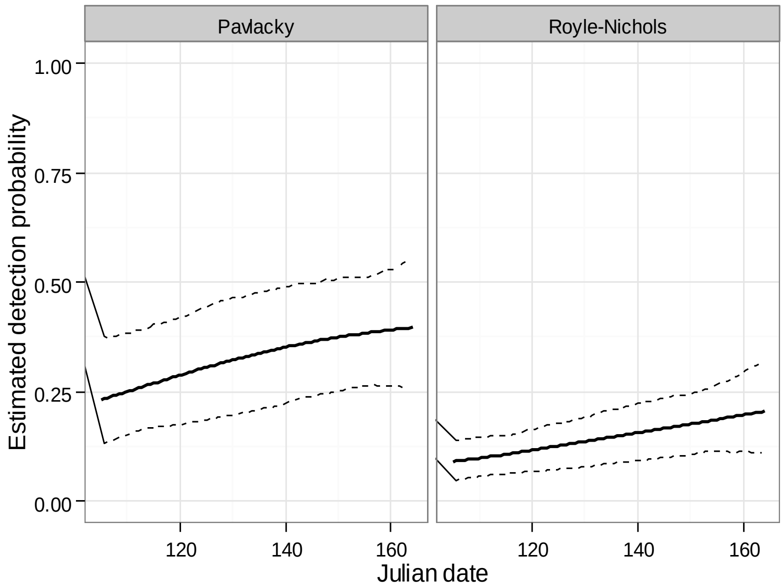
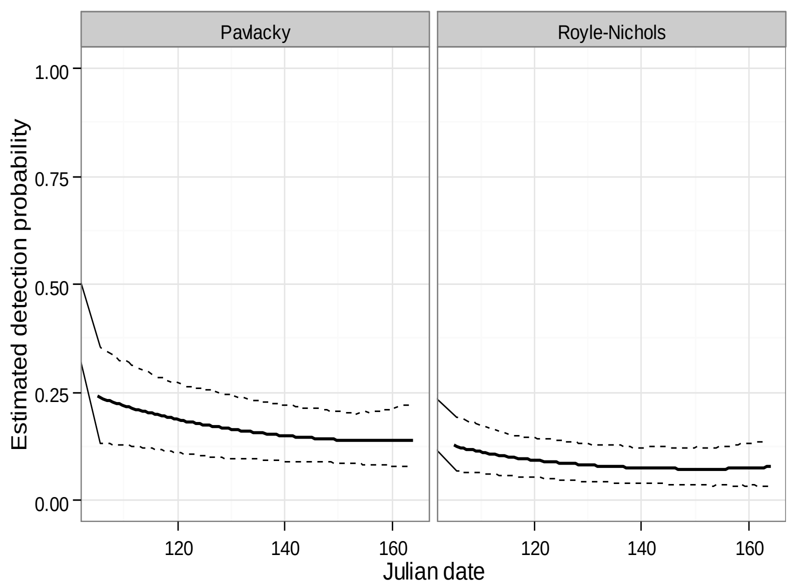


Figure 3: Association between Oregon slender (top) and ensatina (bottom) salamander detection probability and date, Oregon Cascades, 2013-14. Estimates were averaged from 2013 and 2014 data. Note that the Pavlacky et al. (2012) model estimates species level detection probability and the Royle and Nichols (2003) model estimates individual capture probability.





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Nichols, J. D., L. L. Bailey, A. F. O'Connell, Jr., N. W. Talancy, E. H. C. Grant, A. T. Gilbert, E. M. Annand, T. P. Husband, and J. E. Hines. 2008. Multi-scale occupancy estimation and modelling using multiple detection methods. Journal of Applied Ecology 45:1321-1329.

Pavlacky, D. C., Jr., J. A. Blakesley, G. C. White, D. J. Hanni, and P. M. Lukacs. 2012. Hierarchical multi-scale occupancy estimation for monitoring wildlife populations. Journal of Wildlife Management 76:154-162.

Royle, J. A., and J. D. Nichols. 2003. Estimating abundance from repeated presence-absence data or point counts. Ecology 84:777-790.