November 18, 2015

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 wrighti*) 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 74 harvest units (>10 acres in size, <2500 ft. in elevation within western Cascade Range, OR) from ownership databases in two geographic blocks. Thirty and 44 units occurred on the Clackamas and Snow Peak Blocks, respectively. Port Blakely owns 13 units on the Clackamas Block and Weyerhaeuser owns 17 units; on the Snow Peak Block, Oregon Department of Forestry (ODF) owns 6 units, Bureau of Land Management (BLM) owns two units, and Weyerhaeuser owns 36 units. We sampled 61/74 harvest units in the 2015 season. We did not sample 13 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 two quantities: ψ (probability that a harvest unit 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 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 λ and coarse woody debris. Our sampling design (three search intervals of each of seven plots within each of the 74 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 sampled 61/74 (82%) harvest units in 2015. We did not sample 13 units in 2015 because they were being harvested or had been harvested in 2014. Twenty of the sampled stands were treatment units and 38 were control units. We found OSS on sampling plots in 40/61 (66%) of the units. We found OSS on sampling plots in 5/12 (42%) of the treatment units and 35/49 (71%) of control units. On the Clackamas block, 3/6 (50%) treatment units and 16/19 (84%) control units had OSS detections. On the Snow Peak block, 2/6 (33%) treatment units and 19/30 (63%) control units had OSS detections. We detected a total of 113 OSS: eight on treatment units and 105 on control units.

We found ENES on sampling plots in 37/61 (61%) of the units. We found ENES on sampling plots in 4/12 (33%) of the treatment units and 33/49 (67%) of control units. On the Clackamas block, 1/6 (17%) treatment units and 15/19 (79%) control units had ENES detections. On the Snow Peak block, 3/6 (50%) treatment units and 18/30 (60%) control units had ENES detections. We detected a total of 86 ENES: six on treatment units and 80 on control units.

Summary information for sampling covariates indicated that plots in the Snow Peak block contained ~20% more downed wood than plots on Clackamas (Table 1). Stands in both blocks had the same average sampling date (~May 14).

Harvest unit occupancy for OSS was 0.95 (95% CRI: 0.84-1.0) on Clackamas and 0.77 (95% CRI: 0.59, 0.91) on Snow Peak. For ENES, harvest unit occupancy was 0.86 (95% CRI: 0.64-0.99) on Clackamas and 0.86 (95% CRI: 0.64, 0.99) on Snow Peak. Plot-level abundance for OSS was 0.6 (95% CRI: 0.08-1.4) on Clackamas and 0.4 (95% CRI: 0.05, 0.9) on Snow Peak. For ENES, plot-level abundance was 1.6 (95% CRI: 0.4-5.2) on Clackamas and 1.4 (95% CRI: 0.3, 4.3) on Snow Peak.

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 wrighti*) and ensatina salamander (ENS; *Ensatina eschscholtzii*) occupancy and abundance with heartwood quantity.**

Summary of accomplishments towards Second objective-

Justification- We predict 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 (Maguire and Batista 1996, Bunnell and Houde 2010). 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 units were harvested in 2014-15, thus data collection on heartwood characteristics will begin in 2016.

Problems, barriers, proposed changes to Second objective-

This component of the project has not started due to the similarity in characteristics of new wood in harvested treatment units. As such, we will have to refine our sampling protocols for 2016.

7. Planned Work:

Site Selection- Our 2016 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 ~25 units and post-treatment sampling on 32 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 2015-2016 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 2014-15 sampling seasons 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.:

Kroll, A.J., T. Garcia, B. Murden, J. Jones, J. Johnson, S. Peterman, and M. Rochelle. 2015. Oregon slender salamander responses to intensive forest management. Joint Annual Meeting of the Oregon Chapters of The Wildlife Society and Society of American Foresters (29 April-1 May), Eugene, OR.

11. List of publications, thesis citations:

Kroll, A.J., T. Garcia, J. Jones, K. Dugger, B. Murden, J. Johnson, S. Peterman, B. Brintz, and M. Rochelle. 2015. Evaluating multi-level models to test occupancy state responses of plethodontid salamanders. PLOS ONE, *in press*.

Table 1: Summary information for sampling covariates, Clackamas and Snow Peak blocks, Oregon Cascades, 2015.

	Clackamas (n=25)		*Snow Peak (n=36)*	
Covariate	**Average**	**SD**	**Average**	**SD**
Date	May 14	15 days	May 15	19 days
Downed wood (# of pieces)	2.5	2.1	3.1	2.5
Air temperature (^{o}C)	12	4.6	12	4.9
Soil temperature (^{o}C)	10	2.2	10	2.9
Elevation (m)	593	173	632	323

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Literature Cited

Bunnell, F. L., and I. Houde. 2010. Downed wood and biodiversity - implication to forest practices. Environmental Management **18**:397-421.

Maguire, D. A., and J. L. F. Batista. 1996. Sapwood taper models and implied sapwood volume and foliage profiles for coastal Douglas-fir. Canadian Journal of Forest Research **26**:849-863.

Maser, C., and J. M. Trappe, editors. 1984. The Seen and Unseen World of the Fallen Tree. Gen. Tech Rep. PNW-164, U.S. Department of Agriculture, Pacific Northwest Forest and Range Experimental Station, Portland, OR, USA.

Mordecai, R. S., B. J. Mattsson, C. J. Tzilkowski, and R. J. Cooper. 2011. Addressing challenges when studying mobile or episodic species: hierarchical Bayes estimation of occupancy and use. Journal of Applied Ecology **48**:56-66.

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.