**Research Proposal**

ASHLEIGH PICCOLI, *The Pennsylvania State University, **417 Old Main, University Park, PA 16802, USA***

## INTRODUCTION

Habitat maintenance and improvement are critical aspects of endangered species recovery (Kerr and Deguise 2004, Taylor et al. 2005). Northern Spotted Owls (NSO; Strix occidentalis caurina) are a federally threatened subspecies inhabiting western Washington, western Oregon, and northwestern California (USFWS 1990) that primarily utilizes old-growth forest (USFWS 1991, Courtney et al. 2004). Most timber harvest practices, including thinning, harm NSO by degrading or eliminating old-growth forest habitat such that reproduction is reduced and nesting sites are abandoned (Forsman et al. 1984, King 1993, Hicks et al. 1999, Meiman et al. 2003). According to Davis et al. (2016), forest structure variables that best define NSO nesting/roosting habitat are high density of large conifers (highly suitable habitat = 6-16 trees/ac) and high conifer cover (highly suitable habitat = 62-89% conifer cover). According to Mills et al. (1993), there was a positive correlation between NSO nest sites and vertical canopy layering as well as greater snag diameter. Herter et al. (2002) claims that in the Western Cascades, Spotted Owls used mature/old forest stands more than expected for roosting while young stands were used less often than expected (based on availability) during the non-breeding season. These results appear to be consistent with foraging patterns in the same region (Irwin et al. 2000). Spotted Owl preference for old growth stands for roosting and foraging may not universally extend to nesting. In a California redwood forest privately owned by the Simpson Timber Company, 54% of nests found were in stands 31-60 years old, 30% 61-80 years old, and only 17% in stands greater than 80 years old (Folliard et al. 2000). It was proposed that the chosen stands were selected due to

increased heterogeneity and vertical complexity with a high proportion of edge habitat, perhaps supplementing foraging opportunities.

Maintenance and recruitment of Spotted Owl habitat is one of 4 criteria for recovery of the species (USFWS 2011). In order to determine where the Critical Habitat is for the NSO the US Fish and Wildlife Service identified relevant attributes based upon 4,000 known owl pairs, which were used to draw a habitat suitability map (USFWS 2012). From that map, potential habitat networks were built and zonation analyses were conducted to ensure the critical habitat is as contiguous as possible and well distributed throughout their range. The US Fish and Wildlife Service then determined where the essential features were on the landscape (such as water features) and took into consideration where suitable unoccupied locations were (USFWS 2012).

Analysis of NSO old-growth forest habitat change from losses due to logging and fire (-) and regrowth (+) from 1993-2013 found a net habitat loss of ~1.5% (Davis 2015), but no re-assessment has been done since 2013. I propose to partially fill this knowledge gap by analyzing how NSO designated critical habitat changed due to logging (commercial, pre-fire, and post-fire salvage) within National Forests from 2012-2021. This will be done by collecting publicly available data, recategorizing the data, and calculating the change in area of logging activity between all the years in question.

## METHODS

First the NSO Critical Habitat boundary layer from Data.gov, the National Forest boundary layer from the USFS FACTS database (USDA/USFS 2021), and Landsat imagery within the Critical Habitat boundary layer (2012-2021) were collected. As these images were taken in pieces, they

were unzipped, uploaded into ArcGIS Pro 2.8, and merged using the mosaic tool to compile all of the individual images into one cohesive image per year.

Once the layers were loaded, all of them (logging, USFS boundary, Landsat imagery) were clipped to the NSO Critical Habitat Boundary layer. At that point, it was necessary to spot check the logging dataset against the Landsat imagery to ensure the accuracy of the records in the attribute table. Along with that, it was necessary to spot check the NSO Critical Habitat boundary layer against the Landsat imagery to ensure the exclusion of roads, buildings, and any built unnatural surfaces.

Once the layers were properly loaded and clipped, a column was added to the attribute table of the logging layer (labeled LOGGING_TYPE) to differentiate between commercial, pre-fire, and post-fire logging types. The logging projects were separated by year using a SQL statement through the 'Select by Attribute' tool for each of the years between 2012 and 2021. Once the year in question was selected, a new layer was developed for that specific year's logging activities by clicking data>export data and adding to the current map. Each entry for every year layer was then classified into the commercial, pre-fire, and post-fire categories via the LOGGING_TYPE column. To capture the data needed to assess logging through time, each year's attribute table was opened to extract the area measurements from each year's logging layer, separated by logging type (three area measurements per year). The NSO Critical Habitat layer's attribute table was then opened and the area measurement extracted from the table. To calculate the percent of NSO Critical Habitat area logged per year (per logging type), the area of NSO Critical Habitat was divided by the logging-type level data.

**NSO critical habitat area =A, commercial logging area=B, pre-fire logging area =C, post-fire salvage area=D**

**Percent logged per year: Commercial=B/A, Pre-fire=C/A, Post-fire=D/A**

To calculate average rate logged per year for each logging type, the average was taken from each logging type calculation throughout the study period.

**Commercial (2012+2013+2014…)/10 years**

The logging types were then compared over the entire study period.

## RESULTS

Northern Spotted Owl Critical Habitat was measured out to contain more than 9,577,341 acres. Commercial logging over the 10 year period was 171,345.115 acres. Pre-fire logging was 11,575.174 acres and post-fire logging was 29,681.327 acres. In total, 212,601.617 acres were logged in NSO Critical Habitat between 2012 and 2021. 80.59% of the total logging was classified as commercial; 5.44% was classified as pre-fire, and 13.96% as post-fire.

Amount logged per year, in acres

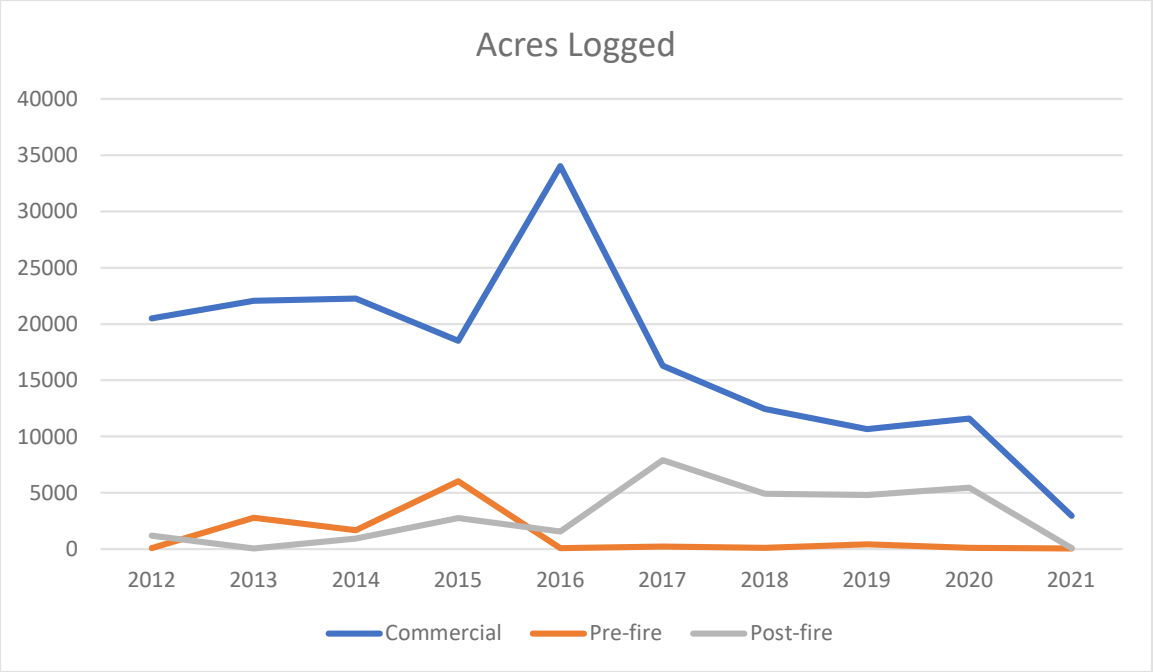
| | Commercial | Pre-fire | Post-fire |
|---|---|---|---|
| 2012 | 20486.747 | 89.461 | 1204.039 |
| 2013 | 22058.479 | 2773.683 | 45.473 |
| 2014 | 22271.630 | 1669.631 | 933.893 |
| 2015 | 18515.043 | 6021.827 | 2756.041 |
| 2016 | 34040.386 | 91.442 | 1566.398 |
| 2017 | 16298.428 | 228.507 | 7915.723 |
| 2018 | 12461.643 | 111.702 | 4923.231 |
| 2019 | 10654.836 | 417.701 | 4794.136 |
| 2020 | 11604.747 | 107.988 | 5468.159 |
| 2021 | 2956.372 | 63.444 | 74.784 |
| Total | 171,348.32 | 11,575.39 | 29,681.88 |

On average, 0.178% of NSO Critical Habitat was commercially harvested per year. The average percentages of pre-fire (0.0120859990883334) and post-fire (0.0309911956711798) harvest per year were lower. Cumulatively, across all categories and throughout the entire study period, there was a 2.22% loss of NSO habitat.

Percent of NSO Critical Habitat logged per year

| | Commercial | Pre-fire | Post-fire |
|---|---|---|---|
| 2012 | 0.213 | 9.340e-4 | 0.012 |
| 2013 | 0.230 | 0.028 | 4.747e-4 |
| 2014 | 0.232 | 0.017 | 0.009 |
| 2015 | 0.193 | 0.062 | 0.028 |
| 2016 | 0.355 | 9.547e-4 | 0.016 |
| 2017 | 0.170 | 0.002 | 0.082 |
| 2018 | 0.130 | 0.001 | 0.051 |
| 2019 | 0.111 | 0.004 | 0.050 |
| 2020 | 0.121 | 0.001 | 0.057 |
| 2021 | 0.030 | 6.624e-4 | 7.808e-4 |
| Total | 1.789 | 1.21E-01 | 0.309 |

Commercial logging had the highest total acreage logged out of the three categories, with post-fire salvage having the next highest total and pre-fire logging having the least. 2016 was a high-value outlier year with regards to commercial logging. 2021 was also an outlier year, with significantly less logging in all three categories than in years past.




## DISCUSSION

In Washington and Oregon, old-growth forest in the pre-logging era was estimated to cover 60-70 percent of the landscape (Franklin and Spies 1991). According to Booth (1991), 62% of Western Oregon and Washington held forests on average greater than 200 years old. These forests were subject to large, infrequent fires (Wimberley et al. 2000). However, since then, practices such as logging have significantly reduced the amount of habitat available for wildlife use, including the Northern Spotted Owl. This study aims to assess the success or failure of the FWS and USFS to adequately protect Northern Spotted Owl habitat through critical habitat designations.

According to Davis (2015) over a 20 year period ending in 2013 there was a 1.5% net loss of critical habitat. About 1.3% of this loss came from logging; this amounted to 116,100 acres. During the consecutive 10-year study period, a 2.22% loss of NSO Critical Habitat due to

logging was observed. In total 212,601.617 acres were logged in the NSO Critical Habitat zone from 2012-2021. This indicates that there was a substantial increase in logging during 2012-2021 in comparison to the previous 20 years.

Over 80% of the logging during the study period was classified as commercial in nature. The best strategy in the future to protect the Northern Spotted Owl might be to reduce or shift commercial logging outside of the Critical Habitat zone. The sustained decrease in commercial logging over the study period (with the exception of 2016) would suggest that the U.S. Forest Service may already be implementing such a shift. Although post-fire harvest was comparatively small, an emphasis on increased overall fire prevention by the USFS could also potentially help ensure the preservation of NSO habitat. An increase of post-fire salvage in 2017 was not the result of one large fire-multiple fires such as the Walker, Middle Creek, and Grider fires all contributed.

One limitation of this study is that it ends in the middle of a particularly tumultuous period on a global, national, and regional scale. Future outbreaks of COVID-19, natural disasters, shifts in public perception, and geopolitical events could all significantly alter future USFS logging activities. Additionally, studies on how specific harvesting methods (such as group selection cuts, salvage cuts, thinning, patch clearcutting) may affect NSO recruitment could be helpful for decisionmakers in the future.

## LITERATURE CITED


Booth, D.E. 1991. Estimating prelogging old-growth in the Pacific Northwest. Reconstructing age structure from the 1933 survey. J. Forestry 89:25-29.

Congressional Research Service [CRS]. 2021. COVID-19 and the US Timber Industry. < COVID-19 and the U.S. Timber Industry (congress.gov)> Accessed 19 October 2021.

Courtney, Steven P., Blakesley, J.A., Bigley, R.E., Cody, M.L., Dumbacher, J.P., Fleischer, R.C., Franklin, A.B., Franklin, J.F., Gutiérrez, R.J., Marzluff, J.M. and Sztukowski, L. 2004. Scientific evaluation of the status of the Northern Spotted Owl. US Fish and Wildlife Service, Sustainable Ecosystems Institute, Portland, Oregon .

Davis, R. 2015. Northwest Forest Plan (NWFP) Interagency Regional Monitoring, 20 Year Report Status and Trend of Northern Spotted Owl Habitat. US Forest Service.

Davis, R. J., Hollen, B., Hobson, J., Gower, J. E., & Keenum, D. 2016. Northwest Forest Plan—the first 20 years (1994-2013): status and trends of northern spotted owl habitats. Gen. Tech. Rep. PNW-GTR-929. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 54 p., 929.

Folliard, L.B., K.P. Reese, and L.V. Diller. 2000. Landscape characteristics of northern spotted owl nest sites in managed forests of northwestern California.J.Raptor Res. 34(2):75-84.

Forsman, Eric D., E. Charles Meslow, and Howard M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs 3-64.

Franklin, J.F. and T.A. Spies. 1991. Ecological Definitions of Old-Growth Douglas-Fir Forest. Pages 61-69 in PNW-GTR-285, Pac. Northwest Res. Sta., USDA For. Serv., Olympia, WA.

Goss, M., Swain, D. L., Abatzoglou, J. T., Sarhadi, A., Kolden, C. A., Williams, A. P., & Diffenbaugh, N. S. 2020. Climate change is increasing the likelihood of extreme autumn wildfire conditions across California. Environmental Research Letters *15*:9

Herter, Dale R., Hicks, L. L., Stabins, H. C., Millspaugh, J. J., Stabins, A. J., & Melampy, L. D. 2002. Roost site characteristics of northern spotted owls in the nonbreeding season in central Washington. Forest Science 48.2: 437-444.

Hicks, Lorin L., Henning C. Stabins, and Dale R. Herter. 1999. Designing spotted owl habitat in a managed forest. Journal of Forestry 97.7: 20-25.

Irwin, Larry L., Dennis F. Rock, and Gregory P. Miller. 2002. Stand structures used by northern spotted owls in managed forests. Journal of Raptor Research 34.3: 175-186.

Kerr, Jeremy T., and Isabelle Deguise. 2004. Habitat loss and the limits to endangered species recovery. Ecology Letters 7.12: 1163-1169.

Meiman, Susan, et al. 2003. Effects of commercial thinning on home-range and habitat-use patterns of a male northern spotted owl: a case study. Wildlife Society Bulletin 1254-1262.

Mills, L.S., R.J. Fredrickson, and B.B. Moorhead. 1993. Characteristics of old-growth forests associated with northern spotted owls in Olympic National Park. J. Wildlife Management 57(2):315-321.

The Lassen County Times [LCT]. 2021. Dixie Fire Update as of Wednesday, Oct. 20 < Dixie Fire Update as of Wednesday, Oct. 20 - Lassen News>. Accessed 20 October 2021.

USDA Forest Service [USDA/USFS]. 2021. Geodata Clearinghouse – Download National Datasets. < USDA Forest Service FSGeodata Clearinghouse - Download National Datasets>. Accessed 29 August 2021.

U.S. Fish and Wildlife Service. 1990. Endangered and threatened wildlife and plants: determination of threatened status for the northern spotted owl. U.S. Federal Register. 55: 26114-26194.

U.S. Fish and Wildlife Service. 1991. Endangered and threatened wildlife and plants; revised proposed determination of critical habitat for the northern spotted owl; proposed rule. 50 CFR Part 17. U.S. Federal Register. 56: 40001-40143.

U.S. Fish and Wildlife Service [USFWS]. 2011. Revised Recovery Plan for the Northern Spotted Owl (Strix occidentalis caurina). U.S. Fish and Wildlife Service, Portland, Oregon. xvi + 258 pp.

United States Fish and Wildlife Service [FWS]. 2012. Species Fact Sheets. < NSOfinal.pdf (fws.gov) >. Accessed 29 August 2021.

United States Fish and Wildlife Service . 2012. Modeling and Analysis Procedures used to Identify and Evaluate Potential Critical Habitat Networks for the Northern Spotted Owl. U.S. Fish and Wildlife Service, Portland, Oregon.

188 Wimberly, M.C., T.A. Spies, C.J. Long, and C. Whitlock. 2000. Simulating historical variability
189 in the amount of old forests in the Oregon Coast Range. Conservation Biology 14(1):167-
190 180.