Northern Spotted Owl Conservation and Management on Mendocino Redwood Company Forestlands

January 14, 2016

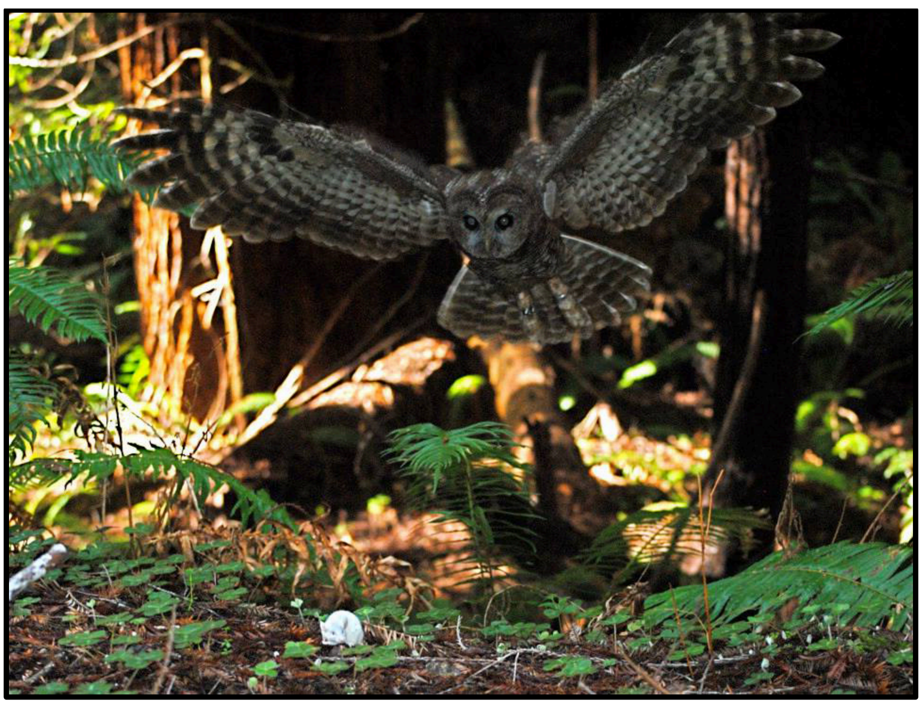

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TABLE OF CONTENTS

INTRODUCTION

The Northern Spotted Owl (*Strix occidentalis caurina*; NSO) was listed as federally threatened in 1990 because of continued timber harvesting throughout its range, uncertainties about its population status, and the absence of any regulatory mechanisms to conserve and manage this species on working landscapes (USDI 1990). Today, despite an increased understanding of its biology and status, the NSO still remains a species of strong scientific interest in the Pacific Northwest (PNW) and is regulated for timber harvest activities on both private and public lands in northwestern California.

In the 26 years since it was listed as federally threatened, the NSO is now the most studied bird of prey in the PNW, and one of the most studied in the world. A substantial body of research indicates that the northern spotted owl's population status, habitat associations, natural and anthropogenic disturbance regimes, and preferred prey vary over its range (Forsman et al. 2011; USFWS 2011). Thus, any discussion of spotted owl biology, including the development of conservation measures, must be put into the appropriate ecological context and acknowledge this variation in natural history. Applying inferences across study areas and biophysical provinces may be inappropriate and could lead to poor management decisions. Regional differences in spotted owl biology are complex and continue to be a source of conflicting viewpoints among scientists, environmentalists, regulators, and timber communities. One such viewpoint that continues to be a point of contention is the degree of spotted owl dependence on old-growth forest ecosystems and the environmental factors influencing their populations.

The coast redwood (*Sequoia sempervirens*) belt, ranging from coastal southwest Oregon south to Marin County of northwestern California, comprises only 9% of the northern spotted owl's range. This region contains relatively little old-growth forest due to historical timber harvesting (approximately 5% is located in state and federal reserves), yet has one of the highest densities of northern spotted owls when compared to its entire range (Diller and Thome 1999; California Natural Diversity Database 2013). On commercial forestlands within the redwood zone, spotted owls nest and roost in stands that are lower on the slope, contain residual trees (i.e., trees retained during previous harvest entries), and have higher amounts of forest edge in greater proportion to their availability on the landscape (Thome et al.1999; Folliard et al. 2000; Douglas unpublished data). Although these stands are relatively young when compared to old-growth forest, they often contain structural legacies, which may include individual large trees, snags, and trees with other features conducive for wildlife. This often cited "anomaly" can be attributed to coast redwood's association with a cool maritime climate as well as its ability to rapidly regenerate following timber harvest, form dense canopies, generate nest structures (debris accumulations and broken-top platforms), and support high densities of woodrats in early-seral stands.

Regional differences in spotted owl territory densities and habitat associations are also driven by the composition and availability of prey species. Spotted owls in western Washington and northwestern Oregon predominantly prey on northern flying squirrels (*Glaucomys sabrinus*; Forsman et al. 2001, 2004), which feed on hypogeous fungi (e.g. truffles and false truffles that form fruiting bodies below the surface of the ground) commonly associated with mature and late-seral coniferous forests (Carey 1995). Hence, in these areas, spotted owl presence is associated with old-growth forest characteristics. In contrast, diets of spotted owls in southwestern Oregon and northwestern California are largely comprised of woodrats (*Neotoma* spp.), which are abundant in early-seral stands containing a shrub component such as blueblossom (*Ceanothus thyrsiflorus*), manzanita (*Arctostaphylos* spp.) and tanoak (*Notholithocarpus densiflorus*; Carey et al. 1999; Hamm and Diller 2009). Spotted owls in the northern part of their range tend to have larger territory sizes and are associated with mature and old-growth forests compared to their extreme southern range, where spotted owls have smaller territories and thrive on landscapes containing a heterogeneous mixture of mature and early-seral habitat (Franklin et al. 2000). Therefore, northern spotted owl density and habitat use can be dependent on both the degree of habitat disturbance and how primary prey species respond to changes in vegetative composition and structure.

The most recent meta-analysis of demographic data from 11 study areas indicates that the northern spotted owl has declined at an annual rate of 3.8% over its entire range from 1985 to 2013 (Dugger et al. 2016). A majority of study areas reported declining trends in fecundity, apparent survival, occupancy, and finite rate of population change. In general, the strength of the population decline was strongest in the north and weakest in the south; however, the relationship did not conform perfectly to latitudinal gradient (Dugger et al. 2016). Although demographic trends were often similar between study areas, the regional environmental factors explaining such patterns were frequently different (e.g. attributable to habitat, local weather, and regional climate). Nevertheless, the barred owl (*Strix varia*) was a common factor associated with lower spotted owl occupancy in all study areas and lower apparent survival in 10 of 11 study areas. Declining occupancy trends were attributed to increased extinction rates and decreased colonization rates on 11 and 5 study areas, respectively (Dugger et al. 2016). Experimental removal of barred owls from treatment areas on Green Diamond Resource Company lands in northwestern California had a strong positive effect on both spotted owl survival and rate of population change, indicating that barred owl removal may be a viable management option to reverse spotted owl population declines (Hamm et al. 2015; Dugger et al. 2016). While the maintenance and growth of habitat supporting various spotted owl life-history functions still remain a key aspect to spotted owl conservation (Dugger et al. 2011), competition from the barred owl is now the single-most pressing threat to the continued existence of the northern spotted owl throughout its entire range (USFWS 2011).

Mendocino Redwood Company, LLC (MRC) forestlands have a long history of spotted owl surveys, research on local spotted owl ecology, and regulatory compliance for timber harvest plans. Although MRC formed in 1998, the Louisiana-Pacific Corporation (LP)—MRC's predecessor—initiated and maintained a survey and monitoring program when the listing of the northern spotted owl appeared to be imminent in 1989. This program continued through to the transfer of title marking the inception of MRC. In total, MRC forestlands have amassed 27 years of spotted owl survey and population monitoring data, spanning 1989–2015. This large dataset provides insight into spotted owl occupancy and reproduction dynamics during a period when this species has been continuously regulated for timber harvest in California. In addition, several research projects have also investigated spotted owl diet, home-range size, nest-site characteristics, and demography.

This document summarizes MRC's spotted owl territory distribution, survey methodology, occupancy and reproductive trends over the past two decades.

OWNERSHIP

Mendocino Redwood Company forestlands consist of 229,000 acres of coast redwood (*Sequoia sempervirens*) and mixed coniferous forests in Mendocino (220,000 acres) and Sonoma (9,000 acres) counties and are primarily managed for commercial timber (Figure 1). These forests are dominated by three tree species (percent by volume): coast redwood (45%), Douglas fir (*Pseudotsuga mensziesii*; 37%), and tanoak (*Notholithocarpus densiflora*; 15%). The remaining 3% of the tree species includes hardwoods such as madrone (*Arbutus menzesii*), red alder (*Alnus rubra*), California bay (*Umbellularia californica*), big leaf maple (*Acer macrophyllum*), true oaks (*Quercus* spp.); and shade-tolerant conifer such as grand fir (*Abies grandis*) and western hemlock (*Tsuga heterophylla*). Vegetation patterns vary across the landscape and are the result of an interaction between precipitation gradients, soil type, fire history, past agricultural use, and timber harvest.

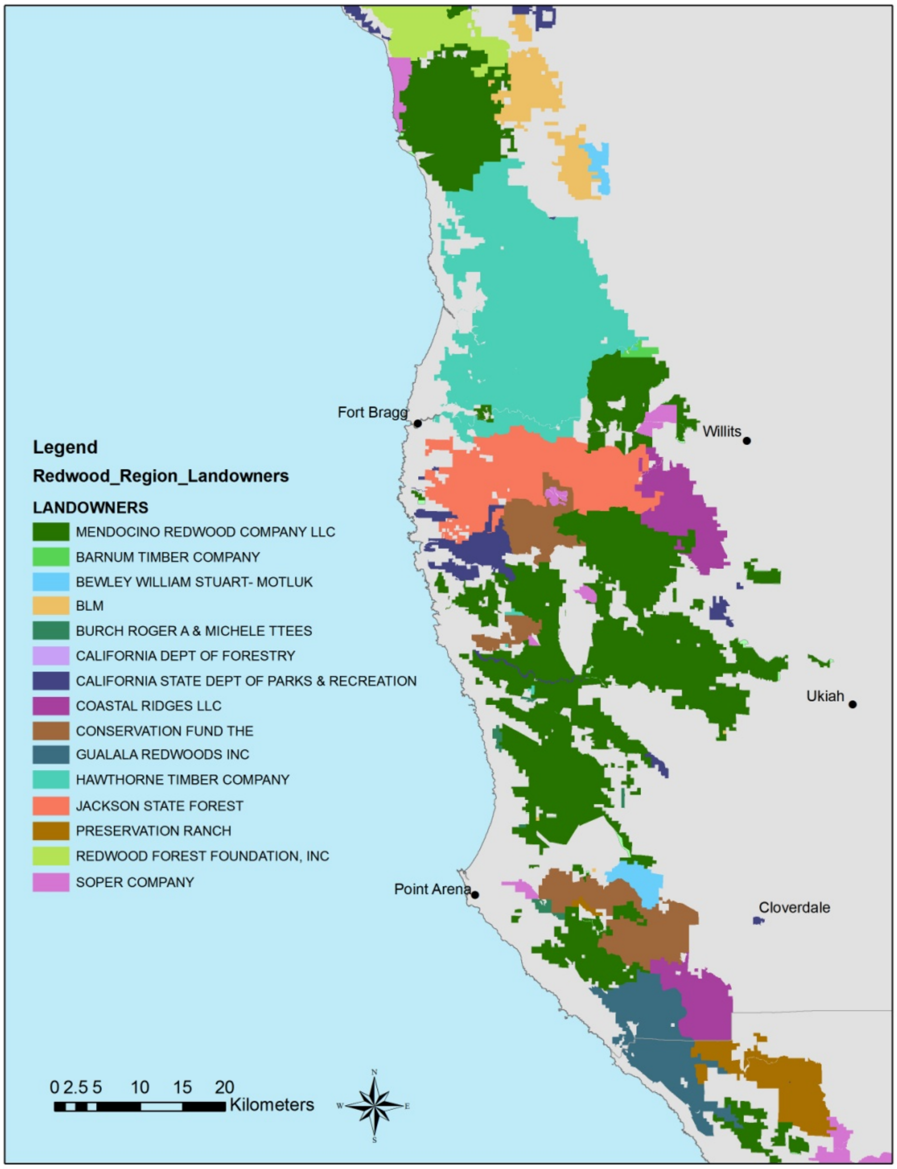

Figure 1. Map showing Mendocino Redwood Company landholdings and other large ownerships in coastal Mendocino and Sonoma counties.

SILVICULTURAL HISTORY

Forest structure patterns on the landscape have been heavily influenced by commercial timber harvests over the past 120 years. These timberlands have experienced at least two harvest entries, and have been shaped by a regimen of clear-cutting and repeated burning that removed most of the old-rowth forest and large valuable trees.

In the two decades prior to MRC forming, LP managed these forestlands using a combination of even- and uneven-aged silvicultures. A majority of the harvests consisted of shelterwood removal (50-60%), followed by clear-cut (15-25%) and selection (15-25%). The significant amount of overstory removal, combined with a failure to manage for adequate conifer regeneration following harvest entries, resulted in large heterogeneous patches of advanced regeneration dominated by pioneering tanoak that has become today's forest—one which consists of more tanoak than pre-settlement times.

In an effort to restore the species balance on its landscape, MRC is actively working to transition tanoak dominated stands (that were formerly conifer) back to conifer by managing these pioneering hardwoods and replanting areas with conifer (primarily redwood) following restoration harvests. At the same time, tanoak is a species long recognized as having cultural and ecological significance in forest ecosystems throughout its range. Areas where tanoak is actively being managed also contain retention areas where tanoaks are maintained for their ecological value such as mast crop, ectomycorrhizal fungal associations, and structural features (nests, platforms, and tree cavities) important to numerous wildlife species. The company is also committed to making a full transition to selection-based harvesting systems focusing on single tree and group selection methods, as well as growing more conifer and larger trees throughout its ownership. This transition will not only ensure a sustainable supply of future wood products, but also improve ecological function for terrestrial and aquatic species over time.

NORTHERN SPOTTED OWL DISTRIBUTION

MRC lands support approximately 160 NSO territories (Figure 2; California Natural Diversity Database 2013). Because the ownership is divided into large discontinuous blocks, there is a high amount of property edge that also supports a significant number of nearby, off-property territories whose home-ranges overlap with MRC's ownership. When MRC lands are buffered by 1000 feet, the number of territories increases by 70 for a total of 230. Given that spotted owl home-range size and shape may conform to topographic features and habitat distribution, it is likely that MRC lands provide roosting and foraging habitats for even more territories residing farther off-property.

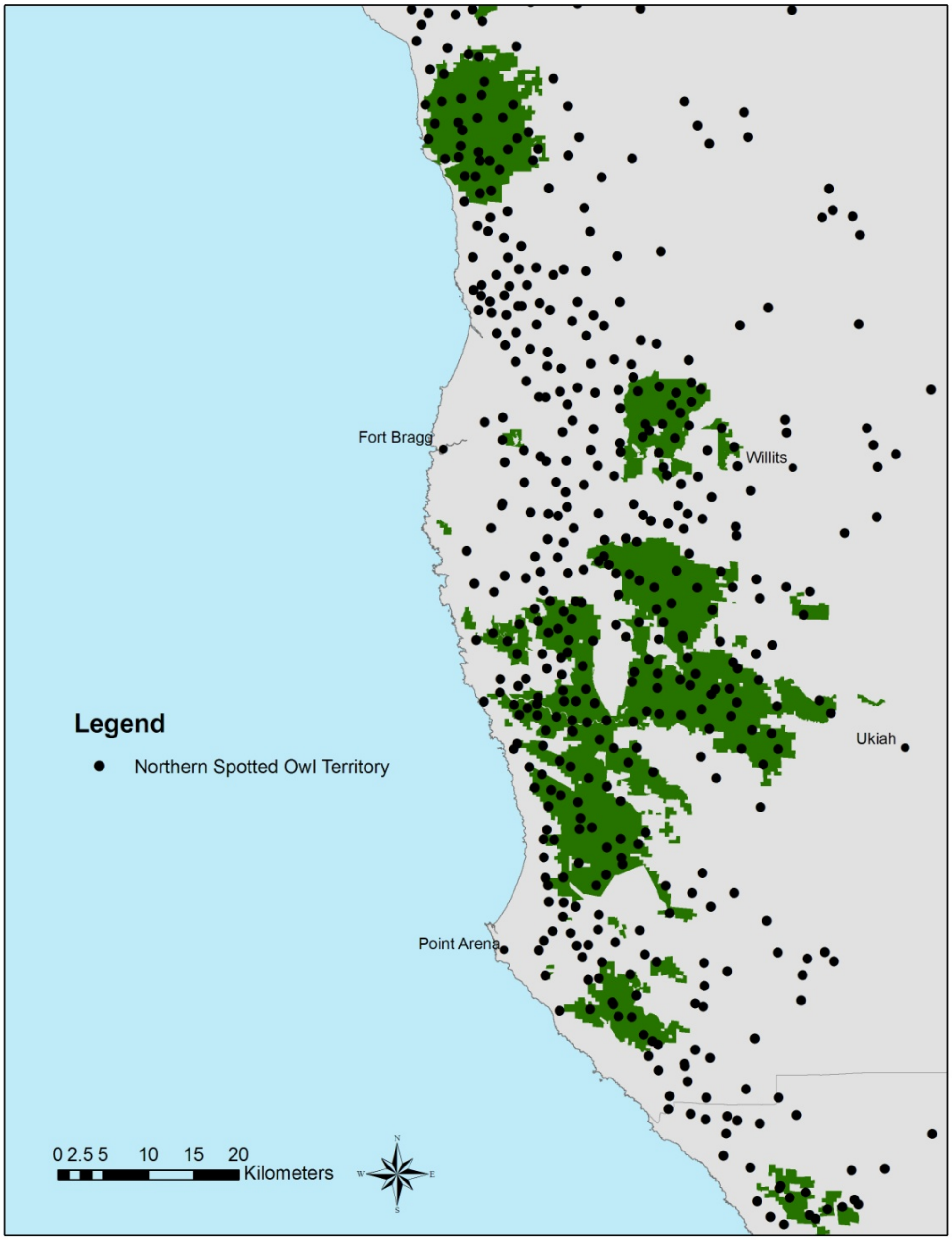

Figure 2. Distribution of northern spotted owl territories in coastal Mendocino and northern Sonoma counties.

SPOTTED OWL SURVEY PROTOCOL

Mendocino Redwood Company follows a modified version of the 1992 USFWS-endorsed protocol and relies on a combination of night surveys around project areas and day surveys (monitoring visits) at known owl territories. Most night surveys follow a two-year, three-visit protocol; however, in some instances a one-year, six-visit protocol may be used. If either the one- or two-year protocol is completed, then a minimum of three night surveys are required within 0.7 miles of a project during March (or the breeding season), and all historic owl territories within 0.5 miles of a project must be located prior to the commencement of operations during the early part of the breeding season (February 1–May 15).

The most current USFWS-endorsed protocol (2012) mandates a two-year, six-visit night survey protocol because of declining spotted owl detection probabilities throughout the PNW attributed to the increasing presence of barred owls. This protocol presumes barred owl presence and was specifically designed for landscapes lacking an extensive spotted owl survey history. MRC utilizes a different approach to surveying owls on its ownership that is equal to or more effective than the USFWS protocol. MRC's survey protocol requires additional surveys in the form of monitoring visits to historically occupied sites across its entire landscape every year. In addition, MRC also conducts night surveys outside of THPs to locate missing owls or new territories, and invests a substantial effort into banding owls. This means that territories are visited over successive years even when harvesting activities have ceased within their assessment areas. Annual monitoring visits are beneficial for owl conservation because they inform land managers about changes in owl occupancy status, location, and reproductive success. Although monitoring is not required under the California Forest Practice Rules, this information is essential to assessing population trends over time. Moreover, since MRC is committed to surveying for owls beyond THPs and there is an extensive survey history on the property, many owl sites receive habitat and disturbance protections that would otherwise not receive them if the current USFWS survey protocol was being followed.

SPOTTED OWL SURVEY EFFORT

Consideration of survey effort is an important factor when monitoring populations over successive years because it may influence detectability of the target species, and hence, overall variation in observed occupancy patterns. Failing to account for survey effort may result in survey bias (e.g., over- or under-represent true occupancy), which can erroneously lead one to conclude that a population is stable when it is not, or vice-versa.

Spotted owl survey effort consists of two elements: 1) the number of visits to a survey station at night or to a spotted owl territory during the day; and 2) the spatial area of survey coverage as represented by the number of unique locations where surveys occurred. Outside of preventing "take," surveys are used to locate spotted owls at historic sites, determine if any have changed location, and if there are any new territories. Surveys associated with projects also overlap with owl territories that are regularly monitored. Night surveys offer a fallback method to locate birds that were not found in historically occupied areas during daytime site visits, which not only aids in tracking territory movements over time but may also help identify alternate nest/roost areas on the landscape.

Over the past 15 years, night-survey effort varied with the number of THPs, road restoration projects, and other disturbance activities planned at least 3 years in advance (Figure 3). Notable low points in night-survey effort occurred both in 2003 and 2009. In 2003, there was a relatively small number of THPs being considered for harvest; and in 2009, the sudden downsizing of MRC reduced the overall ability of wildlife staff to maintain night and day surveys at previous levels. With the exception of 2009, the number of monitoring visits has been fairly consistent, even in years when night surveys were reduced (Figures 3 and 4).

Monitoring is primarily associated with daytime site visits to known territories. Over time, however, it was found that balancing day visits with night surveys can improve owl detection, particularly for owls that have moved. Night surveys provide greater area-wide acoustic survey coverage at a time when owls are generally more responsive, while day surveys provide fine-scale information on site use (e.g. roost/nest sites, whitewash, pellets, etc.) and owl identity (via band resights). A combination of night and day surveys may be employed to locate historic owls that are unresponsive after one or two daytime site visits. If, over several years, a territory displays poor occupancy history unrelated to barred owls, a regimen of night surveys may be prescribed until there is an owl detection which can be followed-up during the daytime.

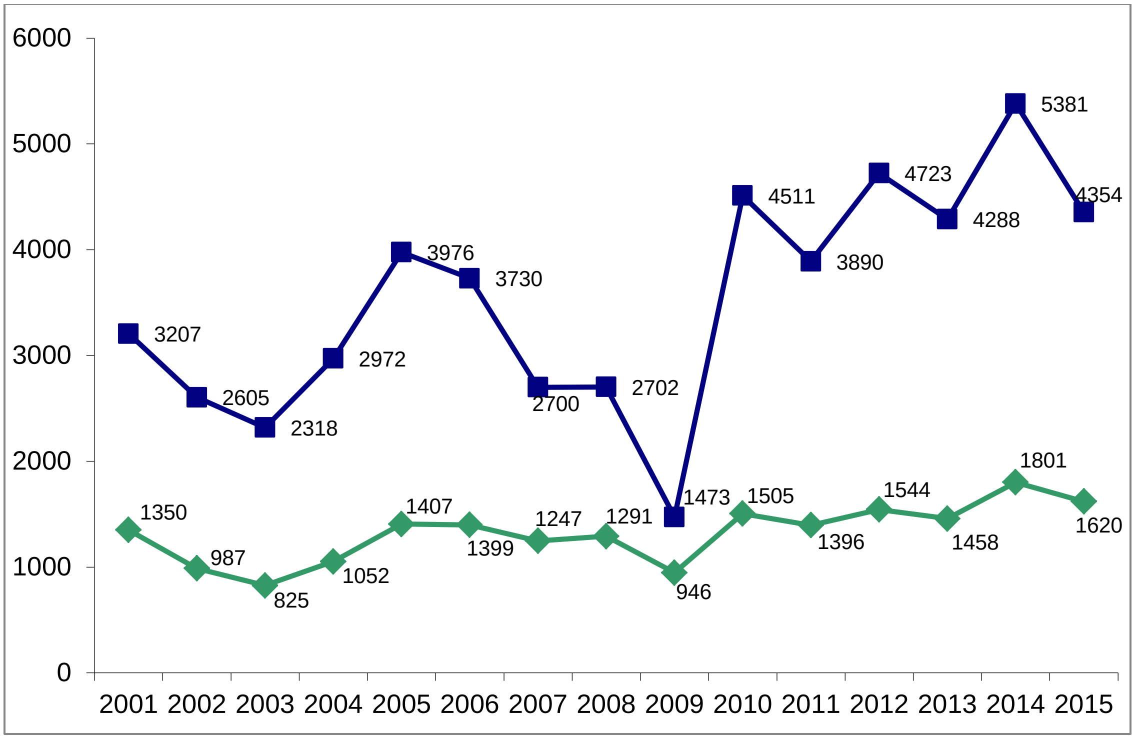

Figure 3. Survey effort by year showing the total number of 10-minute station surveys (blue squares) and the total number of unique stations surveyed (green diamonds).

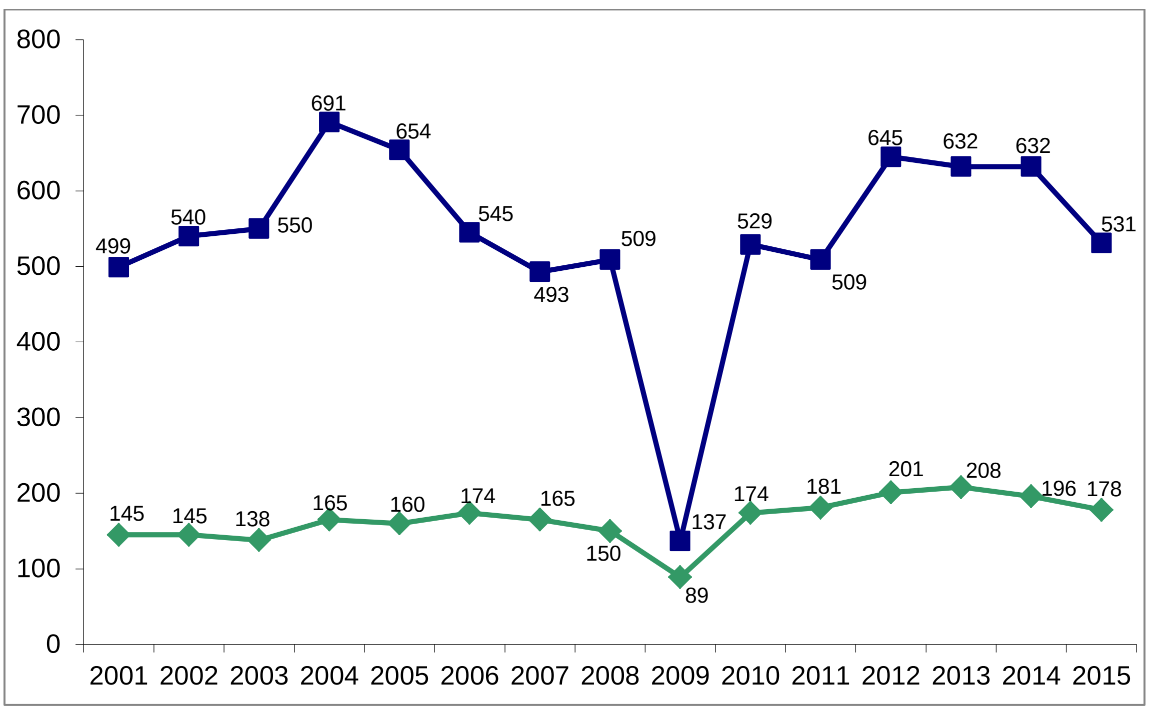

Figure 4. Monitoring effort by year showing the total number of daytime visits to known spotted owl territories (blue squares) and the total number of unique territories visited (green diamonds).

Survey stations and occupied owl sites were buffered by 0.5 miles to calculate the spatial amount of survey coverage for each year as a percentage of MRC property. This distance was chosen because it represented one-half the average nearest-neighbor distance for owl territories on MRC property. It has been applied in a consistent manner for scaling survey effort to a portion of MRC's landscape that was actually surveyed, as opposed to using the entire ownership, which would include un-surveyed acreage. Spatial coverage averaged 77% for the past 15 years and ranged from 60 to 92% (Figure 5). The greatest consistency in survey effort, as seen in both the number of surveys and spatial coverage, occurred during the past six years (Figures 3-5).

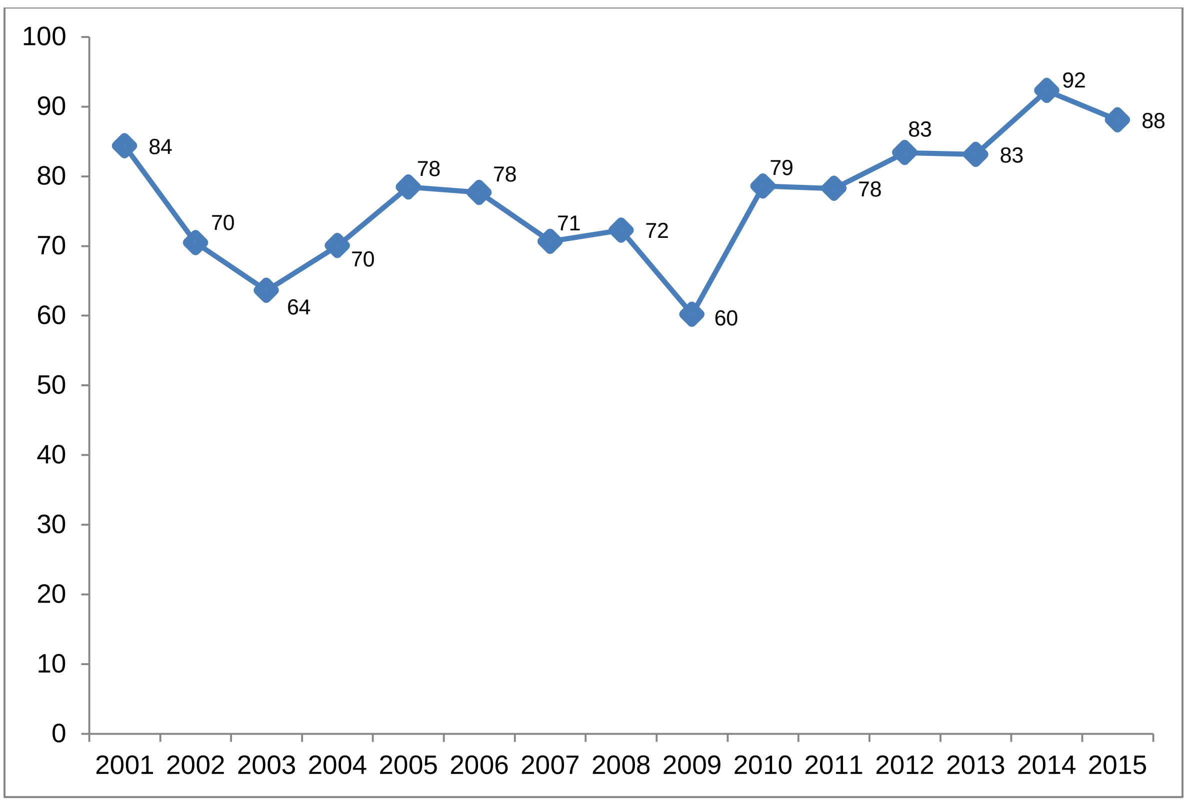

Figure 5. Annual spatial survey coverage percentages for MRC lands, 2001–2015. Percentages are based on 0.5-mile buffers around survey stations and occupied owl sites surveyed during the year and clipped to MRC land.

OCCUPANCY TRENDS

Spotted owl population numbers are typically dynamic, and thus, may fluctuate annually. Determining a population trend requires a long-term view (at least 10 years) and a consistent survey effort across the landscape. Inferring trends from a limited number of years is difficult because multiple causal factors often interact differently over short time scales and may result in drastically different population responses annually. Outside of detailed field experiments and measurement of environmental factors, discussion of trends and causal mechanisms underlying the ensuing spotted owl empirical counts are best framed as hypotheses.

Annual empirical counts of spotted owls show a dynamically stable population trend over the past 16 years, with several dips and spikes in annual numbers of total occupied sites, pairs, and singles (Figure 6). Although the total number of birds was influenced by annual fluctuations in the number of pairs and single birds found during a season, territory occupancy remained relatively constant from 2010 to 2014, then experienced a strong decline in 2015 (Figure 6). From 2000 to 2013, pairs remained dynamically stable, while the number of single birds exhibited an increasing trend. Prior to 2009, the ratio of pairs to singles appeared to be partly associated with population-level reproductive patterns such that a higher number pairs relative to single birds were seen in years with above-average reproduction. During the past six years, however, this pattern has defied expectation as reproduction has been consistently low yet the ratio of pairs to singles were comparable to years with above-average reproduction. Over the past two years the number of pairs has declined; and in 2015, single birds also declined resulting in one of the lowest occupancy levels since 2003. This pattern is a concern because survey effort has been at an all-time high during this period.

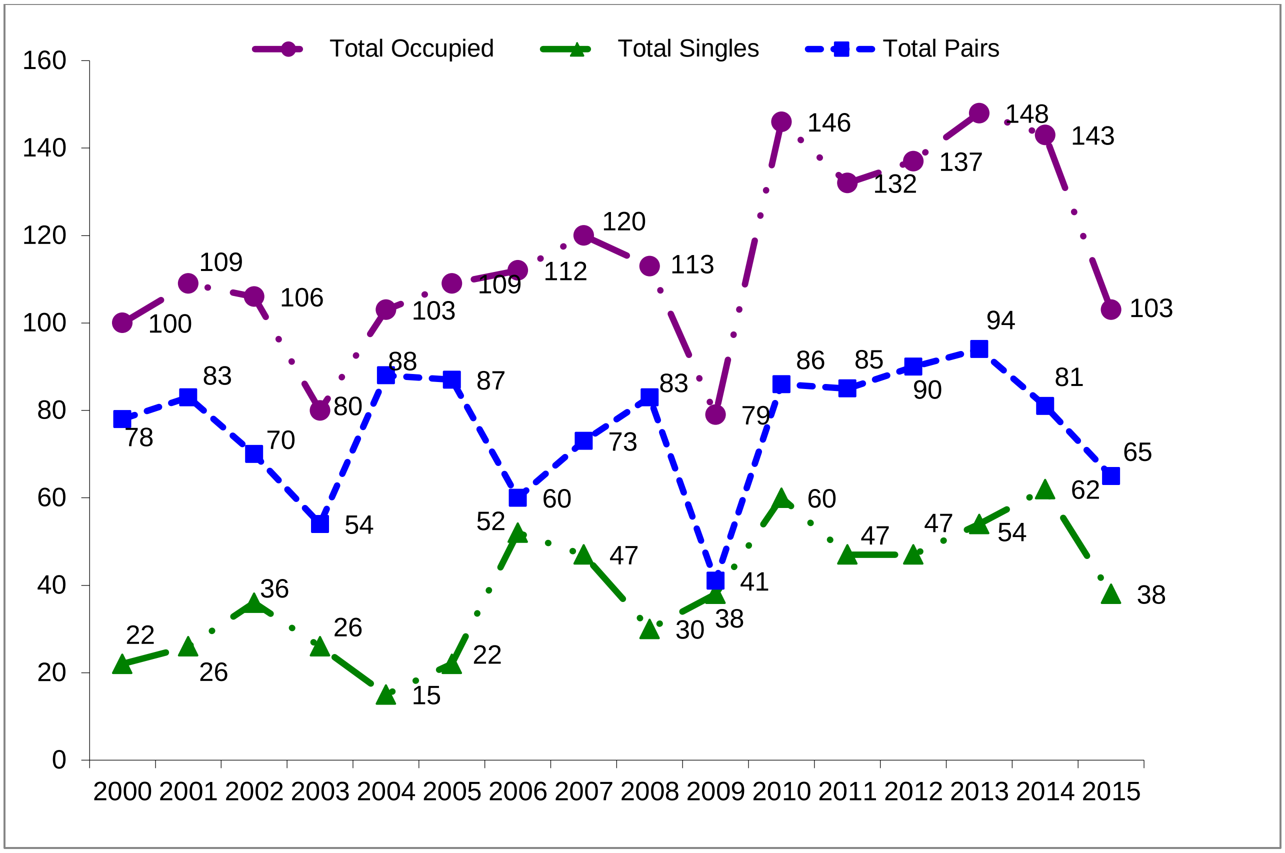

Figure 6. Number of northern spotted owl singles, pairs, and occupied sites by year for Mendocino Redwood Company timberlands, 2000–2015.

Disentangling the potential influence of survey effort on the above results requires scaling the data by considering the total number of sites surveyed or the spatial area covered by surveys. A naïve estimate of occupancy was calculated as a proportion of the total number of spotted owl sites occupied by either a single bird or pair (Figure 7). The proportion of sites occupied varied annually, exhibited similar dips as the empirical counts, and averaged 0.68 (or 68%) over the past 15 years (Figure 7). The proportion of occupied sites was the lowest in 2015 because the total number of spotted owl territories surveyed was high while owl territory occupancy was low. One possible reason for this phenomenon may be related to the barred owl, whose increasing presence on the landscape has displaced many spotted owls from historically occupied areas to new locations. In many instances, the “displacement” effect has resulted in the creation of new territories and the simultaneous retention of old spotted owl territories (now occupied by barred owls), thereby artificially inflating the number of territories on the landscape and driving down this proportion. Regardless, spotted owl numbers were lower than previous years, and the underlying causes of this apparent reduction in occupancy can only be judged in light of additional population information collected in the future.

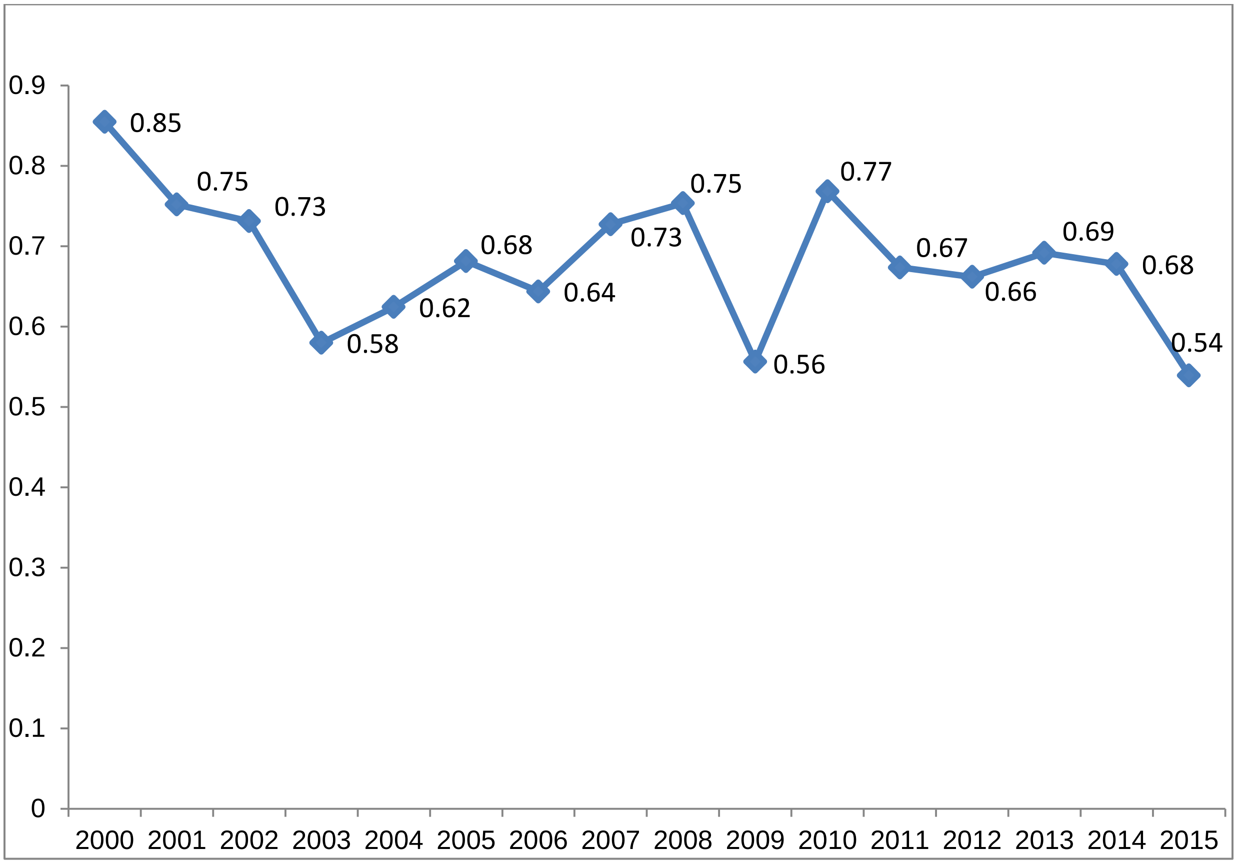

Figure 7. Proportion of occupied northern spotted owl territories on MRC lands, 2000–2015.

Calculating crude density of spotted owls based on the amount of area surveyed is another method that scales the variation in spatial sampling among years. As mentioned previously, the spatial area surveyed varied annually but averaged around 76% for the past 15 years. Similar to the empirical count data, crude densities of owls declined over the past two seasons (Figure 8).

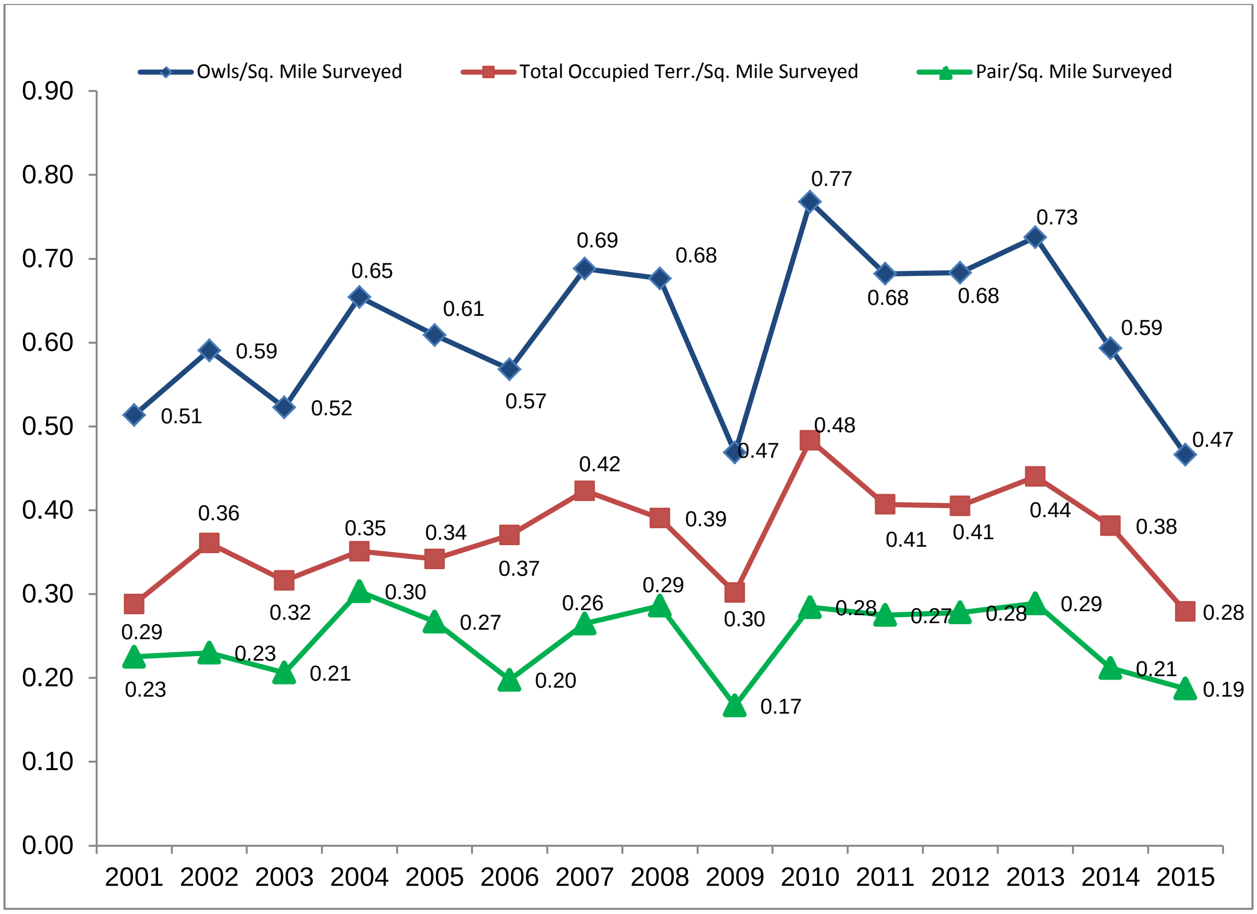

Figure 8. Crude densities of northern spotted owl pairs (green triangles), occupied sites (red squares), and adult birds (blue diamonds).

REPRODUCTIVE TRENDS

Reproductive success is an important metric because owls that successfully reproduce have a higher chance of contributing offspring—and genes—to future generations of spotted owls. Successful reproduction is also necessary for generating a surplus pool of non-territorial birds (i.e. “floaters”) available for recruitment when there is territory vacancy. Spotted owl reproduction is sporadic and closely linked to local weather and regional climate patterns, but may also be influenced by habitat, spotted owl breeding experience, prey availability, the presence of barred owls, disease, chemical exposure, and other environmental factors.

Data for MRC lands further corroborates the view that spotted owl reproduction is cyclic, which has been consistent with other study areas throughout northwestern California over the past 16 years (Figure 9).

Similar to previous studies, we found that precipitation in the early nesting period (March-April) was the most informative model explaining the negative relationship with reproductive output (Figure 9; Franklin et al. 2000; Glenn et al. 2009). And while the significance of this statistical relationship has declined in recent years, there are also additional variables not considered here that may explain the current unprecedented decline in spotted owl reproductive success over the past six seasons.

Potential stressors impacting the spotted owl population include the presence of barred owls, the use of toxic pesticides in trespass marijuana gardens, and long-term drought over the past decade. The extended drought (2007–2009, 2012–2015) may have a negative effect on small mammal populations, which could in turn affect not only spotted owls but other top predators that rely on this prey base. In 2015, night detections were drastically lower for all owl species, including the barred owl. The cyclic nature of spotted owl reproductive patterns and their link with climate makes it very difficult to attribute timber harvest activities with declining reproductive rates without a carefully designed study. Regardless, a similar pattern of declining reproduction in spotted owls has been observed on multiple ownerships in Mendocino and Sonoma counties over the past six years. This pattern appears to be independent of site-specific management activities.

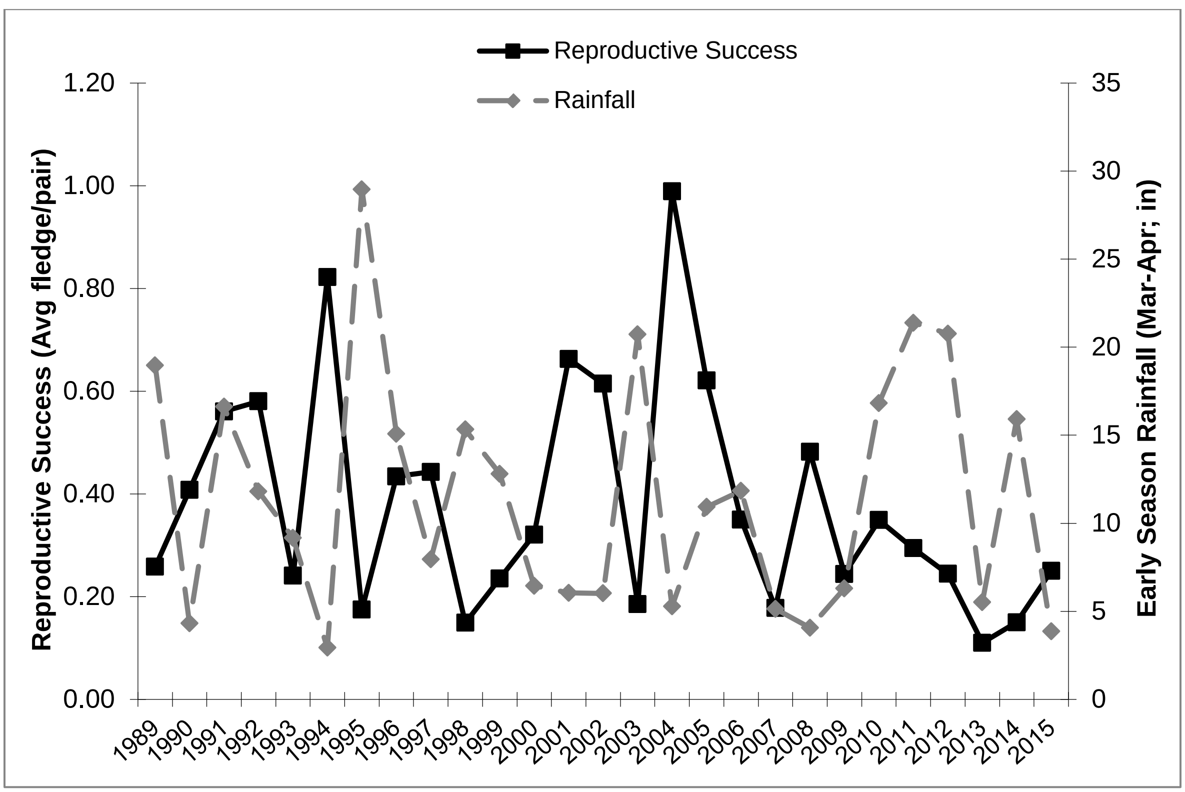

Figure 9. Annual reproductive success (mean number of fledglings/pair) of spotted owls and early season rainfall (inches) by year for Mendocino Redwood Company timberlands, 1989–2015.

SPOTTED OWL BANDING

Demographic analysis of mark-recapture data, derived from owl banding, is useful for estimating rates of population change, survival, fecundity, turnover, and dispersal. Generating these data usually take a substantial investment of time and effort. For spotted owls, the minimum amount time necessary to generate a demographic dataset is 10 years, but the data must be of a certain quality to estimate specific parameters.

Spotted owl banding started in 1990 and has continued for the past 26 years with the exception of 1999 (Figure 10). Banded birds consisted of 525 adults, 79 subadults, 265 juveniles, and 4 unknowns. Sex ratios of adult and subadult owls were nearly 1:1, with 295 males and 299 females. Band resights totaled 844 for the 26 year dataset (Table 1). Since MRC was established, a total of 463 birds have been banded and 448 band resights have been made.

Estimating dispersal patterns commonly requires large datasets since the probability of recapturing owls banded as juveniles is usually very low. Although banded territory holders are regularly resighted, the incidence of breeding dispersal is also infrequent. To date, we have documented natal and breeding dispersal of 22 and 24 owls, respectively (Table 2). Average natal dispersal distances of male and female owls were 8.4 km and 19.4 km, respectively. The pattern for breeding dispersal was reversed compared to natal dispersal, and the average distances were substantially smaller for both sexes. Average breeding dispersal distances for male and female owls were 3.4 km and 1.8 km, respectively (Table 2). The most extensive northern spotted owl dispersal analysis conducted to date showed a similar pattern of natal dispersal differences by sex, however, the average distances were 5-6 km more for each sex (Forsman et al. 2002). Interestingly, Forsman et al. (2002) found no differences in average breeding dispersal distances by sex (6.1 km).

While it is very possible that small sample size explains the differences in dispersal distances between our study area and the more comprehensive Forsman et al. (2002) study, MRC lands are comprised of multiple disjunct tracts of land along an 80 km longitudinal gradient, and thus, may capture representative variation in natal dispersal distances within this region. Eight recaptures—seven foreign and one from MRC—were excluded from this analysis (see footnote in Table 2). Two of the foreign recaptures were highly influential on the mean natal dispersal distances for male owls because they were in excess of 100 km, which was considered an extreme distance in other studies (Forsman et al. 2002; Table 2). If all of the recaptures were considered together, average natal dispersal distance would be 19.9 km with no differences by sex.

Breeding dispersal can occur for a variety of reasons, such as death of a mate, displacement by a more aggressive territory holder, and reproductive condition. In 2015, there were several breeding dispersal events worthy of noting, all involving nesting territories. There were two instances where one member of an adjacent territory moved into another territory to breed. The female formerly at “NEW058” switched places with the female at MD552 to breed with the male (dispersal distance 1.4 km). The displaced female was relocated in the “NEW058” territory and confirmed by recapture. Additionally, the male associated MD396 moved to the adjacent territory, MD220, to breed and successfully fledge young with the female (dispersal distance 0.8 km). The whereabouts of the former male owl at MD220 was unknown, but the female from MD396 was still present in her territory. She successfully produced young with the now dispersed male in 2012 at the MD396 location. Lastly, a male owl confirmed at MD144 in 2012 traveled 6.4 km to breed with the female at MD428. The underlying social dynamics of this dispersal event, and the status of the previous mates at both MD428 and MD144, were unknown.

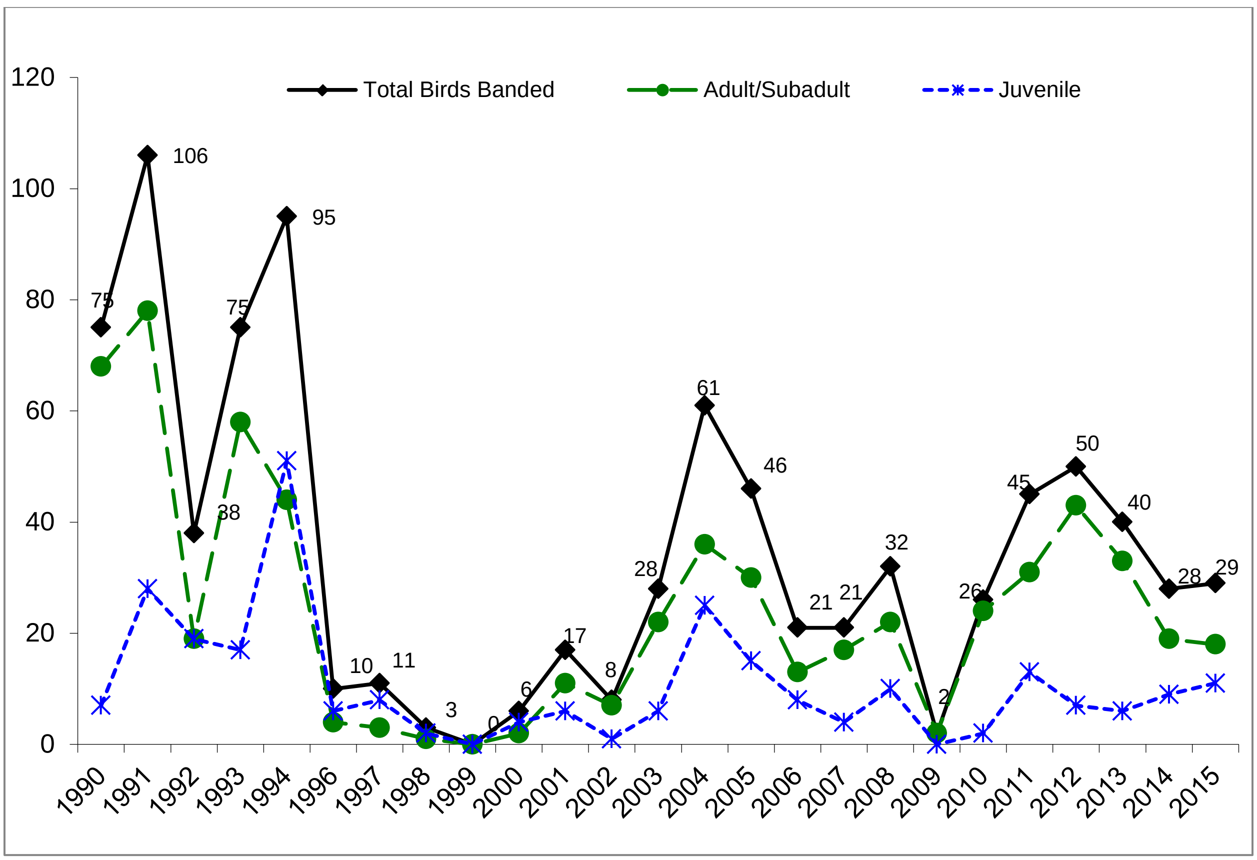

Figure 10: The total number of owls banded annually by life stage, 1990–2015.

Table 1: NSO banding and resight totals for MRC Property, 1990–2015

	Adults	**Subadults**	**Juveniles**	**Unknown**	**Total**
Male	241	51	-	3	295
Female	276	22	-	1	299
Unknown	8	6	265	-	279
Band Totals	**525**	**79**	**265**	**4**	**873**
Resight Totals					**844**

Table 2: Natal and breeding dispersal distances by male and female northern spotted owls on MRC land[1]

	Male	Female
<u>Natal</u>		
Mean (km)	8.4	19.4
SE	2.5	3.0
Median (km)	6.1	15.2
Range	4.0-25.2	7.8-50.3
N	8	14
<u>Breeding</u>		
Mean (km)	3.4	1.8
SE	0.5	0.4
Median (km)	2.8	1.4
Range	0.8-6.7	0.4-4.4
N	14	10

[1]Natal dispersal statistics excluded seven foreign recaptures (other study areas): males distances of 120.8 km, 107.9 km, and 18.2 km, and female distances of 10.0 km, 18.5 km, 22.3 km, and 28.9 km. One recapture of 16.5 km was excluded on MRC land because sex was not confirmed.

UNREGULATED THREATS

BARRED OWLS

Over the past 25 years, the barred owl population has increased substantially and is now displacing the spotted owl throughout the PNW (Kelly et al. 2003; Pearson and Livezey 2007). Barred owl presence may negatively affect spotted owl social behavior, detectability, occupancy, reproduction, and even survival (Kelly et al. 2003; Olson et al. 2005; Crozier et al. 2006; Forsman et al. 2011; Wiens et al. 2011;

Dugger et al. 2016). As previously mentioned, mounting evidence indicates that the barred owl is partly responsible for declining spotted owl populations in Washington, Oregon, and California (Anthony et al. 2006; Forsman et al. 2011; Dugger et al. 2016). In British Columbia, the northern spotted owl was briefly extirpated from the northern-most part of its range by the barred owl but is now being reintroduced to the wild through a captive breeding program (USFWS 2011).

Barred owl presence was initially confirmed in Mendocino County in 1989 when area-wide surveys for spotted owls began. However, barred owls may have been present as early as 1978 (Dark et al. 1998;California Natural Diversity Database 2013). They have significantly increased during the past ten years on commercial forestlands in northwestern California, especially in coastal areas (Douglas 2015). In Mendocino County, barred owls were initially detected on California State Park lands and other reserve areas, then later on commercial timberlands (California Natural Diversity Database 2015). From 2005 to 2013, the total number of barred owl detections increased exponentially during spotted owl surveys on MRC forestlands (Figure 11). However, during the past two years, barred owl detections have decreased, with 2015 having the lowest number of detections since 2010 (Figure 11). The total number of spotted owl territories with barred owl detections within one mile has increased to 86 over the past 11 years, which represents 54% of the spotted owl territories present on MRC land. Only a subset of these spotted owl sites had consistent barred owl detections over multiple years. In many areas, barred owls were transitory and never detected again; while in others areas they established territories, formed pairs, and repeatedly bred and fledged young. Spotted owls were not only increasingly difficult to locate in areas where barred owls were repeatedly detected over successive years, but were also prone to traveling long distances within the season, possibly to avoid interactions with this larger more aggressive species. In 2014 and 2015, barred owls also successfully fledged young at four and two sites, respectively. Overall, the numbers associated with barred owl detections and reproduction are likely underestimates given that spotted owl calls were primarily used during surveys (with the exception of a few barred owl impacted areas where 20-minute, "*Strix*-mix" calls were used).

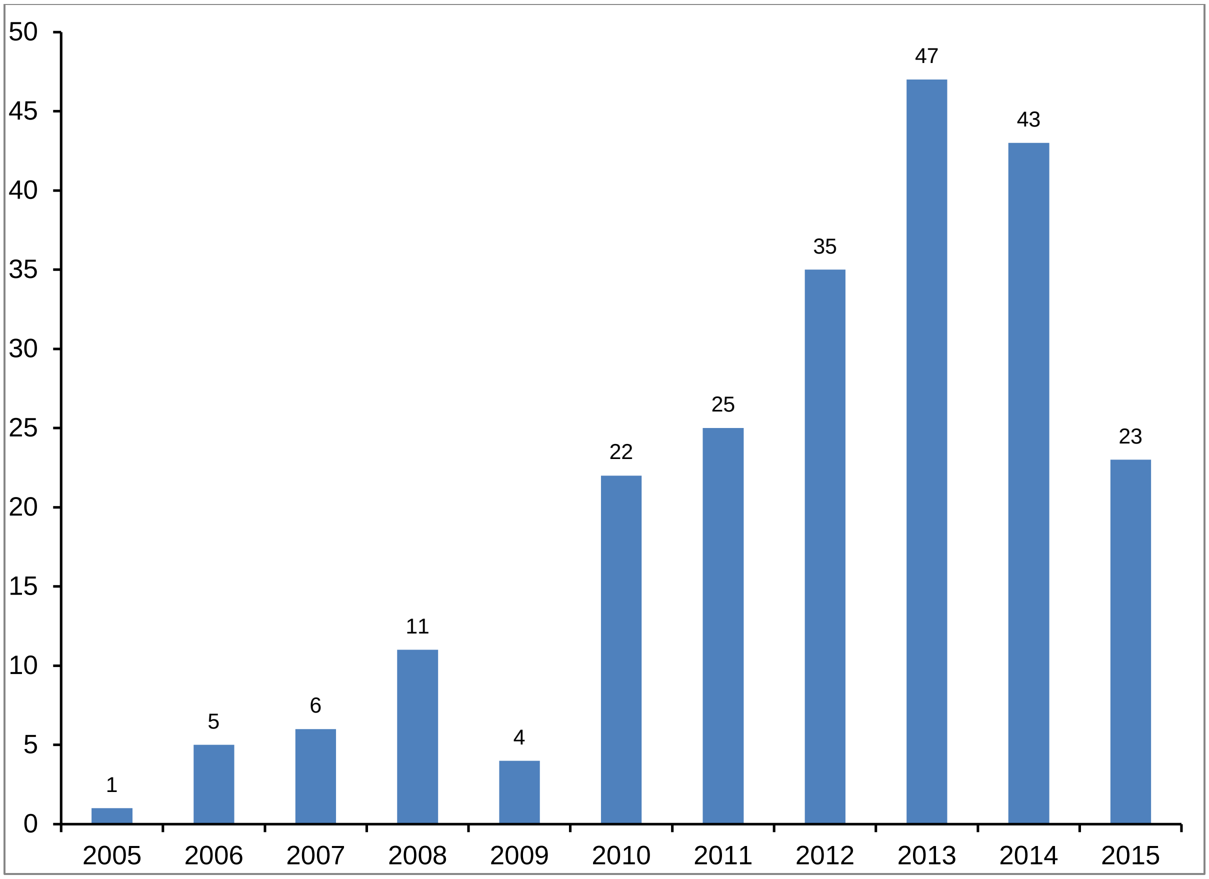

Figure 11.The number of northern spotted owl territories with barred detections within one mile by year. Since 2005, 86 spotted owl territories have some history of barred owl detections at this distance.

TRESPASS MARIJUANA GARDENS

Over the past several years, the number of trespass marijuana gardens encountered on MRC lands has decreased. At the same time, the amount of landscape reconnaissance via aerial overflights has also decreased. When aerial reconnaissance is employed, even for only a few days during key times of the year, garden detection significantly improves. Incidental encounters of marijuana gardens by field staff comprise the majority of our current dataset on garden activity and thus do not represent the actual number of gardens that were likely present on MRC property. In 2015, approximately 14 gardens were located, seven of which were located during a single flyover by the County of Mendocino Marijuana Eradication Team.

Pesticide (e.g., rodenticides, insecticides, molluscicides, etc.) use in trespass marijuana gardens continues to be a significant concern because of their ability to directly kill wildlife and proliferate throughout the food chain (Gabriel et al. 2012, 2013, 2015; Thompson et al. 2013). The frequency and spatial extent of toxicants used in marijuana gardens are largely unknown because there is no forensic monitoring of these compounds on MRC forestlands. Current knowledge of illegal pesticide use has been gained by a series of anecdotes from foresters and biologists working on forestlands over the years. In many instances, these individuals have directly observed the presence of specific toxicants in marijuana gardens, and sometimes, in association with dead wildlife. In 2011, a necropsy conducted on a dead spotted owl found by an adjacent landowner revealed the owl had detectable amounts of anti-coagulant rodenticide in its system. Although anti-coagulant rodenticides, molluscicides, and other pesticides (e.g. carbofuran) have been observed in gardens on MRC lands, no such toxicants were observed in the limited number of gardens inspected in 2015.

Toxic exposure of wildlife to pesticides found in trespass marijuana gardens have been increasing over the past decade and have been attributed to direct and indirect mortalities of Pacific fisher (*Pekania penannti*; Gabriel et al. 2015). These events have generated concern about exposure of other species, such as the northern spotted owl, which is a focal point for conservation efforts by numerous forestland owners. To investigate the potential exposure of spotted owls to anti-coagulant rodenticide, both the Hoopa Tribe and Green Diamond Resource Company submitted liver samples from barred owls—lethally taken as part of an experimental removal program—for chemical analysis. Seventy-eight of 155 barred owls (50%) had measurable amounts of anti-coagulant rodenticide in their livers suggesting that spotted owl exposure to these compounds could be similar (Higley 2015). These results highlight the insidious nature of pesticide exposure to wildlife and the difficulty in assessing pesticide presence and distribution on large landscapes. Additional monitoring tools need to be developed for evaluating pesticide presence in the environment and its impact on wildlife, especially those species that are federally and state listed.

CONCLUSIONS

Mendocino Redwood Company forestlands have a 27-year history of spotted owl surveys, including detailed population monitoring, research, and conservation. Surveys were conducted to locate and protect spotted owl activity centers from timber operations and other disturbance activities, and to monitor owl occupancy and reproduction over time to assess population health. Results from MRC's long-term monitoring program show that spotted owl occupancy has been dynamically stable during most of the past 15 years; however, in recent years several observations have generated concern about the future trajectory of the spotted owl population in the region: 1) spotted owl reproduction has been low for the past six consecutive years; 2) barred owl detections and spatial distribution have increased substantially during this time; and 3) spotted owl pairs have declined over the past two seasons. Temporal trends in declining spotted owl populations are coincident with the barred owl invasion that has been moving southward along the Pacific Coast for the past three decades. Despite this apparent correlation, confirming a population decline will require additional years of monitoring data to determine if the pattern observed on MRC lands represents the beginning phase of a trend or is simply natural variation. And while the barred owl remains a significant threat to the spotted owl, other local and regional environmental factors must also be evaluated for their influence on spotted owl population dynamics. These include weather and climate patterns, health and status of primary prey populations, presence of toxicants in the environment, disease, and changes in habitat (not only nesting/roosting but also primary prey habitat). Mendocino Redwood Company will continue to work with industry and agency biologists, foresters, private consulting biologists, state parks, and other landowners to monitor spotted owl population trends and to develop effective conservation measures for this species on forestlands throughout northwestern California.

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