Point Blue

Northern Spotted Owl Monitoring on Marin County Parks and Marin Municipal Water District Lands, 2023 Report

Report to Marin County Parks & Marin Municipal Water District

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Report prepared for Marin County Parks and the Marin Municipal Water District

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Cover Photo: Northern Spotted Owl (*Strix occidentalis caurina*) in Marin County by Maggie Brown.

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INTRODUCTION

The Northern Spotted Owl (NSO; *Strix occidentalis caurina*), ranging from southern British Columbia to Marin County, California, is one of three subspecies of the Spotted Owl. It is a year-round resident found primarily in older, coniferous forests. The NSO was listed by the U.S. Fish and Wildlife Service (USFWS) as a Federally Threatened subspecies in 1990, with declines mostly attributed to habitat loss. Due to continued declines (Forsman et al. 2011, Dugger et al. 2016), the NSO was also approved for listing as Threatened under California's State Endangered Species Act in 2016. The USFWS now identifies habitat loss – including lag effects of past loss and continued timber harvest – and competition from the Barred Owl (*S. varia*) as the two primary threats to the continued survival of the NSO (USFWS 2023). The historic range of the Barred Owl was once limited to the forests of eastern North America, but after a range expansion westward that now includes the entire range of the NSO, their presence has caused displacement of NSO, competition with NSO for space and food, and negative impacts on NSO demographics (Gutiérrez et al. 2007, USFWS 2011, Wiens et al. 2014, Franklin et al. 2021).

NSO in Marin County are not impacted by commercial tree harvesting operations as in many other parts of their range, but other potential threats to their habitat include urban development and high-severity wildfire (Hysen et al. 2023). While the invasion of Barred Owls in Marin County has not yet reached the high densities documented in other parts of the NSO range (Jennings et al. 2011, Brown and Cormier 2022), an increase in Barred Owl numbers would pose a serious threat to the NSO population in Marin (e.g., Franklin et al. 2021, Wiens et al. 2021). Other stressors to NSO in Marin County include noise and/or other disturbance by humans (e.g., construction, landscaping noise, traffic), rodenticide poisoning, climate change (which could have direct impacts to NSO and/or to their habitats and prey), and genetic isolation (Barrowclough et al. 2005, Stralberg et al. 2009, Klein and Merkle 2016, Ganey et al. 2017). Sudden Oak Death (*Phytophthora ramorum*) may also impact NSO by changing forest structure and food availability; the dusky-footed woodrat (*Neotoma fuscipes*), a primary prey of the NSO in Marin County, depends on oaks for food and shelter, and their abundance has been found to be negatively correlated with Sudden Oak Death (Swei et al. 2011).

Since 1997, biologists from Point Blue Conservation Science (hereafter Point Blue) have been monitoring NSO in Marin County. Marin County Parks (MCP) and Marin Municipal Water District (Marin Water) have contracted Point Blue to survey NSO annually since 1999. Surveys are primarily on Marin Water and MCP lands, but can also include sites on nearby private, municipal, state, and national park lands, because protections for NSO may extend beyond land ownership boundaries. The purpose of these surveys is (1) to monitor the population for trends in occupancy and reproductive success over time and (2) to determine occupancy and nesting

status at sites where proposed management activities may occur, so that disturbance to NSO is avoided.

In 2023, Point Blue biologists continued to monitor occupancy, nesting, and reproductive status for known NSO sites (i.e., sites that have been surveyed in the past and that have had resident pairs of NSO) on MCP, Marin Water, and nearby lands. We also conducted inventory surveys in 2023 at new locations for MCP and at one previously surveyed location for Marin Water. Here, we report on the results on the occupancy, nesting status, and reproductive status for all sites surveyed on Marin Water, MCP, and nearby lands in 2023.

METHODS

Study sites

In 2023, we surveyed a total of 51 survey areas: 47 known sites, one new incidental site, and three inventory areas, on or adjacent to MCP or Marin Water lands in Marin County. In this report, a "known site" includes sites that have been occupied by a pair of NSO in at least one previous year. We confirmed the presence of one additional pair on MCP lands after an incidental detection by MCP staff, and once found, we continued surveys of this site. We also surveyed three inventory areas in 2023. Inventory surveys are conducted in areas with proposed management activities that are in or near potential NSO habitat, or where the land manager had an interest in knowing the status of NSO in an area that had not been previously classified as being occupied by a NSO pair. The inventory area surveyed for Marin Water in 2023 has been surveyed since 2018, and the two new inventory areas surveyed for MCP contained potential NSO habitat, one of which was recently acquired land.

Because NSO are sensitive to disturbance, we do not present specific site names or location information in this report. Instead, results from each NSO site are provided to Marin Water and MCP (as well as to USFWS and California Department of Fish and Wildlife [CDFW]) in supplemental tables to this report, and in annual Geographic Information System (GIS) files.

Data Collection

At all known sites and inventory areas, we assessed occupancy (if owls were present and resident/territorial), nesting status (nesting versus non-nesting since not all pairs nest every year), and reproductive status (number of young produced); see Status Designations below for more details. For every survey, we completed a site search form (including weather, survey times, owl detection information, and a detailed narrative) and a map (showing the search area and location(s) of any owl(s) detected, including non-NSO owl species). For each site and inventory area, we completed a status form detailing occupancy, nesting, and reproductive

outcome for the year, age of owls detected, and supporting information. For every site or inventory area with a detection of a NSO, we determined the activity center for the year. An activity center is the best-known location to represent each NSO site in a given year (e.g., nest tree, roost location; CDFW 2019). For every known nest tree, we collected vegetation measurements of the tree and the surrounding area. Annual status data, including spatial information, are submitted to MCP and Marin Water. Data are also submitted to the CDFW's California Natural Diversity Database by National Park Service (NPS) staff after Point Blue and NPS data have been merged into one county-wide database. NPS conducts independent surveys from Point Blue, including at Point Reyes National Seashore, Golden Gate National Recreation Area, Muir Woods National Monument, Mount Tamalpais State Park, and Samuel P. Taylor State Park (Ellis 2020). The National Park Service (NPS) contracted Point Blue to monitor seven known NSO sites on national park lands in 2023 and the results of those surveys have been shared directly with NPS and will be reported with the rest of their 2023 data; therefore, we did not include NPS sites for the purposes of this report.

Status Designations

Occupancy refers to whether an owl is detected or not at a given site or inventory area. Occupancy surveys in 2023 followed the USFWS protocol (USFWS 2012) to determine whether owl(s) were present. For sites where owl(s) were detected at least once in 2023 (occupied), we determined residency status – whether owls were territorial – based on Marin and USFWS protocols (Press et al. 2010, USFWS 2012). For sites or inventory areas where NSO were not detected early in the season, we added 5-minutes of Barred Owl playback to our 10-minute NSO nighttime calling stations on the fifth and sixth visits to determine if Barred Owls may be present (USFWS 2012). There are slight differences between the two protocols, and results from the Marin Protocol are presented in this report including in figures; however, occupancy status differences between the two protocols are noted below and in the text of the results section. Occupancy categories are summarized as follows (for more details see Press et al. 2010, and USFWS 2012):

- Territorial Pair (hereafter, Pair) = male and female heard in close proximity and/or nesting is confirmed (male and female detections must be on the same visit for the USFWS protocol, and for the Marin protocol detections must occur on at least one daytime or two nighttime occasions, but not necessarily on the same visit);
- Resident Single = response by a single owl on three or more occasions in the same year or over subsequent years, with no response by an owl of the opposite sex (same definition for both protocols);

- Two Birds/Pair Status Unknown ("Pair Unknown") = male and female detected but pair status not confirmed (i.e., does not meet the above criteria for Pair) and at least one owl meets Resident Single requirements (same definition for both protocols);
- Single Unknown = a single owl is detected but does not meet the above criteria for Resident Single (this category is specific to the Marin protocol and not part of USFWS protocol; in the USFWS protocol, these sites would be classified as Unknown);
- Unknown = male and/or female detected but did not meet the criteria above for other occupancy designations; in the USFWS protocol, this category includes the Single Unknown classifications from the Marin protocol (above).
- Unoccupied = a site is considered unoccupied after 2 years of surveys consisting of 6 nighttime visits each year with no NSO response (USFWS 2012). However, for sites surveyed for disturbance-only management projects (e.g., no planned habitat modification), 6 visits with no response in one year is sufficient, and the management action can take place until the start of the next breeding season, but the site is still officially classified as "Unknown" until after a second year with no detections (USFWS 2012). A minimum of three nighttime visits per year over two consecutive years with no NSO detections is required to designate a site unoccupied in the Marin protocol (Press et al. 2011). For Point Blue occupancy surveys, we follow the updated USFWS protocol (2012) to determine that a site is unoccupied, since the additional visits required by that protocol accounts for reduced NSO detectability if Barred Owl(s) are present.

Occupancy is presented from 1999 to 2023 as the percent of sites with each status: Pair, Resident Single, Unknown Combined (includes sites with Pair Unknown, Single Unknown, and Unknown status), or Unoccupied (single year with six visits and no detections; for the current year results, we specify if it was the first or second consecutive year with no detections). Because not all sites have been surveyed each year, and because in some years we surveyed more areas where pairs are less likely to occur (e.g., inventory surveys in marginal habitat), only sites that met Pair status at least once (this year or historically) are included in the occupancy breakdown. To check whether the proportion of sites occupied by pairs in 2023 was statistically different from previous years (1999-2022), we fit a logistic regression with year group as a predictor and the number of sites surveyed as weights (to account for the different number of sites surveyed each year).

For occupied sites, we used the Marin protocol to determine nesting and reproductive status, and whenever possible we attempted to gather nesting and reproductive information without the use of mice (Press et al. 2010). The Marin protocol attempts to minimize "mousing" owls to avoid habituating them to being fed, since the owls in Marin County are often in close proximity to humans, residential areas, and heavily used trails and roads. For some occupied sites with

planned management activities (e.g., noise disturbance) in previous years, we followed the USFWS protocol to determine nesting status, which includes conducting mousing surveys if nesting status could not be determined without the use of mice by early April (USFWS 2012), as opposed to late April for the Marin-specific protocol (Press et al. 2010); however, we did not conduct any early mousing surveys in 2023.

To compare nesting status for sites with pairs from 1999 to 2023, we determined the percent of pairs that nested successfully, had a failed nest, had a nest with unknown outcome, were non-nesting, or where nesting status was unknown, per the Marin Protocol (Press et al. 2010). Nesting status was usually the same between Marin and USFWS protocols. However, there are two common scenarios when status designations differed between the two protocols: 1) for nests suspected as failed, the USFWS protocol requires mousing adult NSO to confirm they do not have young, and the Marin protocol only includes mousing to confirm a nest failure in specific situations, and 2) to confirm a pair is non-nesting without the use of mice, the USFWS protocol requires watching the female roost (not on a nest) on two occasions in April, with the two visits separated by 3 weeks, while the Marin protocol requires watching a female roost on one visit anytime between April 15 and May 1; these mostly-overlapping periods are both when nesting females would be incubating eggs or brooding small young except that not all Marin nests have been initiated by the first few days of April, so the first of the two USFWS roost watches is never used as sole evidence of non-nesting (see protocols for more detail, Press et al. 2010 and USFWS 2012). To check whether the proportion of sites with owls that attempted nesting and the proportion of nest attempts that were successful 2023 were statistically different from all prior years, we fit a logistic regression with year group as a predictor and the number of sites surveyed as weights (to account for the different number of sites surveyed each year). We used data from 1999-2022 for the proportion of pairs that attempted nesting and 2000-2022 for the proportion of pairs with successful nests out of those that were confirmed to attempt nesting, excluding 1999 due to a high proportion of nests with unknown outcomes.

Fecundity

Fecundity is a productivity measure commonly used with NSO data that can be compared across studies (e.g., Franklin et al. 2021); it is defined here as the total number of female young produced per territorial female. Fecundity was calculated by dividing the total number of young that fledged by 2 (assuming a 1:1 sex ratio of young), and then dividing that number by the total number of territorial females (paired and resident single females). We calculated fecundity from 2000 to 2023, excluding 1999 when a large proportion of nesting pairs had unknown nesting outcomes.

To evaluate the trend over time, we used Poisson regression to describe any relationship between the number of young produced offset by the log number of females and year, such that the slope (β) of the line represented the change in fecundity. We used $\alpha = 0.05$ to evaluate if the slope was statistically different from zero for this and other statistical tests described above.

Wildlife Rehabilitation

Due to the regular occurrence (typically 1-5 individuals per year) of NSO in Marin County being taken to the local wildlife rehabilitation center (WildCare in San Rafael) by members of the public, we present the number of NSO collected since the last report (15 December 2022 through 22 November 2023) from Marin Water or MCP lands. If NSO are collected from Marin Water or MCP lands, Point Blue communicates immediately to the agency staff as soon as Point Blue is notified. Point Blue works with WildCare personnel to band NSO before release whenever feasible, if individuals are releasable and have fully grown legs.

Permit Requirements

Activities presented in this report were conducted under USFWS Native Endangered & Threatened Species Recovery permit ES807078-20, and under a Memorandum of Understanding with CDFW that is connected to Point Blue's scientific collecting permit S-193120001-18312-001. For reporting requirements of our permits, we also present the number of birds banded this year, planned future activities, and report any incidental take. Supplemental information will also be provided to CDFW and USFWS, including a map of activity centers, and coordinates for each owl detection in 2023.

Personnel

All 2023 surveys were conducted from March through July by Point Blue personnel trained in NSO survey protocols: Margaret Brown, Renée Cormier, Viviana McKinley, and Jadzia Rodriguez.

RESULTS

Occupancy at inventory areas. No NSO were detected at two of the three inventory areas surveyed in 2023. This marks the second consecutive year of no NSO detections at the inventory area on Marin Water land which can now be classified as Unoccupied by Marin and USFWS protocols. For the inventory area on MCP land, we conducted 3 nighttime visits in 2023 and had no NSO detections; this area is classified as Unknown by Marin and USFWS protocols and after additional assessment of the habitat during surveys, we determined that the patch of forest was too small and the canopy was too open to support nesting NSO and we discontinued

surveys. At the third inventory site on MCP land, we detected a pair (this site was combined with known sites to assess occupancy of sites that have met pair status in the past or current year; Figure 1).

Occupancy at known sites. Of the 48 non-inventory sites surveyed in 2023 (47 previously-known sites and one new site incidentally confirmed this year), 41 (85%) were occupied by pairs, 4 (8%) by Resident Singles (all males), 1 (2%) had Pair Unknown status, 1 (2%) was Unknown (Pair Unknown and Unknown statuses are classified as "Unknown-Combined" in Figure 1), and 1 (2%) was classified as Unoccupied by the Marin and USFWS protocol after two consecutive years of no NSO detections in 2022 and 2023. Combined with the new pair from the inventory area (see above), the percentage of sites occupied by pairs in 2023 (86%; 42/49) was below the 1999-2022 study average (90%) but was not statistically different (logistic regression coefficient = -0.459; SE = 0.43; P-value = 0.28); Figure 1).

Nesting and Reproduction. Of the 42 sites that were occupied by pairs in 2023, 25 (60%) were known to attempt nesting, which is below the 1999-2022 study average (62%), but this difference was not statistically significant (logistic regression coefficient = -0.100; SE = 0.32; P-value = 0.76; Figure 2). Twenty (80%) of 25 nests were successful (i.e., produced at least one fledgling), which is higher than the 2000-2022 study average (78%) and also not statistically significant (logistic regression coefficient = 0.12; SE = 0.52; P-value = 0.82; Figure 2). Fecundity was 0.40 in 2023, which is equal to the 2000-2022 study average (Figure 3). The estimated trend in fecundity over time is negative, but not statistically significantly different from zero (Poisson regression coefficient = -0.005; SE = 0.007; P-value = 0.40)

Barred Owls. Two Barred Owls were detected on or near MCP and Marin Water lands in 2023. During the breeding season, Point Blue biologists located one Barred Owl in Fairfax on private property, at a long-term NSO site adjacent to Marin Water lands. The Barred Owl was collected in May as part of a research project led by University of Wisconsin in conjunction with the California Academy of Sciences; objectives of this ongoing project are to study Barred Owl genetics, diet, and exposure to rodenticides, plus to investigate how NSO respond to Barred Owl removals (Hofstadter, unpublished data). The second Barred Owl was detected in September on MCP land in Bolinas at a preserve not historically occupied by NSO. This individual was not detected again, and we suspect that it may have been a dispersing juvenile. We know of two additional Barred Owls that were detected by members of the public in Marin County outside of Marin Water and MCP lands in the fall of 2023, but to our knowledge, neither was detected after the initial reports.

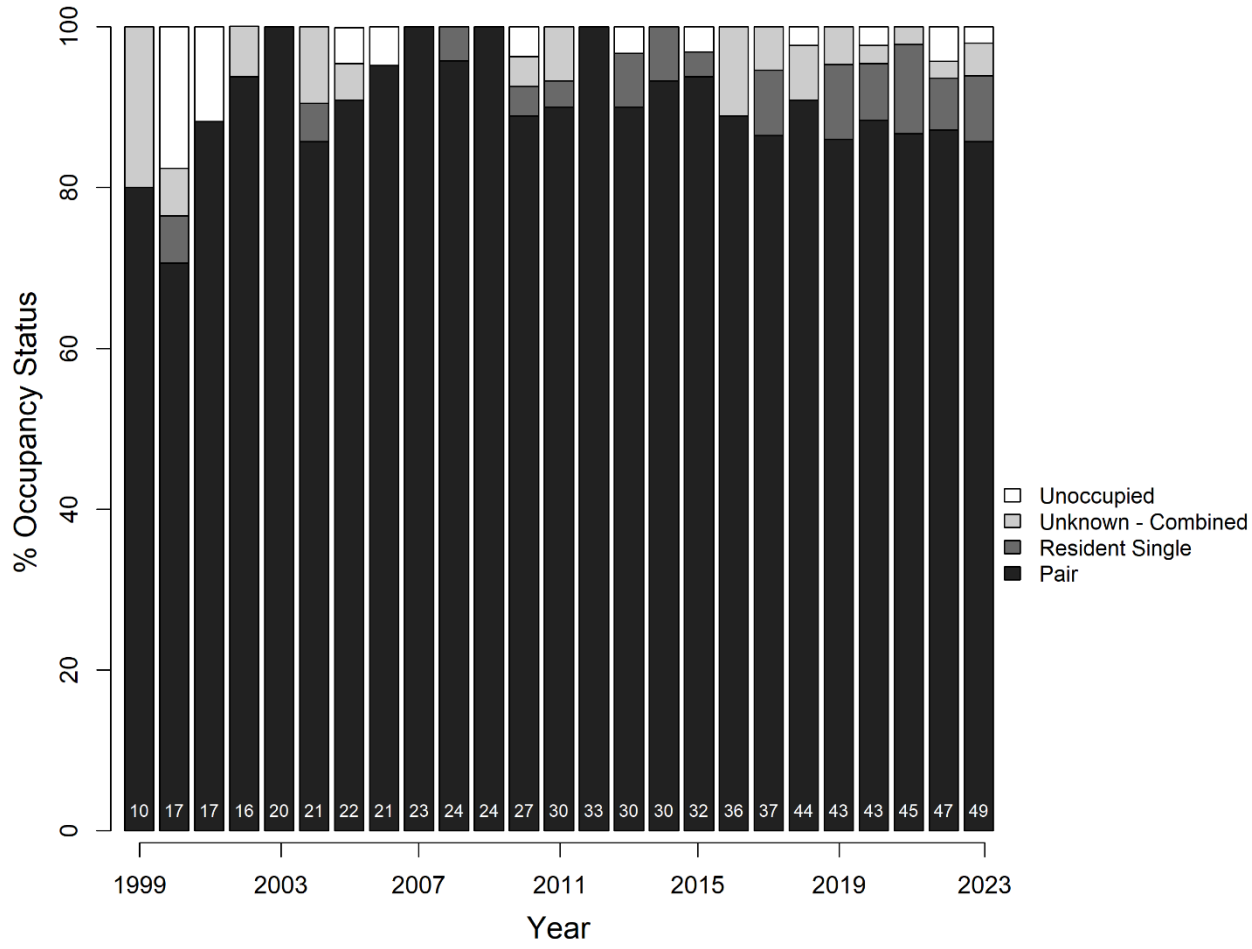

Figure 1. Northern Spotted Owl occupancy status for known sites surveyed by Point Blue Conservation Science in Marin County (1999 to 2023). Because not all sites have been surveyed each year, and because in some years we survey more areas where pairs are less likely to occur, only sites that have been occupied by a pair at least once during the study period, including the current year, are included. Sample size for each year is shown at the base of each bar. The *Unknown - Combined* category includes sites classified as Pair Unknown, Single Unknown, and Unknown (see methods for detail).

NSO taken to wildlife rehabilitation centers. From 15 December 2022 through 22 November 2023, six NSO from Marin County locations were taken to WildCare wildlife rehabilitation center by members of the public (B. Morse, WildCare, pers. comm.). One was found near a roadside in the San Geronimo Valley in January and euthanized due to poor prognosis (it is unknown if this owl was from a nearby MCP site where we monitor). Another adult was found in the San Geronimo Valley (near a different MCP site, but not on MCP lands) in March and released at the same location in April; three weeks later, another mature NSO was found nearby (unknown if it was the same individual), treated, and released. Two additional NSO taken to WildCare were fledged young that were found on the ground near their nest at a site

that we monitor on private land near a MCP preserve in Larkspur; the owlets were assessed as healthy and returned to the site and were observed with their parents and third sibling up to a week after release – one of the young was found dead by Point Blue biologists approximately 2 weeks after release (identifiable by a talon colored by WildCare staff to differentiate between the two in their care). The sixth NSO taken to WildCare in 2023 was hit by a vehicle on NPS lands; after several weeks in recovery, the owl was deemed healthy and its release was coordinated with NPS staff; this NSO was the only one banded prior to release in 2023 (see banding section below).

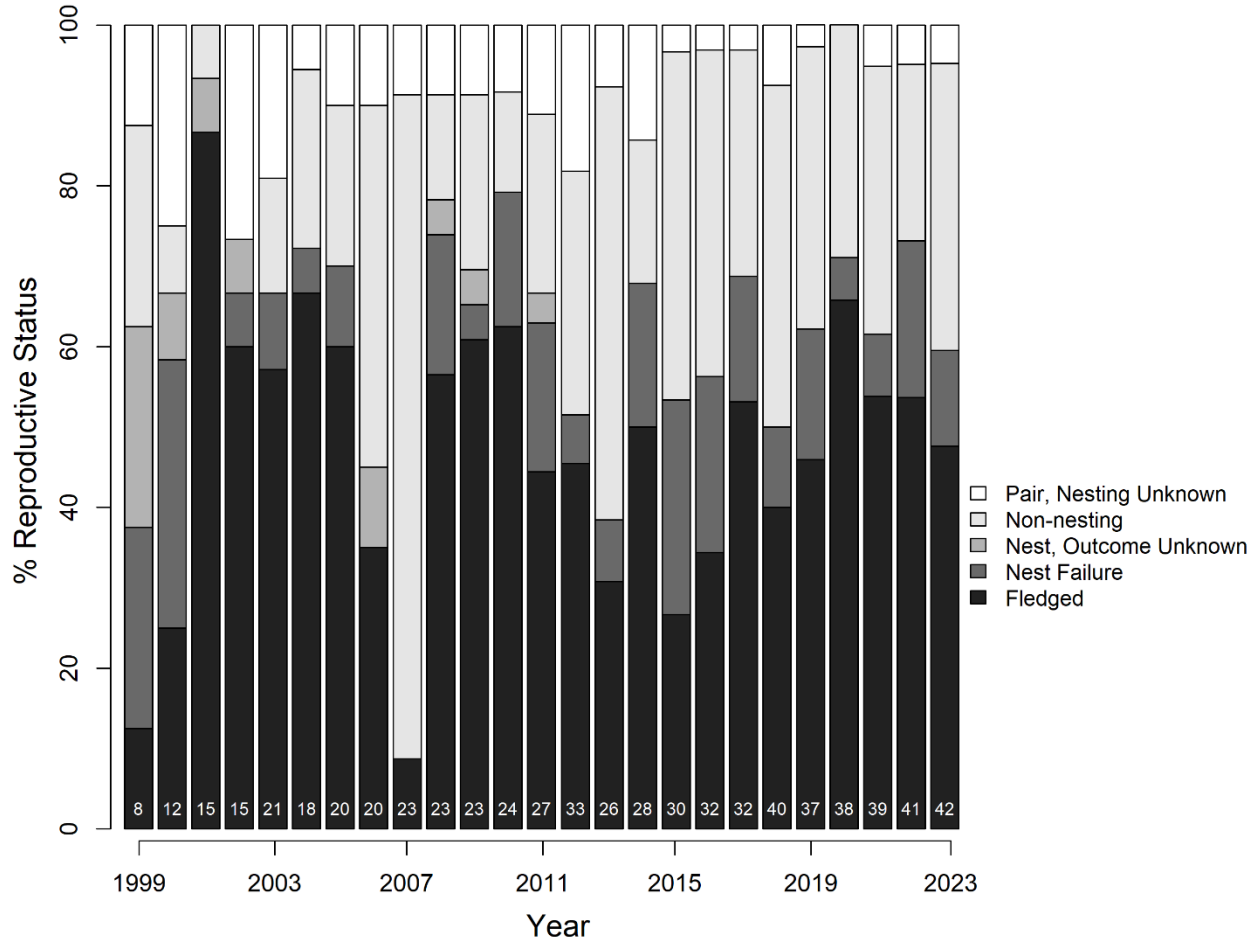

Figure 2. Reproductive status for Northern Spotted Owl pairs surveyed by Point Blue Conservation Science in Marin County (1999 to 2023). Sample size for each year is shown at the base of each bar.

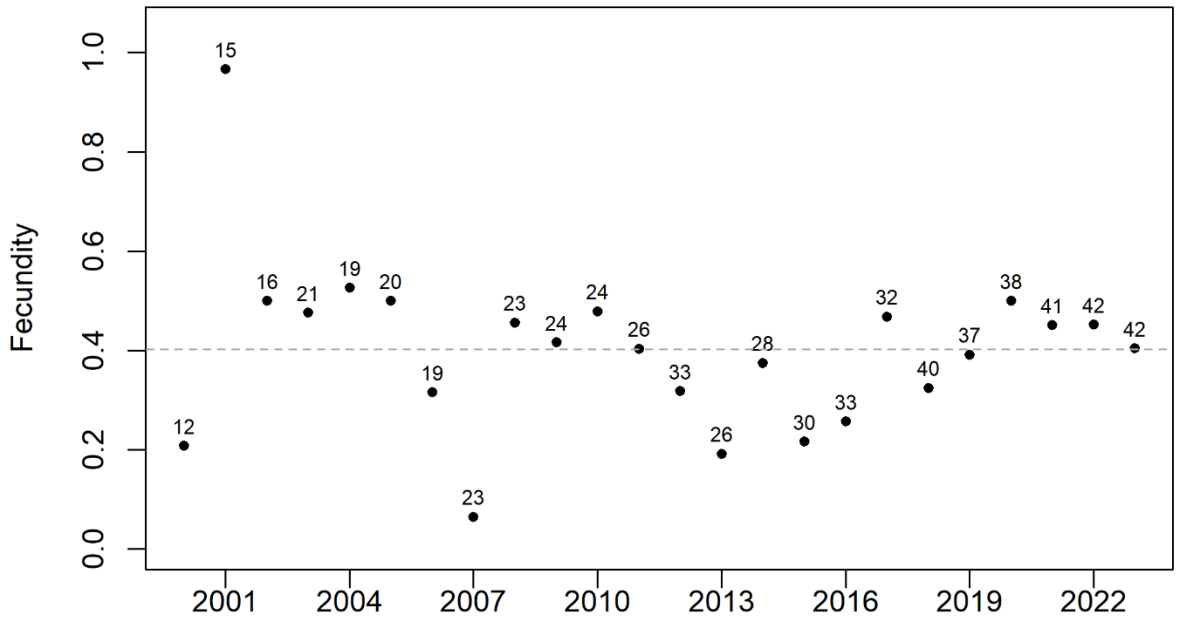

Figure 3. Annual fecundity (number of female young produced per territorial female) for Northern Spotted Owls as a function of year (2000-2023), monitored by Point Blue Conservation Science in Marin County. Annual sample size of territorial females is shown above each annual data point. The dashed line represents the 2000-2022 study average.

Recovery Permit Activities

This section details information required for Point Blue's USFWS Recovery Permit and our Memorandum of Understanding with CDFW (additional data will be submitted to the CNDDB database, per permit requirements of both agencies; and this report and components from it will also be submitted to the USFWS Recovery Office and CDFW Department Contacts).

Banding activities. In 2023, one NSO was banded under our permits. The owl had been hit by a vehicle in the Marin Headlands and brought to Wildcare wildlife rehabilitation center on 23 September by NPS personnel. WildCare holds their own USFWS and CDFW permits for NSO. After receiving medical treatment, the NSO was determined to be hunting well in captivity and deemed releasable by WildCare staff. Cormier, under Point Blue's permit, banded the NSO on 9 October at WildCare. The owl was released by NPS personnel on 10 October.

Planned future activities. We plan to conduct the same work in 2024 with some shifts in sites monitored based on agency needs, although most sites will remain the same.

Incidental Take. There was no incidental take under our permit in 2023.

Dead NSO collected. One dead juvenile NSO was collected under Point Blue's permit in 2023 on 28 August near a site that we monitor for MCP in Larkspur. The dead owl was collected from the roof of a house and shipped to CDFW for a necropsy, where the cause of death was determined to be likely caused by a bacterial infection, potentially introduced through a break in the owl's left tibiotarsus, although the exact sequence could not be concluded (K. Rogers, pers. comm.). The necropsy also determined that the NSO was a first-year female in good nutritional condition and had the remains of a small mammal in its stomach, indicating some level of parental care prior to death (K. Rogers, pers. comm). The remains were then transferred to the California Academy of Sciences.

DISCUSSION

Occupancy. The proportion of sites occupied by pairs of NSO in 2023 was below the 1999-2022 study average, but this difference was not statistically significant. Of the seven known sites that did not meet pair status in 2023, six are sites for which pairs have been detected in some but not all survey years; these sites may be of marginal quality (e.g., in habitat or landscape characteristics) for NSO, and more likely to transition in and out of pair occupancy (Blakesley et al. 2005). The remaining site that did not meet pair status in 2023 has been occupied by pairs in all other years it has been surveyed (since 2018).

We detected a pair that successfully nested at one new inventory site, and we did not detect any NSO at the other two inventory areas we surveyed in 2023. Detections of NSO in new survey areas can increase our understanding of the local population, and the habitats and other landscape features associated with them. This was the case for the pair that occupied the new inventory area, where habitat around the nest was dominated by live oak (*Quercus agrifolia*), Pacific madrone (*Arbutus menziesii*) and California bay laurel (*Umbellularia californica*). This forest type is not typically associated with NSO in other parts of their range where these habitat types are less prevalent or lacking, and only represents a very small portion of known NSO sites in Marin County. The unoccupied inventory area on Marin Water land has been surveyed since 2018 with occasional NSO response from single individuals in previous years. We suspect that these could have been detections of transient individuals, or potentially younger NSO moving between territories. These detections highlight the importance of NSO surveys in areas with appropriate habitat where proposed management activities are planned, including in certain forest types not typically-associated with NSO in other parts of their range. In some cases, it can take more than one survey year to make precise occupancy determinations (e.g., not an Unknown status) at a new site. Thus, when large management projects are planned, long-term or multiple-year data collection near the project area can help increase precision in early-

season status determinations during the year of the management action because Spotted Owls are central place foragers (Rosenberg and McKelvey 1999) and can even reuse roosts and nests.

Nesting and Reproduction. The proportion of NSO pairs that attempted nesting and the proportion of nest attempts that were successful in 2023 were also not statistically different from prior years data. The below-average number of nesting attempts this year might have been influenced by heavy rainfall during March, when many NSO in Marin initiate nesting. Total monthly rainfall accumulation in March 2023 was 19.2 inches at Lake Lagunitas, which is notably more than the March average of 7.4 inches for our study period (1999-2023), and the second rainiest March for that same period (Marin Water 2022, 2023 and unpublished data). Nesting attempts for some pairs may have been discouraged by decreased foraging success during adverse weather conditions, or some individuals may have even experienced early nest failures prior to our detection due to strong winds and rainfall causing damage to nest sites (North et al. 2000). Interestingly, in 2023, pairs at three sites that we surveyed successfully raised 3 fledglings each, which is relatively uncommon in NSO, with 1-2 young produced being typical (Forsman et al. 1984). While we cannot definitively determine the cause of number of young at each site, it's possible that the wet winter preceding the breeding season could have led to increased plant growth and seed production which may have contributed to increased woodrat abundance in some areas and allowed some NSO parents to support additional young (LaHaye et al. 2004), or there may be other individual parental qualities driving variation in fecundity that we did not assess here (e.g., age, Dugger et al. 2016). Fecundity in 2023 was equal to the study average, and we did not find support for a significant trend over time in fecundity.

The likelihood of a successful nest and the number of young produced can depend on a variety of factors, including predator abundance, food availability (Courtney et al. 2004), weather (North et al. 2000, Olson et al. 2004), or a combination of these or other factors (Franklin et al. 2000, Rosenberg et al. 2003). In a previous broader NSO analysis, fecundity ranged from 0.306 to 0.560 depending on geographic region, and on the California coast – including Marin County and this monitoring program – it averaged 0.442 (Anthony et al. 2006). In a more recent analysis of many of the same study areas, excluding Marin County, Franklin et al. (2021) found fecundity to vary over time and to be negatively impacted by Barred Owls. The Marin population on MCP and Marin Water lands also experiences high variability in fecundity year-to-year, and while 2023 was an average year, multiple recent years (2020-2022) with above-average fecundity is encouraging.

Barred Owls. Point Blue biologists detected two Barred Owls on or near MCP and Marin Water lands in 2023. The first Barred Owl was located during the breeding season at a long-term NSO

site that had been historically occupied by an NSO pair in most years prior to 2022. In the early spring, we detected the Barred Owl and also detected a single NSO at the site. Less than a month after the Barred Owl was removed, we located a pair of NSO at the site, indicating that the Barred Owl's presence may have temporarily displaced the NSO or at least reduced our ability to detect them consistently earlier this season; a nearby landowner recorded the pair of NSO calling a week after the Barred Owl removal. The second Barred Owl was initially found by a member of the public on MCP land in September and confirmed by Point Blue biologists on that same day. This MCP preserve has not been historically occupied by NSO due to it being mostly riparian habitat, which is less suitable for NSO occupancy. We conducted two additional visits to this area (using Barred Owl playback) to determine if the Barred Owl was still present in the weeks following the initial detection but did not detect the owl, and we suspect it may have been a dispersing juvenile. We received 2 additional reports of other Barred Owls in Marin County (not on MCP or Marin Water lands) in the fall of 2023, possibly juveniles dispersing after the breeding season.

We expect that an increase in Barred Owls would threaten the local NSO population through competition for space and food, as has been well-documented in other parts of its range (Wiens et al. 2014, Dugger et al. 2016, Franklin et al. 2021). Negative effects of Barred Owls on NSO have been found to negatively impact occupancy, fecundity, apparent survival, and overall rates of population change (Kelly et al. 2003, Olson et al. 2004, Olson et al. 2005, Anthony et al. 2006, Forsman et al. 2011, Wiens 2012, Dugger et al. 2016, Weins et al. 2021, Franklin et al. 2021). Additionally, Barred Owls produce more young than NSO, have higher survival, and tend to have a more diverse diet, likely reducing their sensitivity to declines in one prey species (Wiens et al. 2014). Holm et al. (2016) suggested that Barred Owl range expansion could also have significant direct and indirect effects on local food webs within the NSO range, putting pressure on not only a larger array of prey species than NSO, but also on diurnal and nocturnal avian predators. We continue to follow the USFWS NSO protocol (USFWS 2012) to increase our ability to detect Barred Owls by conducting late-season playback surveys for Barred Owls when NSO were not detected. However, because we detect NSO at most sites that we monitor, Barred Owl-specific surveys are therefore not triggered at most sites, potentially limiting our ability to detect Barred Owls (Wiens et al. 2011). Additional surveys that are specific to Barred Owls can increase our detection likelihood of this species. Barred Owl inventory surveys would be useful to gather baseline data throughout Marin Water lands – including in forested areas not currently surveyed for NSO where data are lacking – similar to previous surveys on MCP lands in 2020 (Duncan and Cormier 2020); repeated surveys may also be useful on MCP lands.

Conclusions. During 2023 surveys on Marin Water and MCP lands, we documented NSO pairs at most known sites, and the proportion of sites occupied by pairs was not statistically different

from prior years. Nesting rates and the proportion of successful nests in 2023 were also not statistically different from previous years of the study. Fecundity in 2023 was equal to the study average, and we did not find evidence for a significant trend over time in fecundity. We detected two Barred Owls in 2023 on or adjacent to MCP and Marin Water lands, and received two additional reports of Barred Owls elsewhere in the county this fall. The known number of Barred Owls is still low in Marin County compared to other parts of the NSO range; that combined with the many protected forested areas in the region likely explains the relatively stable NSO population here compared to other parts of their range. Monitoring NSO in Marin County during the breeding season is an essential component to evaluating their population health and ensuring that management activities do not negatively impact owls, including where management activities are slated to occur.

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