# Scripps's Murrelet and Cassin's Auklet Reproductive Monitoring and Restoration Activities on Santa Barbara Island, California in 2013

FINAL
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# EXECUTIVE SUMMARY

- An extensive project funded by the Montrose Settlements Restoration Program to restore seabird habitat on Santa Barbara Island was initiated in 2007. This project is aimed specifically at restoring the native plant communities utilized by Scripps's Murrelets (*Synthliboramphus scrippsi)* and Cassin's Auklets (*Ptychoramphus aleuticus),* and has resulted in more than 25,000 native plants propagated and planted at locations around the island. In addition to habitat restoration activities, the program has included nest monitoring, social attraction, and installation of artificial nesting habitat.

- In the 2013 nesting season, 241 Scripps's Murrelet clutches in 182 active nest sites were monitored on Santa Barbara Island. We could reliably determine the fates for 220 nests.

- Nesting data were collected at seven plots in 2013: Arch Point North Cliffs, Boxthorn, Bunkhouse, Cat Canyon, Elephant Seal Cove Restoration Plot, Landing Cove, and the Landing Cove Dock. Nesting data collected at three of these plots (Boxthorn, Bunkhouse, and Elephant Seal Cove) are less representative of nesting effort due to low numbers detected and/or infrequent surveys (e.g., Boxthorn Plot was checked only once in 2013).

- The 2013 Scripps's Murrelet breeding season lasted nearly 5 months (142 days) from the first clutch initiation (2 February) to the latest hatching date (22 June).

- We estimated nest success for Scripps's Murrelets on Santa Barbara Island at 51 percent (n=220 clutches). Hatch success was approximately 44 percent, and 46 percent of all monitored eggs were depredated, presumably by deer mice.

- We monitored a total of 374 individual eggs, 288 of which were of a known lay order.

- Where lay order was known, first eggs had a higher rate of depredation (54 percent, n=145) versus second eggs (32 percent, n=143).

- Nest sites are sometimes reused through the season, either by the same or a different pair. First clutches were more successful than second attempts with a clutch success rate of 55 percent versus 42 percent, respectively. Third clutches were much less successful at 17 percent.

- Cassin's Auklet artificial burrows were inactive in 2013, and social attraction was not attempted. No nesting was observed in artificial habitat, though auklets were observed nesting at Arch Point North Cliffs and Elephant Seal Cove in natural burrows. One auklet

was observed attempting to nest in Landing Cove, but abandoned the effort after a few days.

- This report provides results of monitoring efforts conducted for Scripps's Murrelets and Cassin's Auklets in 2013 as well as recommendations for future colony restoration and protection strategies for use in assessing the long-term outcome of the native plant restoration work.

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# INTRODUCTION

Santa Barbara Island, the smallest island in the Channel Islands National Park, is host to several species of breeding seabirds. Kelvin Murray, in an extensive investigation into the breeding biology of the Xantus's Murrelet (*Synthliboramphus hypoleucus scrippsi*) on Santa Barbara Island in 1975-79 estimated 6,000 to 10,000 individuals at that island (Murray et al. 1983). In 1989-1991, Carter et al. identified Santa Barbara Island as the "most important well-documented colony known on the west coast of North America, including Baja California" for the Scripps's Murrelet. Eighty-eight percent of the State of California's Scripps's Murrelet population was located at Santa Barbara Island, including nearby Shag Rock and Sutil Island, and it was advocated to be a priority to monitor the species at that location in the future (Carter et al. 1992). In that same study, 100 percent of the state's Black Storm-Petrels (*Oceanodroma melania*) were located at Santa Barbara Island, as well as an estimated 20 percent of the state's Ashy Storm-Petrels (*O. homochroa*). In 2009-2010, Whitworth et al. (2011) estimated 642 - 1,276 breeding murrelets at Santa Barbara Island, "still … the largest colony in California."

Cassin's Auklets (*Ptychoramphus aleuticus*) were once recorded as so abundant on Santa Barbara Island that in 1863 "they had undermined almost every part of the soft, earthy surface with their burrows" (Howell 1917). Between 1897 and 1908, cats were introduced to the island, and by 1911, G. Willet reported that "on visiting Santa Barbara Island… I found that the old breeding colony of these birds was entirely abandoned. From the bones and feathers of the birds found all over the island I concluded that they had been exterminated by the cats with which the island is infested" (Hunt et al. 1978, Willet 1912). Interestingly, Xantus's Murrelets were reported to have been "breeding sparingly on Santa Barbara Island in 1863, and H. Wright found a single fresh egg in a hole on this island, July 2, 1912. They are surely destined to be driven from this locality, as have the auklets, by the cats" (Howell 1917). Habitat loss during homesteading, ranching, and military operations has restricted the amount of usable native habitat for most resident and migratory species to the remnant populations found patchily across the island, on cliff sides and in more resilient canyons (Whitworth et al. 2011).

In 2007, habitat restoration efforts were implemented in three plots: Landing Cove, Northeast Flats, and Prohibition Point (now Bunkhouse Plot, Figure 1). The project's main goal was to improve nesting habitat and reproductive success of Scripps's Murrelets and Cassin's Auklets. Restoration locations were chosen to maximize potential colonization, based on known nesting distributions and habitat preferences (Harvey and Barnes 2009). Logistical considerations of accessibility, personnel safety, and proximity to existing infrastructure were also taken into account. That year, a temporary nursery facility was erected near the National Park Service housing, and on-island propagation of native shrubs began in 2007 (Harvey and Barnes 2009). Surveys of local populations of murrelets in 2007 documented an approximate 42 percent hatch success rate and 45 percent egg depredation rate (n=130 eggs, Harvey and Barnes 2009). Searches for Cassin's Auklet nest burrows and Ashy Storm-Petrel nests documented no nests of either species in 2007.

Over the next five years, 2008-2012, increases in plant propagation, restoration sites, and seabird monitoring advanced the project goals and provided more monitored nests to determine the population's productivity and nesting success at Santa Barbara Island. In 2008-2010, a more concentrated effort to locate Cassin's Auklet nesting habitat and numbers was made, resulting in the first confirmation of auklet nesting since 1994 (Whitworth et al. 2011). Auklet nesting locations were identified at Sutil Island, Arch Point and North Cliffs, Pinnacle Point, and Elephant Seal Point.

In 2008, hatch success increased slightly to 53 percent, though 57 percent of the eggs observed that year were eaten (N=60, Harvey et al. 2012). Then in 2009, a substantial drop in Scripps's Murrelet hatch success, an increased egg depredation rate, and high adult mortality attributed to Barn Owl (*Tyto alba*) predation (45 percent hatch success, 51 percent egg depredation, n=182 eggs, Harvey et al. 2012) prompted an assessment of adult murrelet mortality by Barn Owls, which has been ongoing through 2013. Annual estimates of predation by Barn Owls from data collected through this study ranged from 11 to 172 individual murrelets (Thomsen and Harvey 2012, Thomsen et al., 2013, Nur et al. 2013). Population growth modeling from Nur et al. (2013), based on data collected between 1991 and 2010, resulted in a best estimate of a 1.17 percent population decline. A 50 to 80 percent reduction in predation pressure as modeled in the study could theoretically result in a 1.15 to 2.54 percent positive growth rate, barring an increase in egg depredation from island mouse populations. This assessment further implicates the role of Barn Owls in the suppression of the Scripps's Murrelet population recovery on Santa Barbara Island.

Surveys in 2010 included a much expanded search area, including eleven sea caves, two off-shore rocks, habitat searches of the West Cliffs and shoreline between Landing Cove and Arch Point, as well as habitat identified at the bases of Graveyard, Cliff, and Cave Canyons. The surveys showed an improved nesting success on Santa Barbara Island, with a 70 percent hatch success and very low depredation rate of 15 percent (n= 446 eggs, Harvey et al. 2013b). Spotlight surveys were conducted in 2010 to estimate the total island nesting population, and a range of 321-638 pairs (Whitworth et al. 2011) was calculated. This population level identified Santa Barbara Island as the largest known breeding location for the Scripps's Murrelet. Murrelet nesting success has declined since 2011, when nest searches resulted in a calculated hatch success rate of 68 percent and egg depredation rate of 14 percent (n=218, Harvey et al. 2013b). The 2012 season found lower hatch success at 62 percent, and increased depredation with 54 percent of eggs eaten (n=279 eggs, Harvey et al. 2014). Monitoring effort post 2011 was slightly reduced, and no longer included the West Cliffs Plot.

Social attraction of Cassin's Auklets at the Landing Cove restoration plot showed positive response in 2011, and is the first successful use of this technique for this species (Harvey et al.

2013b). Social attraction efforts were abandoned in 2012 due to increased mortality of Cassin's Auklets attributed to Barn Owls.

Banding efforts for Murrelets, Auklets and Storm-Petrels began in 2009, and have been conducted annually in varying degrees through 2013. Spotlight captures of Scripps's Murrelets and nocturnal mist netting efforts for Cassin's Auklets and Ashy Storm-Petrels have been conducted during appropriate times of the year. Motion activated camera and video monitoring for murrelets was initiated in 2010 and has continued through 2013.

In 2013, the restoration effort continued with the installation of approximately 5,000 native plants, infilling within established restoration plots and expanding the Beacon Hill Plot by 1 acre. Land-based nest monitoring for Scripps's Murrelet and incidental location of Cassin's Auklet continued at five plots: Arch Point North Cliffs, Cat Canyon, and Landing Cove, under the Dock and around the Bunkhouse (National Park Service Housing). Habitat at the Elephant Seal Cove Restoration Plot was monitored periodically through the season, and one survey was conducted at the Boxthorn plot. Subsequent checks of the Boxthorn Plot were cancelled because of California Brown Pelican nesting. At-sea capture and banding of Scripps's Murrelets occurred in May of 2013. Twelve sites were monitored with video surveillance for the ongoing murrelet nest behavior study.

This report provides summary reproductive data for Scripps's Murrelets and incidental data for Cassin's Auklets and Storm-Petrel species encountered on Santa Barbara Island in 2013 for use in assessing the eventual outcome of the restoration project, and to document information relevant to the conservation of seabirds on Santa Barbara Island.

# METHODS

**Scripps's Murrelet Reproductive Monitoring.** Detailed descriptions of Scripps's Murrelet monitoring protocols can be found in past reports; see Harvey et al. 2013b and references therein. A basic overview of techniques follows:

The Scripps's Murrelet nesting season lasts from February through June (Murray et al. 1983, Harvey et al. 2014), and monitoring schedules within that timeframe were designed to record nest contents at approximately one week intervals (Table 1). Transportation to and from the island was conducted based around a Wednesday-to-Wednesday boat schedule provided by the National Park Service, with periodic transportation and logistics contracted through Aspen Helicopters in Oxnard, California. Monitoring staff were housed at Channel Islands National Park housing on Santa Barbara Island.

In 2013, previously active nest sites were identified using a hand drawn map to locate small metal tags mounted on the rocks or branches immediately beside the nest bowl. While searching available habitat, new or previously undetected nesting locations were documented. All nesting habitat was explored with a small flashlight for signs of murrelet nesting activity. Individual nest sites were identified by the physical presence of either murrelet eggs or a nesting bird. The appearance of a nest bowl structure in an appropriate location was noted and checked until occupied, but not considered a nest site until occupancy was confirmed by the presence of eggs or an adult murrelet. New or previously unrecorded sites found while conducting checks were marked with a metal tag and checked regularly from that point on.

Nest contents were collected as appropriate, and recorded both on printed datasheets and in a PDA using Pendragon software. Eggs that were deemed accessible (within safe reach of researchers and without an adult attending) were photographed and marked with a Sharpie permanent marker for identification in egg order and fate determination. Each egg's length and width (at the widest point) were measured to the nearest millimeter using calipers. Adult birds were noted and not handled. Unattended eggshell fragments from depredated eggs or hatched eggs were recorded, collected, labeled appropriately, and are temporarily stored at Channel Islands National Park facilities. Eggshell fragments will be housed at the Western Foundation of Vertebrate Zoology in Camarillo, CA.

After the completion of the season, fate determinations were determined based on observed data and published timetables (Murray et al. 1983). Where eggs were determined to have failed (i.e., any fate but hatching), further fate determinations were based on the primary cause of failure. Murray et al. 1983 provided the required intervals of egg neglect, incubation and abandonment to determine the initial cause of failure versus any secondary causes. For example, the longest period of neglect Murray reported was 19 days, therefore any egg neglected for a shorter term that is then depredated is said to have been depredated as the cause of failure, not abandoned. An egg eaten after 20 days of neglect is considered failed due to abandonment, not depredation. Some egg fates could not be determined reliably, due to a range of circumstances. These eggs were excluded from analyses.

The following metrics were used to describe seasonal reproductive parameters on Santa Barbara Island:

1) Hatch Success is determined as the number of hatched eggs divided by the total eggs laid. This measurement provides a percentage indicating how many young birds likely entered the population during the season.
2) Egg Depredation is reported as the percentage of eggs that failed as a direct result of depredation. Based on evidence recorded in the field, depredation is determined to have occurred where tooth marks are observed on an unhatched eggshell with a shiny adherent membrane. While this determination is not 100 percent certain, the existence of broken

eggs and abandoned eggs within plots where depredation is evident lends support to the assumption that eggs that are broken or neglected are at risk, but can be detected before depredated as a secondary cause of failure.

3) Clutch Success is calculated as the proportion of all clutches which hatched, at minimum, one egg.

In 2013, five plots were consistently monitored throughout the murrelet nesting season. These plots were Arch Point-North Cliffs, Bunkhouse, Cat Canyon, Dock, and Landing Cove. The Elephant Seal Cove Restoration Plot and the Boxthorn Plot were monitored less consistently and frequently (Figure 1, Table 1). We conducted 108 surveys on 88 individual days between 21 February and 13 July. Each survey included all potential habitat into June, late season surveys recorded only active nests, and a final all-habitat check was performed mid July (Table 1, Appendix 2). Restoration plots planted in 2007 through present were checked routinely for nesting evidence, including the Northeast Flats, Landing Cove, and Beacon Hill Plots.

We monitored a total of 414 tagged nest sites, generally weekly, through the 2013 season. From June through September, plot boundaries and individual site locations were mapped using a Trimble GPS unit with sub-meter accuracy. These data are used in the preparation of the maps in this report.

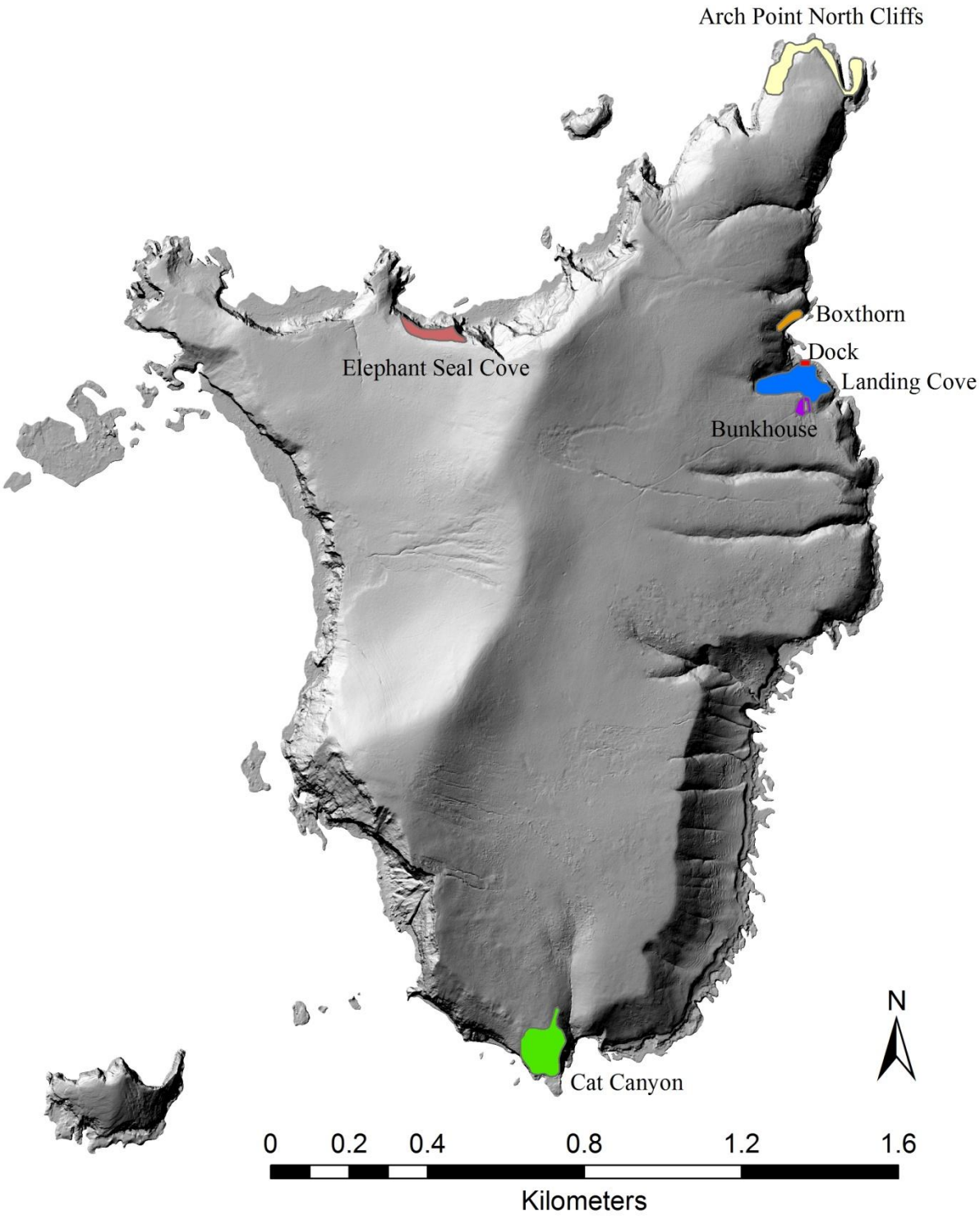


**Figure 1. Overview map of monitoring plots on Santa Barbara Island in 2013.**

**Table 1. Survey intervals in monitoring plots in 2013. See text for details and Appendix 2 for all survey dates.**

| Monitoring Plot | Survey Date Range | Interval (days) | Final Survey | Total Surveys |
|---|---|---|---|---|
| APNC | 21 February-13 July | 13 to 18 | 13 July | 11 |
| BT | 23 March | -- | 23 March | 1 |
| BH | 27 February-10 July | 7 | 10 July | 20 |
| CC | 28 February-9 July | 3 to 6 | 9 July | 29 |
| DO | 27 February-10 July | 7 | 10 July | 20 |
| ESC | 16 March-25 May | 5 to18 | 25 May | 6 |
| LACO | 1 March-12 July | 6 to 8 | 12 July | 20 |

APNC=Arch Point-North Cliffs; BT=Boxthorn; BH=Bunkhouse; CC=Cat Canyon; DO=Dock; ESC=Elephant Seal Cove; LACO=Landing Cove

**Scripps's Murrelet at-sea captures.** Mark-recapture efforts for Scripps's Murrelets were conducted on a limited basis in May 2013. Based from the Landing Cove Dock, and following standardized methods as in previous years (Whitworth et al. 1997, Harvey et al. 2013a, 2013b), spotlight captures occurred on 4 survey nights in 2013 (Table 2). These captures involved a three person team consisting of a driver, a spotlight operator and a net handler. Congregating murrelets were located by sight and sound from a 14ft Zodiac inflatable boat with 20 hp Yamaha outboard engine. Once the birds were located, the individual birds were captured with a dip net. Once captured, breeding condition was assessed by presence or absence of a brood patch, and the bird was banded (USGS metal size 2) and released. An on-island safety officer and radio relay to Sequoia-Kings Canyon National Park Dispatcher was used in lieu of a support vessel. All banding was conducted in the capture boat. All capture and banding of birds was conducted under United States Geological Survey's Bird Banding Lab Permit #22539.

**Table 2. Survey details for Scripps's Murrelet dip-net capture effort at Santa Barbara Island in 2013.**

| Survey Night | | | Start Time | End Time |
|---|---|---|---|---|
| 5/15/2013 | to | 5/16/2013 | 2252 | 0218 |
| 5/17/2013 | to | 5/18/2013 | 2245 | 0145 |
| 5/19/2013 | to | 5/20/2013 | 2256 | 0259 |
| 5/20/2013 | to | 5/21/2013 | 2128 | 0100 |

**Cassin's Auklet social attraction and captures.** Social attraction implemented in 2010 was discontinued in 2012 due to excessive Barn Owl predation of attracted auklets. In 2013 the moratorium on social attraction continued, though artificial burrow monitoring was conducted. The 100 artificial nest burrows located strategically to promote Cassin's Auklet nesting were checked on 43 individual days between 2 January and 8 June. Elephant Seal Cove sites were

checked 11 times, Northeast Flats sites 10 times, and Landing Cove sites were checked as follows: Lower checked 20 times, Middle 19 times, and Upper 17 times (Appendix 4). All original data are stored on site at Channel Islands National Park.

In December of 2013 the artificial burrows were excavated and redistributed throughout the Landing Cove Restoration Plot to help prevent Barn Owls keying in on - or perching on top of - the structures. The artificial burrows were repositioned under native shrubs that appeared to provide adequate cover for increased protection from predation. The spread out arrangement of the artificial burrows should also help lessen erosion issues seen around the burrows when they were located closer together.

There were no attempts to capture or band auklets in 2013 on Santa Barbara Island.

**Other seabird species.** Storm-Petrel mark-recapture efforts were not included in the original 2013 work plan. However, with the help of CSU-Northridge Professor Fritz Hertel, three net-nights on Santa Barbara Island were conducted, capturing and banding one Ashy Storm-Petrel and three Black Storm-Petrels in August. Also see below for Storm-Petrel species encountered in Scripps's Murrelet monitoring plots. Reproductive monitoring for California Brown Pelican (*Pelecanus occidentalis californicus*) and cormorant species were conducted through the nesting season. Data associated with these species are stored at Channel Islands National Park and are not included in this report.

# RESULTS

## SCRIPPS'S MURRELET INDIVIDUAL MONITORING PLOT RESULTS

Detailed descriptions of monitoring plots are provided in Harvey et al. 2014 and references therein.

**Arch Point-North Cliffs.** The northernmost plot, and situated directly below the Beacon Hill Restoration Plot. Accessible habitat at Arch Point-North Cliffs is entirely made up of rocky crevices; there are no nearby shrub sites of sufficient size to include in the search. The outplantings within the Beacon Hill Restoration Plot are still too young to provide the necessary cover to support nesting murrelets.

**Figure 2. Overview photograph of the Arch Point North Cliffs monitoring plot, 16 April 2012. Photo: A.L. Harvey.**

Arch Point-North Cliffs was surveyed eleven times in 2013, from 21 February through 13 July (intervals of 13 to 18 days; Table 1, Appendix 2). This plot was monitored more frequently in 2013 than in 2012, which allowed for better fate determinations of nests located in the plot.

There are a total of 57 marked sites at Arch Point-North Cliffs, including the 3 previously undetected sites located in 2013. Thirty active sites at Arch Point-North Cliffs housed 46 Scripps's Murrelet clutches. Clutch Success at Arch Point North Cliffs was 57 percent (n=44 clutches); hatch success and depredation rates were 53 percent and 33 percent, respectively (n=73 eggs).

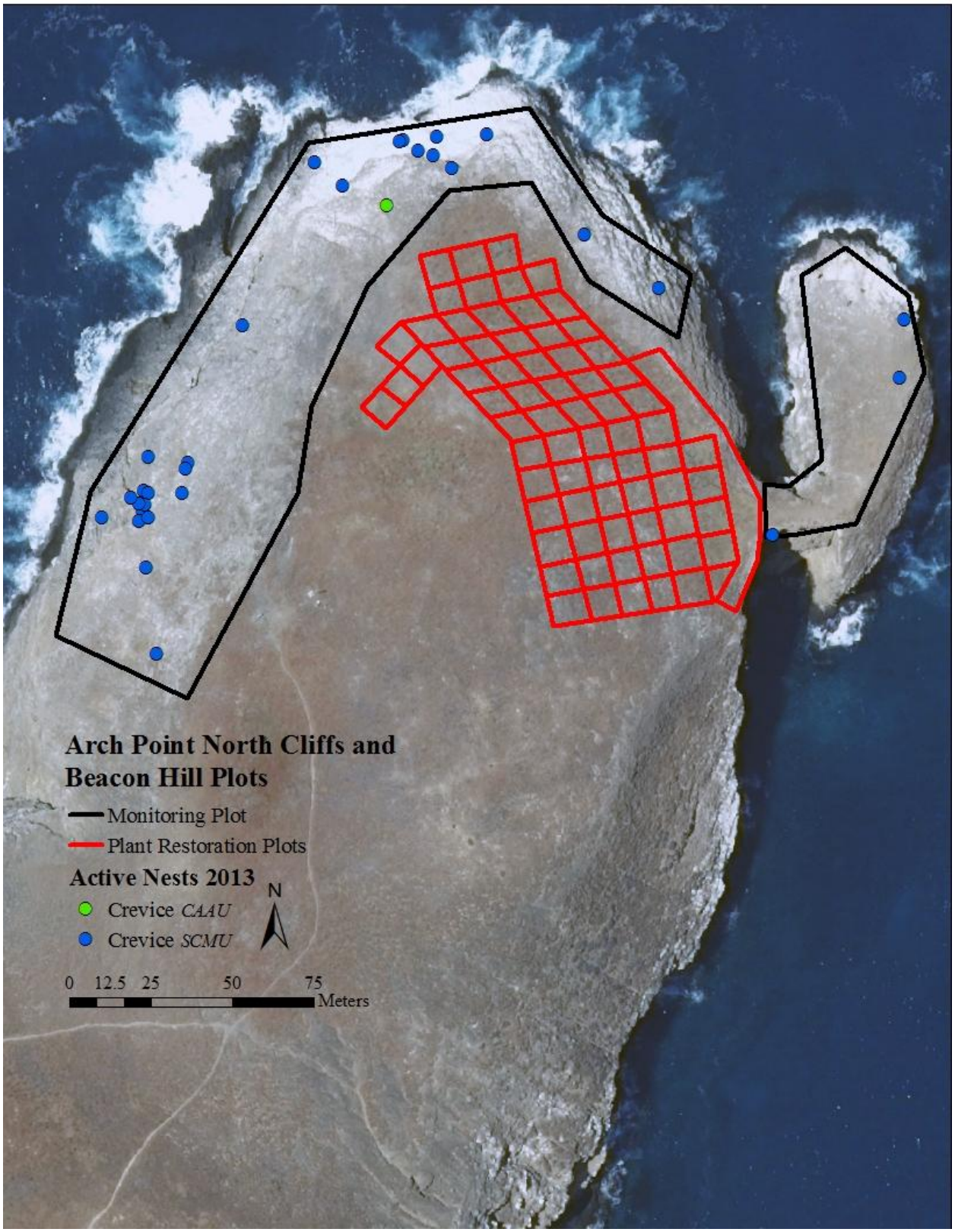


**Figure 3. Active nest sites at the Arch Point-North Cliffs monitoring plot in 2013. Prepared by S.J. Kim**

**Cat Canyon.** Situated at the southern end of Santa Barbara Island, Cat Canyon is comprised mostly of rocky crevice habitat interspersed with mature shrub and cactus habitat. Nesting habitat provided by vegetation cover is mostly California Boxthorn *(Lycium californicum*), Santa Barbara Island Buckwheat (*Eriogonum giganteum compactum*), and Prickly Pear (*Opuntia littoralis*). Large swaths of Cholla cactus (*Cylindropuntia prolifera*) and some Santa Barbara Island Live-forever (*Dudleya traskae)* are present as well, though the majority of the habitat is exposed rock. A few Scripps's Murrelet nests were located under old Brown Pelican nest structures.

Cat Canyon's southern aspect hosts a warmer, drier environment than the other plots on Santa Barbara Island. The monitoring plot itself is situated above a 40 to 50 foot sea cliff, with large tide pools below. Other seabirds utilize the local area, notably California Brown Pelicans and the cormorant species, and can effectively close down access to portions of the plot in high number nesting years. 2013 was not such a year, and the full plot was accessible for the entirety of the season.

Murrelet monitoring occurred at Cat Canyon on 29 days between 28 February and 9 July 2013. Nest checks took place approximately every 4 to 5 days, with two checks in June occurring 3 and 6 days apart due to staff availability (Appendix 2). Nest contents of all accessible nesting habitat and 185 tagged sites were investigated. Eleven previously unknown nest sites were tagged in 2013.

Through the season, 91 separate nesting attempts occurred in 67 active sites at Cat Canyon in 2013 (Table 5). Clutch success at Cat Canyon was 40 percent (n=89), continuing a decreasing trend from the last three years' rates: 68 percent in 2010, 62 percent in 2011, 59 percent in 2012 (Harvey et al. 2014). Of all eggs observed, 29 percent successfully hatched, and 69 percent of eggs laid failed with signs of depredation (n=150, Table 7).

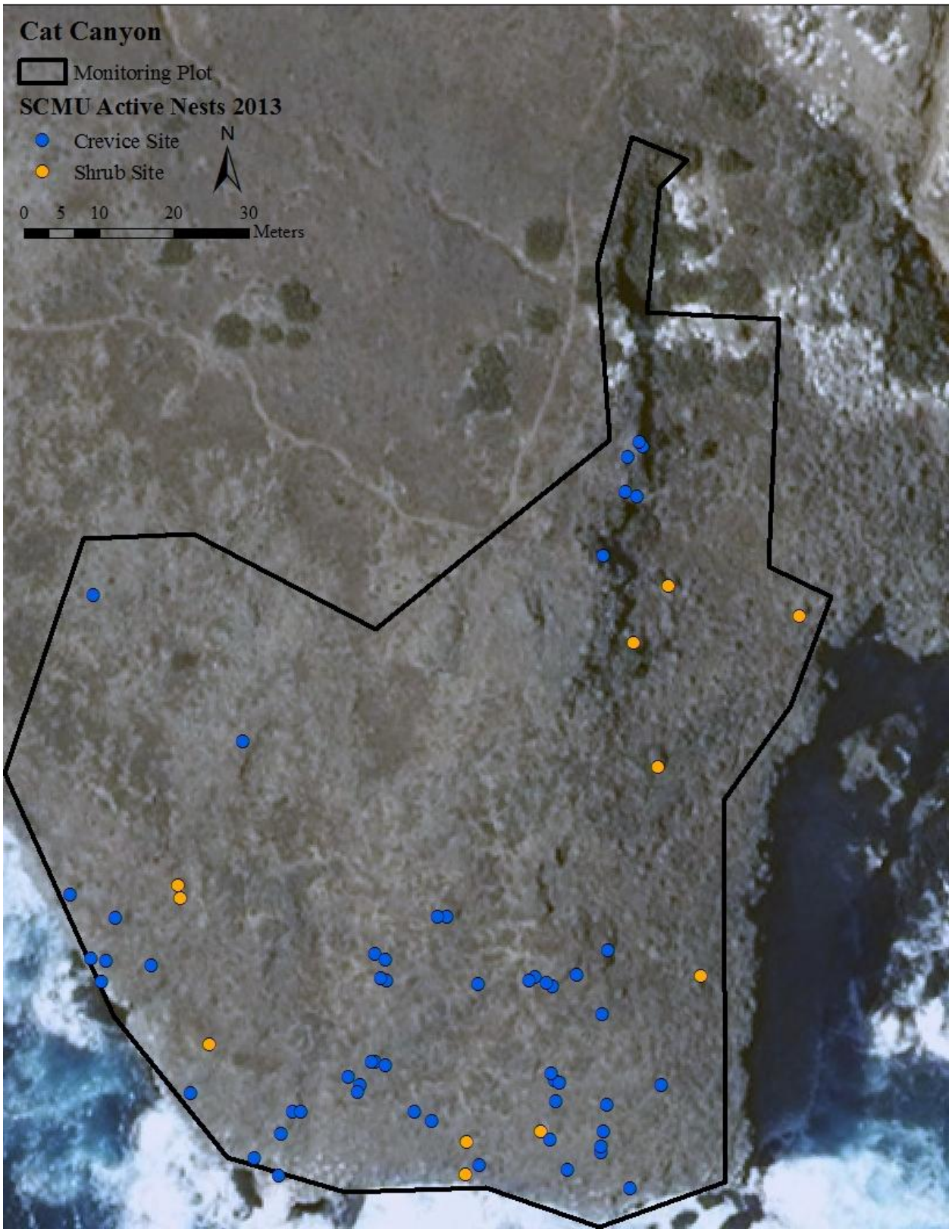


**Figure 4. Active nests in the Cat Canyon Scripps's Murrelet monitoring plot in 2013. Prepared by S.J. Kim.**

**Landing Cove.** Landing Cove plot is located in the northeast portion of the island, and is comprised almost entirely of shrub habitat. Nesting habitat provided by vegetation is mostly Santa Barbara Island Buckwheat, Island Tarweed (*Deinandra clementina*), and Prickly Pear. Nest bowls are often located in the soft soil and leaf litter beneath these plants (less so under cactus, which may be due to observer bias/access).

Landing Cove faces roughly east to northeast, and is generally shielded from the prevailing Northwest wind. It tends to be cooler and more humid than Cat Canyon's climate. The monitoring plot spans the Landing Cove drainage and the adjacent slope to the south, and most of the sites are situated above a 15-30 foot sea cliff. The monitored plot includes the lower section of the Landing Cove restoration plot, and a portion of the southern section overlaps with the historic Nature Trail Plot.

As in other plots, Landing Cove is used by other nesting seabirds, especially California Brown Pelicans, whose presence can close access to portions of the monitoring plot during the pelican nesting season. In 2013, a small portion of the south end of the plot was closed to monitoring after 22 March 2013.

Both known sites and potential habitat were checked at 7 day intervals from 1 March through 12 July (Table1). Excluding short incursions into the plot to check video monitored sites, 20 surveys of the 82 previously tagged sites and available habitat were conducted throughout the season (Appendix 2). Thirteen previously unknown nest sites were located and tagged in 2013. No new nesting was discovered in the portion of the plot that included the restoration plot. The shrubs within the plot were possibly still of insufficient size to support murrelet nesting in 2013.

**Figure 5. Top: Overview photograph of the North side of the Landing Cove plot prior to restoration taken March 2007. From Harvey et al. 2014. Photo: A.L. Harvey. Bottom: Overview of same area of Landing Cove, taken April 2014. Photo: Andrew Yamagiwa.**

Landing Cove experienced the highest clutch success of the main monitored plots, where 64.7 percent (n=51, Table 5) of the nest attempts successfully hatched at least one egg. In the 48 active nest sites, 55 clutches were laid, which was the lowest rate of reuse of all the plots. Approximately 1.1 clutches were laid per site, or one in ten active sites were reused in 2013.

Hatch success at Landing Cove was 58 percent, and 25 percent of eggs observed were later discovered with evidence of depredation (n=85, Table 5).

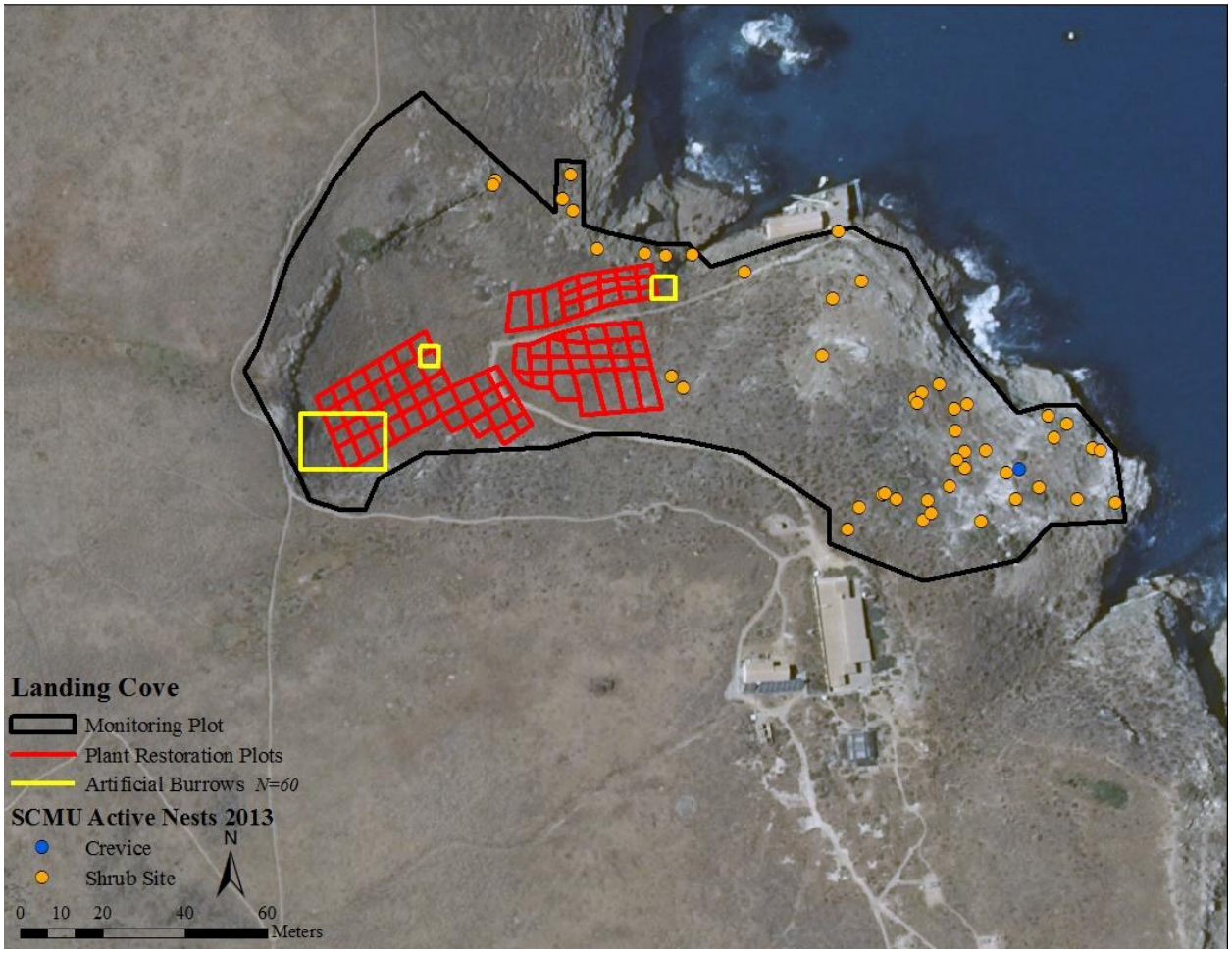


**Figure 6. Active nests monitored in the Landing Cove monitoring plot in 2013. Prepared by S.J. Kim**

**The Dock.** The Dock plot is located in the northeast portion of the island, below the Landing Cove monitoring plot. Nesting habitat is restricted to 15 artificial nest boxes, the area under the dock itself, and one small pocket cave above the dock. No plant cover occurs within the boundaries of the Dock plot.

The microclimate of the dock is cool and humid, and it is almost completely shielded from the prevailing Northwest wind. It is however exposed to any storm activity and the occasionally large south swell that comes into the cove. Most nests are located no more than 15 feet from the water's edge.

Nesting surveys of all potential habitat under and around the dock were conducted at seven day intervals (Table 1). Twenty surveys were conducted from 27 February through 10 July (Appendix 2), excluding limited checks of nest sites with video monitoring equipment (three sites).

Twenty-nine separate nesting attempts occurred in the 19 active sites in 2013 (Table 5). Eleven of 15 nest boxes were active in 2013. The Dock plot experienced clutch success on par with the island wide success rate, with 52 percent of nesting attempts resulting in a successful hatch (n=29 clutches). Approximately 50 percent of eggs laid hatched, and 37 percent of observed eggs were later found with evidence of depredation (n=54 eggs, Table 5, Table 7).

**Bunkhouse Area.** The Bunkhouse area was surveyed 20 times in 2013 for murrelet nesting activity, once per week (7 day intervals, Table 1) from 27 February through 10 July (Appendix 2). These searches involved checking 16 artificial nest boxes and all potential habitat (shrub, crevices, and other nest sites associated with housing and nursery structures) around the house. A total of 33 tagged sites were checked. Only four sites at the Bunkhouse were active, with a total of five clutches (Table 5). Only one nest fledged successfully, H4. Clutch success was 20 percent (n=5 clutches), and 50 percent of the eggs observed were abandoned (n=8 eggs). Two eggs were depredated, for a 25 percent depredation rate (n=8, Table 5).

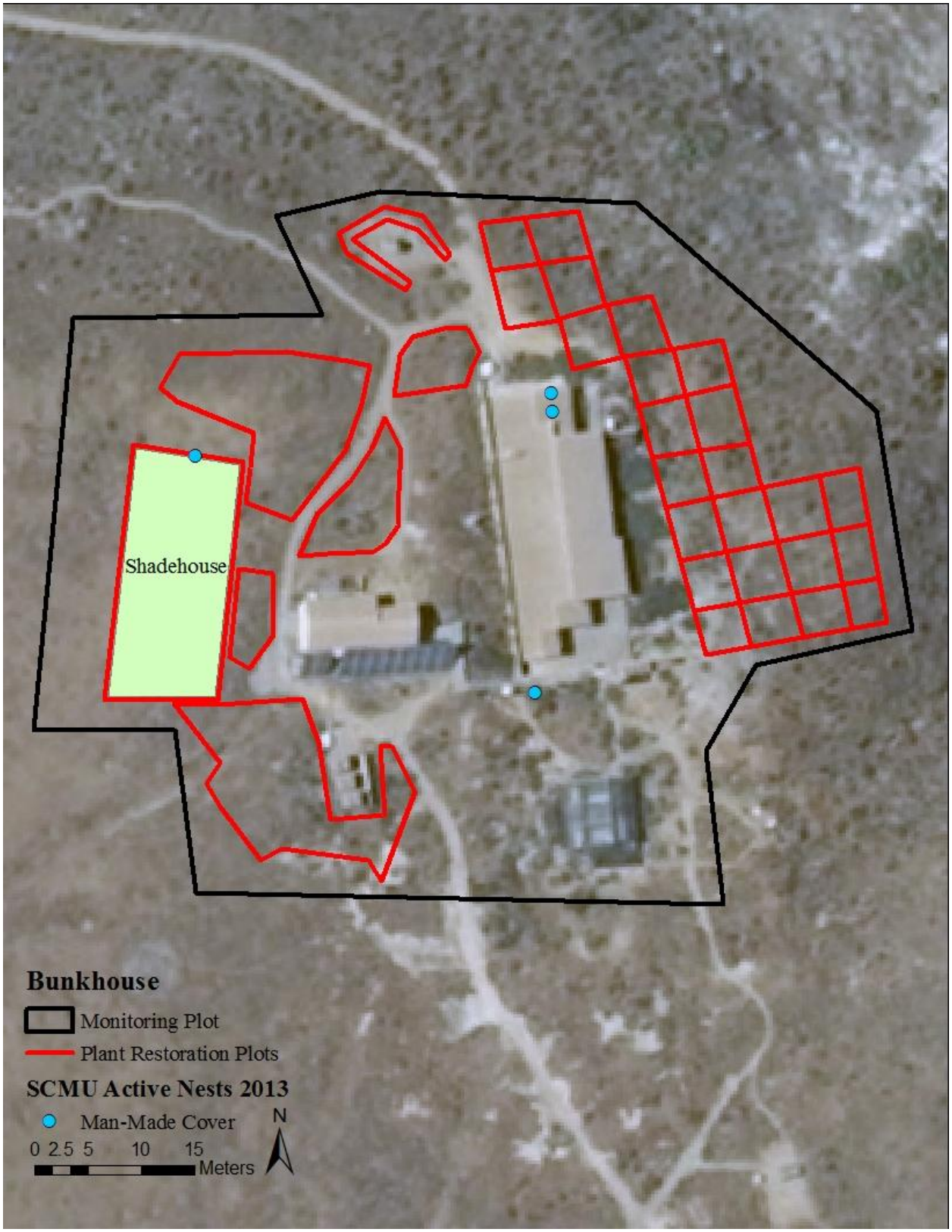


**Figure 7. Active nests monitored in the Bunkhouse monitoring plot in 2013. Prepared by S.J. Kim**

**Elephant Seal Cove Cliffs Restoration Plot**. All potential habitat at Elephant Seal Cove was surveyed periodically (5-18 days between checks, Table 1) in 2013, and included an exposed rock band over native shrub habitat planted since 2008. From 16 March through 25 May (Appendix 2), 6 surveys were conducted to monitor the five marked sites and available habitat. These surveys recorded two successful murrelet nest sites at A2 and A4. A third attempt occurred in site A2, but was not tracked after 25 May and its fate cannot be determined. Hatch success was estimated at 100 percent (n=4). Both sites were located in the rock band at the top of the restoration plot, but A4 was located outside of the plot boundaries to the east of the restoration area.

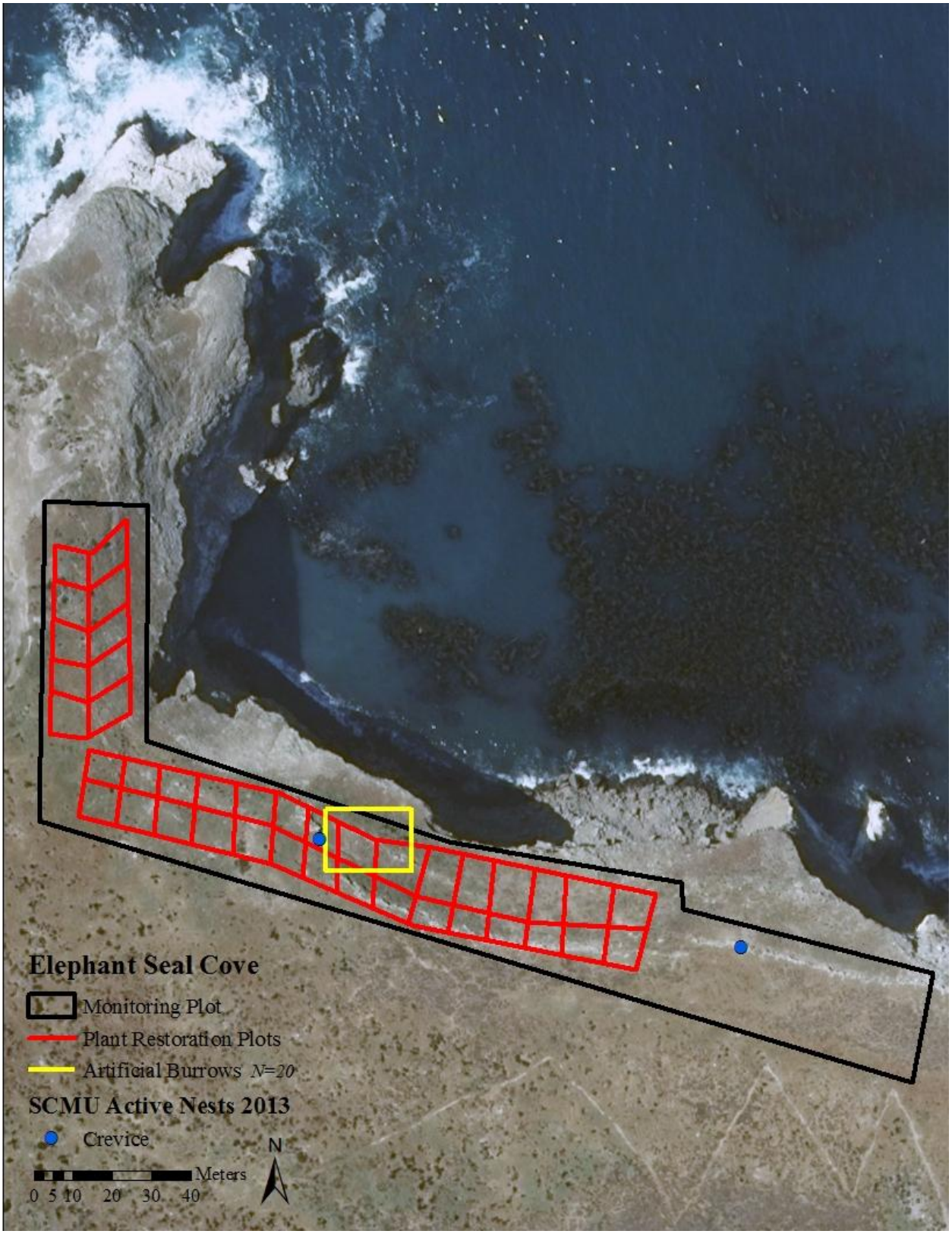


**Figure 8. Active nests monitored in the Elephant Seal Cove monitoring plot in 2013. Prepared by S.J. Kim.**

## SCRIPPS'S MURRELET ISLAND-WIDE MONITORING RESULTS

The 2013 Scripps's Murrelet breeding season lasted 142 days, or just under five months from the first clutch initiation to the latest hatching date (Tables 3, 4). Nest sites were used in up to three separate nesting attempts through the season. The earliest clutch initiation was on 2 February at Arch Point North Cliffs. The median nesting date for first clutches was 11 March. The latest date a previously unused nest site became occupied was 30 May. Median and latest initiations for all clutches occurred on 16 March and 3 June, respectively. Median dates represent the point at which 50 percent of the nests that would occur in the season had been initiated.

The first hatching occurred on 17 March at Arch Point-North Cliffs, and the latest hatch date observed in 2013 was 1 July at Cat Canyon; median hatch date occurred on 22 April 2013.

**Table 3. Scripps's Murrelet clutch initiation dates from all monitoring locations in 2013**

| Statistic | Clutch Initiation Date (all clutches combined) | Clutch Initiation Date (first clutches only) |
|---|---|---|
| N | 192 | 140 |
| Earliest Day | 2 February | 2 February |
| Latest Day | 3 June | 30 May |
| Mean Day | 23 March | 13 March |
| SD (days) | ±28 | ±20 |
| Median Day | 16 March | 11 March |

**Table 4. Scripps's Murrelet hatching dates at all monitoring locations in 2013.**

| Statistic | Hatch Date (all clutches combined) | Hatch Date (first clutches only) |
|---|---|---|
| N | 99 | 76 |
| Earliest Day | 17 March | 17 March |
| Latest Day | 1 July | 11 June |
| Mean Day | 26 April | 17 April |
| SD (days) | ±25 | ±18 |
| Median Day | 22 April | 15 April |

We consistently monitored 229 Scripps's Murrelet clutches in 170 active nest sites on Santa Barbara Island in 2013, and detected another 12 active nests in the Boxthorn Plot, for a total of 241 clutches in 182 active sites (Table 5). The 12 sites at Boxthorn Plot were recorded only once, due to California Brown Pelican nesting, and were not included in calculations of fate.

Island wide clutch success was approximately 51 percent, and ranged from 20 percent at the Bunkhouse Plot to 65 percent at Landing Cove (n=220 clutches). The number of clutches per site

varied from 1.10 to 1.50, with highest rates of reuse at the Arch Point and Dock plots (Table 5). Thirty-two percent of sites at Arch Point North Cliffs were used more than once, the northeastern plots- Landing Cove, Bunkhouse, and the Dock area- held a combined 20 percent, and 21 percent of sites at Cat Canyon produced multiple clutches (Table 6). Clutch success of first clutches was higher than second clutches, 55 percent (n=164) versus 42 percent (n=50). Seventeen percent of third clutches (n=6) hatched at least one egg (Table 6).

**Table 5. Scripps's Murrelet reproductive success at Santa Barbara Island in 2013.**

| Reproductive metric | APNC | CC | DO | BH | LACO | All |
|---|---|---|---|---|---|---|
| Active Sites | 30 | 67 | 19 | 4 | 48 | 182 |
| Total Clutches | 46 | 91 | 29 | 5 | 55 | 241 |
| % Clutch Success[1] | 57% | 40% | 52% | 20% | 65% | 51% |
| Clutch Success (n) | 44 | 89 | 29 | 5 | 51 | 220 |
| Hatch Success [2] | 53% | 29% | 50% | 25% | 58% | 44% |
| Egg Depredation[3] | 33% | 69% | 37% | 25% | 25% | 46% |
| Egg Metrics (n) | 73 | 150 | 54 | 8 | 85 | 374 |
| Clutches per site | 1.5 | 1.4 | 1.5 | 1.3 | 1.1 | 1.3 |

1 Clutch Success as percentage of known fate clutches that hatch at least one chick (n=number of clutches with ≥1 hatched egg).

2 Hatch Success as number of eggs hatched per egg laid (n=hatched eggs).

3 Depredation Rate as number of eggs depredated per eggs laid (n=depredated eggs).

**Table 6. Clutch success of subsequent nesting attempts within discrete nest sites in 2013.**

| Clutch | APNC | n | BH | n | CC | n | Dock | n | LACO | n | All | n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 65.5% | 29 | 25.0% | 4 | 41.5% | 65 | 47.4% | 19 | 71.1% | 45 | 54.9% | 164 |
| 2 | 35.7% | 14 | 0.0% | 1 | 47.4% | 19 | 60.0% | 10 | 16.7% | 6 | 42.0% | 50 |
| 3 | 100.0% | 1 | -- | -- | 0.0% | 5 | -- | -- | -- | -- | 16.6% | 6 |

n= number of individual nesting attempts within each clutch category

In 2013, 170 nest sites provided reliable enough observational data to determine fates for 374 eggs (Table 7). Forty-four percent (n=374 eggs) of these eggs hatched successfully. A total of 210 eggs were observed to fail, and 171 were determined to have been depredated by mice, 16 were abandoned before being fully incubated, 6 addled eggs failed to hatch after a full incubation period, and 5 eggs were found broken in the nest. Ten eggs disappeared before their earliest possible hatch date, and were unable to be accounted for despite searches of nearby habitat (Table 7). Because a fate could not be determined for eggs that disappeared before a possible hatch date, these eggs are considered as failed and entered into calculations accordingly.

As observed last year, hatch success was highest at Landing Cove sites, and lowest at Bunkhouse; depredation rates were highest at Cat Canyon, which has been consistently higher

than other plots in past years as well (Schwemm et al. 2005, Harvey and Barnes 2009, Harvey et al. 2012, 2013b, 2014). Where egg order was recorded and known, depredation rates were higher for first eggs (54 percent, n= 145) than second eggs (32 percent, n=143; Table 8). The only observed eggs that were abandoned were found at the Northeastern Plots (Landing Cove, Dock and Bunkhouse), where nearly 11 percent (n=147) were abandoned. No abandonment was observed at the other monitored plots (Table 7).

**Table 7. Scripps's Murrelet egg fates at Santa Barbara Island in 2013 from the five basic monitoring plots. Fates in italics are primary causes of failure of unhatched eggs.**

| Fate | APNC | BH | CC | DO | ESC | LC | ALL |
|---|---|---|---|---|---|---|---|
| Hatch | 39 | 2 | 43 | 27 | 4 | 49 | 164 |
| Fail | 34 | 6 | 107 | 27 | 0 | 36 | 210 |
| Depredated | 24 | 2 | 104 | 20 | 0 | 21 | 171 |
| Abandoned | 0 | 4 | 0 | 5 | 0 | 7 | 16 |
| Addled | 1 | 0 | 0 | 1 | 0 | 4 | 6 |
| Broken | 2 | 0 | 2 | 1 | 0 | 0 | 5 |
| Chick died in nest | 0 | 0 | 1 | 0 | 0 | 1 | 2 |
| Disappeared | 7 | 0 | 0 | 0 | 0 | 3 | 10 |
| Total | 73 | 8 | 150 | 54 | 4 | 85 | 374 |

**Table 8. Percentages of first versus second Scripps's Murrelet eggs depredated by mice on Santa Barbara Island in 2013. See text for details.**

| Egg | APNC | BH | CC | DO | LC | ALL |
|---|---|---|---|---|---|---|
| First Egg | 36% | 33% | 84% | 38% | 27% | 54% |
| N | 25 | 3 | 61 | 24 | 30 | 145 |
| Second Egg | 14% | 0% | 53% | 32% | 10% | 32% |
| N | 22 | 0 | 60 | 25 | 31 | 143 |

**Clutch success relative to nest site description.** As discussed above, naturally occurring Scripps's Murrelet nesting habitat on Santa Barbara Island consists of both rocky crevice and native shrub cover (Table 9). Of the 220 active nest sites monitored in 2013, 66 were located in native shrubs, 125 in natural rock crevices, 17 in artificial nest boxes, and the final 12 were located under manmade structures not originally intended to provide for seabird housing, such as under the dock and house decking.

Within these categories, clutch success was highest within the artificial habitat provided by nest boxes (64.7 percent, n=17). The most successful native habitat type were shrub sites (63.6 percent, n=66) then rocky crevice nests (44.0 percent, n=125). The least successful nest sites were found under the manmade structures (33.3 percent, n=12; Table 10). Consistent with island-wide observations, depredation rates were highest in rocky crevice sites (56 percent,

n=210 eggs, i.e. Cat Canyon) and lower in shrub sites (33 percent, n=110 eggs, i.e. Landing Cove). The higher clutch success seen in nest boxes seems to be related to the much lower depredation rate seen in that nest type (18 percent, n=32, Table 10).

**Table 9. Active Scripps's Murrelet nest site types at Santa Barbara Island in 2013. Numbers are for sites where fate of the nest was determinable**

| Site Type | APNC | BH | CC | DO | ESC | LC | Total |
|---|---|---|---|---|---|---|---|
| Crevice | 44 | 0 | 74 | 5 | 2 | 0 | 125 |
| Nest box | 0 | 0 | 0 | 16 | 0 | 0 | 16 |
| Shrub | 0 | 0 | 15 | 0 | 0 | 51 | 66 |
| Under Structure | 0 | 5 | 0 | 8 | 0 | 0 | 12 |
| Total | 44 | 5 | 89 | 29 | 2 | 51 | 220 |

**Table 10. Scripps's Murrelet clutch success (CS) and egg depredation rates by site type and plot at Santa Barbara Island in 2013. See Table 9 for sample sizes.**

| | | CS per Monitoring Plot | | | | | |
|---|---|---|---|---|---|---|---|
| Site Type | Depredation Rates | APNC | BH | CC | DO | LC | Total |
| Crevice | 56% (n=210) | 56.8% | -- | 36.5% | 20.0% | -- | 44.0% |
| Nest box | 19% (n=31) | -- | -- | -- | 68.8% | -- | 68.8% |
| Shrub | 33% (n=110) | -- | -- | 60.0% | -- | 64.7% | 63.6% |
| Under Structure | 48% (n=23) | -- | 20.0% | -- | 37.5% | -- | 30.8% |
| Total | 46% (n=374) | 56.8% | 20.0% | 40.4% | 51.7% | 64.7% | 50.9% |

## OTHER SEABIRD SPECIES

### Cassin's Auklet.

Cassin's Auklet monitoring on Santa Barbara Island in 2013 was restricted to incidental observation of auklets within Scripps's Murrelet monitoring efforts, and approximately bi-weekly surveys of 100 artificial burrows installed since 2009 at three restoration plots: Landing Cove, Northeast Flats, and Elephant Seal Cove.

**Arch Point North Cliffs.** Several likely active sites were located in 2013, but as in previous years, the only confirmed site was APNC 1303. An incubating adult was first detected on 21 February, and a chick was seen in the nest cavity on subsequent checks through 7 April. Cassin's Auklets typically fledge at 41 days, which fits the interval seen in this case. This site was first found in 2009, and has been active every year since, and is the first auklet site confirmed on Santa Barbara Island since 1994 (Whitworth et al. 2011). Cassin's Auklets were also observed on camera traps placed at a rock jumble that may have contained multiple nests. No eggs or chicks were seen, but multiple individual auklets were confirmed at these sites. Further investigation

aimed at assessing the extent of auklet use of this area would be beneficial, including the use of burrow scopes, motion activated video or still cameras, audio recording units, and possibly mist netting efforts.

**Landing Cove.** The 60 artificial nest burrows in the Landing Cove Restoration Plot installed in 2009-2011 were located in three main areas, named the Upper Landing Cove, Middle Landing Cove, and Lower Landing Cove Condos (Figure 6, Harvey et al. 2013b). Each group consisted of 20 individual artificial burrows. The lower and middle condos were situated in a tight cluster with plywood covers, while the upper condos were placed 1-3 meters apart in the upper drainage. Social attraction was discontinued in 2011 and not reinstated in 2013 due to the elevated mortality attributed to the island's Barn Owl population keying in on the calls and predating on the investigating auklets (Thomsen et al. 2013). Motion triggered infrared cameras were set up at the two lower clusters, and one motion triggered video camera was installed at the lower condos. Artificial burrows were checked generally every 2 weeks between 2 January and 7 June (Appendix 4).

Minimal activity was recorded by researchers and camera footage at the artificial burrows. No nesting was observed at any artificial site in 2013, versus five active sites in 2012, of which none were confirmed fledged (Harvey et al 2014). One auklet was observed on motion activated camera early in the 2013 season prospecting and possibly excavating natural burrow #100 under the lower Landing Cove auklet complex, but abandoned the effort after only a few days. Barn Owls were seen sporadically on the lower condo cameras, and footage of a murrelet being depredated was obtained from the lower condo video monitoring.

**Northeast Flats Restoration Plot.** The 20 artificial burrows in the southeastern portion of the plot (Figure 9) were surveyed every 2 weeks between 13 January and 8 June (Appendix 4). No seabird nesting activity was recorded within the artificial burrows in 2013.

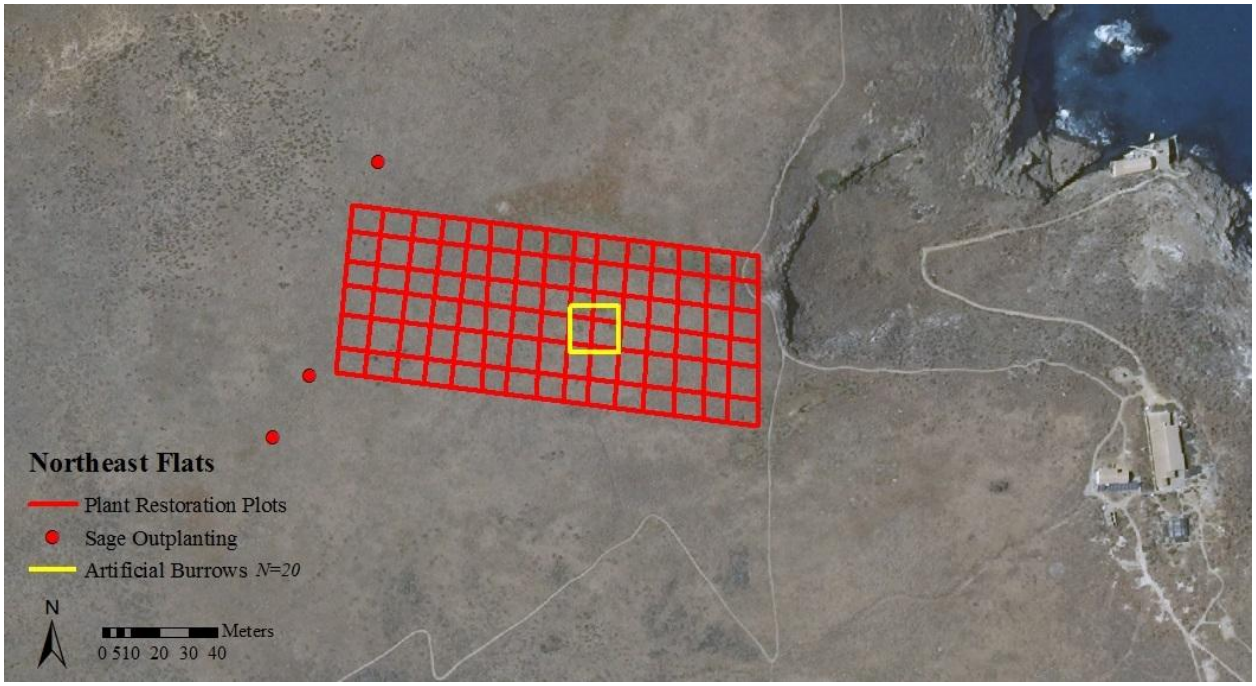


**Figure 9. Northeast Flats restoration plot area and artificial habitat locations. Prepared by S.J. Kim.**

**Elephant Seal Cove Restoration Plot.** In 2013, two active auklet nests were observed within the plot in 2013. On 16 March, nest number A5 was discovered to contain an adult auklet sitting on an egg. This egg failed to hatch and was not monitored after 25 May. On 13 April, A3 contained hatched eggshell fragments. These fragments may or may not have been from the previous years' successful fledge. No auklet nests monitored at the Elephant Seal Cove restoration plot could be reliably determined to have fledged a chick in 2013. At the artificial burrows located within the Elephant Seal Cove plot, no seabird activity was recorded in 2013 (Figure 8).

**Other species in artificial burrows.** Despite a lack of seabird activity, artificial habitat at all of the locations was utilized by several species on the island in 2013. Island Deer Mice (*Peromyscus maniculatus elusis*) were observed at all locations, and Island Night Lizard (*Xantusia riversiana*) was recorded at both Landing Cove and Northeast Flats artificial burrows. One Burrowing Owl (*Athena cunicularia*) was consistently seen at Landing Cove Upper Condo # 17. Many species of island arthropods were also seen during checks. All data are archived at Channel Islands National Park for future use.

**Ashy Storm-Petrels.** Nest searches and monitoring for Storm-Petrels was also restricted to incidental observation within Scripps's Murrelet monitoring protocols. No additional effort was attempted to assess Storm-Petrel nesting at Santa Barbara Island in 2013.

**Arch Point North Cliffs.** Ashy Storm-Petrel presence was observed at five sites at Arch Point-North Cliffs, and three nests were confirmed in 2013; APNC 1328, 1329, and 1330 held adult Storm-Petrels with eggs during several checks. None succeeded in fledging chicks, and on 30 June, motion activated cameras recorded Barn Owl investigation of Ashy Storm-Petrel nest sites prior to nest failure.

**Other plots.** No other Ashy Storm-Petrel nest sites were identified in 2013; however, several locations were identified as having the odor of Storm-Petrel. Included in these sites are a small cave below housing within the Landing Cove Plot, and a few inaccessible sites below Cat Canyon's monitoring area where the Storm-Petrel scent was detected but could not be safely investigated.

## SEABIRD MISTNETTING AND AT-SEA CAPTURES

**Scripps's Murrelet.** On four capture nights from 15 May through 21 May 2013, 52 individual Scripps's Murrelets were captured using nocturnal dip net/spotlighting protocols outlined in Whitworth et al 1997. Of these, 49 individuals were released with new bands deployed (USGS size 2), one bird was released without a band, and 3 were previously banded (Table 11). Of these recaptured birds, one was a same-night recapture, one was a recapture from 2012, and one was an adult first banded in 1995 as an after hatch year bird. Thirty-one percent of captured birds had brood patches (n=52). One Ashy Storm-Petrel flew into the capture vessel on 20 May and was banded with a USGS band.

**Table 11. Scripps's Murrelets captured during at-sea banding efforts at Santa Barbara Island in 2013.**

| Survey Night | New | Recapture | Total | # Brood Patch Present |
|---|---|---|---|---|
| 15-16 May 2013 | 14 | 1 | 15 | 1 |
| 17-18 May 2013 | 12 | 1 | 13 | 4 |
| 19-20 May 2013 | 17 | 1 | 18 | 6 |
| 20-21 May 2013 | 6 | 0 | 6 | 5 |
| Total | 49 | 3 | 52 | 16 |

**Table 12. Scripps's Murrelet recaptures in 2013 of birds banded in previous years at Santa Barbara Island.**

| Band Number | First Banding Date | Recapture Date | Brood Patch Present |
|---|---|---|---|
| 1262-03150 | 16 March 2010[1] | 16 May 2013 | Yes |
| 0892-98104 | Spring 1995[2] | 17 May 2013 | Yes |
| 1322-22035 | 20 May 2013 | 20 May 2013 | Yes |

[1] Birds originally banded in 2009 and 2010 were reported in Whitworth et al. 2011

[2]Whitworth et al. 1995 Progress Report did not specify by band number

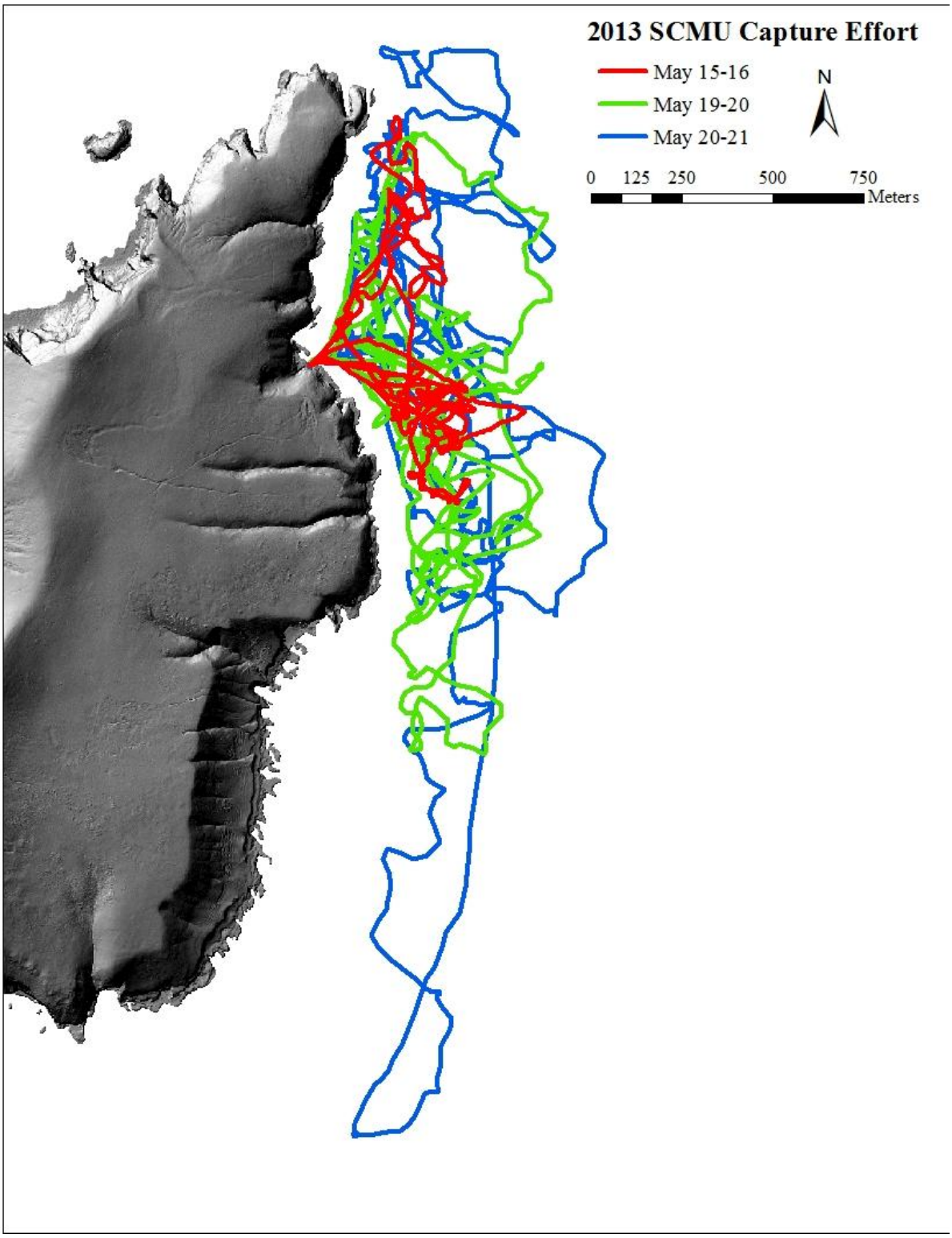


**Figure 10. Search areas for Scripps's Murrelet at-sea mark-recapture efforts at Santa Barbara Island in May 2013. GPS track data for 17-18 May was unavailable. Prepared by S.J. Kim.**

**Cassin's Auklet.** No mist-netting or other capture method was implemented in 2013 to collect data on Cassin's Auklets nesting at Santa Barbara Island. A nocturnal audio survey was conducted at dusk during the week of 16 - 23 January 2013 at Elephant Seal Point, confirming continued Cassin's Auklet presence at this location.

**Storm-Petrel species.** From 9-11 August 2013, limited mist-netting was performed with the assistance of CSU-Northridge Professor Fritz Hertel and Master's student Josh Sausner. During three net-nights, morphometrics were collected on three Black Storm-Petrels and one Ashy Storm-Petrel. Two of three Black Storm-Petrels were incubating (by evidence of fully naked brood patches) and the third Black and only Ashy Storm-Petrel's brood patches were mostly refeathered. Data is archived at the Channel Islands National Park headquarters.

# DISCUSSION

The seventh year of alcid monitoring related to restoration activities on Santa Barbara Island was conducted in 2013. The monitoring effort was largely directed toward nest monitoring of the Scripps's Murrelet, formerly Xantus's Murrelet, recently accepted as a species separate from the Guadalupe Murrelet (Chesser et al. 2012). No Guadalupe Murrelets are thought to breed on Santa Barbara Island at present, though they have been recorded as breeding in the past (Hunt et al. 1978). In 2010, a single individual was recorded during spotlight surveys off of Webster Point (Whitworth et al. 2011), possibly during post breeding dispersal. As a result of the murrelet-heavy focus of the monitoring effort, other species that are accounted for in this report are only incidental to the monitoring protocols, and cannot be truly quantified as to their utilization of Santa Barbara Island as a breeding location. Only presence can be documented from the small numbers of Ashy Storm-Petrels and Cassin's Auklets located in the murrelet monitoring plots.

**Reproductive success.** For the Scripps's Murrelet population of Santa Barbara Island, this season saw another decrease in island-wide clutch success, for the third season in a row. Fifty one percent of all clutches laid hatched at least one chick, compared to 62 percent in 2012, and 68 percent in 2010 (Harvey et al. 2014). The highest factor in clutch failure was egg depredation, and approximately 46 percent of all eggs monitored showed evidence of depredation as the cause of failure. The 2002 species assessment for the Xantus's murrelet (Burkett et al. 2003), and other studies (Murray et al. 1983, Schwemm and Martin 2005) identified deer mouse predation at breeding locations as a major obstacle to the long-term success of the Scripps's Murrelet. From the data collected this year, more eggs were depredated than hatched- 46 percent versus 44 percent of the 379 eggs observed- and this year's depredation rate is more than twice the observed rate of 20 percent from 2012 (Table 5, see Harvey et al. 2014). This increase occurred across the island as all monitored plots experienced a much greater amount of depredation compared to 2012 numbers. The highest percentages came from Cat Canyon, which lost almost

70 percent of all eggs observed, and has consistently had the highest depredation rates. This is nearly double the depredation from 2012 when Cat Canyon showed the highest at 36 percent. The observed depredation rate at Landing Cove increased from 9 percent in 2012 to almost 25 percent in 2013.

Hatch success was highest at Landing Cove and Arch Point, and lowest at Cat Canyon. Landing Cove and the Dock sites had the same hatch success for 2012 and 2013, 57 percent and 50 percent respectively. Arch Point was not monitored adequately in 2012 and was not counted in the island-wide calculations, but in 2013 had a 57 percent clutch success, just under the island-wide success rate from 2012, and very similar to the aforementioned plots. This places the apparent decrease in island-wide productivity heavily on the sheer volume of failed eggs at Cat Canyon, which hatched 29 percent in 2013.

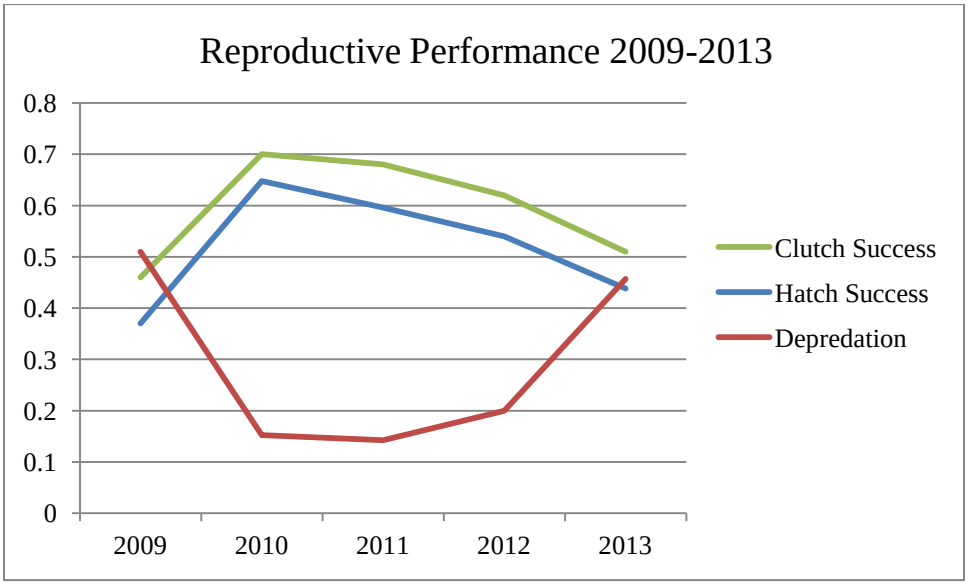


**Figure 11. Comparison of clutch success, hatch success, and depredation rates for 2009-2013.**

The last five years' clutch success percentages from Santa Barbara Island show an oscillation between a low of 45 percent (2009) to a high of 70 percent (2010, Figure 11). Depredation rates at Cat Canyon in 2009 were higher than in 2013, 77 percent in 2009 compared to 69 percent in 2013 (Harvey et al. 2012). A decreasing population trend indicated by Nur et al. 2013 and the annual decrease in estimated clutch success rates (Harvey et al. 2013b, Harvey et al. 2014, this report) should be watched carefully in case the population continues to decline despite restoration efforts.

**Predation.** Sometime between 1897 and 1908, feral cats were introduced to Santa Barbara Island, and remained through the late 1970s. Hunt et al. (1978) posited that an observed increase in numbers of nesting murrelets on Santa Barbara Island might have been related to the absence

of feral cats, and the extirpation of Peregrine Falcons, which were notably absent from the island during the 1975-1977 study. They also note that a single pair of breeding falcons in British Columbia could prey upon nearly 1000 Ancient Murrelets per year (citing Nelson and Myers 1976), which are only slightly larger than Scripps's Murrelets. In 2007, one active Peregrine Falcon territory was observed on Santa Barbara Island (Latta 2012). In 2013, researchers located three separate breeding territories of Peregrine Falcon, and nest content analysis of one of the nests from Santa Barbara Island contained 12 individuals of Scripps's Murrelet, and only two other species samples (Sharpe 2014). An assessment of the predation pressures exerted by Barn Owls on Scripps's Murrelets identified owls as responsible for approximately 30% of all murrelet mortality on Santa Barbara Island. While the owl diet is mainly focused on island deer mice, this impact is partially responsible for a 1.17 – 2.9 percent annual decrease in the Santa Barbara Island Scripps's Murrelet population (Nur et al. 2013). Compounding this, egg depredation by the island deer mouse is ubiquitous, and responsible for the loss of 46 percent of the eggs observed in 2013. Relocation efforts for deer mice at Cat Canyon in 2004 (Millus et al. 2006) resulted in a substantial reduction in depredation rates, to 20.5 percent (n=15 eggs) versus the 1993-2005 average of 36.7 percent. Of 1652 individuals relocated, only 8 returned, and depredation rates in 2005 remained below the calculated average.

**Egg Abandonment.** Whole eggs that have not reached the full term incubation and have been neglected for more than 19 days (Murray et al. 1983) are considered abandoned. Neglect periods occurring during the 8 days between clutch initiation and completion are considered normal. In 2013, first laid eggs were depredated at a higher rate than second laid eggs (Table 8). No abandoned eggs were observed at Cat Canyon or Arch Point in 2013. This could be related to the possible depredation of abandoned eggs at these locations, which in Cat Canyon especially could be the case. Both plots lost a substantial number of eggs to presumed depredation, and while we can observe depredated eggshells at these sites, we cannot determine the reason they were available to the mouse. Requiring 19 days of neglect may skew the count of "abandoned" eggs toward the "depredation" category by allowing them to be an available food item for a longer period.

The only observed abandoned eggs in 2013 were found at the northeastern plots, which are very near the few buildings on Santa Barbara Island. The two highest rates of abandonment were observed at the Dock and the Bunkhouse plots, which are directly associated with human structures. The perching locations that are associated with these structures may provide an attractive location for the island's Barn Owls, which in turn may prey upon a higher number of murrelets within the local area. Nesting murrelets and their eggs are susceptible to predation during incubation shift changes or during departure from the nest for foraging trips. Periodic neglect by attending adults occurs throughout the incubation period (Murray et al. 1983), but if the adult does not return, the eggs are assumed to be to be abandoned after 19 days.

The human disturbance associated with the Dock and Bunkhouse sites may also affect the nesting birds. Machinery operations at the dock include high decibel engine noise and vibration of the dock structure. Human traffic there and at the NPS Visitor Center within the Bunkhouse Plot could affect nesting murrelets beneath the decking of these structures. Human disturbance has been identified as a cause of nest abandonment and a major threat to this and other seabird species (Anderson and Keith 1980, Murray et al. 1983, Burkett et al. 2003, Schwemm et al. 2005, Harvey and Barnes 2009, Harvey et al 2013a, 2013b, 2014), and should continue to be minimized through the nesting season.

**Monitoring Effort.** The Santa Barbara Island seabird team monitored 62 more active sites in 2013 than in 2012, including 28 previously undetected nest sites. A total of 414 tagged sites were monitored through the season, of which 182 were active. Assuming each tagged site represents a usable nest cavity, 43 percent of the marked habitat was occupied, not including unmarked available habitat. It would stand to reason that murrelets have potential to expand their nest areas instead of reutilizing previously occupied nests. It may be beneficial to the scope of the restoration effort to find out why these sites are reused preferentially to the potential site (shrub or crevice) mere centimeters away. With nest sites being reused through the season, as many as three times, quantifying the microhabitat parameters might be a good way to assess and inform continued restoration efforts on Santa Barbara Island. As murrelet chicks leave the nest site within two days of hatching, and are not capable of flight, a shrub site too far from the edge of the island might translate to an unacceptable expenditure of effort or risk of exposure for chicks, or for adults as they move to or from the ocean. Scripps's Murrelets are known to have high site fidelity (Murray et al. 1983), reusing the same nest cavity for years, but it is yet to be determined as to what mechanisms are involved in the expansion of these colonies. The testing of genetic samples (i.e., eggshells and membranes) collected at nest sites of consistent annual use and repeated in-season use may help us to understand the site selection of murrelets reaching breeding age, if they nest in proximity to genetic relatives or go far away from any relatives. This knowledge could also aid our restoration process, in that if they will nest preferentially near relatives, using these known nest locations as islands to expand from and increasing cover locally (infilling) would perhaps benefit the population and augment the larger scale restoration efforts. The selection of restoration locations near active alcid nesting areas has been the reasoning behind the locations of all of the current restoration plots, and as they establish and expand, this should continue to be one of the major criteria for decisions on the direction of expansion as well as in establishing new restoration plots.

The Arch Point-North Cliffs plot was monitored every two weeks based on a schedule that allowed researchers with higher technical ability and competency in working on exposed cliff habitat to monitor this location. Most fates were able to be determined with a good confidence level, though in some instances (i.e., eggs that disappeared) a tighter interval may have provided better egg fate and fate date accuracy. The increase in monitoring from 2012, when the sites were

checked just 4 times, provided 46 clutches for the island-wide clutch success calculations, and is comparable to the numbers seen at Landing Cove. Additionally, the north coast monitoring plots (Arch Point and Elephant Seal Cove) were the only locations in which Cassin's Auklets were found nesting, and Arch Point contained the only Ashy Storm-Petrel nesting detected on Santa Barbara Island. Black Storm-Petrels with naked brood patches (likely incubating) were captured immediately above the Arch Point North Cliffs monitoring plot. The diverse assemblage of seabirds nesting in and around this plot, and the fact that it is easily accessible by land, makes it a valuable and interesting part of the monitoring protocols for the island. Arch Point should therefore continue to be monitored for activity in the future, and where possible, checks should be increased to at least weekly to compare to the other monitoring plots. This plot could serve as both a comparison to habitat at Cat Canyon and in juxtaposition to Landing Cove's habitat. In the 2009-2010 population assessment, Whitworth et al. (2011) performed extensive surveys of the Arch Point area, and these surveys should be revisited as the five year anniversary of those surveys arrives.

**Murrelet Captures.** The dip-net captures of Scripps's Murrelets in May of 2013 revealed some interesting new information about the species. Two chicks and an attending adult were banded on May 19, 2013. An additional adult stayed nearby, and as the chicks were calling three more adults gathered nearby the boat and were calling. Biologists recorded the event, and the resulting audio recording is possibly the first recorded at-sea chick vocalization. The banded chicks are important for a species that has very few known age birds in the population. From the apparent attraction of the adult birds in the area to the calling chicks, it would be interesting to examine the mist-netting opportunities that playing chick vocalizations may open up for locations where it would be difficult to use the spotlighting technique.

On May 17, 2013, a Scripps's Murrelet with USGS band number 0892-98104 was recaptured near Landing Cove. This bird was first captured and banded as an After Hatch Year bird in 1995 and recaptured on May 5, 2010 (Whitworth et al. 2011). This would make this individual at least 19 years of age (min. age 1 in 1995 +18 years) and the oldest recorded Scripps's Murrelet. This bird had a refeathering brood patch, so is likely still breeding at this age.

**Cassin's Auklets.** Cassin's Auklets did not use the artificial burrows in 2013, but were still present at the island. The social attraction used in 2011 was not reinstated, and both middle and lower auklet artificial burrows were redistributed throughout the Landing Cove drainage in November of 2013, as Barn Owls had been recorded perching on the cover structures, and several feather piles identified as Cassin's Auklet were found in the immediate vicinity.

Arch Point North Cliffs nest site 1303 successfully fledged a chick in early April, and other Cassin's Auklets were seen in the monitoring plot on motion activated infrared cameras. At least two sites at Elephant Seal Cove contained evidence of auklet activity, though no confirmed

fledging could be determined. Ten auklet carcasses were collected on Santa Barbara Island, and nesting was observed at Elephant Seal Cove and Arch Point. One live adult individual was found at Cat Canyon ensnared by cholla cactus (*C. prolifera*) and died overnight. No nest was found.

In January 2013, an audio survey was conducted at Elephant Seal Point and substantial auklet calling and activity was reported. This area was first identified as a nesting colony in 1976, was reaffirmed in 1991 (Whitworth et al. 2009, Carter et al. 1992), and recently estimated to contain at least 7 pairs (Whitworth et al. 2011). More effort is required to quantify this location's breeding population, possibly including mist-netting for attending adults. A more directed approach to monitoring specifically for Cassin's Auklets might aid the restoration effort by locating future restoration priorities for the species. Historically, Santa Barbara Island held a large number of nesting auklets, which were nearly wiped out by ranching activities and introduced feral cats, and the species has been recovering slowly since the turn of the last century. Restoring this large colony is and should be a priority goal for the future restoration efforts on Santa Barbara Island.

**Storm-Petrel species.** Ashy Storm-Petrels were recorded in five sites at Arch Point North Cliffs, and three contained evidence of nesting (visible eggs or eggshells). The other two sites likely represented instances of prospecting for nest sites. A Barn Owl was recorded on infrared motion activated camera entering the small cave with at least two nests which failed soon after. Other locations around Santa Barbara Island were suspected of Storm-Petrel activity, including a small cave directly below housing at Landing Cove, and a few locations below the monitoring plot at Cat Canyon. These were identified by the presence of the musty Storm-Petrel scent and small amounts of visible fresh guano at entrances. These locations could not be confirmed for safety reasons.

One Ashy Storm-Petrel was captured during Scripps's Murrelet banding operations (it landed in the capture boat) and was banded and released offshore southeast of the Sea Lion Rookery. Mist-netting efforts for Black Storm-Petrels in August of 2013 resulted in the banding of one Ashy Storm-Petrel, with a refeathering brood patch, and three Black Storm-Petrels, two of which had fully pink, naked brood patches. This provides evidence for the existence of a small number of Black Storm-Petrels likely breeding on offshore rocks near Santa Barbara Island, and coming fairly close to the northern coast as these individuals were captured between Arch Point and the Shag Rock Overlook, just east of North Peak. More effort will be necessary to assess the extent to which Black Storm-Petrels use Santa Barbara Island and its offshore rocks for breeding sites.

# RECOMMENDATIONS FOR FUTURE MONITORING

**Scripps's Murrelet.** Many recommendations have been made as to the future restoration and management of the Santa Barbara Island seabird colony. Past annual reports and studies (Harvey

et al. 2013b, 2014) have encouraged the continued monitoring of Scripps's Murrelet, Cassin's Auklet and other seabirds utilizing Santa Barbara Island during their nesting season, and the continued restoration of native, accessible habitat to promote and expand the current populations thereof.

In addition to these general recommendations, future monitoring efforts may be improved by the following (based in part on recommendations in Harvey et al. 2014):

1) **Yearly Reporting.** Continued yearly reporting should remain a priority, to provide up-to-date species information for future management/restoration decisions. These reports should include breeding phenology (clutch initiation/hatch dates, numbers of clutches per site, etc.), calculations of clutch success, hatch success and depredation, and updates on restoration plot utilization. These figures should be compared between plots and be comparable between years for Santa Barbara Island, as well as for other California Channel Islands.

2) **Long-term Monitoring.** The long-term data set associated with Santa Barbara Island, especially in regards to the Scripps's Murrelet nesting population, is an important resource and should be maintained into the future. Variation of search effort between years should be minimized to provide a more comparable data set. Logistically and realistically, a once-per-week check of each plot provides a reasonable window of opportunity to determine egg fates and nest success without encroaching into the time required by the restoration effort.

   The nest monitoring efforts in the four main plots reported here (Arch Point North Cliffs, Cat Canyon, Landing Cove, and the Dock plot) provide a reasonably robust number of clutches and eggs, distributed across the island. It appears to be a good representative sample of the actual nesting success and rate/method of failure of the island's Scripps's Murrelets. These four plots should be regarded as the minimum necessary effort, and should be monitored consistently through the breeding season. The Bunkhouse plot is minimally utilized by murrelets, but is quickly monitored, and provides awareness of nesting murrelets to avoid disturbance around the high traffic areas near housing.

3) **Colony Attendance Surveys.** Spotlight surveys conducted in 2009-2010 at Santa Barbara Island combined with an increased monitoring effort gave a more robust population estimate of the attendant murrelets during the breeding season than land based monitoring alone. Since population size and trends cannot be determined by land based monitoring alone, it is important to augment these methods with periodic population assessments. It has been four years since that survey effort and it would

benefit the long term restoration/management to repeat this work at what is still considered the largest breeding colony of the species. As recommended in previous reports, this increased effort should be done through two seasons to avoid sampling in an abnormal year (Whitworth et al. 2011).

Thermal imaging monitoring could be a non-invasive way to monitor for nesting seabirds within the maturing restoration plots without disturbance by researchers, both to the birds and plants. Less disturbance to nest sites in the first few years of utilization might encourage expansion of the colony by not displacing potential possibly first time breeders.

4) **Mark-recapture Studies.** Mark-recapture efforts of Scripps's Murrelets have been conducted at Santa Barbara Island intermittently since the 1970's. Data collected in 2013, including chick vocalizations and the 19 year-old adult murrelet, show the useful information that can be pulled from banding efforts for Santa Barbara Island's Scripps's Murrelet population. Maintaining a minimum goal for number of capture nights per season might aid in standardizing the year-to-year effort, and allow for a greater success rate in capturing previously banded birds. Since the captures have lately been focused on the east side of the island, maintaining the effort at that locality might be a better choice than expanding the capture area. The aforementioned spotlight surveys may provide an approximate number of individuals in attendance, and by defining a standardized annual effort, we might be able to extrapolate trends in data more effectively.

5) **Nest Ecology.** There are still gaps in the knowledge of the ecology and behavior of murrelets in their nests. Many hours of video have been filmed at several nests in the Landing Cove and Dock plots in 2010-2013. Video evidence of nest competition, mouse depredation, egg laying, and fledging - and call audio during most of these events - may expand the knowledge of the species and should be funded for analysis.

6) **Microhabitat Influence.** Because the habitat types are tied to plot locations, nesting success and depredation rates should be investigated further to determine microhabitat influences. For instance, Cat Canyon and Arch Point North Cliffs have very different clutch success and depredation rates, but are both mainly rocky crevice habitat (Tables 5, 8, 9). Large differences in aspect, wind, heat, humidity, and exposure exist between these plots and may contribute to the overall success of the seabirds nesting within them.

7) **Ectoparasites.** Other possibilities for furthering the knowledge of the species include the identification of bird lice observed on captured murrelets, and stable isotope

analysis of feathers. Bird lice have been shown to be very host specific, and even have been shown to speciate with their hosts. For a newly acknowledged host species, the evolution of the associated parasites might be an interesting research opportunity. According to the Cornell Lab of Ornithology's Birds of North America Species Account, no ectoparasite species are known to associate specifically with Scripps's Murrelet. Further literature searches may be required to verify that claim, but lice have been seen on captured murrelets at Santa Barbara Island (J. Howard pers. obs.).

8) **Eggshell Analysis.** Eggshells have been collected at nest sites around the island as part of the monitoring protocol since 2010. These eggshells may contain valuable information that this project has access to: 1) four years of eggshell thickness variation; 2) stable isotopes for adult diet during egg development; 3) possible investigations in eggshell color as related to diet; and 4) genetic material from post-hatch eggshell membranes to help clarify what role relatedness has in site selection, and which could elucidate why some nests are reutilized in consecutive nesting attempts versus creating a new nest bowl in a different location, or if the same pair is relaying a second brood. These are all questions that may be valuable to the restoration effort and the decisions made for the best benefit of the conservation and restoration of the Scripps's Murrelet population.

9) **Predator Effects.** Continued study to inform any future management plans should be conducted on the Island Deer Mouse and Barn Owl populations of Santa Barbara Island. In long lived species with low reproductive rates, such as Scripps's Murrelet, the loss of breeding aged adults is considered more detrimental to the population's future than the loss of eggs, many of which do not make it to sexual maturity due to a host of other factors. (Croxall and Rothery 1991, in Millus 2007). Barring a greater but currently unknown threat to the adults at sea (fisheries bycatch, catastrophic loss of prey items, etc.) this concept combined with the population modelling from Nur et al. (2013) would identify the Barn Owl predation pressure as the most detrimental force to the success of the colony on Santa Barbara Island.

   According to Nur et al. (2013), "even a 50% reduction in owl-related predation mortality would result in substantial positive impacts on future population trajectory, and can be expected to turn an apparent population decline into near-stability or population increase." C. Drost (1989) reported the numbers of depredated murrelets as high as 130 per year, and Thomsen (in Nur et al. 2013) reported them to be as high as 172 per year. In a colony calculated to hold approximately 642-1276 breeding birds (Whitworth et al. 2011) this potentially amounts to a large loss to the breeding population, plus whatever eggs are abandoned or subsequently depredated by mice.

   The Island Deer Mice of Santa Barbara Island are a well differentiated phenotype having been established for thousands of years (Pergams and Ashley, 1999), which would include them in the suite of factors influencing the evolution of breeding ecology of the seabirds on the Channel Islands. They have, as mentioned above, been identified as a major factor in the breeding success of murrelets in the Channel

Islands. Previous attempts at relocating mouse populations saw a marked decrease in depredation of eggs at the Cat Canyon site (Millus et al. 2007) but no associated increase in hatching success.

Continued and long-term monitoring of Barn Owls and Deer Mice in conjunction with seabird monitoring should be conducted to provide a better understanding of the predation pressures the seabirds are exposed to during the nesting season, if possible continuing to utilize methodology as established by Thomsen and Harvey 2012.

10) **Carcass Assessments.** Approximately 60 alcid carcasses were collected in 2013. This number only reflects those carcasses readily observable during normal island surveys and restoration efforts, and does not likely reflect the amount of take by the raptor species of the island. Both Cassin's Auklets and Scripps's Murrelets are preyed upon by Peregrine Falcons and Barn Owls, and possibly other species (Northern Harriers, Short-eared Owls, other transient raptors). There are currently three identified breeding territories for Peregrine Falcon on Santa Barbara, a very high density for the species. Continued nest content analysis of Peregrine aeries and Barn Owl nests, as well as continuing carcass collection protocols to identify relatively high or low mortality years could aid in tracking the effects of these pressures on Santa Barbara Island.

***Cassin's Auklet.*** Most effort within the seabird monitoring program is directed toward Scripps's Murrelet nesting, though restoration activities are also aimed at the recovery the Cassin's Auklet colony on Santa Barbara Island. In addition to continued planting of soil stabilizing plants near the island's edges for the eventual use as cover and structural support for auklet burrows, the following recommendations are made:

1) **Social Attraction.** Social attraction within the Landing Cove proved to be an effective tool for attracting Cassin's Auklets, and encouraging them to burrow in the vicinity. Unfortunately, the Landing Cove area was within active Barn Owl hunting grounds, and the small colony failed soon after it was created. Because of this dynamic, social attraction remains an option in augmenting the restoration activities on Santa Barbara Island, but should not be utilized until the Barn Owl predation issue is addressed.

2) **Directed Monitoring Efforts.** The known Cassin's Auklet nesting areas at Elephant Seal Point, Sutil Island, and Arch Point-North Cliffs should be periodically assessed for breeding auklets by nest searches, motion camera, automatic recording unit, and/or mist-net efforts to band and recapture attending adults. Sea cave surveys as done in 2009-2011, as well as a more directed and dedicated approach to auklet monitoring, would be helpful in determining the growth or decline of the last vestiges of the once expansive colony on Santa Barbara Island.

**Storm-Petrel Species.** Two species of Storm-Petrel (Ashy and Black Storm-Petrel) have been recorded breeding on Santa Barbara Island (or its associated offshore rocks), and there is currently no directed monitoring effort aimed at assessing the productivity or nest success of these seabirds. In 1992, Carter et al. identified the Santa Barbara Island area as the breeding location for the entirety of the Black Storm-Petrel population of California. In August of 2013, two Black Storm-Petrels with naked brood patches (indicating incubation of an egg) were mist netted near the Shag Rock Overlook on the north side of Santa Barbara Island.

Recommendations for monitoring the Storm-Petrel population of Santa Barbara Island include:

1) Dedicated breeding season surveys or mist netting efforts through the breeding season would help to at least minimally assess the breeding population of Ashy, Black, and possibly Leach's Storm-Petrels of Santa Barbara Island.

2) Audio recording units placed in likely Storm-Petrel nesting locations might aid in locating small colonies in hard to monitor locations, such as sea caves and sea cliffs.

3) Nocturnal spotlight surveys as done in 2009-2010 might help to assess numbers of Storm-Petrel species feeding in the vicinity of Santa Barbara Island and offshore rocks.

**General Recommendations.** Disturbance to nesting seabirds should be avoided as much as possible, especially during the onset of breeding/nesting season. Light pollution from housing, noise and air pollution from dock activities, and visitor disturbance should continue to be reduced, if not eliminated. The following recommendations should be implemented as suggested by past annual reports (Harvey et al. 2014):

1) The history of Santa Barbara Island is one of non-native plant and animal introduction and destruction of native communities. We should continue to strive to prevent the arrival of non-native plants, predators, and competitors to the island's ecosystem. Through increased biosecurity, we can prevent future degradation of the remnant native populations of Santa Barbara Island.

2) Island visitors should be well educated about the trail closures during nesting season and the need to stay on trail. They should not be allowed to investigate the cliffs or other nesting locations of seabirds. Island Naturalist Volunteers with the National Park Service should likewise be informed of any closures and the need to enforce them for the preservation and protection of the island's precious natural resources, and for the long-term recovery of the island. Trail closures should be well marked,

with explanatory signs placed in the center of the trail, and updated maps should be displayed prominently at the visitor center and kiosk. Information posters should be replaced as necessary.

3) Black-out curtains replaced in 2013 should be well maintained and used throughout the seabird nesting seasons on Santa Barbara Island. This usually begins in late November with calling Scripps's Murrelets below Landing Cove, and extends through August, possibly longer for Storm-Petrel species. Lights at the Dock and Bunkhouse hallways should be turned off at night. Bright lights from boats (especially squid boats) should be documented and reported to the appropriate parties. Harvey et al. (2014) suggested a boater outreach program to inform private boaters of the hazards to seabirds associated with lights at sea.

4) Crane and water pumping activities at the Landing Cove Dock should be assessed for noise reduction (i.e., a quieter hydraulic pump for the water delivery system). The two-stroke fire pump used to deliver water creates quite a bit of noise and exhaust. Looking into alternatives to this method might decrease noise pollution, and also air pollution for birds nesting in the area, and possibly create safer working conditions for on-island staff.

5) Maintenance activities involving power tools or loud engines should be planned appropriately and completed outside of the seabird nesting season. Unless required by emergency or public safety, tools such as impact drivers, circular saws, septic mixers and pumps, weed whackers and lawnmowers should only be used far away from nesting birds to reduce the disturbance caused by the loud and abrupt noises.

6) Helicopter landings should be properly planned for outside of the nesting season for Santa Barbara Island. Seasonal closure of airspace, like the trails, is necessary for disturbance reduction. Flying birds also represent a significant danger to the pilot and crew. Notices of closure for local helicopter-utilizing agencies including the United States Coast Guard and local law enforcement, should be sent to the appropriate parties. Proper flight planning for a high descent to the landing zone should be well explained for emergency operations during nesting seasons.

7) Loose building materials can be used by crevice and burrow nesters, and nests may go undetected until the nest site is destroyed. Preemptive organization of materials around housing and the dock will help minimize the possibility of nest failure or mortality by accidentally crushing the nest site when moving material.

In summary, we recommend that nest monitoring and disturbance reduction activities, as well as expanded studies described herein, should be conducted annually to ensure adequate information is collected with which to assess the status of this important seabird breeding location.

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# APPENDICES

**Appendix 1. Data collection fields used for standardized Scripps's Murrelet monitoring. Reproduced from Harvey et al. 2014.**

| PDA Field Name | Type | Description |
|---|---|---|
| Program Code | Text | 2 letter program code (SB for Seabird Program) |
| Year | Text | YYYY. Year in which survey was conducted |
| Island Code | Text | 2 letter island code (SB= Santa Barbara Island) |
| Event Code | Text | Alphabetical code assigned chronologically per sampling event per year. |
| Observation Date | Date/Time | DD/MM/YYYY. Actual date when data collection took place. |
| Plot | Text | 2 letter code for monitoring plot (BH=Bunkhouse, CC=Cat Canyon, DO=Dock, LC=Landing Cove, NT=Nature Trail) |
| Nest Number | Text | Unique identifier for an individual nest site (name or number) |
| Species | Text | 4 letter code indicating species of bird occupying a site. Options include: ASSP=Ashy Storm-Petrel, CAAU= Cassin's Auklet, SCMU=Scripps's Murrelet, N/A= Not applicable, empty site, Other (list in comments) |
| Observer | Text | Initials of primary observer. |
| Recorder | Text | Initials of data recorder. |
| Proofer | Text | Initials of the data proofer. |
| Adult Disturbed | Text | Y/N. Disturbance to adult murrelets during monitoring is a concern. Any disturbances should be described in the comments field. |
| Nest Contents | Text | The number of adults (SIN), eggs [E], and chicks [C] is recorded in the Nest Contents field. Options include: 0, 1SIN, 1E, 2E, 1SIN+1E, 1SIN+2E, 1SIN+1C, 1SIN+2C, 1C, 2C, 2SIN, Comments, NC (not checked), 2SIN + 1E, 2SIN+2E, 2SIN+1C, 2SIN+2C |
| Egg1 | Text | The status of the first (or only) egg. Options include: 0 (no egg), E (intact egg), DE (depredated egg), HE (hatched egg), BE (broken egg), Comments. |
| Egg 2 | Text | The status of the second egg found. Options include: 0 (no egg), E (intact egg), DE (depredated egg), HE (hatched egg), BE (broken egg), Comments. |
| Egg Order Known | Text | Y/N. If the order in which the eggs were laid is known because the first egg was depredated or marked before the second egg was laid, then Yes is selected. |
| Chick1 | Text | The status of the first (or only) chick found. Options include: 0 (no chick), C (live chick), DC (dead chick), Comments. |

| | | |
|---|---|---|
| Chick2 | Text | The status of the second chick found. Options include: 0 (no chick), C (live chick), DC (dead chick), Comments. |
| Comment List | Memo | Comments generated by multiselection list in PDA. See Protocol for Monitoring SCMU Nesting Sites for definitions. |
| Comments | Memo | Comments manually entered into the PDA. Should begin with list of nest contents for active sites. The size characteristics and color of eggshells should be noted. If the fate of the egg is uncertain detailed notes should be entered. |
| Egg1 Length | Number | Length of Egg1 in millimeters. Measured using calipers if egg can be safely handled and adult is not present. |
| Egg1 Width | Number | Width of Egg1 in millimeters. Measured using calipers if egg can be safely handled and adult is not present. |
| Egg2 Length | Number | Length of Egg2 in millimeters. Measured using calipers if egg can be safely handled and adult is not present. |
| Egg 2 Width | Number | Width of Egg2 in millimeters. Measured using calipers if egg can be safely handled and adult is not present. |

**Appendix 2. Survey dates for Scripps's Murrelet monitoring in 2013.**

| Date | APNC | BT | BH | CC | DO | ESC | LC | Date | APNC | BT | BH | CC | DO | ES | LC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2/21/2013 | x | | | | | | | 5/4/2013 | | | | x | | | |
| 2/27/2013 | | | x | | x | | | 5/5/2013 | x | | | | | | |
| 2/28/2013 | | | | x | | | | 5/8/2013 | | | x | | x | | |
| 3/1/2013 | | | | | | | x | 5/9/2013 | | | | x | | | |
| 3/2/2013 | | | | | | | | 5/10/2013 | | | | | | | x |
| 3/5/2013 | | | | x | | | | 5/11/2013 | | | | | | x | |
| 3/6/2013 | | | x | | x | | | 5/14/2013 | | | | x | | | |
| 3/8/2013 | | | | | | | x | 5/15/2013 | | | x | | x | | |
| 3/10/2013 | | | | x | | | | 5/17/2013 | | | | | | | x |
| 3/11/2013 | x | | | | | | | 5/18/2013 | | | | x | | | |
| 3/13/2013 | | | x | | x | | | 5/19/2013 | x | | | | | | |
| 3/14/2013 | | | | x | | | | 5/22/2013 | | | x | | x | | |
| 3/15/2013 | | | | | | | x | 5/23/2013 | | | | x | | | |
| 3/16/2013 | | | | | | x | | 5/24/2013 | | | | | | | x |
| 3/19/2013 | | | | x | | | | 5/25/2013 | | | | | | x | |
| 3/20/2013 | | | x | | x | | | 5/28/2013 | | | | x | | | |
| 3/22/2013 | | | | | | | x | 5/29/2013 | | | x | | x | | |
| 3/23/2013 | | | | x | | | | 5/31/2013 | | | | | | | x |
| 3/24/2013 | x | x | | | | | | 6/1/2013 | | | | x | | | |
| 3/27/2013 | | | x | | x | | | 6/2/2013 | x | | | | | | |
| 3/28/2013 | | | | x | | | | 6/5/2013 | | | x | | x | | |
| 3/29/2013 | | | | | | | x | 6/6/2013 | | | | x | | | |
| 3/31/2013 | | | | | | x | | 6/7/2013 | | | | | | | x |
| 4/2/2013 | | | | x | | | | 6/11/2013 | | | | x | | | |
| 4/3/2013 | | | x | | x | | | 6/12/2013 | | | x | | x | | |
| 4/5/2013 | | | | | | | x | 6/13/2013 | | | | | | | x |
| 4/6/2013 | | | | x | | | | 6/14/2013 | | | | x | | | |
| 4/7/2013 | x | | | | | | | 6/15/2013 | x | | | | | | |
| 4/10/2013 | | | x | | x | | | 6/19/2013 | | | x | | x | | |
| 4/11/2013 | | | | x | | | | 6/20/2013 | | | | x | | | |
| 4/12/2013 | | | | | | | x | 6/21/2013 | | | | | | | x |
| 4/13/2013 | | | | | | x | | 6/25/2013 | | | | x | | | |
| 4/16/2013 | | | | x | | | | 6/26/2013 | | | x | | x | | |
| 4/17/2013 | | | x | | x | | | 6/28/2013 | | | | | | | x |
| 4/19/2013 | | | | | | | x | 6/29/2013 | | | | x | | | |
| 4/20/2013 | | | | x | | | | 6/30/2013 | x | | | | | | |
| 4/21/2013 | x | | | | | | | 7/3/2013 | | | x | | x | | |
| 4/24/2013 | | | x | | x | | | 7/4/2013 | | | | x | | | |
| 4/25/2013 | | | | x | | | | 7/5/2013 | | | | | | | x |
| 4/26/2013 | | | | | | | x | 7/9/2013 | | | | x | | | |
| 4/27/2013 | | | | | | x | | 7/10/2013 | | | x | | x | | |
| 4/30/2013 | | | | x | | | | 7/12/2013 | | | | | | | x |
| 5/1/2013 | | | x | | x | | | 7/13/2013 | x | | | | | | |
| 5/3/2013 | | | | | | | x | | | | | | | | |

**Appendix 3. Scripps's Murrelet bands deployed/recaptured in 2013 at Santa Barbara Island.**

| Band Number | Banding Date | Band Number | Banding Date |
|---|---|---|---|
| 1322-22001 | 5/15/2013 | 1322-22031 | 5/19/2013 |
| 1322-22002 | 5/15/2013 | 1262-03510** | 5/19/2013 |
| 1322-22003 | 5/15/2013 | 1262-03511** | 5/19/2013 |
| 1322-22004 | 5/15/2013 | 1262-03512 | 5/19/2013 |
| 1322-22005 | 5/15/2013 | 1322-22032 | 5/20/2013 |
| 1322-22006 | 5/15/2013 | 1322-22033 | 5/20/2013 |
| 1322-22007 | 5/16/2013 | 1322-22034 | 5/20/2013 |
| 1322-22008 | 5/16/2013 | 1322-22035 | 5/20/2013 |
| 1322-22009 | 5/16/2013 | 1322-22037 | 5/20/2013 |
| 1322-22010 | 5/16/2013 | 1322-22038 | 5/20/2013 |
| 1322-22012 | 5/16/2013 | 1322-22039 | 5/20/2013 |
| 1322-22013 | 5/16/2013 | 1322-22040 | 5/20/2013 |
| 1322-22014 | 5/16/2013 | 1322-22041 | 5/20/2013 |
| 1322-22015 | 5/16/2013 | 1322-22042 | 5/20/2013 |
| 1322-22016 | 5/17/2013 | 1322-22043 | 5/20/2013 |
| 1322-22017 | 5/17/2013 | 1322-22046 | 5/20/2013 |
| 1322-22018 | 5/17/2013 | 1322-22047 | 5/20/2013 |
| 1322-22019 | 5/18/2013 | 1322-22048 | 5/20/2013 |
| 1322-22020 | 5/18/2013 | 1322-22045 | 5/20/2013 |
| 1322-22021 | 5/18/2013 | 1322-22049 | 5/21/2013 |
| 1322-22022 | 5/18/2013 | 1322-22050 | 5/21/2013 |
| 1322-22023 | 5/18/2013 | | |
| 1322-22024 | 5/18/2013 | RECAPTURES | |
| 1322-22025 | 5/18/2013 | 1262-03150 | 5/15/2013 |
| 1322-22026 | 5/18/2013 | 0892-98104* | 5/17/2013 |
| 1322-22027 | 5/18/2013 | | |
| 1322-22029 | 5/19/2013 | *Banded in 1995: ≥19 years old | |
| 1322-22030 | 5/19/2013 | **HY chick, known age of 0 | |

**Appendix 4. Cassin's Auklet artificial burrow monitoring dates.**

| Date | ESC | LACO | NEF | Date | ESC | LACO | NEF |
|---|---|---|---|---|---|---|---|
| 1/2/2013 | | x | | 3/31/2013 | | | x |
| 1/11/2013 | x | | | 4/3/2013 | | x | |
| 1/13/2013 | | | x | 4/10/2013 | | x | |
| 1/14/2013 | | x | | 4/12/2013 | | x | |
| 2/10/2013 | | x | | 4/13/2013 | x | | x |
| 2/12/2013 | x | | | 4/17/2013 | | x | |
| 2/13/2013 | | x | | 4/24/2013 | | x | |
| 2/15/2013 | | | x | 4/26/2013 | | x | |
| 2/17/2013 | | x | | 4/27/2013 | x | | x |
| 2/21/2013 | | x | x | 5/1/2013 | | x | |
| 2/22/2013 | x | | | 5/8/2013 | | x | |
| 3/1/2013 | | x | | 5/10/2013 | | x | |
| 3/2/2013 | x | | x | 5/11/2013 | x | | x |
| 3/6/2013 | | x | | 5/15/2013 | | x | |
| 3/12/2013 | x | | | 5/22/2013 | | x | |
| 3/13/2013 | | x | | 5/24/2013 | | x | |
| 3/15/2013 | | x | | 5/25/2013 | x | | x |
| 3/16/2013 | | | x | 5/29/2013 | | x | |
| 3/20/2013 | | x | | 6/5/2013 | | x | |
| 3/27/2013 | | x | | 6/7/2013 | | x | |
| 3/29/2013 | | x | | 6/8/2013 | | | x |
| 3/30/2013 | x | | | | | | |