STATUS AND MONITORING OF ASHY STORM-PETRELS *OCEANODROMA HOMOCHROA* AT POINT REYES NATIONAL SEASHORE, CALIFORNIA, 2012–2015

BENJAMIN H. BECKER[1], HARRY R. CARTER[2,4,5], ROBERT P. HENDERSON[2], ANNA M. WEINSTEIN[3] & MICHAEL W. PARKER[2,4]

[1]*Pacific Coast Science and Learning Center, Point Reyes National Seashore, 1 Bear Valley Road, Point Reyes Station, California 94956 USA (ben_becker@nps.gov)*
[2]*California Institute of Environmental Studies, 3408 Whaler Avenue, Davis, CA 95616, USA*
[3]*California Audubon, 220 Montgomery Street, Suite 1000, San Francisco, CA 94104, USA*
[4]*Humboldt State University, Department of Wildlife, 1 Harpst Street, Arcata, CA 95521, USA*
[5]*Current Address: Carter Biological Consulting, 1015 Hampshire Road, Victoria, BC V8S 4S8, Canada*

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SUMMARY

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While the largest Ashy Storm-Petrel *Oceanodroma homochroa* (ASSP) colonies are at offshore islands, small colonies also occur along the mainland coast of northern and central California. We describe past and current monitoring efforts along the coastline of Point Reyes National Seashore, California. From 2012 to 2015, we conducted nest searches and mist netting in late August or early September at the Bird Rock and Stormy Stack colonies, as well as the Point Reyes Headlands. Potential nest sites on Stormy Stack (~17) and Bird Rock (~40) included 4–7 and 3–6 active nests, respectively. These nest numbers were similar to those from past complete surveys at Bird Rock in 1989 and Stormy Stack in 2001, suggesting little change in colony size over time. Birds per capture hour during single nights of mist-netting at Bird Rock in 2012 (1.46) and 2013 (1.44) were lower than on two nights in 1989 (5.47 and 3.08), leading to a higher estimate of 37 pairs in 1989. Two ASSP were also netted at the Point Reyes Headlands in 2013, but no nests were found during limited searches in 2013 and 2015. Standardized long-term monitoring of nests at Bird Rock and Stormy Stack will provide better information on future population trends and conservation issues.

Key words: Ashy Storm-Petrel, California, nest, mist-net, *Oceanodroma homochroa*, Point Reyes

INTRODUCTION

Despite the concentration of most of the Ashy-Storm Petrel *Oceanodroma homochroa* (hereafter ASSP) breeding population at the South Farallon Islands and the Channel Islands, some smaller colonies are known along the northern and central California coast, although their status is more poorly known (Carter *et al.* 2015, and references therein). Except for the South Farallon Islands (hereafter, "Farallones"), knowledge of breeding at northern coastal inshore rocks has been primarily obtained from the Point Reyes National Seashore (PRNS), Marin County, California. ASSP were first noted at Point Reyes in 1898 (Carter *et al.* 2008, 2015) but not documented again until 1969 and 1972, when breeding was first documented at Bird Rock (Ainley & Osborne 1973; Figs. 1 and 2). Subsequent monitoring at Bird Rock took place in 1979, 1989 and 2001 (Sowls *et al.* 1980, Carter *et al.* 1992, Whitworth *et al.* 2002; see Appendix 1, available on the website). Breeding was first documented at Stormy Stack and presence first detected at Chimney Rock within the Point Reyes Headlands in 2001 (Whitworth *et al.* 2002; Fig. 1). Due to irregular and non-standardized surveys, determining the population size and status of ASSP at PRNS has been an elusive task.

Carter *et al.* (2008) recommended monitoring of ASSP at Bird Rock to measure trends and identify factors affecting breeding at mainland colonies. Data derived from such monitoring would be critical for (1) assessment of the future status of ASSP at the northern end of the breeding range; (2) proper management and protection of ASSP in PRNS; and (3) comparison of breeding patterns with the colony at the nearby Farallones and other parts of the range. During 2012–2015, we initiated a long-term monitoring program for ASSP at PRNS. The main goals of the present study were to (1) assess breeding and attendance in 2012–2015; (2) summarize results of past surveys; (3) assess trends from 1989 to 2015; and (4) develop a standardized approach for long-term monitoring of this species (also see Carter *et al.* 2012; Henderson *et al.* 2014 for additional information).

METHODS

Study area

All three areas that we surveyed (Bird Rock, Stormy Stack and the Point Reyes Headlands) have been managed by the National Park Service since 1962. Subsequently, these important coastal areas with many breeding seabirds and marine mammals have received further recognition and protection: Areas of Special Biological Significance (1974–1975), Phillip Burton Wilderness (1976), Gulf of the Farallones National Marine Sanctuary (1980), UNESCO Golden Gate Biosphere Reserve (1988) and the Point

Reyes Headlands as a no-take marine reserve and special closure (2010). Because of the presence of many breeding seabirds, the protective designations and remoteness, limited seabird research and monitoring has been conducted at these locations, except through the use of aerial photography or a telescope. However, greater concern about the status of ASSP range-wide led to our work to develop a limited on-site monitoring program in 2012–2015. To reduce observer impacts, we accessed these locations by drop-off from an inflatable boat on only one or two days after the breeding season for most seabirds, and at times when few marine mammals were present. Some roosting pelicans, cormorants and gulls were flushed for short periods. We did not use any climbing equipment and were careful not to affect any fragile substrates; many parts of the Point Reyes Headlands were not accessed.

Bird Rock (38.23°N, 122.99°W) is a small rocky island (0.8 ha) located about 1.1 km south of Tomales Point (Figs. 1, 2). It is about 280 m from the mainland and composed of granite with a partial layer of mudstone or siltstone. Little vegetation is present, and much of the rock is covered with a thin layer of seabird guano. The rate of erosion appears to be slow, and no fresh losses of mudstone or rock since 1989 were noted during this study (H.R. Carter & M.W. Parker, pers. obs.).

Bird Rock is well known for its use by breeding and roosting seabirds, and as a pupping and haul-out site for pinnipeds. Besides ASSP, hundreds of Brandt's Cormorants *Phalacrocorax penicillatus* and Western Gulls *Larus occidentalis* breed, along with small numbers of Pelagic Cormorants *P. pelagicus* and Pigeon Guillemots *Cepphus columba* (Sowls *et al.* 1980, Carter *et al.* 1992). Hundreds of Brown Pelicans *Pelecanus occidentalis* also roost on the rock in fall and winter. Harbor Seals *Phoca vitulina* pup and haul out on Seal Beach and intertidal rocks. California Sea Lions *Zalophus californianus* and Northern Elephant Seals *Mirounga angustirostris* also haul out on Seal Beach and intertidal rocks.

Stormy Stack (37.95°N, 122.79°W) is a small, rocky, vegetation-free island (~0.4 ha) in Drakes Bay just offshore of Double Point (Figs. 1, 3). Besides ASSP, hundreds to thousands of Brandt's Cormorants and Common Murres *Uria aalge* breed at this site, along with small numbers of Pelagic Cormorants, Western Gulls *Larus occidentalis* and Pigeon Guillemots. Brown Pelicans also roost here in late summer and fall.

Point Reyes Headlands is a 5.4 km long section of the California mainland from Lighthouse Point (38.00°N, 123.02°W) to Chimney Rock (37.99°N, 122.96°W) (Fig. 1). In addition to habitat on mainland cliffs, Chimney Rock at the eastern end may have ASSP breeding habitat and is separated from the mainland except during extreme low tides. Hundreds to thousands of Brandt's Cormorants, Pelagic Cormorants, Western Gulls, Common Murres and Pigeon Guillemots breed at this site. Brown Pelicans also roost here in late summer and fall.

Breeding habitat assessment and nest numbers (2012–2015): In late August or early September 2012–2015, during the ASSP chick period (see Ainley 1995), we assessed potential ASSP breeding habitats at Bird Rock and Stormy Stack using a wide definition of potential habitat to ensure that all nesting habitat was considered. ASSP nests occur in a wide variety of natural and artificial cavities (Ainley 1995). In exposed habitats on offshore rocks and islands, these birds often select small, partially to fully darkened, cavities that allow access and nesting by ASSP but otherwise protect nests from predators, other cavity-nesting seabirds and weather conditions. However, the entire range of crevice types used, especially on small mainland rocks, is not well known. We identified and numbered all potential ASSP crevice sites, some including active nests and some without evidence of current use, found on accessible areas of Bird Rock (2012–2013) and Stormy Stack (2013–2015). After Carter *et al.* (1992), we defined "potential-nest sites" for ASSP (hereafter referred to as "sites") as rock cavities, including crevices, grottos and other types of cavities, that have adequate space, sufficient depth and a level area for egg placement. We also assigned approximate sizes to the entrances of sites, based on seabird body sizes and typical burrow or crevice sizes for the species that could possibly breed in them: "small" (storm-petrel only), "medium" (storm-petrels and Cassin's Auklet *Ptychoramphus aleuticus*), and "large" (storm-petrels, Cassin's Auklets, Pigeon Guillemot, Rhinoceros Auklet *Cerorhinca monocerata* and Tufted Puffin *Fratercula cirrhata*).

Single-day nest surveys were conducted at Bird Rock (5 September 2012, 29 August 2013, 3 September 2014 and 7 September 2015) and Stormy Stack (12 September 2013, 9 September 2014 and 8 September 2015). We also conducted nest surveys on parts of the Point Reyes Headlands on 1 September 2013 near the mist-net site (see below) and on 8 September 2015 at several locations along the parts of the shoreline that could be safely reached by boat. Nests

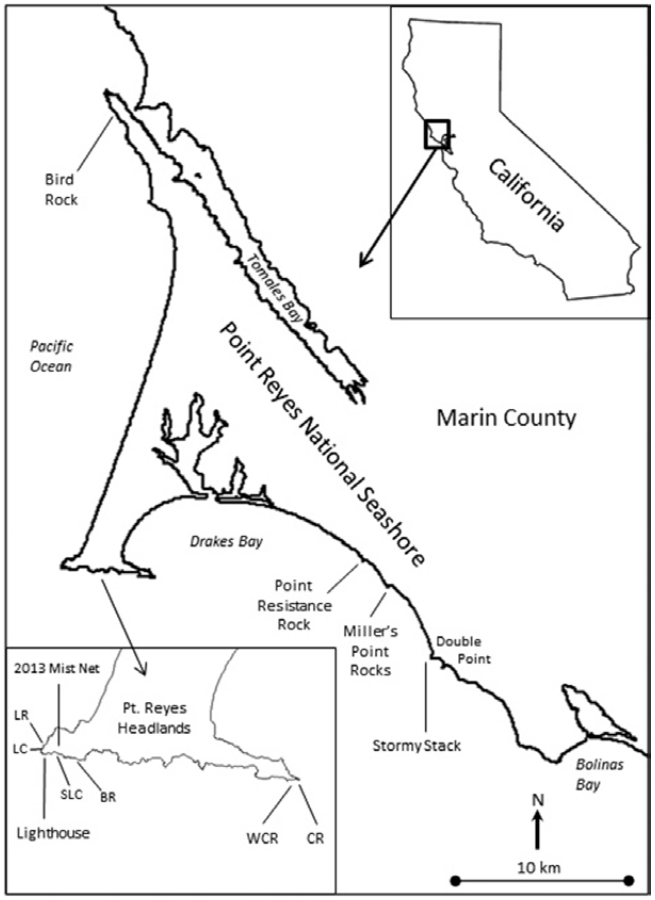

Fig. 1: Map of Point Reyes National Seashore, Marin County, California, showing survey areas at Bird Rock, Stormy Stack and Point Reyes Headlands (CR, Chimney Rock; WCR, West Chimney Rock; BR, Boulder Rock; SLC, South Lighthouse Cliffs; LC, Lighthouse Cave; and LR, Lighthouse Rock).

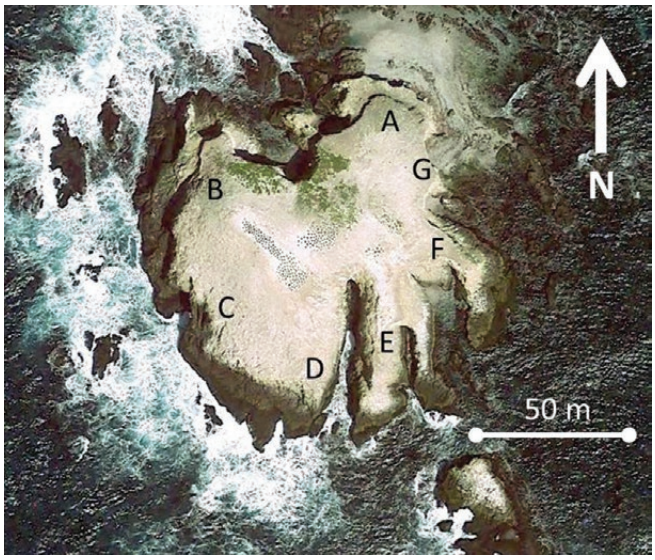

Fig. 2: Locations of nest areas A–G at Bird Rock in 2012–2015. Caves at Northwest Gulch (between A and B) and South Gulch (between D and E) have not yet been examined for possible nests.

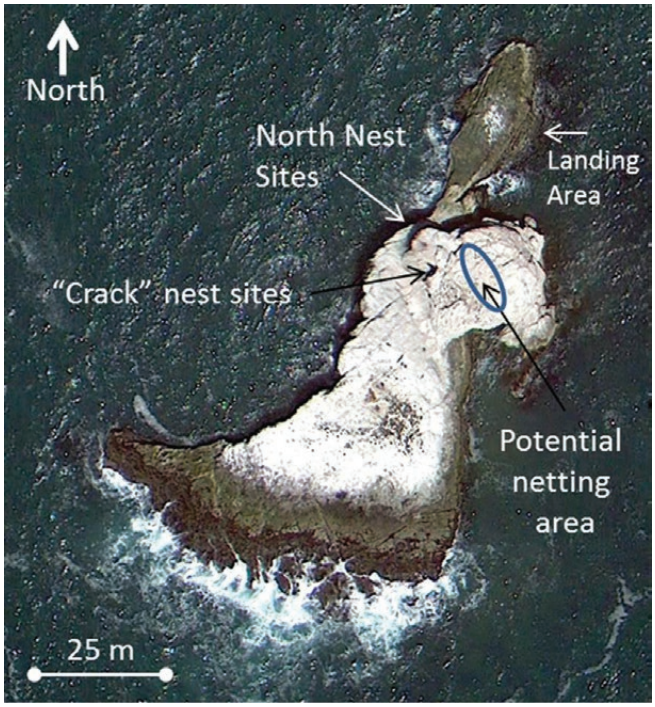

Fig. 3: Overview of Stormy Stack, showing north and crack nest site areas, and potential mist-net location.

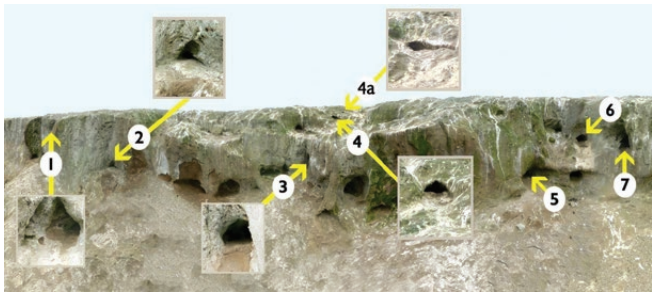

Fig. 4: Southern section of the "Wall of the Holes" at Bird Rock, showing sites 1–7 (photo by R.P. Henderson, 5 September 2012). Nests were found in sites 2, 4 and 4a. See Appendix 2 for details.

Fig. 5: Area D of Bird Rock, showing sites 25–28 (photo by R.P. Henderson, 5 September 2012). Nests were found in sites 25, 26 and 28. See Appendix 2 for details.

Fig. 6: North face of Stormy Stack, where sites 1–10 are located (photo by D. Press, 12 September 2013). Nests were found in sites 2, 3, 4, 5, 6 and 9 (not shown). See Appendix 3 for details.

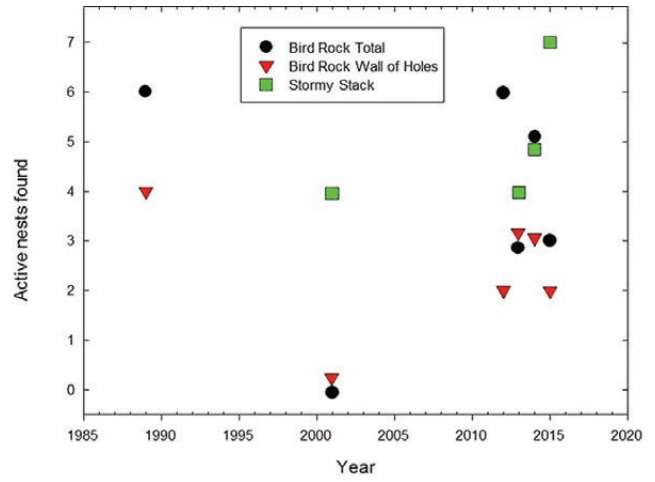

Fig. 7: Active nests found at Bird Rock (1989–2015) and Stormy Stack (2001–2015).

were viewed with a small flashlight, and we recorded adults, eggs, eggshell fragments or chicks seen. We described ASSP chicks based on their degree of plumage development and body size as small downy, large downy, small gawky (down-covered feathers but some visible remiges if seen well), medium gawky (mostly downy but remiges clearly visible), large gawky (some down but mostly feathered with prominent remiges), mostly feathered (little down and mostly feathered) and fully feathered (at times with wisps of down). Eggs were noted as whole, cracked, broken (no bite holes, no veins with blood visible, and clean membrane), depredated or scavenged (bite holes in edges and no veins with blood visible), hatched (with blood-filled veins), old (dirty and membrane not shiny and faded) or unknown. If an adult was observed in incubating posture and an egg may have been present but could not be seen, we recorded this as an adult in incubating posture. When nest contents could not be viewed with a flashlight, the site was treated as "unknown."

In 2013–2015, we also used an electronic video inspecting scope (2 m range) with a color LCD screen to search the back portions of certain crevices at Bird Rock that were too deep to be viewed with a flashlight. Each site was photographed, and overview photographs of the general vicinity and breeding habitats were taken (see Carter *et al.* 2012, Henderson *et al.* 2014).

Mist-net captures (2012–2013): At Bird Rock, on the nights of 5–6 September 2012 and 29–30 August 2013, we erected one nylon mist-net (70 dernier, two-ply, 30 mm mesh size, 2.6 m high × 9 m long) in front of the Wall of Holes (Fig. 2, Area A) in the same general location (within ~1–2 m) as in 1989 and 2001. A portable CD player, placed on the ground at the center of the net, continuously played ASSP vocalizations that had been originally recorded at the Farallones by D.G. Ainley (see Carter *et al.* 1992). Captured birds were carefully untangled from the mist-net and placed in a holding bag. At the banding station, birds were removed from the holding bag, banded, measured, photographed (usually) and released. Birds were banded using USGS stainless steel bands (size 1B). After Carter *et al.* (1992), we scored brood patches: 0 (no patch), 1 (5%–50% defeathered), 1+ (50%–95% defeathered), 2 (bare unvascularized), 3 (bare vascularized), 3+ (bare with a few blood-filled papillae), 4 (5%–50% refeathered), 4+ (50%–95% refeathered) and 5 (95%–100% refeathered but patch still visible). Culmen, tarsus, wing length, tail length and body weight were measured. Mist-net data were used for general comparison to 1989 and 2001 mist-net data, using similar methods. For comparisons, we standardized the numbers of birds captured per capture hour (BPCH) for each night (i.e., between the time of first detection or capture and last detection or capture). By handling data in this manner, we excluded periods before ASSP arrived at the rock and after they had departed from the rock.

Mainly to detect occurrence at the Point Reyes Headlands, we also conducted limited mist-net captures at a safe and accessible location high up on the Point Reyes Headlands in 2013 on the nights of 4–5 August and 1–2 September. The net was placed in a gully behind the garage (near the visitor's center) at the top of very steep slopes, above the lighthouse at ~150 m elevation (Fig. 1). This area was not directly illuminated by the lighthouse or nearby buildings, but there was some low lighting nearby.

Past information: We conducted a literature search of published and unpublished information about ASSP at Bird Rock, Stormy Stack and Chimney Rock, including unpublished survey archives for 1979–1980 (Sowls *et al.* 1980) and 1989 (Carter *et al.* 1992) housed at the San Francisco Bay National Wildlife Refuge Complex (US Fish and Wildlife Service, Fremont, CA). A summary of information between 1969 and 2001 is provided in Table 1 and Appendix 1. Since the method of determining potential nest sites was different in 1989 and 2001, and nest searches were incomplete in 1969, 1972 and 1979, we did not calculate nest occupancy rates during past years.

RESULTS

Number of nests and potential nest sites: In 2012–2015, the annual number of "active" ASSP nests (i.e., with eggs laid in the survey year) at Bird Rock ranged from three to five (Appendix 2, available on the website). About half were found in the Wall of Holes in Area A (Fig. 2) but one to three nests were also found each year in Areas B–G (Appendix 2; Figs. 2, 7). We identified 44 potential nest sites in Areas A–G, including 25 in the Wall of Holes and 19 in Areas B–G (Appendix 2; Table 2). However, four sites in the

TABLE 1
Ashy Storm-Petrel monitoring efforts at Point Reyes National Seashore, California

Year	Bird Rock	Stormy Stack	Point Reyes Headlands	Source
1898			Present	Carter *et al*. 2008
1969	Limited nest search[a]			Ainley & Osborne 1973
1972	Limited nest search			Ainley & Osborne 1973
1979	Limited nest search			Sowls *et al.* 1980
1989	Nest search / mist-net			Carter *et al.* 1992
2000			Limited nest search	M.W. Parker & H.R. Carter (unpubl. data)
2001	Nest search / mist-net	Nest search	Mist-net	Whitworth *et al.* 2002
2012	Nest search / mist-net			Carter *et al.* 2012
2013	Limited nest search / mist-net	Nest search	Mist-net	Henderson *et al.* 2014
2014	Nest search	Nest search		this paper
2015	Nest search	Nest search	Limited nest search	this paper

[a] Limited nest searches did not encompass the entire island owing to time or other constraints.

Wall of Holes (12a, 13, 17, 18) were too deep for the burrowscope and five sites in Areas B, F and G (21, 33, 34, 35, 36) were not accessible by foot. Also, in 2012, we did not use a burrowscope and nest contents could not be determined at 15 sites in the Wall of Holes. In 2013–2015, we used a burrowscope and 11 more sites in the Wall of Holes could be checked. Other areas on Bird Rock generally had crevices shallow enough that they did not require the use of the burrowscope. All nests, except one in 2015, were found in small or medium holes (Table 2, Appendix 2). With use of the burrowscope, our calculation of occupancy at the Wall of Holes changed from 0.29 in 2012 to 0.09–0.18 in 2013–2015 (Table 2). However, none of the large crevices were used by birds, so the number of nests found did not change much. For small and medium crevices at the Wall of Holes, occupancy ranged between 0.25 and 1.0 per year.

At Stormy Stack (Fig. 3), the annual number of active nests ranged from four to seven (Appendix 3, Fig. 7). Three nests were found in the north face, one nest in the crack area, and one nest in one year was adjacent to the "potential netting area" (Figs. 3, 6). A total of 17 potential nest sites were identified, including 10 in the north wall and 7 in the crack area. Nests here did not require use of the burrowscope to see nest contents.

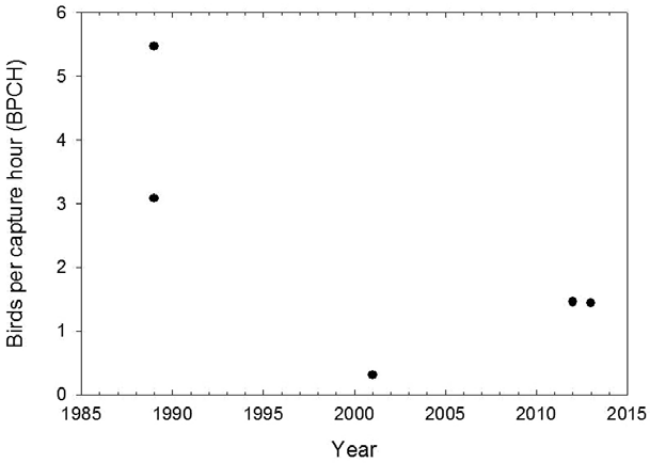

Fig. 8: Mist-net capture rates (birds per capture hour or BPCH) at Bird Rock, 1989–2013. The time period for BPCH extended from first to last capture or detection.

At Point Reyes Headlands, no nests were found in areas examined near the mist net in 2013 or at coastline areas checked in 2015 (West Chimney Rock, Boulder Rock and South Lighthouse Cliffs) (see Fig. 1 for locations). Similarly, no petrel odor was detected when searching potential nest crevices, holes or caves. We were unable to access Lighthouse Cave and Lighthouse Rock because of high waves, but it did not appear that there was a large amount of suitable nesting habitat at these locations.

Mist-net captures: We captured six ASSP at Bird Rock on the single night of mist-net captures in early September 2012. The capture period was 21h00–01h06 (4.10 h); BPCH was 1.46. On the single night in late August 2013, nine birds were captured, including three recaptures (one banded in 2001 at Bird Rock and two banded in 2012 at Bird Rock). The capture period was 21h36–03h51 (6.25 h); BPCH was 1.44. No mist-netting was conducted at Bird Rock in 2014–2015.

At the Point Reyes Headlands in 2013, we captured two ASSP on the night of 4–5 August and none on 1–2 September. The capture period was 23h40–03h06 (3.43 h), with only single birds captured at 23h40 and 03h06 and no others heard or seen; BPCH was 0.58.

Colony size and trends: In 2012–2015, we estimated 5–10 pairs of ASSP at Bird Rock, based on three to five nests found and some inaccessible sites. Given the small sample sizes and variable timing and methods of past surveys, and variable amount of nesting habitat surveyed, we considered that the best way to assess past trends in colony size at Bird Rock was to examine changes in the numbers of nests found in the Wall of Holes (Area A, sites 1—19). This part of Bird Rock was, for the most part, completely surveyed in August or early September on each visit in 1989 to 2015. In addition, use of the burrowscope led to inclusion of only one more nest (A16) in 2013 and 2014 (Appendix 2) than in 2012. Four nests were found in 1989 versus none in 2001 and two to three in 2012–2015 (Fig. 7). No trend was evident, although insufficient information was available for regression analysis.

TABLE 2
Occupancy for Ashy Storm-Petrels at Bird Rock in 2012–2015

Nest site size[a]	Proportion (number of active nests/number of potential sites checked)						
	2012		2013[b]	2014		2015	
	Wall of Holes (A)	Areas B–G	Wall of Holes (A)	Wall of Holes (A)	Areas B–G	Wall of Holes (A)	Areas B–G
Small	0.33 (1/3)	0.5 (2/4)	0.25 (1/4)	0.25 (1/4)	0.50 (2/4)	0.25 (1/4)	0.0 (0/4)
Medium	1.0 (1/1)	0.5 (1/4)	1.0 (2/2)	1.0 (2/2)	0.0 (0/4)	0.5 (1/2)	0.0 (0/5)
Large	0.0 (0/3)	0.0 (0/2)	0.0 (0/11)	0.0 (0/16)	0.0 (0/3)	0.0 (0/17)	0.33 (1/3)
Total	0.29 (2/7)	0.3 (3/10)	0.18 (3/17)	0.14 (3/22)	0.19 (2/11)	0.09 (2/23)	0.08 (1/12)

[a] Small-medium were assigned to small; medium-large were assigned to medium.
[b] Areas B–G were not checked in 2013 to avoid disturbing late cormorant chicks.

Based on nest numbers found at Stormy Stack in 2012–2015 (three to five), recognizing that some suitable habitat could not be checked, our current population estimate is 10–15 pairs. To generally assess trends at Stormy Stack, we compared 2013–2015 nest counts (n = 3–5) to 2001 (n = 4) and did not note any change (Fig. 7).

Occurrence at Point Reyes Headlands: ASSP were noted at Point Reyes Headlands in 1898 (two specimens, unknown location; Carter *et al.* 2008), 2001 (five birds captured in a mist-net at Chimney Rock; Whitworth *et al.* 2002; Appendix 1), and 2013 (two birds captured in a mist-net near the visitor's center; Henderson *et al.* 2014). No nests have been found, and there is currently insufficient mist-net data to suggest that ASSP breed on the headlands. Mist-net captures may reflect movements of birds past this major headland at night and attraction to the mist-net by broadcast vocalizations and headlamps.

DISCUSSION

PRNS population size and distribution: Occurrence of ASSP in the PRNS region, likely at Point Reyes Headlands, was first noted in 1898, when one specimen was obtained in April and another in July (further details are lacking; Carter *et al.* 2008). These birds may have struck the Point Reyes lighthouse (established 1870) or some other structure. Squires & Hanson (1918:8) reported low avian mortality at California lighthouses; however, three "small sea birds (possibly petrels)" were reported to have died after striking lighthouses. The exact lighthouse(s) involved in the bird strikes was not identified, but Point Reyes was one of the lighthouses examined.

Breeding was first documented at Bird Rock in 1969 and 1972 (Ainley & Osborne 1973) and at Stormy Stack in 2001 (Whitworth *et al.* 2002). Occurrence (based on birds captured in a mist net) at Point Reyes Headlands was first well documented in 2001 (at Chimney Rock; Whitworth *et al.* 2002), and then near the visitor's center in 2013. Breeding may occur on occasion at Chimney Rock, as petrel odor was found in some crevices in 2001. However, regular breeding does not appear to occur, possibly because of connection to the headlands at low tides, allowing for periodic access by mammalian predators. Limited nest searches on several other lower parts of the Point Reyes Headlands in 2000 (M.W. Parker & H.R. Carter, unpubl. data) and 2015 (this study) did not result in discoveries of nests, but more work is needed to check Lighthouse Rock and Lighthouse Cave, where suitable habitats appear to exist (although access by boat is typically difficult owing to current and wave conditions). However, we feel that sufficient surveys have been conducted at the headlands to confirm that few or no ASSP may breed there.

In 1979–1980, seven pairs were estimated to be breeding at Bird Rock, based on one nest found and six other sites with petrel odor (Sowls *et al.* 1980, unpubl. survey archive; see Appendix 1). In 1989, 37 pairs were estimated, using mist-net capture and recapture data from two nights of mist-netting in August (Chapman's modified Lincoln-Petersen method) to estimate 65 birds on the north side; then nine birds were added for the south side (Carter *et al.* 1992, unpubl. survey archive). However, relatively high capture rates occurred only in 1989 (Fig. 7), and low numbers of nests were found in each of the years that Bird Rock was completely surveyed (1989, 2012, 2014, 2015). In retrospect, we believe that the 1989 mist-net-based estimate for Bird Rock likely was too high. In 2001, the first evidence of breeding by ASSP at Stormy Stack was found, and 20–40 breeding pairs were estimated, based on four nests found and additional available habitat that could not be searched (Whitworth *et al.* 2002; Appendix 1). We also believe that this estimate was too high. In the 2001 study, a greater number of sites were inaccessible than in the current study.

By 2015, most suitable nesting habitat in PRNS had been surveyed, with results indicating that the main or only breeding colonies occur at Bird Rock (5–10 pairs) and Stormy Stack (10–15 pairs). The PRNS population is small because of the limited availability of suitable crevices on these two rocks. The Wall of Holes on Bird Rock is an unusual formation of sedimentary mudstone and contains a wide variety of cavities, of which 22 were considered potential ASSP nest sites (Figs. 4, 5). Many of the larger cavities appear to have been excavated or their size increased in the past by Tufted Puffins or Pigeon Guillemots. ASSP bred in only three small-to-medium cavities in this wall in 2012–2015, possibly because large crevices were not preferred for nesting by ASSP or because ASSP had been ejected from three large sites currently used by nesting Pigeon Guillemots. Reproductive success has not been studied at these colonies, but at least some if not all chicks appeared to fledge at Bird Rock in 1989, at Stormy Stack in 2001 and at both rocks in 2012–2015, based on the presence of chicks (some near fledging) in late August and early September. Almost no evidence of predation has yet been found, except for a set of wings likely due to depredation by an avian predator at Chimney Rock in 2001 (Appendix 1).

At Bird Rock, no recaptures of individuals from the Farallones (where many birds have been banded annually since 1992 [Sydeman *et al.* 1998; Bradley 2011]) or the Channel Islands (where many birds have been banded almost annually since 1991 [Carter *et al.* 1992, McIver *et al.* 2009, Adams *et al.* 2016]) were made in 2001 and 2012–2013, although mist-net effort was very low. While some immigration or emigration is expected over the long term, the Bird Rock colony (known for 46 years, from 1969 to 2015) and the Stormy Stack colony (known for 14 years, from 2001 to 2015) may be largely self-sustaining.

Population trends: From 1969 to 2001, the main goal of ASSP nest surveys in this area was to detect the presence of nests at Bird Rock and Stormy Stack and to develop population estimates. At Bird Rock, nest searches were conducted once per year in most years (except two searches in 1989), before most or all eggs were laid in certain years (i.e. 3 July 1972 and 1 July 1979), and not all parts of the rock were searched in most years (1969, 1972, 1979 and 2001). Under these circumstances, data in most past years could not be compared with 2012–2015, except for data from 1989, when the most extensive previous survey was conducted, with two surveys in August (Carter *et al.* 1992). With limited past data and large gaps with no data, simple regressions could not be used to show trends between 1989 and 2015. However, little or no evidence of major changes in the numbers of nests was found at Bird Rock and Stormy Stack. At the Wall of Holes, where survey efforts were more consistent, four nests were found in 1989 versus none in 2001 and two to three in 2012–2015; neither was an obvious trend evident in this data subset.

Lower mist-net capture rates at Bird Rock in 2012–2013 compared with 1989 are difficult to explain, given that numbers of nests did not change much between these years. The high percentage of recaptures (60%) on the second night in 1989 (i.e. 12 banded on

the first night and eight newly banded; Appendix 1) suggested that most birds netted in 1989 were from Bird Rock. However, more birds were captured in 1989 than could be accounted for by active nests found, suggesting either that the colony was actually larger and many nests were not found in 1989 (i.e. some birds may have laid eggs in deep, large sites that were not checked in the Wall of Holes at that time), or that some birds from other colonies were also captured (i.e. many birds from the Farallones may occur near Bird Rock at night under thick fog conditions). In either case, the relatively high capture rates in 1989 should be regarded as non-reconcilable with 1989 nest data.

Another inconsistency we note was the lack of nests and low capture rates found at the Wall of Holes at Bird Rock in 2001 (Whitworth *et al.* 2002). In five other years (1989, 2012–2015), two to four nests were found in the Wall of Holes and no obvious trend was evident when comparing those years. Whitworth *et al.* (2002) suspected that the small colony at Bird Rock might have declined between 1989 and 2001. As noted above, 1989 mist-net data were not reconcilable with nest data, but the 2001 capture rate also seemed atypically low compared to 2012–2013. The lack of nests found in 2001 suggested that a breeding failure may have occurred earlier that year for unknown reasons. If so, it did not lead to an obvious decline over the long term.

Long-term monitoring: To measure future trends at Bird Rock and Stormy Stack, our initial goal in 2012–2013 was to conduct single standardized surveys of all numbered sites to determine the number of nests found at each location in each year (as indexes of the sizes of each colony) and then conduct annual or periodic surveys to measure trends over time. From 1989 and 2001 surveys, we recognized that (1) landings could be conducted safely at these rocks with appropriate planning and experience, (2) nest searches could be conducted over almost all of these small rocks without climbing gear, and (3) a narrow window of time existed between late August (to avoid disturbance, after Brandt's Cormorants and Common Murres had completed breeding) and early September (after ASSP had completed egg laying and before most ASSP chicks fledged). During that period, a single survey can determine the total or near total number of ASSP nests with eggs laid in the survey year at both Bird Rock and Stormy Stack (see McIver *et al*. 2016). Almost all nests contain chicks at this time of the season, but evidence of breeding (i.e. eggs, broken eggshells or dead chicks) can remain in earlier failed nests, and hatched eggshells can remain in fledged nests. While certain areas at Bird Rock and Stormy Stack are not easily accessible, we do not believe that many nests could be missed there. With use of a burrowscope, we also reduced the proportion of deep, large sites at the Wall of Holes that could not be inspected. A single survey per year at Bird Rock and Stormy Stack is achievable with relatively low effort. Annual data collected over a decade or more will provide solid baseline data for better future assessment of trends in colony sizes.

While limited mist-net data in 2012–2013 were useful for comparison with data from 1989 and 2001, we felt that little additional information on the status of ASSP can be gathered by continuing annual single-night mist-netting sessions at Bird Rock. Greater mist-net effort would be needed within and between years to (1) confirm population size and trends from nest searches, (2) possibly detect small numbers of banded birds from the Farallones or Channel Islands and (3) examine longevity. However, it may be useful to conduct some limited mist-netting at Stormy Stack to evaluate whether higher numbers of birds are captured than can be accounted for by nests found there. A suitable location for a mist-net (Fig. 3) was identified during surveys.

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