CHANGING BREEDING STATUS OF THE ASHY STORM-PETREL *OCEANODROMA HOMOCHROA* ON ANACAPA ISLAND, CALIFORNIA

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SUMMARY

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Ashy Storm-Petrels (ASSP) breed in a range restricted to the southern California Current, from Mendocino County in northern California, United States, to the Coronado Islands in northwest Baja California, Mexico. Approximately half the global population nests on the California Channel Islands, but nesting at one of them, Anacapa Island, had not been recorded before this study. In 2011, 10 years after rats were eradicated, we conducted a study to determine the breeding status of ASSP on Anacapa Island. We used habitat searches coupled with acoustic sensors to assess potential nesting areas and conducted mist netting to determine general presence. We found one active nest containing a nearly fledged ASSP chick in 2011, representing the first breeding record for the island.

Key words: Ashy storm-petrel, California Channel Islands, Anacapa Island, rat eradication, recolonization.

INTRODUCTION

The global population of the Ashy Storm-Petrel *Oceanodroma homochroa* (ASSP) occurs in a range restricted to the southern California Current, with breeding on offshore islands and coastal rocks from Mendocino County, California, United States, south to the Coronado Islands, in northwest Baja California, Mexico (Ainley 1995; Carter *et al.* 2008a, 2016a). Approximately half of the total breeding population is thought to occur on the California Channel Islands (CCI) off the coast of southern California (Hunt *et al.* 1979, 1980; Carter *et al.* 1992, 2008a, 2016a; Ainley 1995). Before 2011, ASSP nests had been found at four of the eight Channel Islands and their associated offshore rocks and islets: San Miguel, Santa Cruz, Santa Barbara and San Clemente (Hunt *et al*. 1979; Carter *et al*. 1992, 2008a, 2016a). However, with the exception of Santa Cruz Island (McIver 2002, McIver *et al*. 2009) and, to a lesser extent, Santa Barbara Island (Harvey *et al.* 2013a, 2014), there has been little consistent monitoring of ASSP breeding colonies in the CCI. Anacapa Island (hereafter, Anacapa) is the easternmost of the four northern Channel Islands and is composed of three islets: East, Middle and West Anacapa (Fig. 1). Together, they currently host at least nine breeding seabird species, including important colonies of Brown Pelican *Pelecanus occidentalis californicus*, Western Gull *Larus occidentalis* and Scripps's Murrelet *Synthliboramphus scrippsi* (Hunt *et al.* 1980, Carter *et al.* 1992, Whitworth *et al.* 2013, Harvey *et al.* 2013b, Harvey & Mazurkiewicz 2015).

In reviewing all known historical literature and unpublished field notes (Grinnell 1902, Willett 1912, 1933, Wright and Snyder 1913, Grinnell 1915, Howell 1917, Grinnell & Miller 1944), we found

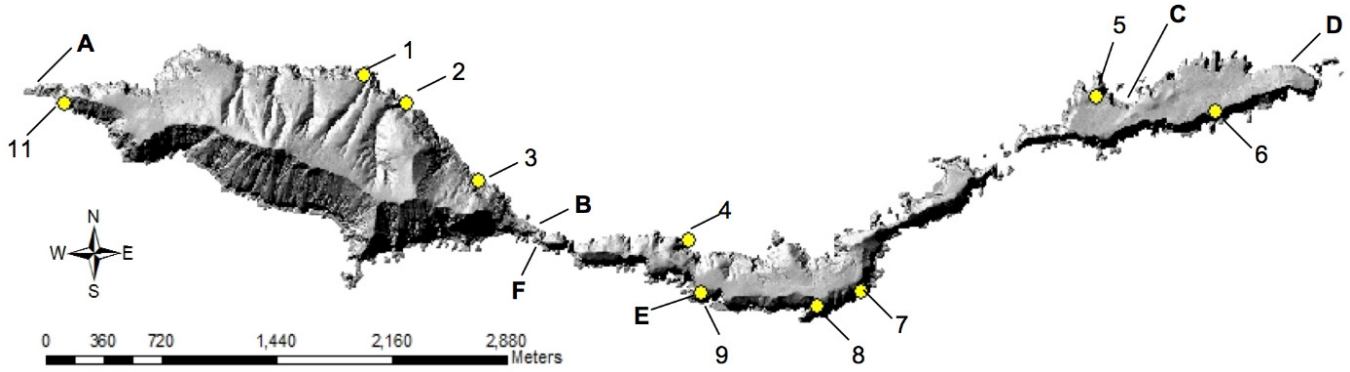

Fig. 1: Locations of mist nets (letters) and automatic recording units (numbers) on West Anacapa (A, B, F, 1, 2, 3, 11), Middle Anacapa (E, 4, 7, 8, 9), and East Anacapa (C, D, 5, 6), Anacapa Island, California, in 2011.

no breeding records of storm-petrels at Anacapa. One occurrence was noted in Sumner & Bond (1939:14), in which a "single petrel was seen in flight on the evening of April 15 at the east end of west Anacapa. It appeared to be the Ashy Petrel (*Oceanodroma homochroa*), but the light was too poor to make identification at all certain." Seabird colony surveys between 1975 and 1977 (Hunt *et al.* 1979*,* 1980) and in 1991 (Carter *et al.* 1992) found no evidence of breeding ASSP on Anacapa, although the methods employed were not directed primarily at storm-petrels. In 1994, 50 ASSP were captured in mist nets at six locations during 11 nights in April and May on East Anacapa (n = 40) and one location on West Anacapa (n = 10). Most captured birds (56%) had partly or well-developed brood patches, and six birds were recaptured 9–52 d after their original capture, indicating repeated visitation (Carter & Whitworth 2013). On the basis of that evidence, it appeared possible that ASSP bred or at least were prospecting for breeding sites on the island during that period.

Locating storm-petrel nests is challenging, in part because the presence of introduced and native mammalian predators restricts crevice-nesting seabirds to areas inaccessible to these predators, such as offshore rocks, steep cliffs and sea caves. Such areas are also difficult to access by researchers, and ground searches do not include areas that cannot be accessed without the use of technical climbing equipment. That issue being recognized, extensive nest searches for crevice-nesting seabirds were conducted at Anacapa between April and November 1994–1997, but no storm-petrel nests were found (H.R. Carter, unpubl. data). The existence of Black Rats *Rattus rattus* on the island could have been one factor behind lack of evidence for breeding. Thorough searches of researcher-accessible habitat for crevice-nesting seabirds before the eradication of Black Rats (2000–2002; ATTC 2001) and after (2003–2010; Howald *et al*. 2009) failed to detect storm-petrel nests (Whitworth *et al.* 2005, 2013). However, the characteristic musky body scent of storm-petrels was detected in a potential breeding site at Portuguese Rock Cove in April 2010 (D. Whitworth, unpubl. data).

Despite the lack of documented nests during 2000–2010, storm-petrels were occasionally observed in flight during nocturnal spotlight surveys for murrelets in 2000–2006 (D. Whitworth, unpubl. data) and during night-time radar surveys for murrelets on the southeast side of Middle Anacapa in April–May 2000–2003 (Hamer *et al*. 2005); one ASSP was captured in a mist net on East Anacapa in May 2001 during a media field trip related to rat eradication (H.R. Carter, unpubl. data). On the basis of these multiple detections, Carter *et al.* (2008a) considered it highly likely that ASSP bred at Anacapa, although visitation from nearby islands, especially from the large colonies at northeast Santa Cruz Island (7 km west of Anacapa; McIver *et al.* 2009) was possible.

Here, we report results of surveys at Anacapa to investigate the status of ASSP as well as other cavity- and burrow-nesting species (Scripps's Murrelets and Cassin's Auklets *Ptychoramphus aleuticus*; Harvey *et al.* 2013b), as part of the Montrose Settlements Restoration Program (MSRP 2005). During these surveys, we documented an ASSP nest at Anacapa for the first time and obtained additional evidence of ASSP breeding and occurrence, as described below.

METHODS

The total land mass area of the three Anacapa islets is estimated at 700 acres, and shoreline length at 31 km (Terrapoint 2010 in Harvey *et al.* 2013b; Fig. 1). We used three techniques during 11 trips (22 survey days) between March and November 2011 to assess the status of crevice- and burrow-nesting seabirds at Anacapa: (1) diurnal searches of suitable crevice-nesting habitats; (2) detections of seabird vocalizations using passive acoustic sensors (hereafter, sensors); and (3) nocturnal mist-netting.

Diurnal nest searches and acoustic sensors

We coupled deployment of sensors with diurnal nest searches of suitable nesting habitat (rocky slopes, talus) within researcher-accessible locations (Fig. 1). We accessed the three islets via an inflatable skiff for diurnal habitat searches and used handheld flashlights to inspect crevices within suitable nesting habitat that could be searched without the use of technical climbing equipment. We searched for nests near established monitoring areas for alcids and along many other coastline areas that are not regularly monitored (Whitworth *et al*. 2013, 2015; Harvey *et al.* 2013b).

Sensors were tested and found to have an effective distance of 50–100 m, depending on conditions. They were programmed to record for one of every 10 minutes (i.e. six recordings per hour) on each night from local sunset to local sunrise (Song Meter 2+; Wildlife Acoustics, Inc., Concord, MA; http://www.wildlifeacoustics.com). We deployed sensors near potential ASSP nesting locations to sample these habitats. On subsequent surveys, we retrieved the sensors and re-deployed them at additional locations after collecting their memory cards and inserting blank ones. We automated the detection of ASSP vocalizations using the spectrogram cross-correlation detection tool in the Extensible Bioacoustic Tool software package (Figueroa & Robbins 2007; XBAT http://www.xbat.org). All vocalizations detected by the software were manually reviewed to confirm the species identity. Recordings were processed between trips to allow for return visits to locations where sensors had recorded ASSP vocal activity.

Nocturnal mist netting

We conducted mist netting at seven locations in June and July, four of which replicated locations where most ASSP had been captured in mist nets in 1994 (Carter & Whitworth 2013; Fig. 1: locations A, C, D and E). We standardized capture methodology to that used by Carter in 1994 (Carter & Whitworth 2013) to the extent possible by using the same net size (2.6 × 9 m nylon nets, 4 shelves, 38 mm mesh; Avinet, Dryden, NY; http://www.avinet.com) with vocalization broadcasting using portable compact disc (CD) players and/or MP3 players to continuously play the same vocalizations as used in 1994 (calls were recorded by D.G. Ainley in the early 1970s at the South Farallon Islands, California).

RESULTS

Diurnal nest searches and acoustic sensors

We did not find evidence of nesting during diurnal searches until we reached a location at which ASSP vocalizations had been detected by one sensor deployed from 6 to 24 June. The sensor was in Portuguese Rock Cove on the north shore of West Anacapa (location 1 in Fig. 1). We returned to this location on 27 August to conduct a nest search in the rocky scree (Fig. 2) and discovered a rock crevice containing a nearly fledged ASSP chick (age ≥76 d; Fig. 3; see McIver 2002 for plumage development in ASSP chicks). Two other crevices

containing broken storm-petrel eggshell fragments (i.e. non-hatched) were found in the same area. We assumed they were from ASSP. We also discovered an old rat midden in a cave in the upper portion of the cove. In total, we logged 283 h of recordings on 361 survey night-hours of sensor deployment.

The mean ASSP call rate at Portuguese Rock Cove was 0.09 calls/min (SD ± 0.14; n = 19 survey nights). Calls were detected on 10 of 19 survey nights (53%); acoustic activity occurred between 21h00 and 04h59, with peak activity measured between 01h00 and 03h59. No vocalizations of other storm-petrel species occurred at this or other sensor locations, and we did not detect ASSP vocalization activity at the other sensor locations.

Nocturnal mist netting

We captured 20 ASSP during seven capture nights; three of these birds were later recaptured. Most captured birds (68%) had partly or well-developed brood patches. We did not capture ASSP at Middle Anacapa, but use of night-vision goggles revealed storm-petrels flying near the tops of the cliffs near the net location. Most ASSP (87%; n = 23, including three recaptured birds) were captured at West Anacapa, with the remaining 13% at East Anacapa.

DISCUSSION

The discovery of an ASSP chick and presumed ASSP eggshell fragments on the north shore of West Anacapa in 2011 confirmed breeding there. We found no other evidence of ASSP nesting during 2011 nest searches of sea caves, shorelines and upper island habitat at Anacapa. The downy chicks and eggshells of ASSP and Leach's Storm-Petrel *O. leucorhoa*, both of which breed among the CCI (Hunt *et al.* 1980, Carter *et al.* 1992, Carter *et al*. 2016b), are nearly impossible to identify to species without genetic techniques. However, the light gray feathers on the head of the near-fledgling, coupled with audio recordings consisting solely of ASSP calls, confirmed that this bird was an ASSP (Fig. 3). Leach's Storm-Petrels were neither captured in mist nets nor heard vocalizing during mist-net captures or in any of the sensor recordings (Harvey *et al.* 2013b). The ASSP chick we discovered in 2011 at Portuguese Rock Cove represents the first known breeding record for Anacapa Island.

As noted on the basis of several types of information, ASSP have likely been breeding on Anacapa, although mostly in inaccessible locations. The Portuguese Rock Cove area was accessible to rats, as indicated by an old rat midden found in 2011; both auklets and murrelets have begun nesting in this location following rat eradication (Harvey *et al.* 2013b, Whitworth *et al.* 2014). Consequently, this first ASSP breeding record could represent (1) a new colonization, possibly from neighboring Santa Cruz Island; (2) a recolonization after earlier colony extirpation by rats or organochlorine pollution; or (3) an expansion of a small remnant population from adjacent habitats inaccessible to rats and researchers. We believe the latter explanation to be the most likely. The current size of the ASSP breeding colony at Anacapa is difficult to estimate. Before recent efforts, surveys were not directed toward determining presence of storm-petrels (cf. Hunt *et al.* 1979, 1980). While abundant crevice habitat exists at Anacapa, and nearby Santa Cruz Island hosts a substantial ASSP colony (McIver *et al.* 2016), the Anacapa ASSP population may have been reduced in the 1970s either as a result of predation by Black Rats, introduced by shipwreck before 1939 (Collins 1979), and/or organochlorine contamination (Carter *et al*. 2016a). Hence, detecting the presence of ASSP may have been compromised despite the survey techniques used earlier. ASSP hatching success and eggshell thinning were not investigated in the 1970s (when pollution was maximal), but Santa Cruz Island ASSPs exhibited eggshell thinning and reduced hatching success in 1992–1997 due to remaining levels of organochlorine pollutants (Gress 1995; Carter *et al.* 2008 a, b, 2016a). Reduced levels of pollutants in Santa Cruz ASSP eggs sampled in 2008 coincided with relatively high hatching success since 2005, and lingering impacts of pollutants do not appear to be affecting current population growth in the CCI (Carter *et al.* 2008b, 2016a; McIver *et al.* 2009).

Colony size can be partially inferred from mist-netting results. Mist-netting efforts at Anacapa varied between surveys conducted in 1994 (before rat eradication) and in 2011 (afterwards), and so we did not attempt statistical comparisons (Harvey *et al.* 2013b, Carter *et al.* 2013). Yet, even given the different and relatively low survey efforts in each year, small numbers and low capture rates of ASSP were seen in both years, as well as similar percentages of birds with brood patches. These findings suggest that population size did

Fig. 2: Overview of Ashy Storm-Petrel nesting habitat at Portuguese Rock Cove, Anacapa Island, 6 June 2011. The white arrow indicates the location of the nest found on 27 August. Photo by A.L. Harvey.

Fig. 3: Fledgling Ashy Storm-Petrel (with down feathers visible on upper abdomen) in nest crevice in Portuguese Rock Cove, Anacapa Island, 27 August 2011. Photo by A.L. Harvey.

not change substantially in nearly two decades. Lack of detection at other sensor locations, and low numbers and rates of mist-net captures in our 2011 study, indicated a relatively small breeding population on the three Anacapa islets, which we estimate at fewer than 50 breeding pairs.

If we are to better understand the presence of ASSP at Anacapa, additional surveys are needed to establish baseline population levels (using mist-net captures, mark-recapture studies, sensors and nest searches) and to measure long-term population trends. In contrast, baseline population level monitoring for Scripps's Murrelets and Cassin's Auklets can be continued using well-established methodology (nest monitoring, as well as spotlight surveys for murrelets). If the Anacapa ASSP colony does not increase naturally, restoration using social attraction may be warranted in the future (McIver *et al*. 2016).

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