

# BREEDING OF THE LEACH'S STORM-PETREL *OCEANODROMA LEUCORHOA* AT SANTA CATALINA ISLAND, CALIFORNIA

HARRY R. CARTER<sup>1,3,4</sup>, TYLER M. DVORAK<sup>2</sup> & DARRELL L. WHITWORTH<sup>1,3</sup>

<sup>1</sup>California Institute of Environmental Studies, 3408 Whaler Avenue, Davis, CA 95616, USA

<sup>2</sup>Catalina Island Conservancy, 125 Clarissa Avenue, Avalon, CA 90704, USA

<sup>3</sup>Humboldt State University, Department of Wildlife, 1 Harpst Street, Arcata, CA 95521, USA

<sup>4</sup>Current address: Carter Biological Consulting, 1015 Hampshire Road, Victoria, BC V8S 4S8, Canada (carterhr@shaw.ca)

Received 4 November 2015, accepted 5 January 2016

Among the California Channel Islands (CCI) off southern California, the Ashy Storm-Petrel *Oceanodroma homochroa* (ASSP) is the most numerous and widespread breeding storm-petrel; it is known to breed at San Miguel, Santa Cruz, Anacapa, Santa Barbara, and San Clemente islands (Hunt *et al.* 1979, 1980; SOWLS *et al.* 1980; Carter *et al.* 1992, 2008; Harvey *et al.* 2016; Fig. 1B; Appendix 1, available on the website). Low numbers of Black Storm-Petrels *O. melania* (BLSP) also breed at Santa Barbara Island (Pitman & Speich 1976; Hunt *et al.* 1979, 1980; Carter *et al.* 1992; Appendix 1). Leach's Storm-Petrels *O. leucorhoa* (LESP) have been captured widely in mist nets at Santa Barbara, Santa Cruz and San Clemente islands, but nests have not been documented there (Hunt *et al.* 1979, 1980; Carter *et al.* 1992; Carter & Henderson 2015; Adams *et al.* 2016; Appendix 1).

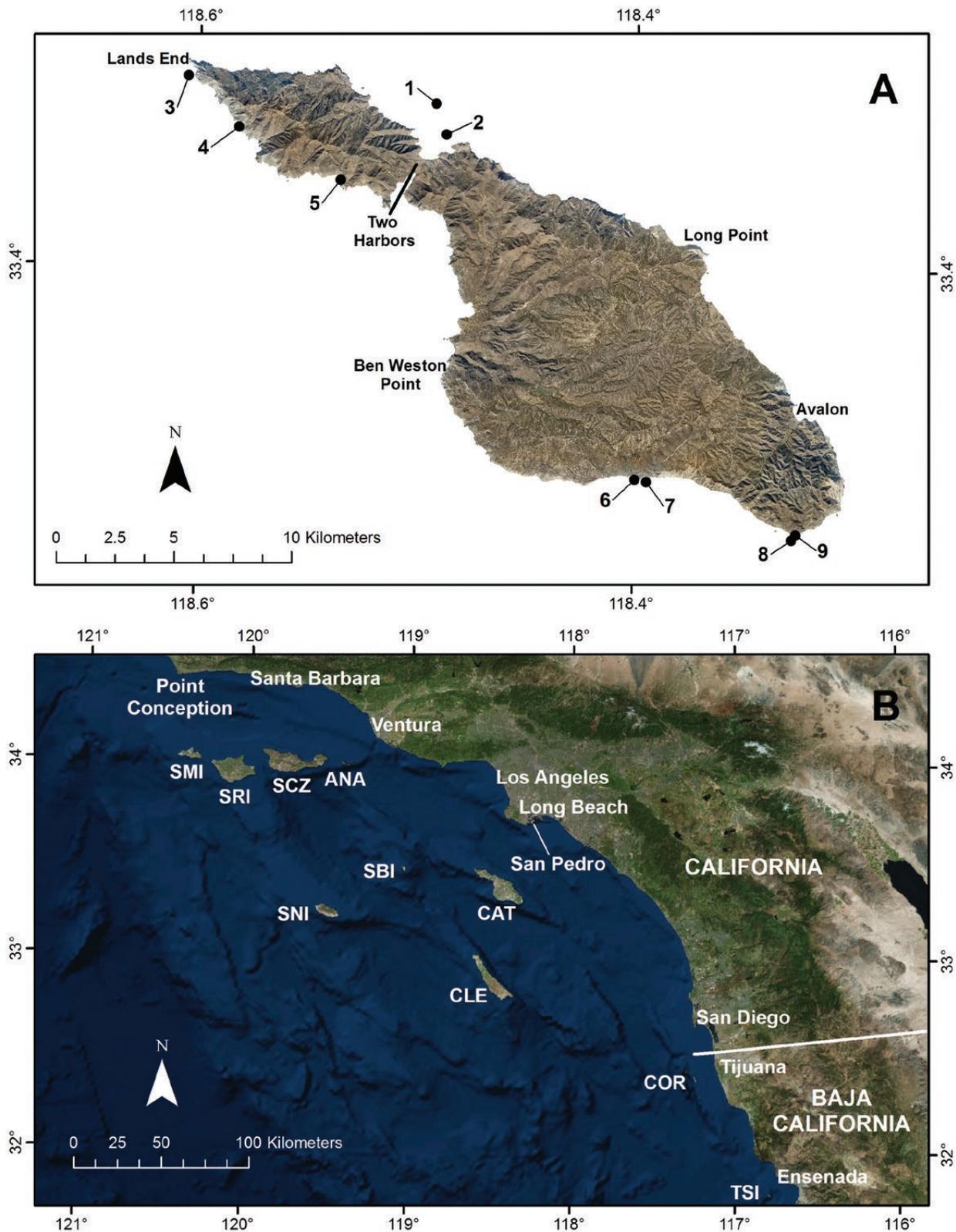
Early historical summaries (Howell 1917, Willet 1933, Grinnell & Miller 1944) did not note storm-petrels breeding at Santa Catalina Island (hereafter, "Catalina"), a large island (34 km long; area 194 km<sup>2</sup>) with parts now heavily developed, 32 km southwest of the Palos Verdes Peninsula. Extensive surveys of seabird colonies in the CCI during 1975–1977 (Hunt *et al.* 1979, 1980) and in 1991 (Carter *et al.* 1992) did not find any storm-petrel nests at Catalina, although suitable crevices were noted in 1991 on Ship Rock (Figs. 1A and 2), off the town of Two Harbors on the north side of the isthmus (H.R. Carter, unpubl. data). In 1994–1996, more focused nest searches for Scripps's Murrelet *Synthliboramphus scrippsi* (Whitworth *et al.* 2014) and other crevice-nesting seabirds led to greater suspicion of storm-petrel nesting at Catalina. A few burrows were found and storm-petrel odor was detected at crevices at Ship Rock; storm-petrel odor also was noted at one small offshore rock in the Silver Canyon Landing Area (Fig. 1A), off the uninhabited south side of the island (H.R. Carter, unpubl. data). A 1937 storm-petrel egg specimen collected at Catalina (exact location not specified) was rediscovered in 1996; it had been recorded by the collector as ASSP without details (Carter *et al.* 2008). In 2008, an unidentified storm-petrel was finally observed in a crevice on Ship Rock, among four other suitable crevices, but an egg was not seen (H.R. Carter, unpubl. data).

In 2012–2014, during online and museum searches for storm-petrel specimens collected by Franklin J. Smith in northern California in 1910–1926 (Carter *et al.* 2015), one of us (H.R.C.) found two egg specimens of the "Socorro Petrel *Oceanodroma socorroensis*" collected by Smith at Catalina in 1903 that had not been reported in historical summaries (Table 1). The identification of these egg specimens seemed suspect, because Townsend's LESP *O. socorroensis* are currently known to breed only at

Guadalupe Island, off central-west Baja California (Ainley 1980, Power & Ainley 1986, Ainley 2005, Pyle 2008, Howell *et al.* 2009). Alternatively, these egg specimens may have been from dark-rumped LESP, which are known to breed at the Coronado and San Benito islands, Baja California (Ainley 1980, Power & Ainley 1986).

Within this context, we asked the following questions: (1) Were the 1903 egg records the first breeding records of LESP at Catalina and in the CCI?; (2) Was the 1937 egg record at Catalina really that of a misidentified LESP?; and (3) Did LESP or ASSP breed at Catalina without our detection in 1991–1996? To attempt to resolve these questions, we conducted nest searches for storm-petrels at Ship Rock and Silver Canyon Landing Area in 2014–2015, resulting in the discovery of LESP breeding at Ship Rock. In this paper, we describe our 2014 and 2015 observations at Ship Rock and Silver Canyon Landing Area, re-examine 1903 and 1937 egg specimen records to try to verify their authenticity, discuss past efforts that failed to fully document breeding by storm-petrels at Catalina, and summarize historical literature to clarify the earliest known documentation of breeding storm-petrels in the CCI.

*Ship Rock (2014):* On 2 July, two of us (D.L.W. & T.M.D.) conducted a nest search, using hand-held flashlights (Figs. 2 and 3). All accessible areas of the 18 m high rock were searched for potential breeding crevices and each area was carefully inspected. Adult storm-petrels were found in five rock crevices (i.e. large enough for storm-petrels but too small for alcids; Carter *et al.* 1992) near the top of the rock (Table 2; Fig. 3; see Appendix 2 for photographs of two crevice entrances). Gray heads were apparent on all five adults observed in crevices, but their rumps could not be seen; we assumed they were ASSP. Two nests apparently had small chicks (based on adults with hatched eggshells), one nest had an egg, and in the two other nests only an adult was seen. Another nest (number 6) found inside a partly collapsed dirt/guano burrow contained an adult storm-petrel with gray head plumage (Fig. 4) and lacking any white on the rump, along with one quarter of an eggshell; we also assumed it was an ASSP. Unfortunately, we had not noticed the burrow entrance, and it collapsed when we stepped near to it. ASSP do not typically excavate burrows (Ainley 1995). However, this dirt/guano "burrow" appeared to be a natural cavity of some kind under the hard surface crust of old guano, with a small entrance through which an adult storm-petrel had entered the cavity and partly excavated a nest. Afterwards, the burrow was repaired by clearing out the tunnel and placing sections of the crust on top of the partly collapsed section. On 8 August, storm-petrel nests on Ship Rock were re-inspected (Table 2). Four nests had chicks (three



**Fig. 1:** Locations of breeding colonies of storm-petrels in the Southern California Bight: (A) Santa Catalina Island, with numbered locations mentioned in Table 3, 1 — Ship Rock, 2 — Bird Rock, 3 — Eagle Rock, 4 — Main Island; 5 — Main Island; 6 — Silver Canyon Landing Area (Subcolony 02), 7 — Silver Canyon Landing Area (Subcolony 01), 8 — Church Rock, and 9 — Main Island; (B) eight major Channel Islands in southern California, United States (SMI — San Miguel Island, SRI — Santa Rosa Island, SCZ — Santa Cruz Island, ANA — Anacapa Island, SBI — Santa Barbara Island, SNI — San Nicolas Island, CLE — San Clemente Island, and CAT — Santa Catalina Island), and islands in northwestern Baja California, Mexico (COR — Coronado Islands and TSI — Todos Santos Islands). Storm-petrels have been reported breeding at all islands except for SRI and SNI (Appendix 1, available on the website).

observed and one inferred from hatched eggshells), and an adult was seen in one nest. At the two nests that had hatched eggshells on 2 July, chicks > 37 days of age were found. The repaired burrow (number 6) was not checked in order to avoid further disturbance, although it appeared to be intact.

In addition to the six active nests found at Ship Rock, we also found another suitable crevice with strong storm-petrel odor and about 10 other crevices that seemed to be of marginal suitability and probably were not used. We estimated a breeding population size of six to seven breeding pairs in 2014, based on a thorough check of all

areas of the rock with suitable crevices. Two rock crevices suitable for nesting by Scripps's Murrelets were noted, but no evidence of breeding was found. Below the light structure, two dried and faded unidentified storm-petrel wings (154 mm long, consistent with ASSP or LESP; Ainley 1980, 1995) were found near a pellet that had been regurgitated by a gull or owl (i.e. it contained small brownish contour feathers, apparently from the same individual storm-petrel as the wings).

*Ship Rock (2015)*: On 21 April, the five crevice nest sites noted in 2014 were tagged. Subsequently, these nest sites were monitored



**Fig. 2:** Overview of Ship Rock, Santa Catalina Island, April 2012: north side (top) and west side (bottom). Cormorants and pelicans roost mainly along the top of the rock. (photos by T.M. Dvorak).



**Fig. 3:** Crevice-nesting habitat (crevice number 1 being inspected) on Ship Rock, 2 July 2014 (photo by D.L. Whitworth).

**TABLE 1**  
Storm-petrel egg specimens from Santa Catalina Island, California

Locality	Date	Nest description and notes	Incubation	Identity	Set mark	Collector	Specimen number
"Santa Catalina Island, California"	27 June 1903	"Socorro Petrel" "in a burrow 3 ft. in. Egg laid on bare ground for the nest. On an island on the Pacific Ocean off San Pedro, California"	Fresh	Positive	2	Franklin J. Smith	ROM 1986
"San Pedro Calif"	27 June 1903	"Socorro Petrel" "Collection of E.J. Booth"	ND	ND	1	Unknown	WFVZ 180845
"Santa Catalina Island"	4 July 1937	"Ashy Storm-Petrel"	ND	ND	ND	J.H. Baumgardt	WFVZ 95994

ND = no data.

monthly by one of us (T.M.D.) using a handheld flashlight, but the burrow nest (number 6) could not be observed (Table 2). Two nests contained adults on 21 April (eggs were not noted), while three nests were empty. On 27 May, three nests contained adults, but, again, eggs were not seen. On 1 July, all five nests had adults, and an egg was observed in one nest. On 8 August, downy chicks were observed in four nests, and one nest was empty. On 9 September, one fully feathered chick (>70 d) and 3 partly feathered chicks (~40–70 d) were observed, and one nest was still empty. On 16 October, all five nests were empty. By this date, all chicks were >70 days of age and had likely fledged. For 2015, apparent breeding success was 80% (i.e. four of five eggs laid resulted in fledged chicks).

On 8 August, a small (11 cm × 8 cm × 6 cm) passive infrared sensor-activated camera (Browning Strike Force HD Model BTC-5, Prometheus Group LLC, Birmingham, AL) was wired to the base of the light post at the top of Ship Rock and focused on the



**Fig. 4:** Gray head of an adult storm-petrel found in a collapsed burrow on Ship Rock, 2 July 2014 (photo by D.L. Whitworth).

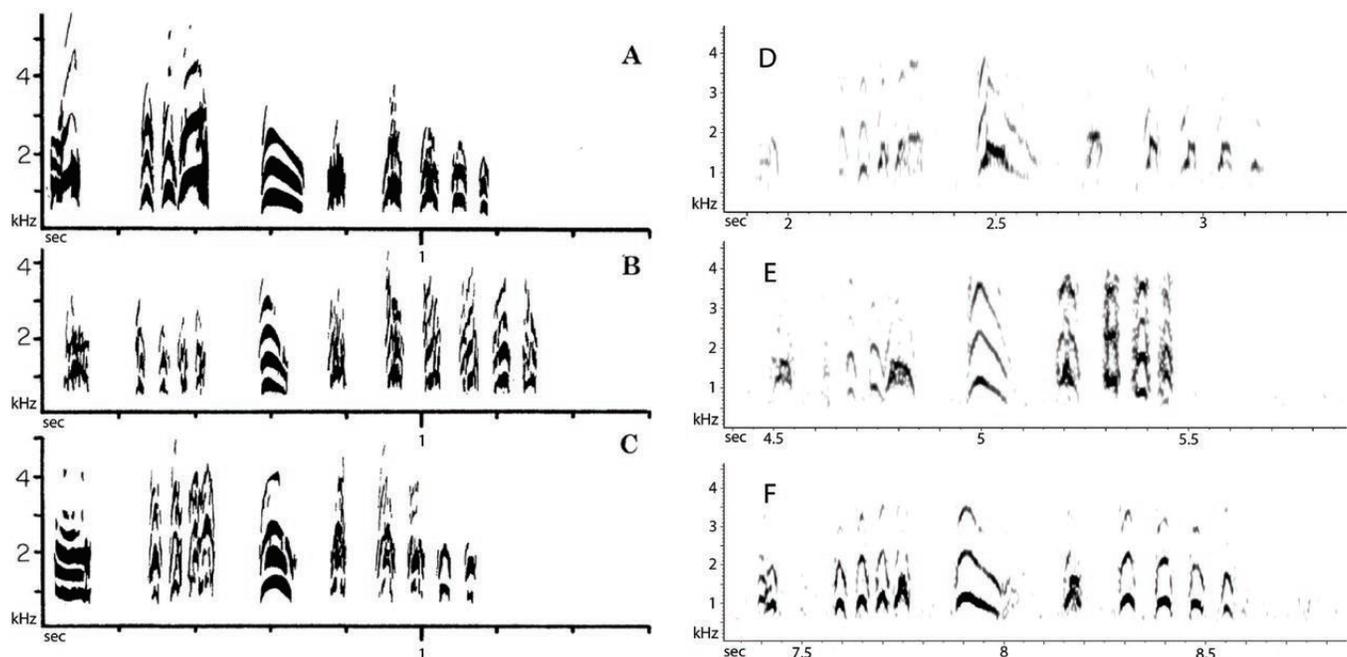
**TABLE 2**  
Leach's Storm-Petrel nests monitored at Ship Rock, Santa Catalina Island, 2014–2015

Year	Date	Crevice nest site <sup>a</sup>				
		1	2	3	4	5
2014	2 July	Adult & egg	Adult & hatched eggshell	Adult & hatched eggshell	Adult <sup>b</sup>	Adult
	8 August	Downy chick	Chick <sup>c</sup>	Chick <sup>c</sup>	Hatched eggshell	Adult
2015	21 April	Adult	Empty	Adult	Empty	Empty
	27 May	Adult	Empty	Adult	Adult	Empty
	1 July	Adult	Adult	Adult & egg	Adult	Adult
	8 August	Downy chick	Downy chick	Downy chick	Downy chick	Empty
	9 September	Partly feathered chick	Fully feathered chick	Partly feathered chick	Partly feathered chick	Empty
	16 October	Empty	Empty	Empty	Empty	Empty

<sup>a</sup>Corresponding tag numbers: 1 (1642), 2 (1643), 3 (1644), 4 (1645) and 5 (1646).

<sup>b</sup>Only head visible.

<sup>c</sup>Only partly visible.



**Fig. 5:** Spectrograms of Leach's Storm-Petrel vocalizations. Left side from Ainley (1980): South Farallon Islands (A), Coronado Islands (B), and San Benito Islands (C). Right side: Ship Rock, Santa Catalina Island – 9 August 2015 (D), 11 August 2015 (E), and 19 August 2015 (F).

entrance to nest number 4 (see Appendix 2 for a photograph of this crevice entrance). This was done to confirm storm-petrel species



**Fig. 6:** Tail of adult storm-petrel with pale-brownish upper tail coverts found in a collapsed burrow on Ship Rock, 2 July 2014 (photo by D.L. Whitworth).

identification and to obtain more information about nocturnal predators, if present. The camera was set to record in video mode (1280 × 720 resolution with audio) each time the sensor was triggered (with a 5 s delay between recorded events). Recording time per event was set at 2 min during the day and defaulted to 10 s at night (with an infrared flash illumination system). By 9 September, many video-clips of storm-petrels entering or departing from the crevice had been obtained, along with LESP vocalizations (Fig. 5). All individuals using nest number 4 had dark rumps. To confirm LESP identification, we compared spectrograms of vocalizations from Ship Rock with those provided in Ainley (1980) (Fig. 5) and available recordings of LESP and ASSP in the Macaulay Library at Cornell University (Ithaca, NY; macaulaylibrary.org). No ASSP vocalizations were recorded at Ship Rock in 2015, but the microphone had a limited detection range and was triggered to record only for 10 s when activity occurred at the crevice entrance. Given these limitations, any vocalizations of birds associated with other nest sites likely would not have been recorded.

Once confronted with clear evidence of LESP at Ship Rock in 2015, we then reconsidered our earlier identification of the adult storm-petrel found in the collapsed burrow in 2014. Initial identification as ASSP was based mainly on the gray head and lack of white on the rump. After reviewing Pyle (2008; see photos in Howell 2012), we



**Fig. 7:** Overview of Silver Canyon Landing Area, Santa Catalina Island, 3 July 2014: (upper right) Subcolony 01; and (lower left) Subcolony 02 (photos by D.L. Whitworth).

were reminded that ashy-gray head coloration also occurs in other LESP forms, including LESP from the Coronado Islands, which largely have dark rumps. Under *O. l. chapmani*, Pyle (2008:282) states: "Populations of the Coronado Is. ("*willettii*") average grayer and with paler aspect to the uppertail coverts than those of the San Benito Is. But differences insufficient for subspecific recognition." Upon re-examination of another photograph of the bird handled in 2014, we also noted pale-brownish uppertail coverts (Fig. 6). We did not examine the underwing coverts (i.e. silvery median and greater secondary coverts contrasting with darker lesser secondary and primary coverts in ASSP versus uniformly dark brown underwing coverts in LESP; see Pyle 2008). With these further considerations, we concluded that the handled bird was most likely a dark-rumped LESP with a grayish head. We also assumed that LESP also likely bred in the other five nests noted on Ship Rock in 2014–2015.

This reidentification process greatly reinforced to us that special care must be taken to distinguish ASSP and dark-rumped LESP when individual storm-petrels are identified at colonies in the CCI and the Coronado Islands, where both may occur and breed. Unlike identification at sea, when flight behavior can assist such differentiation (Ainley 2005, Howell *et al.* 2009, Howell 2012), careful plumage examination is needed when birds are handled, and birds only partially visible inside crevices should not be identified by head plumage alone. Mist-netting of LESP at Prince and Santa Barbara islands in 1991 and 1994 used protocols for identification, and many had whitish rumps, but with some mostly dark-rumped individuals (Carter *et al.* 1992; Howell *et al.* 2009; Adams *et al.* 2016). We suspect that few if any of individuals identified as ASSP in 1991 and 1994 were actually misidentified dark-rumped LESP. However, some past ASSP nest-related work must be re-examined, in light of the possibility of misidentification of dark-rumped LESP. For example, the sole breeding and occurrence record of ASSP at Todos Santos Islands, Baja California, was based on a storm-petrel with a gray head briefly observed with an egg inside a crevice on 7 May 2005 (Carter *et al.* 2008; H.R. Carter & D.L. Whitworth, unpubl. data). We now consider that more work is needed to verify the species of storm-petrel breeding at Todos Santos Islands. This location had been considered the southernmost breeding location for ASSP (Carter *et al.* 2008) but is also within the southern part of the breeding range of LESP in the eastern Pacific Ocean (Huntington *et al.* 1996, Pyle 2008, Howell 2012).

Ship Rock nests inspected in 2014–2015 represent (1) the first verified nest record of the LESP at Catalina (but see earlier probable egg records below); and (2) the first verified nest record of the LESP for the CCI (Appendix 1). Breeding by LESP at Ship Rock is not unexpected, given that it lies only 159 km north of the Coronado Islands (Fig. 1B), where LESP have been documented breeding since 1895 (Appendix 1). Future work is needed to gather tissue samples from storm-petrels at Catalina to further confirm species identification and examine genetics, but adults should not be removed from crevices for sampling in order to avoid possible nest abandonment (Ainley *et al.* 1990).

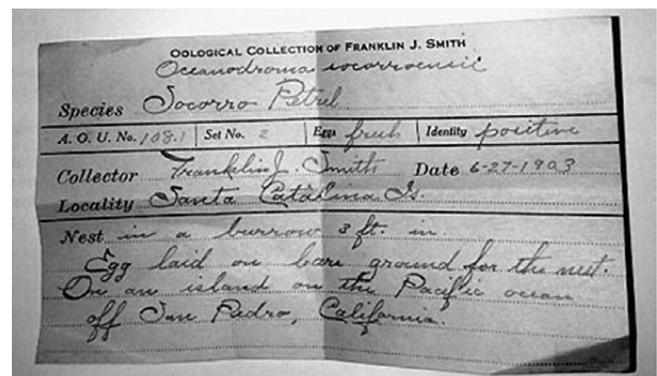
**Timing of Egg Laying:** Two crevice nest sites with small chicks found at Ship Rock on 2 July 2014 (Table 2) reflected egg laying that occurred in early to mid-May, based on an average incubation period for LESP of about 40–44 d (Ainley *et al.* 1990, Huntington *et al.* 1996) and estimated chick ages of <10 d. Three other crevice nests in 2014 and all five crevice nests in 2015 appeared to have eggs laid between late May and late June. Incubation in June is

common for LESP in California and northern Baja California (Anthony 1898, Harris 1974, Ainley *et al.* 1990).

**Silver Canyon Landing Area (2014):** On 3 July, two of us (D.L.W. & T.M.D.) conducted nest searches on two rocks at Silver Canyon Landing Area (see Carter *et al.* 1992). On the largest rock (10 m high) within Subcolony 01 (Fig. 7), a few shallow crevices were noted, but none was considered suitable for breeding by storm-petrels. On the largest rock (6 m high) within Subcolony 02 (Fig. 7), one suitable crevice was found, but the entrance was covered in cobwebs. One partial unidentified storm-petrel carcass (wing length 138 mm; consistent with an ASSP or LESP; Ainley 1980, 1995; Power & Ainley 1986), along with a small amount of regurgitated stomach oil, was found in an exposed location. We closely examined other rocks in this area from an inflatable boat and considered that they likely did not contain suitable rock crevices for storm-petrels.

**Egg Specimens (1903):** Through online searches of specimens at the Royal Ontario Museum (ROM; Toronto, ON), one egg (ROM 1 986) of "Socorro Petrel (*O. socorroensis*)" was located with the original egg card that specifically stated in Smith's handwriting that the egg was collected at Catalina on 27 June 1903 (Table 1; Fig. 8). The egg was obtained from "a burrow 3 ft. in." Identification was marked as "positive," likely because an incubating adult was found with the egg. Incubation was noted as "fresh," with little or no embryo development (i.e. collection about 1–2 weeks after egg laying). Smith apparently sold this egg to an unknown collector before it eventually resided in the ROM, but the accession date is not known (M. Peck, pers. comm.).

During an in-person search of specimens at the Western Foundation of Vertebrate Zoology (WFVZ; Camarillo, CA), a second egg (WFVZ 180845) of "Socorro Petrel" was located that had been collected at "San Pedro Calif" on 27 June 1903; however, further location or nest description details were not provided, the original egg card was missing, and the collector was not listed (Table 1). No other information was available, except that this egg belonged to the E.J. Booth collection. Smith likely sold this egg to Booth. It is clear that this egg also was collected at Catalina by Smith, given that the limited specimen information, collection date, partial nest location description (which also mentions "San Pedro," from which a boat likely departed to take Smith to Catalina [see Table 1; Fig. 1B]), and set marks matched the ROM specimen above.



**Fig. 8:** Specimen card for "Socorro Petrel" egg collected at Santa Catalina Island, in 1903 (Royal Ontario Museum 1986) (photo by M. Peck).

In 1903, storm-petrels were not yet widely known to breed in the CCI, but LESP and BLSP had been known to breed at the Coronado Islands since 1895 (Fig. 1; Appendix 1). Smith was 24 years old in 1903, his interest in ornithology was still developing, and he had only recently begun collecting bird eggs. Based on an online search of specimens in the Ornithology Information System (ORNIS), he apparently made his only collecting trip to southern California in 1903, including a short visit to Catalina. Subsequently, he collected almost entirely in Humboldt and Del Norte counties near his home in Eureka (northern California). He published few of his specimen records and retained most specimens in his personal collection, with some sold to other collectors (Carter *et al.* 2015). Earlier historical summaries (Willett 1912, 1933; Howell 1917; Grinnell & Miller 1944) did not mention these Catalina storm-petrel eggs, likely because they were not published and not located in primary research collections in California. The WFVZ specimen remained in Smith's collection until it was eventually accessioned at the WFVZ (Carter *et al.* 2015). L.F. Kiff (pers. comm.) had provided most historical data from WFVZ and many other museum collections to G.L. Hunt, Jr., for the most recent historical summary of breeding seabirds in the CCI (Hunt *et al.* 1979). Kiff was not aware of this specimen because WFVZ obtained the Booth collection from the Whatcom Museum of History and Art (Bellingham, WA) only in about 1979–1980 (Kiff 1981).

In 1903, Smith undoubtedly had little experience with storm-petrel identification, even though he clearly was a careful observer and by 1910–1926 had become very experienced with LESP, ASSP, and Fork-tailed Storm-Petrels *O. furcata* (Carter *et al.* 2008, 2015). Smith most likely knew about dark-rumped LESP breeding at the Coronado Islands, where the name “Socorro Petrel *O. socorroensis*” was applied at the time of his 1903 Catalina egg records (e.g. Anthony 1898, Grinnell & Daggett 1903). Given difficulty in separating dark-rumped LESP from ASSP, especially in 1903 when their ranges were poorly known (Appendix 1), we could not confirm Smith's species identification of these two egg specimens, likely made by examining the incubating adults. However, we strongly suspect that they had been correctly identified by Smith as LESP eggs collected at Ship Rock, based on our 2014–2015 findings there. These 1903 specimens at Catalina represent the second record of any species of storm-petrel breeding in the CCI, after the 1875 record of ASSP breeding at Prince Island (Henshaw 1876; Appendix 1).

*Egg Specimen (1937)*: Carter *et al.* (2008) first reported an egg specimen (WFVZ 95,944), identified as that of an ASSP, collected at “Santa Catalina Island” on 4 July 1937 by John H. Baumgardt (1922–2002), but lacking further details, apparently because the original egg card was missing (Table 1). Baumgardt was an

**TABLE 3**  
Nest searches for crevice-nesting seabirds at Santa Catalina Island in 1991–1996

Location	USFWS colony number <sup>a</sup>	Map number <sup>b</sup>	Year	Date	Notes	
Ship Rock	524-039	1	1991	31 May	15–20 empty crevices, some with cobwebs; no evidence of use	
				1994	13 May	20 sites (10 crevices with storm-petrel odor, 7 unused crevices with cobwebs, 3 burrows)
				1995	20 April	17 crevices; “Several small crevices (some with feathers and odor) storm-petrel odor on South to S.E. side below light station; a few with odor on top; several in catacomb-like area just SW of light on top.” One possible Scripps's Murrelet site also noted.
Bird Rock	524-010	2	1991	31 May	No crevices noted	
				1994	13 May	No crevices noted
				1995	20 April	3 small crevices on east side in a fissure; no evidence of use
				1996	7 May	Crevices on east side checked; no evidence of use
Main island between Iron Bound Bay and Star Bay	524-054	4	1996	7 May	Checked large crevice near water; 2 crevices; no evidence of use	
Main island between Kelp Point and Cape Cortes	524-054	5	1996	7 May	Checked cave and scree; many potential crevices; no evidence of use	
Silver Canyon Landing Area (Subcolony 02)	524-049	6	1991	31 May	No crevices noted	
Silver Canyon Landing Area (Subcolony 01)	524-049	7	1991	31 May	“Quite a lot of crevice habitat” although snake seen	
				1996	7 May	4 crevices and 1 burrow with strong storm-petrel odor
Church Rock	–	8	1996	7 May	1 small crevice; no odor or other evidence of use	
Main island adjacent to Church Rock	–	9	1996	7 May	>10 medium crevices and many small crevices in lower boulders and cliff face; no odor or evidence of use	

<sup>a</sup> US Fish and Wildlife Service Colony Number (see Carter *et al.* 1992). Dash indicates no known seabird colony.

<sup>b</sup> See Fig. 1A for locations.

outdoorsman and birder from Glendora (southern California) and became a member of the southern division of the Cooper Club in 1937. He donated 200 sets of eggs to WFVZ in 1964 (R. Corado, pers. comm.). This specimen was not published and stayed in Baumgardt's collection until 1964. Why L. Kiff did not note this record when providing historical egg record data to G.L. Hunt Jr. (Hunt *et al.* 1979) in the 1970s is not clear, although Baumgardt's collection may not have been incorporated into the WFVZ collection until the 1980s, or Kiff may not have considered species identification to be confirmed. Based on a VertNet search, Baumgardt apparently collected only this single storm-petrel egg. Presumably, he identified an incubating adult storm-petrel that was removed from the nest when the egg was collected on 4 July. We could not confirm species identification because ASSP and dark-rumped LESP are difficult to distinguish without a protocol or experience. Based on apparent nesting by LESP at Ship Rock on 1903 and verified nesting by LESP there in 2014–2015, we also suspect that this 1937 breeding record was of a dark-rumped LESP from Ship Rock.

*Past Surveys (1967–2008)*: Before the 1970s, only one other report of early naturalists examining crevices for nesting seabirds at Ship Rock is known, in addition to the 1903 and 1937 egg records noted above. A historical Scripps's Murrelet egg record from 1967 (exact date unknown) was likely collected at Ship Rock, not nearby Bird Rock (Fig. 1A) as previously reported (Hunt *et al.* 1979, 1980; see Whitworth *et al.* 2014). In June 1976 and 1977, very limited surveys for crevice-nesting seabirds were conducted at Catalina during the first major survey of seabirds in the CCI (Hunt *et al.* 1979). Researchers apparently landed only on Bird Rock, located about 1.3 km southeast of Ship Rock, where crevice-nesting seabirds were not found.

In 1991–1996, nest searches for crevice-nesting seabirds were conducted at seven locations around Catalina (Table 3). Initial suspicions of possible breeding by a few pairs of storm-petrels at Ship Rock were aroused on 31 May 1991, when 10–15 potential crevices were noted, but no odor or nesting activity was detected (Carter *et al.* 1992, unpubl. survey archives stored at the US Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge, Fremont, CA). Storm-petrel odor in suitable nest crevices was first noted at Ship Rock in 1994–1995, and a few burrows were noted in 1994. At Silver Canyon Landing Area (Subcolony 01), storm-petrel odor and suitable crevices were noted in 1996 but not in 1991. The lack of solid evidence of nesting by storm-petrels at Catalina in 1991, 1994–1996 and 2008 likely reflected inadequate surveys conducted before egg laying by most LESP at Ship Rock, based on the timing of breeding in 2014–2015. In these earlier years, the timing of Ship Rock surveys in April and May were related to the phenology of earlier-nesting Western Gulls *Larus occidentalis* and Scripps's Murrelets (Carter *et al.* 1992, Whitworth *et al.* 2014).

*Breeding Habitats and Conditions*: Hunt *et al.* (1979, 1980) thought that small nocturnal crevice-nesting seabirds did not breed at Catalina in 1976 and 1977 because of the presence of predatory mammals (i.e. endemic Island Fox *Urocyon littoralis catalinae*, introduced Black Rats *Rattus rattus*, and feral cats *Felis catus*) on the main island (also see Carter *et al.* 1992, McChesney & Tershy 1998, Whitworth *et al.* 2014). However, in 2012–2013, nests of Scripps's Murrelets were first found in small pockets of cliff and shoreline scree on the north side of the main island southeast of Two Harbors (Whitworth *et al.* 2014). Access by mammalian predators

in these habitats would be difficult or impossible. A few small nearshore rocks at Catalina could provide refuges for breeding murrelets and storm-petrels, but only Ship Rock has suitable nesting crevices. It is located farthest from shore (1.4 km), greatly reducing the possibility of access by mammals. The only other rock that was not examined for crevice-nesting seabirds in 1994–1996 is Eagle Rock, 0.7 km southeast of Lands End. However, it did not appear to have crevices when inspected closely by boat in 1991 and 1996 (H.R. Carter, pers. obs.), and waves likely wash over this exposed rock periodically during the breeding season. Four unidentified storm-petrels were observed off the northwest side of the island (north of the isthmus and southeast of Lands End) on the night of 20–21 April 2014 (23h13–00h27 Pacific Daylight Time), during an at-sea spotlight survey for Scripps's Murrelets (D.L. Whitworth & T.M. Dvorak, unpubl. data). Storm-petrels on this part of the main island may breed in steep slopes and cliffs, which are largely inaccessible and have not been fully searched for crevice-nesting seabirds, although two accessible locations were checked in early May 1996 (Table 3).

Reproduction of LESP at Ship Rock in 2014–2015 was successful, with low or non-existent avian predation of nesting adults, given that eggs hatched in at least five of six nests in 2014 and four of five nests in 2015, and at least three chicks were documented in August 2014 (when last checked) and four chicks fledged in 2015. Only one Western Gull chick was noted at Ship Rock on 8 August 2014, and one gull nest with three chicks was noted on 1 July 2015. Gulls were not found breeding in 1974, 1976, 1991, and 1994–1996 (Hunt *et al.* 1979, Carter *et al.* 1992; H.R. Carter, unpubl. data). Roosting Brandt's Cormorants *Phalacrocorax penicillatus*, Double-crested Cormorants *P. auritus* and Brown Pelicans *Pelecanus occidentalis* (Fig. 2) likely prevent most gulls from nesting at Ship Rock, and gulls breed mainly at nearby Bird Rock. A gull or owl (based on pellet appearance) was likely responsible for the death of one storm-petrel noted in 2014, but carcasses were not found in 2015. Visitation by storm-petrels at rocks with very few suitable rock crevices at Catalina (e.g. Silver Canyon Landing Area) may indicate occasional nesting at these locations, or visits by small numbers of birds without breeding. One carcass found at Silver Canyon Landing Area (Subcolony 02) in 2014 had regurgitated stomach oil (possibly indicating that it was a breeding adult), but it did not appear to breed at this location.

*Conservation Needs*: Humans have accessed Ship Rock occasionally for many years to establish and maintain navigation markers and lights; this access may have resulted in damage to and loss of rock crevices and especially any burrows or natural cavities used for nesting (given very limited soil or natural cavities). An old navigation marker (apparently without a light) is clearly visible on top of the rock in a photograph taken in the early 1900s (Anonymous 1911). The marker was later replaced with a small navigation light in 1935 (C. Liddell, pers. comm.; Figs. 2 and 3). Future human activities at Ship Rock should take into consideration this small nesting colony of LESP and seek to minimize disturbance (e.g. scheduling light maintenance outside of the breeding season; avoiding damage to rock crevices, burrows and soil during light maintenance or nest monitoring; and ensuring that people do not land on the rock without authorization). The Catalina Island Conservancy manages all rocks off Catalina and will continue monitoring Ship Rock to assess storm-petrel site occupancy and reproductive success, as well as to gather additional data on storm-petrel behavior and predators.

## ACKNOWLEDGEMENTS

Funding and in-kind support for 2014 and 2015 surveys were provided by the California Institute of Environmental Studies (CIES; F. Gress and J. Brenner), the Catalina Island Conservancy (J. King) and the Marisla Foundation. Field assistance was provided by A. Catalano, C. Duncan and J. Parish.

Surveys by Humboldt State University (HSU) in 1991 and 1994–1996 were funded by the US Navy (Legacy Resource Management Program; T.W. Keeney), California Department of Fish and Game (E. Burkett), US Fish and Wildlife Service (T. Zimmerman) and Minerals Management Service (G. Reetz). In-kind support was provided by the US Navy (Point Mugu Naval Air Weapons Station; T.W. Keeney), US Fish and Wildlife Service and National Biological Service (D. Gilmer) and HSU (R.T. Golightly). Vessel support was provided by Instinct Charters (F/V *Instinct*; D. Christy). Valuable field assistance at Catalina in 1991 and 1994–1996 was provided by J.B. Bulger, B.C. Birmingham, M.J. Gay, D.B. Lewis, G.J. McChesney, W.R. McIver, S.H. Newman, L.K. Ochikubo Chan and M.O. Pierson. The 2008 survey by CIES was funded by Chevron (G. Minnerly) and CIES (F. Gress).

Egg specimen data at the Royal Ontario Museum (Toronto, ON) and Western Foundation of Vertebrate Zoology (Camarillo, CA) were obtained using the Ornithology Information System (ORNIS) or in-person visits, with confirmation by M. Peck and R. Corado, respectively. R. Corado also provided valuable background information about F.J. Smith and J.H. Baumgardt. Skin specimen data were obtained using VertNet and in-person visits to the Los Angeles County Museum (Los Angeles, CA), with assistance by K. Garrett; Natural History Museum (Tring, United Kingdom), with assistance from M. Adams, L. Carter, and K. Cook; and US National Museum (Smithsonian Institution, Washington, DC), with assistance from R. Clapp, C. Angle and J. Saucier. Valuable comments on drafts of this paper were provided by D. Ainley, J. Adams, J. King, W. McIver, and two anonymous reviewers.

## REFERENCES

- ADAMS, J., CARTER, H.R., McCHESNEY, G.J. & WHITWORTH, D.L. 2016. Occurrence, morphometrics and plumage variability among Leach's Storm-Petrels *Oceanodroma leucorhoa* in the California Channel Islands, 1976–2015. *Marine Ornithology* 44: 113–119.
- AINLEY, D.G. 1980. Geographic variation in Leach's Storm-Petrel. *Auk* 97: 837–853.
- AINLEY, D.G. 1995. Ashy Storm-Petrel (*Oceanodroma homochroa*). In: POOLE, A. (Ed.) *The Birds of North America Online*. Ithaca, NY: Cornell Lab of Ornithology. [Available online at: <http://bna.birds.cornell.edu/bna/species/185/articles/introduction>. Accessed 12 March 2016.]
- AINLEY, D.G. 2005. The dark-rumped storm-petrels of the eastern North Pacific: speciation, current status, and future prospects. *Birding* 25: 58–65.
- AINLEY, D.G., HENDERSON, R.P. & STRONG, C.S. 1990. Leach's Storm-Petrel and Ashy Storm-Petrel. In: AINLEY, D.G. & BOEKELHEIDE, R.J. (Eds.) *Seabirds of the Farallon Islands: Ecology, Dynamics, and Structure of an Upwelling-System Community*. Stanford, CA: Stanford University Press. pp. 128–162.
- ANONYMOUS. 1911. New contributor. *Oologist* 28: 141.
- ANTHONY, A.W. 1898. Petrels of southern California. *Auk* 15: 140–144.
- CARTER, H.R. & HENDERSON, R.P. 2015. *Ashy Storm-Petrel monitoring at San Clemente Island, California, in 2014*. Davis, California: California Institute of Environmental Studies.
- CARTER, H.R., McCHESNEY, G.J., JAQUES, D.L., ET AL. 1992. *Breeding populations of seabirds in California, 1989–1991. Volume 1 – Population estimates*. Dixon, CA: US Fish and Wildlife Service, Northern Prairie Wildlife Research Center.
- CARTER, H.R., McIVER, W.R. & McCHESNEY, G.J. 2008. Ashy Storm-Petrel (*Oceanodroma homochroa*). In: SHUFORD, W.D. & GARDALI, T. (Eds.) *California Bird Species of Special Concern: a ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California*. Studies of Western Birds 1. Camarillo, CA: Western Field Ornithologists; and Sacramento, CA: California Department of Fish and Game. pp. 117–124.
- CARTER, H.R., PARKER, M.W., KOEPKE, J.S. & WHITWORTH, D.L. 2015. Breeding of the Ashy Storm-Petrel in central Mendocino County, California. *Western Birds* 46: 49–65.
- CROSSIN, R.S. & BROWNELL, R.L. 1968. *Preliminary report of Channel Islands Survey*. Eastern Area Cruise No. 41. Washington, DC: Smithsonian Institution.
- DORAN, A.L. 1980. *Pieces of Eight Channel Islands: A Bibliographic Guide and Source Book*. Glendale, CA: Arthur H. Clark Company.
- GRINNELL, J. 1897. Report on the birds recorded during a visit to the islands of Santa Barbara, San Nicolas and San Clemente, in the spring of 1897. *Pasadena Academy of Science Publication* No. 1: 1–26.
- GRINNELL, J. & DAGGETT, F.S. 1903. An ornithological visit to Los Coronados Islands, Lower California. *Auk* 20: 27–37.
- GRINNELL, J. & MILLER, A.H. 1944. The distribution of the birds of California. *Pacific Coast Avifauna* No. 27.
- HARRIS, S.W. 1974. Status, chronology, and ecology of nesting storm petrels in northwestern California. *Condor* 76: 249–261.
- HARVEY, A.L., MAZURKIEWICZ, D.M., McKOWN, M.W., BARNES, K.W. & PARKER, M.W. 2016. Changing breeding status of the Ashy Storm-Petrel *Oceanodroma homochroa* on Anacapa Island, California. *Marine Ornithology* 44: 93–97.
- HENSHAW, H.W. 1876. Appendix H8. Report on the ornithology of the portions of California visited during the field-season of 1875. In: WHEELER, G.M. *Annual Report Upon the Geographical Surveys West of the One Hundredth Meridian in California, Nevada, Utah, Colorado, Wyoming, New Mexico, Arizona, and Montana: Being Appendix JJ of the Annual Report of the Chief of Engineers for 1876*. Washington, DC: Government Printing Office. pp. 224–278.
- HOLDER, C.F. 1910. *The Channel Islands of California: a Book for the Angler, Sportsman, and Tourist*. London, UK: Hodder and Stoughton.
- HOWELL, A.B. 1917. Birds of the islands off the coast of southern California. *Pacific Coast Avifauna* No. 12.
- HOWELL, S.N.G. 2012. *Petrels, Albatrosses and Storm-Petrels of North America*. Princeton, NJ: Princeton University Press.
- HOWELL, S.N.G., McGRATH, T., HUNEFELD, W.T. & FEENSTRA, J.S. 2009. Occurrence and identification of the Leach's Storm-Petrel (*Oceanodroma leucorhoa*) complex off southern California. *North American Birds* 63: 540–549.
- HUEY, L.M. 1925. Unpublished San Diego records. *Condor* 27: 72.

- HUNT, G.L., JR., PITMAN, R.L., NAUGHTON, M., WINNETT, K., NEWMAN, A., KELLY, P.R. & BRIGGS, K.T. 1979. Distribution, status, reproductive biology and foraging habits of breeding seabirds. In: *Summary of marine mammals and seabird surveys of the Southern California Bight area, 1975-1978*. Vol. 3. Investigator's reports, Part 3: Seabirds of the Southern California Bight, Book 2. Irvine, CA: University of California.
- HUNT, G.L., JR., PITMAN, R.L. & JONES, H.A. 1980. Distribution and abundance of seabirds breeding on the California Channel Islands. In: POWER, D.M. (Ed.) *The California Channel Islands: Proceedings of a Multidisciplinary Symposium*. Santa Barbara, CA: Santa Barbara Museum of Natural History. pp. 443-460.
- HUNTINGTON, C.E., BUTLER, R.G. & MAUCK, R.A. 1996. Leach's Storm-Petrel (*Oceanodroma leucorhoa*). In: POOLE, A. (Ed.) *The Birds of North America Online*. Ithaca, NY: Cornell Lab of Ornithology. [Available online at: <http://bna.birds.cornell.edu/bna/species/233/articles/introduction>. Accessed 12 March 2016.] doi:10.2173/bna.233
- INGERSOLL, M. 1886. Nesting habits and egg of Ashy Petrel (*Cymochorea homochroa*). *Ornithologist and Oologist* 11: 21.
- JAMES-VEITCH, E.A.T.C. 1970. *The Ashy Petrel, Oceanodroma homochroa, at its breeding grounds on the Farallon Islands, California*. PhD dissertation. Los Angeles, CA: Loma Linda University.
- KIFF, L.J. 1981. Eggs of the Marbled Murrelet. *Wilson Bulletin* 93: 400-403.
- LOOMIS, L.M. 1896. California water birds. No. III. — South Farallon Island in July. *Proceedings of the California Academy of Sciences (Second Series)* 6: 353-366.
- McCHESNEY, G.J. & TERSHY, B.R. 1998. History and status of introduced mammals and impacts to breeding seabirds on the California Channel Islands and Northwestern Baja California Islands. *Colonial Waterbirds* 21: 335-347.
- McIVER, W.R. 2002. *Breeding phenology and reproductive success of Ashy Storm-Petrels (Oceanodroma homochroa) at Santa Cruz Island, California, 1995-98*. MSc thesis. Arcata, CA: Humboldt State University.
- McIVER, W.R., CARTER, H.R., HARVEY, A.L., MAZURKIEWICZ, D.M. & MASON, J.W. 2016. Use of social attraction to restore Ashy Storm-Petrels *Oceanodroma homochroa* at Orizaba Rock, Santa Cruz Island, California. *Marine Ornithology* 44: 99-112.
- MILLER, L. 1936. Some maritime birds observed off San Diego, California. *Condor* 38: 9-16.
- OSBORNE, T.O. 1972. *Ecology and avian use of the coastal rocks of northern California*. MA thesis. Arcata, CA: Humboldt State College.
- PITMAN, R.L. & SPEICH, S.M. 1976. Black Storm-Petrel breeds in the United States. *Western Birds* 7: 71.
- POWER, D.M. & AINLEY, D.G. 1986. Seabird geographic variation: similarity among populations of Leach's Storm-Petrel. *Auk* 103: 575-585.
- PYLE, P. 2008. *Identification Guide to North American Birds. Part II. Anatidae to Alcidae*. Point Reyes Station, CA: Slate Creek Press.
- SAN DIEGO UNION (SDU). 1895. Untitled article. *San Diego Union* (newspaper), 22 October 1895, p. 5.
- SAN FRANCISCO CALL (SFC). 1895. Untitled article. *San Francisco Call* (newspaper), 11 October 1895.
- SOWLS, A.L., DEGANGE, A.R., NELSON, J.W. & LESTER, G.S. 1980. *Catalog of California Seabird Colonies*. FWS/OBS 37/80. US Department of the Interior, Fish and Wildlife Service, Biological Service Program.
- WHITWORTH, D.L., CARTER, H.R., DVORAK, T.M., FARLEY, L.S. & KING, J. 2014. Status, distribution, and conservation of the Scripps's Murrelet at Santa Catalina Island, California. *Monographs of the Western North American Naturalist* 7: 321-338.
- WILLETT, G. 1910. A summer trip to the northern Santa Barbara Islands. *Condor* 12: 170-174.
- WILLETT, G. 1912. Birds of the Pacific slope of southern California. *Pacific Coast Avifauna* No. 7.
- WILLETT, G. 1933. A revised list of the birds of southwestern California. *Pacific Coast Avifauna* No. 21.
- WRIGHT, H. & SNYDER, G.K. 1913. Birds observed in the summer 1912 among the Santa Barbara Islands. *Condor* 40: 86-92.