Mist-net Captures of Ashy Storm-Petrels and Cassin's Auklets at Anacapa Island, California, in 1994

Harry R. Carter [1,2] and Darrell L. Whitworth [1,3]

[1]Department of Wildlife, Humboldt State University, Arcata, California 95521 USA

[2]Current Address: Carter Biological Consulting
1015 Hampshire Road, Victoria, British Columbia V8S 4S8 Canada

[3] Current Address: California Institute of Environmental Studies
3408 Whaler Avenue, Davis, California 95616 USA

Final Report
24 June 2013

Suggested Citation:
Carter, H.R., and D.L. Whitworth. 2013. Mist-net captures of Ashy Storm-Petrels and Cassin's Auklets at Anacapa Island, California, in 1994. Unpubl. report, Carter Biological Consulting, Victoria, British Columbia; and California Institute of Environmental Studies, Davis, California. 21 p.

Executive Summary

In April-June 1994, Humboldt State University conducted mist-net captures for nocturnal seabirds for the first time at Anacapa Island, California. These captures resulted in important discoveries: (1) the first record of occurrence and suspected breeding of Ashy Storm-Petrels (*Oceanodroma homochroa*); and (2) the fourth record of occurrence and additional evidence of breeding for Cassin's Auklets (*Ptychoramphus aleuticus*). Fifty storm-petrels and eight auklets were captured on East and West Anacapa; 9 storm-petrels also were recaptured. Twenty-two percent of storm-petrels (n = 11) and 1 auklet had well-developed brood patches, indicating that eggs had been or would be laid by these individuals or their mates. Most storm-petrel captures occurred before peak egg laying at Santa Cruz Island. Most auklet captures occurred during or after peak egg laying at Prince Island in 1994 but most captured birds appeared to be subadults based on iris colors. Active storm-petrel or auklet nests were not found during limited nest searches at Rat Rock and Landing Cove in 1994. Breeding by crevice-nesting seabirds in most accessible habitats at Anacapa Island in 1994 was unlikely due to the presence of Black Rats (*Rattus rattus*). Ashy Storm-Petrels and Cassin's Auklets probably bred at Anacapa Island in 1994 but numbers likely had been reduced greatly to remnant populations during the 20th century due to the introduction of rats, with nesting limited to small pockets of suitable breeding habitat in inaccessible cliffs prior to rat eradication in 2001-2002.

Introduction

In 1994-1997, Humboldt State University (HSU) conducted surveys of Ashy Storm-Petrels (*Oceanodroma homochroa*), Scripps's Murrelets (*Synthliboramphus scrippsi*) and Cassin's Auklets (*Ptychoramphus aleuticus*) in the Channel Islands off southern California, with primary funding from the U.S. Navy (Legacy Resources Management Program). These surveys were intended to supplement HSU surveys conducted for all breeding seabirds in the Channel Islands in 1991 (Carter et al. 1992). Due to limited time and funds, 1991 surveys of nocturnal burrow and crevice-nesting species (i.e., storm-petrels and nocturnal alcids) had focused on gathering evidence of breeding for estimating or confirming population size at breeding areas reported in 1975-1977 by the University of California Irvine (Hunt et al. 1979, 1980). During 1975-1977 surveys, little evidence of nocturnal crevice-nesting seabirds was recorded at Anacapa Island. However, during 1991 surveys, much unsurveyed but suitable habitat was considered to exist for nocturnal seabirds at Anacapa Island and many other Channel Islands. In 1994-1997, HSU conducted additional surveys at Anacapa Island and other Channel Islands to attempt to find undocumented breeding areas for Ashy Storm-Petrels, Scripps's Murrelets and Cassin's Auklets.

The results of 1994-1997 surveys were not compiled into one report and much remains unpublished. However, some information for certain islands and species (especially Scripps's Murrelets) has been summarized (e.g., Carter et al. 1996, 1997, 2008a,b, 2009, 2010; McChesney et al. 1999, 2000; Whitworth et al. 1997, 2003). At Anacapa Island,

survey methods included mist-net captures (1994), nest searches (1994 and 1997), vocalization surveys (1994 and 1996), and at-sea captures (1995-1996). For Ashy Storm-Petrels, occurrence and suspected breeding at Anacapa Island based on mist-net captures in 1994 has been reported without details (McChesney et al. 1999; Carter et al. 2008b). For Cassin's Auklets, recent occurrence at Anacapa Island has been reported based on mist-net captures in 1994 without details and breeding based on eggshell fragments found in 1997 (McChesney et al. 2000). For Scripps's Murrelets, recent occurrence and breeding also was first reported based on the discoveries of small numbers of nests in sea caves in 1994 and the presence of nocturnal at-sea congregations noted in 1994-1996 (Whitworth et al. 1997, 2003, 2005, 2013; McChesney et al. 2000).

In this report, we provide a detailed summary of mist-net captures of Ashy Storm-Petrels and Cassin's Auklets and related information gathered at Anacapa Island in 1994. This information is valuable for: (1) historical documentation of occurrence and breeding of these two species; (2) designing a research plan for 2011 mist-net captures at Anacapa Island; and (3) comparison to 2011 mist-net captures at Anacapa Island. To update the status of Ashy Storm-Petrels at Anacapa Island after eradication of Black Rats (*Rattus rattus*) in 2001-2002, mist-net captures and other surveys were conducted in 2011 by Channel Islands National Park and the California Institute of Environmental Studies (A.L. Harvey, unpubl. data), with funding from the Montrose Trustee Council.

Methods

In 1994-1997, storm-petrels and small alcids were captured in mist nets at night on various Channel Islands to gather data on: (1) species presence; (2) population size; (3) breeding status of captured birds; and (4) capture rates (Carter et al. 1992, 2009b). In 1994, field trips to the Channel Islands were conducted in April-August for various survey and monitoring purposes. On each trip, several islands were visited and time allotted to each island varied due to weather, personnel available, and work being conducted. Visits to Anacapa Island in 1994 occurred on 15-18 April (n = 3 nights), 2-5 May (n = 3 nights), 14-15 May (n = 1 night), and 7-8 June (n = 1 night). Mist-net captures in 1994 were conducted: (1) at East Anacapa on 7 nights; and (2) on West Anacapa on 1 night (Table 1; Figs. 1 and 2).

Nylon mist nets were 7-feet (2.1 m) high by 30-feet (9.1 m) long and oriented parallel to shore near potential nesting habitats. Storm-petrels were attracted to net areas by vocalizations broadcast from a small portable cassette player placed in front of the mist net. At Anacapa Island in 1994, only vocalizations of Ashy Storm-Petrels were broadcast because we were focused primarily on documenting this species which had been the most abundant and widely distributed storm-petrel during 1991 surveys in the Channel Islands (Carter et al. 1992, 2008b). At East Anacapa, 6 mist-net sites (#1-6; Fig. 1) sampled areas on the top of the islet above potential nesting habitats in inaccessible cliffs. However, 1 mist-net site (#7) was located at the East Landing dock area close to the water. At West Anacapa, only 1 mist-net site (#8) was selected (Fig. 2) because this location was accessible from a small boat and near potential nesting habitats, whereas other potential

locations were either more difficult to access or further from inaccessible cliffs (Fig. 2). No mist-net captures were conducted at Middle Anacapa in 1994.

All net locations could be easily accessed by personnel and mist-net captures could be conducted safely at night without significant disturbance to marine mammals or surface-nesting seabirds. Mist-net capture and bird handling generally followed methods used during 1991 surveys in the Channel Islands (Carter et al. 1992). All captured birds were removed from the mist net, placed in holding bags until processing, and moved a short distance (< 5 m) away from the net site. Birds were released a short distance from the net site immediately after processing. Storm-petrels were held for about 5-10 minutes and auklets for about 2-3 minutes before being released.

Each storm-petrel was examined for: (1) presence and development of the single medial brood patch (scored 0-6 after Sealy 1974); (2) body molt (scored 0 [none], 1 [light], 2 [medium], or 3 [heavy]); (3) primary molt (each of the 10 primaries were scored as old, growing [1/10, 3/10, 5/10, 7/10, 9/10], or new; after Emslie et al. 1990); (4) morpho-metric measurements (culmen and tarsus using calipers; wing length with a 30 cm wing ruler; and tail length with a 15 cm plastic ruler); and (5) body mass (using a 100-g Pesola spring scale). Storm-petrels were banded on either leg with a U.S. Geological Survey #1 stainless steel leg band.

Each Cassin's Auklet was examined for: (1) presence and development of lateral brood patches (scored as above for Ashy Storm-Petrel); (2) primary molt (scored as above for Ashy Storm-Petrel); and (3) iris color scored from 1 (white) to 5 (dark brown), after Manuwal (1978). Auklets were banded on either leg with a U.S. Geological Survey #3 stainless steel leg band.

Since storm-petrels can have partial brood patches (scores 1-2) without having laid eggs (Ainley et al. 1976, 1990), we treated brood patch scores of 0-2 as lacking a brood patch whereas scores of 3-4 were treated as "well-developed" brood patches indicating that eggs likely had been laid or were about to be laid by the captured bird or its mate. Mist-net capture rates for Ashy Storm-Petrels were calculated in 2 ways: a) captures per net hour (CPNH); and b) captures per hour within the capture period (CPHCP). CPNH was calculated using captures over the time period that the net was first opened until it was last closed. CPHCP used the same number of captures but over the time period between the first and last bird captured that night. Thus, CPHCP excluded: (1) post-dusk and pre-dawn times when ambient light levels were too high; (2) dark periods before birds had arrived for the evening; and (3) dark periods after birds may have departed for the night. CPHCP could not be calculated on nights when only one bird was captured.

Results

Ashy Storm-Petrel

Fifty Ashy Storm-Petrels were captured and banded (Table 2); 8 of these 50 also were recaptured. The numbers of Ashy Storm-Petrels captured per night varied by location, date, time, and weather (Tables 1, 6). On 11 net nights, net hours ranged from 0.90 to 8.83 hours per night and CPNH ranged from 0.00 to 2.06 birds per hour. Over 6 nights with more than one capture, capture periods ranged from 3.65 to 5.67 hours per night and CPHCP ranged from 0.82 to 3.17 birds per hour.

Six of 8 (75%) recaptures occurred at or near the original capture site in the Landing Cove area where 3 net sites (#1, #4, and #7) were located less than 200 m apart (Table 5; Fig. 1). One bird (#60707) was recaptured near the west end of East Anacapa (net site #6) after being banded near the east end of East Anacapa (net site #7) 20 nights earlier. One bird (#60726) was recaptured on West Anacapa (net site #8) after being banded near the west end of East Anacapa (net site #6).

Brood patch scores were summarized for 3 time periods (Table 4): (1) 15-18 April: 20.0% well-developed (n = 20); (2) 2-5 May: 14.3% well-developed (n = 21); and (3) 14-15 May: 44.4% well-developed (n = 9). Six of 8 (75%) recaptured storm-petrels lacked brood patches. Only 1 recaptured storm-petrel (#60851) had a well-developed brood patch when first captured on 2 May; this individual also had the same score on 8 June. Six recaptures (Table 5) did not show changes in brood patch scores after first capture, although data were not recorded for 2 other recaptures.

Brief nest searches were conducted in the upper cliff area at Landing Cove on the night of 2-3 May (23:20-23:45 h) and in the immediate area near the mist-net on the north side of Rat Rock on the night of 14-15 May. Storm-petrel (or other crevice-nesting seabird) nests were not found in either area, although suitable crevice sites were abundant.

Cassin's Auklet

A total of 8 Cassin's Auklets were captured; 6 were banded and 2 were not banded because auklet bands had been accidentally left behind on our support vessel which was not nearby (Table 3). Five auklets were captured at net #7 in Landing Cove on 16-17 April, 1 at net #4 near Landing Cove (below the East Anacapa lighthouse) on 2-3 May, and 2 at net #8 at Rat Rock on 14-15 May; none were captured at the 5 other net sites.

Only 1 (12.5%) auklet (Table 3) had well-developed brood patches and an iris color score of 1+ when captured on 2 May. Four of 7 (57%) auklets without brood patches had iris color scores of 2-4, likely indicating subadults. Three other auklets had iris color scores of 1+ and were considered to be adults, either non-breeding individuals or they had not yet laid eggs yet (given that extended egg laying occurred between mid-March and June at Prince Island in April 1994; Carter et al. 1996). One of these birds was captured on 16 April and 2 were captured on 15 May (although one had early primary molt suggesting a

subadult; Emslie et al. 1990; Table 7). It is improbable that these birds had laid eggs in February-March, brood patches had refeathered in March-April, and they were still attending the colony with difficult-to-detect refeathered brood patches in April-May. No auklets were recaptured.

Auklet captures occurred very late at night on 16-17 April at Landing Cove (net #7) and 14-15 May at Rat Rock (net #8) (Tables 3, 7). At Landing Cove, it was not clear from the field notes if vocalizing was heard or if other auklet observations were made. Very little vocalizing occurred at Rat Rock. A few individuals occurred near the net earlier in the night and some seemed to fly directly to nearby nest crevices. At Rat Rock, bright deck lights on a vessel anchored on the south side may have delayed auklet some arrivals or reduced vocalizing.

Auklet nests were not found during brief nest searches in the upper cliff area at Landing Cove on the night of 2-3 May and in the immediate area near the mist-net on the north side of Rat Rock on the night of 14-15 May. A nest search was not conducted in the lower dock area at Landing Cove but few if any potential crevices exist in this area, probably due to habitat loss from building the dock, staircase, and related buildings. However, the dock is located across a narrow channel from cliffs that contain suitable habitat.

Discussion

Prior to 1994, little knowledge of breeding or occurrence by Ashy Storm-Petrels and Cassin's Auklets at Anacapa Island was available. In June 1910, Willet (1910) had noted that "Cassin's Auklets were common at night and were undoubtedly breeding somewhere on the island, but we did not locate the nesting colony." Hunt et al. (1979, 1980) did not find any evidence of either species at East and Middle Anacapa in 1975-77 but they did not examine West Anacapa. Carter et al. (1992) did not expend much effort looking for these species at Anacapa Island because they had not been found in 1975-77; in 1991, no mist-net captures were conducted and crevice searches were conducted only at Cat Rock off the south side of West Anacapa. In 1994, mist-net captures were conducted for the first time at East and West Anacapa, resulting in the discovery of the occurrence and probable breeding of Ashy Storm-Petrels and Cassin's Auklets, including captures of adults of both species with well-developed brood patches indicating that eggs had been or would be laid by these individuals or their mates. Numbers of birds captured (Ashy Storm-Petrel 50; Cassin's Auklet 8) indicated that both species were present in some numbers and captures likely did not represent just a few stray individuals from other colonies. Movements of a few banded individuals between colonies in the Channel Islands have been documented, but this behavior does not appear to be extensive. Storm-petrel capture rates were generally comparable to Santa Barbara Island in 1991 where breeding also appears to be spread out mainly in inaccessible cliffs and on offshore rocks and few nests have been found (Carter et al. 1992; Whitworth et al. 2011), but lower than rates found at several other small islands with relatively dense breeding populations (e.g., Prince Island, Scorpion Rock) in 1991 (Carter et al. 1992). Storm-petrel and auklet nests

were not found during brief nocturnal crevice searches at Landing Cove and Rat Rock during the breeding season nor during post-season sea cave nest searches in August 1994 (Whitworth et al. 2003). Based on 1994 and 1997 data, McChesney et al. (2000) reported the first evidence of recent occurrence and breeding of Cassin's Auklets at Anacapa Island since 1910. Based on 1994 mist-net captures, Carter et al. (2008a) reported occurrence and suspected nesting by Ashy Storm-Petrels at Anacapa Island.

Between mid-April and mid-May 1994, an increasing proportion of mist-net captured Ashy Storm-Petrels (i.e., from 20% to 44%; Table 4) had a well-developed brood patch, consistent with the general timing of egg laying at Santa Cruz Island which begins in March-April and continues until August-September (McIver et al. 2011). A similar increasing proportion of Ashy Storm-Petrels with a brood patch from April to July also was found at known colonies at Prince Island and Santa Barbara Island in 1991 (Carter et al. 1992). Thus, the absence of a brood patch on some birds did not suggest that these birds were not breeding, although some may have been subadults that usually lack brood patches. Recaptures of storm-petrels further indicated continued attendance of Anacapa Island for periods of up to 2 months, but mist-net capture effort did not continue through the majority of the 1994 breeding season. Most recaptured storm-petrels (75%) lacked a brood patch but likely bred after recapture, although a few may have been subadults or non-breeding adults.

Most Cassin's Auklets captured had not yet laid eggs (i.e., did not have brood patches) and iris color suggested that many probably were subadults. In addition, late-night arrivals of most captured auklets also suggested that birds were not attending active nests during mist-net captures; however, the single auklet with well-developed brood patches was captured relatively early in the night (23:10 h) and other auklets were observed but not captured earlier in the night at Rat Rock. Some auklets with iris color scores of 2-3 can breed (Manuwal 1978; HRC, pers. obs.) and younger adults can lay later in the season than experienced adults; thus, iris color may not indicate breeding status for some individuals. In 1994, HSU studied timing of breeding and reproductive success of Cassin's Auklets at Prince Island off San Miguel Island, using monthly nest checks (Carter et al. 1996). Extended egg laying was found between mid-March and late June, although peak laying occurred between mid-March and mid-April, a smaller peak occurred in early May, and another smaller peak occurred in early June (mainly second clutches). If timing of breeding was similar at Anacapa and Prince Islands in 1994, certain individuals at Anacapa Island might not have laid eggs by mid April to mid May when mist-net captures were mainly conducted. Many breeding adults also may have avoided capture by flying directly to nest crevices once incubating or feeding chicks. At Prince Island, hatching ranged from mid April to mid June 1994, mostly in late April (Carter et al. 1996). Many breeding adults also may have avoided capture in mist nets mainly set at the tops of cliffs (i.e., away from nest sites) by flying directly to nest crevices once incubating or feeding chicks. Net sites #7 and #8 that captured 6 of 7 auklets were located close to the water and closer to nest sites confirmed in subsequent years. When active auklet nests were documented after eradication at Landing Cove and Rat Rock in 2003-2010 (Whitworth et al. 2005, 2012), they were obvious and heavily marked with guano (DLW, pers. obs.). Such obvious sites were not noted in 1994 but

captures may have occurred before breeding in that year and areas with later-documented nest sites at Landing Cove and Rat Rock were not inspected in 1994.

Active breeding by auklets at Anacapa Island in 1994 also was suggested limited auklet vocalizing and the capture of subadults attending breeding habitats (i.e., breeding was later determined in these habitats). Low levels of auklet vocalizing during mist-net captures might have reflected normal behavior where auklets breed in small numbers. Similar low auklet vocalizing was noted at Elephant Seal Point at Santa Barbara Island in 2009 where small numbers of auklets were found breeding (Whitworth et al. 2011; HRC, pers. obs.). Subadults also may have been attracted more than adults to mist nets (by either storm-petrel broadcast vocalizations [which also had a few Cassin's Auklets calling in the background when the tape was made at the South Farallon Islands) or periodic head lamps of personnel retrieving storm-petrels and auklets from these nets] or were more likely to encounter nets with less direct flights to potential breeding habitats. Island attendance by subadult auklets without adults also breeding at the same island is not known to occur elsewhere.

After 1994 and before rat eradication in 2001-2002, two other pieces of evidence of breeding by Cassin's Auklets at Anacapa Island also have surfaced: (1) a rodent-depredated eggshell fragment of a Cassin's Auklet was found on the open ground surface of Pinnacle Cave on the northeast side of West Anacapa in 1997 (McChesney et al. 2000); and (2) a broken eggshell found on the surface of the ground on the upper west end slopes at West Anacapa in 1991 by F. Gress had originally been identified as a Scripps's Murrelet egg but this specimen was reidentified by HRC as a Cassin's Auklet eggshell (i.e., about 1/8-1/4 of an auklet-sized eggshell; completely white) in about 2001 (Carter et al. 1992; F. Gress, pers. comm.).

The lack of mist-net captures of Scripps's Murrelets at Anacapa Island in 1994 likely indicated that: (1) mist nets set along the tops of the cliffs were ineffective at capturing murrelets which bred mainly in sea caves near the water prior to rat eradication (McChesney et al. 2000; Whitworth et al. 2013); and (2) murrelets likely did not breed beside the two lower net sites at Rat Rock and Landing Cove. Murrelet nests have not yet been found on Rat Rock and were not found in Landing Cove until 2003 (Whitworth et al. 2003, 2013). Only brief nocturnal nest searches were conducted in portions of these areas during mist-net captures in 1994, but we suspect that murrelets did not breed in accessible areas not searched due to the presence of rats. Nest searches in sea caves in August 1994 resulted in the discovery of small numbers of murrelet nests based on eggshell fragments found after the breeding season (McChesney et al. 2000). Historical breeding by Scripps's Murrelets had been noted at Anacapa Island in 1910-1938 but little evidence of breeding had been found in 1975-77, with only one eggshell found in a sea cave near Landing Cove on 26 June 1976, despite documented vocalizing murrelets in nocturnal at-sea congregations off Landing Cove (Hunt et al. 1979, 1980). In 1988, C. Drost found 1 nest in Garbage Gulch and, in 1991, F. Gress noted murrelets vocalizing at night in the Landing Cove area and he found 1 nest there (Carter et al. 1992). After rat eradication, numbers of murrelet nests in sea cave and non-cave habitats increased from 2003 to 2010 and hatching success was much higher due mainly to reduced egg depredation or scavenging and continuing adequate prey resources, indicating benefits

from rat eradication (Whitworth et al. 2013).

Despite the occurrence of breeding storm-petrels and suspected breeding in 1994, the first Ashy Storm-Petrel nest was not discovered until 2011 on West Anacapa (A.L. Harvey, unpubl. data). Ashy Storm-Petrels and Cassin's Auklets likely have always bred at Anacapa Island but numbers probably were reduced greatly to remnant populations during the 20th century due to the presence of Black Rats, with nesting restricted to inaccessible cliffs. Poor past documentation of occurrence and breeding of both species at Anacapa Island apparently reflected nests located in inaccessible (or difficult-to-access) habitats and reduced population sizes (both in response to the presence of Black Rats), as well as short visits by many early ornithologists, a lack of nocturnal surveys or mist-net captures in 1975-77 and 1991, and a lack of nest searches during the breeding season in certain less accessible habitats until the 1994-2011 period.

Acknowledgments

Major funding for surveys at Anacapa Island in 1994 was provided to Humboldt State University by the U.S. Navy (Legacy Resources Management Program), with assistance from T.W. Keeney (Point Mugu Naval Air Station). Additional funding was provided by the California Department of Fish and Wildlife (E.B. Burkett) and U.S. Fish and Wildlife Service (T. Zimmerman). Significant in-kind support was provided by the National Biological Service (D. Gilmer), U.S. Navy (T.W. Keeney), and Humboldt State University (R. Golightly). Valuable vessel support was provided by Instinct Charters (skipper D. Christy and first-mate B. Christy). Use of park lodgings at Anacapa Island was facilitated by P. Martin and K. Faulkner. Valuable field assistance was provided by J. Adams (JA), S.B.C. Dechesne (SBCD), B.S. Keitt (BSK), N.J. Karnovsky (NJK), S.H. Newman (SHN), L.K. Ochikubo Chan (LKOC), and M.O. Pierson (MOP). F Gress and C. Drost provided valuable historical information. Funding for preparation of this report was provided to Carter Biological Consulting by the Montrose Settlements Trustee Council, with assistance from the Channel Islands National Park (A.L. Harvey) and the National Fish and Wildlife Foundation. Comments were provided by A.L. Harvey, A. Little, and J. Boyce.

Literature Cited

Ainley, D.G., T.J. Lewis, and S. Morrell. 1976. Molt in Leach's and Ashy Storm-Petrels. Wilson Bulletin 88:76-95.

Ainley, D.G., R.P. Henderson, and C.S. Strong. 1990. Leach's Storm-Petrel and Ashy Storm-Petrel. Pages 128-162 *In:* D.G. Ainley and R.J. Boekelheide (eds.). Seabirds of the Farallon Islands: ecology, dynamics, and structure of an upwelling-system community. Stanford University Press, Stanford, California.

Carter, H.R., G.J. McChesney, D.L. Jaques, C.S. Strong, M.W. Parker, J.E. Takekawa, D.L. Jory, and D.L. Whitworth. 1992. Breeding populations of seabirds in California, 1989-1991. Vols. 1 and 2. Unpubl. draft final report, U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Dixon, California.

Carter, H.R., D.L. Whitworth, G.J. McChesney, and L.K. Ochikubo. 1996. Breeding success and phenology of Cassin's Auklets at Prince Island, California, in 1994. Unpubl. draft report, National Biological Service, California Science Center, Dixon, California.

Carter, H.R., D.L. Whitworth, W.R. McIver, G.J. McChesney, L.K. Ochikubo, T.W. Keeney, and M.O. Pierson. 1997. Distribution of Xantus' Murrelet nesting areas in the California Channel Islands, based on nocturnal vocal detection surveys in 1994-96. Pacific Seabirds 24:11 (abstract).

Carter, H.R., W.R. McIver, and G.J. McChesney. 2008a. Ashy Storm-Petrel. Pages 117-124 *In:* W.D. Shuford and T. Gardali (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. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento, California.

Carter, H, D. Whitworth, P. Hébert, J. Koepke, P. Capitolo, G. McChesney, W. McIver, L. Ochikubo Chan, M. Pierson, A. Hebshi, and P. Martin. 2008b. Status of breeding seabirds in the San Miguel Island group, California. Unpubl. report, Carter Biological Consulting, Victoria, British Columbia; and California Institute of Environmental Studies, Davis, California.

Carter, H.R., D.L. Whitworth, W.R. McIver, G.J. McChesney, L.K. Ochikubo Chan, F. Gress, and P.N. Hébert. 2009. Status of the Xantus's Murrelet, Ashy Storm-Petrel, and Black Storm-Petrel at San Clemente Island, California. Unpubl. report, Carter Biological Consulting, Victoria, British Columbia; and California Institute of Environmental Studies, Davis, California.

Carter, H.R., P.J. Capitolo, G.J. McChesney, D.L. Whitworth, W.R. McIver, and L.K. Ochikubo Chan. 2010. Breeding status of Brandt's Cormorant, Double-crested Cormorant, Pelagic Cormorant, Western Gull, and Black Oystercatcher at San Clemente Island, California. Unpubl. report, Carter Biological Consulting, Victoria, British Columbia; University of California, Santa Cruz, California; and California Institute of Environmental Studies, Davis, California.

Emslie, S.D., R.P. Henderson and D.G. Ainley. 1990. Annual variation of primary molt with age and sex in Cassin's Auklet. Auk 107:689-695.

Hunt, G.L., Jr., R.L. Pitman, M. Naughton, K. Winnett, A. Newman, P.R. Kelly, and K.T. Briggs. 1979. Distribution, status, reproductive biology and foraging habits of breeding seabirds. Pages 1-399 *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. Unpubl. report, Univ. of California, Irvine, California.

Hunt, G.L. Jr., R.L. Pitman, and H.L. Jones. 1980. Distribution and abundance of seabirds breeding on the California Channel Islands. Pages 443-460 *In:* D.M. Power (ed.). The California islands: proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History, Santa Barbara, California.

Manuwal, D.A. 1978. Criteria for aging Cassin's Auklets. Journal of Field Ornithology 49:157-161.

McChesney, G.J., H.R. Carter, D.L. Whitworth, L.K. Ochikubo, W.R. McIver, and M.O. Pierson. 1999. Status and distribution of the Ashy Storm-Petrel on the California Channel Islands, 1991-1997. Pacific Seabirds 26:40 (abstract).

McChesney, G.J., F. Gress, H.R. Carter, and D.L. Whitworth. 2000. Nesting habitat assessment for Xantus' Murrelets and other crevice-nesting seabirds at Anacapa Island, California, in 1997. Unpubl. report, U. S. Geological Survey, Western Ecological Research Center, Dixon, California; and Department of Wildlife, Humboldt State University, Arcata, California.

McIver, W.R., A.L. Harvey, H.R. Carter, and L.R. Halpin. 2011. Monitoring and restoration of Ashy Storm-Petrels at Santa Cruz Island, California, in 2010. Unpubl. report, U.S. Fish and Wildlife Service, Arcata, California; Channel Islands National Park, Ventura, California; Carter Biological Consulting, Victoria, British Columbia; and Simon Fraser University, Burnaby, British Columbia.

Sealy, S.G. 1974. Breeding phenology and clutch size in the Marbled Murrelet. Auk 91: 10-23.

Willet, G. 1910. A summer trip to the northern Santa Barbara Islands. Condor 91:170-174.

Whitworth, D.L., J.Y. Takekawa, H.R. Carter, and W.R. McIver. 1997. Night-lighting as an at- sea capture technique for Xantus' Murrelets in the Southern California Bight. Colonial Waterbirds 20:525-531.

Whitworth, D.L., H.R. Carter, R.J. Young, F. Gress, and S. Fangman. 2003. Monitoring plan for Xantus's Murrelets (*Synthliboramphus hypoleucus*) in sea caves and other areas at Anacapa Island, California, following the eradication of Black Rats (*Rattus rattus*). Unpubl. report, California Institute for Environmental Studies, Davis, California; and Humboldt State University, Arcata, California.

Whitworth, D.L., H.R. Carter, J.S. Koepke, R.J. Young, F. Gress and S. Fangman. 2005. Initial recovery of Xantus's Murrelets following rat eradication on Anacapa Island, California. Marine Ornithology 33:131-137.

Whitworth, D.L., H.R. Carter, A. Bailey and F. Gress. 2008. Nest monitoring of Xantus's Murrelets at Anacapa Island, California: 2008 annual report. Unpubl. report, California Institute of Environmental Studies, Davis, California.

Whitworth, D.L., A.L. Harvey and H.R. Carter. 2011. Cassin's Auklets, Xantus's Murrelets and other crevice-nesting seabirds at Santa Barbara Island, California: 2009-10 surveys. Unpubl. report, California Institute of Environmental Studies, Davis, California; Channel Islands National Park, Ventura, California; and Carter Biological Consulting, Victoria, British Columbia.

Whitworth, D.L., H.R. Carter and F. Gress. 2012. Responses by breeding Xantus's Murrelets eight years after eradication of Black Rats from Anacapa Island, California. Unpubl. report, California Institute of Environmental Studies, Davis, California.

Whitworth, D.L., H.R. Carter and F. Gress. 2013. Recovery of a threatened seabird after eradication of an introduced predator: eight years of progress for Scripps's Murrelet at Anacapa Island, California. Biological Conservation 162:52-59.

Table 1. Mist-net capture nights at Anacapa Island in 1994 (n = 11 net nights).

Net Night No.	Net Site Location[1]	Net Site No.[2]	Date	Time	Pers[3]	Weather	Notes[4]
1	EAI North side – dock area	7	15-16 Apr	20:36-04:50	DLW, BSK	20:36 – Clear, cool, NW wind 5-8 kn, moon waxing crescent 21:30 – thick high fog layer moved in, foghorn 2 sec blast followed by 12 sec silence 23:01 – fog layer moved out	20:20 - Heard first SCMU. Tape off during SCMU vocalization surveys at 21:05-21:20, 22:00-22:15, and 23:01-23:18. Tape off 02:57-03:27.
2	EAI South side - near water catchment	2	16 Apr	20:30-21:26	DLW, BSK	20:30 – overcast, cool, NW wind 5 kn 21:26 – windy	20:11 - Heard first SCMU. Closed net early because too windy.
3	EAI South side – far west end, 10 m N of bench overlooking Middle Islet	3	17-18 Apr	20:26-03:00	DLW, BSK	20:26 – Mostly clear, NW wind 5 kn with gusts, 1/3 waxing moon 21:15 – more windy but variable 01:20 – moon set	20:50 - Heard first SCMU. Tape off 02:00-02:15.
4	EAI North side – just above Landing Cove on lighthouse side of cove	1	2-3 May	21:30-03:40	HRC, LKOC, SBCD, JA	21:30 – Clear with distant clouds, NW wind 10-15 kn 22:45 – wind gusting to 15-20 kn 23:24 – wind dropping 00:49 – wind <5 kn	22:45 – net fell down. Tape off during SCMU vocalization surveys at 22:00-22:15, 23:00-23:15, and 00:00-00:15. 23:20-23:45 – HRC and LKOC conducted a nest search in cliff tops – no nests were found. Tape player did not work from 23:50-00:20 but eventually restarted.
5	EAI 75 m west of lighthouse	4	2-3 May	21:14-04:05	DLW, NJK, JA, SHN	21:14 – clear sky, NW wind 10-15 kn 23:19 – wind down to 5-8 kn	21:14 – net billowing in wind, light from lighthouse could be a problem 22:42 – CAAU heard flying by, no ASSP activity yet 02:55 – WEGU in net, removed 04:05 – No SCMU survey conducted, too much activity
6	EAI West end of Cathedral Cove (net faces NNE, 5 m from cliff edge)	5	3-4 May	20:30-02:20	NJK, JA	20:30 – Sky clear, SW wind 5 kn 21:40 – no wind	20:58 – WEGU in net, lights from mainland highly visible, light from lighthouse not a factor nor foghorn 02:20 – Closed down net due to no activity

7	EAI SW end of Anacapa (net faces south, 3 m from cliff edge)	3	4 May	03:00-05:20	NJK, JA	03:00 – ¼ moon to east horizon	04:00 – WEGU hit net
8	EAI (net description above - 3 m from cliff)	1	4-5 May	20:30-05:20	NJK, JA	20:30 – Partly cloudy, NW wind 5-10 kn, gusting to 15 kn 23:27 – fogbank has obscured mainland lights but still have lighthouse and ranger's house lights 00:05 – wind 0-5 kn, oil platform visible	21:11 – heard ASSP and SCMU calling 23:27 – CAAU called nearby, 1st heard, occasional SCMU calling from Landing Cove
9	EAI West side of Cathedral Cove (near net #5)	6	5-6 May	20:43-04:20	NJK, JA	20:43 – Partly cloudy, NW wind 15 kn, lights from platform and mainland, no foghorn 22:00 – lots of lightening high in sky 24:00 – Clear, wind 0-5 kn	
10	WAI Rat Rock – north side	8	14-15 May	20:34-01:45	HRC, MOP	20:34 – mostly clear; cloudy over mainland to north, ¼ moon, SW wind 5 kn 22:40 – moon obscured by clouds, wind zero 23:30 – sky obscured by clouds 23:46 – wind up to 5-8 kn 01:15 – net billowing, wind 8-12 kn.	20:42 – first SCMU calling 20:55 – Tape on 00:40-01:00 – HRC checked 10-20 crevices but found nothing. [General: The dive boat *Vision* was anchored on the south side with bright deck lights so we netted on the north side to reduce net illumination and generator noise. Some light from oil platforms Gilda, Grace and Gail.]
11	EAI (description above)	1	7-8 June	21:05-03:00	LKOC, MOP	ND	From 21:47 to 02:44, ASSP sporadically calling and flying over net.

[1] EAI (East Anacapa Island); WAI (West Anacapa Island).
[2] See Figures 1 and 2 for locations.
[3] Personnel abbreviations are provided in the acknowledgments.
[4] Species abbreviations: ASSP (Ashy Storm-Petrel); CAAU (Cassin's Auklet); WEGU (Western Gull); and SCMU (Scripps's Murrelet).

Table 2. Ashy Storm-Petrels captured and banded in mist nets or heard near mist nets at Anacapa Island in 1994.

Band Prefix	Band Suffix[1]	Date	Capture Time	Islet	Net Site	Brood Patch Score	Body Molt	Culmen Length (mm)	Tarsus Length (mm)	Wing Chord (mm)	Tail Length (mm)	Body Weight (g)
1401	60696	15 April	22:50	East	7	4	0	14.8	23.1	138	78	31.0
1401	60697	15 April	23:23	East	7	1+	0	14.4	23.25	135	81	36.0
1401	60698	15 April	23:40	East	7	4	0	14.9	23.0	141	84	33.5
1401	60699	16 April	00:02	East	7	0	0	14.9	22.3	137	80	32.0
1401	60700	16 April	00:29	East	7	1	0	14.3	22.6	139	82	32.5
1401	60701	16 April	00:29	East	7	1+	0	14.5	22.6	135	78	35.5
1401	60702	16 April	00:41	East	7	0	0	14.55	24.05	135	77	36.0
1401	60703	16 April	00:57	East	7	1	0	14.85	23.35	140	78	33.5
1401	60704	16 April	00:57	East	7	0	0	14.75	23.4	137	81	35.0
1401	60705	16 April	01:10	East	7	1+	0	14.3	23.1	144	83	33.5
1401	60706	16 April	01:23	East	7	1+	0	14.6	23.8	138	80	34.0
1401	60707	16 April	01:23	East	7	1	0	14.5	22.85	137	82	34.5
1401	60708	16 April	01:25	East	7	0	0	15.4	22.9	141	80	35.5
1401	60710	16 April	01:44	East	7	0	0	14.35	22.1	140	82	37.0
1401	60711	16 April	02:17	East	7	0	0	13.55	21.7	135	81	36.5
1401	60712	16 April	03:55	East	7	3	0	14.55	22.4	136	80	38.0
1401	60713	16 April	04:12	East	7	3	0	14.35	23.3	133	71	34.5
1401	60714	17 April	21:06	East	3	0	0	14.1	23.7	133	78	35.5
1401	60715	18 April	00:36	East	3	0	0	14.25	22.05	147	81	35.0
1401	60716	18 April	00:45	East	3	0	0	14.3	22.85	136	81	37.5
1401	60851	2 May	21:45	East	1	3	0	14.2	23.5	141	85	39.0
1401	60852	2 May	23:30	East	1	1+	2	13.8	22.0	138	80	37.0
1401	60853	3 May	03:25	East	1	1	0	14.7	23.8	141	81	31.0
1401	60854	3 May	03:25	East	1	0	0	15.1	23.8	143	79	37.0
1401	60855	3 May	03:25	East	1	1+	0	14.4	23.6	142	84.5	36.5
1401	60856	3 May	03:25	East	1	0	2	14.0	24.3	141	79	37.0
1401	60761	3 May	00:17	East	4	0	0	15.7	24.7	142	80	62.0
1401	60752	3 May	01:38	East	4	1+	0	14.6	23.9	134	80	61.0
1401	60701R	3 May	01:38	East	4	0	0	14.4	25.4	137	80	62.0
1401	60711R	3 May	02:08	East	4	5	0	13.8	22.8	136	81	60.0
1401	60851R	3 May	02:08-03:10	East	4	ND	ND	ND	ND	ND	ND	ND
1401	60752R	3 May	03:10	East	4	ND	ND	ND	ND	ND	ND	ND

1401	60714	3 May	21:00	East	5	0	0	13.7	23.4	137	81	58.0
1401	60718	4 May	21:33	East	1	1	0	15.35	23.7	145	81	34.5
1401	60719	4 May	22:13	East	1	0	0	15.25	27.6	134	79	38.5
1401	60720	4 May	22:13	East	1	1+	0	15.7	23.1	147	81	40.0
1401	60721	4 May	22:24	East	1	3	0	15.25	22.8	142	88	36.5
1401	60706R	5 May	00:40	East	1	1+	0	14.2	23.5	140	79	34.0
1401	60722	5 May	01:08	East	1	0	0	15.4	22.0	144	81	31.5
1401	60723	5 May	01:25	East	1	3	0	15.6	24.0	141	80	40.0
1401	60724	5 May	02:20	East	1	2+	0	14.0	22.6	136	79	34.5
1401	60725	5 May	02:20	East	1	0	0	15.25	23.15	139.5	80	34.0
1401	60726	5 May	21:23	East	6	0	0	15.15	23.0	135	77	34.0
1401	60727	5 May	22:23	East	6	0	0	14.85	23.0	142	85	36.0
1401	60728	5 May	23:40	East	6	1+	0	14.4	22.2	140.5	81	32.0
1401	60707R	6 May	01:45	East	6	1	0	14.75	23.8	140	81	41.0
1401	60729	6 May	02:55	East	6	1+	0	14.25	23.2	148	87	34.5
1401	60783	14 May	20:59	West	8	0	0	14.3	22.9	131	75	35.0
1401	60784	14 May	22:25	West	8	0	0	13.7	20.6	130	74	26.0
1401	60726R	14 May	22:25	West	8	0	0	14.3	21.6	136	77	31.0
1401	60785	14 May	22:25	West	8	4	0	15.0	23.9	135	79	35.0
1401	60786	14 May	23:01	West	8	4	1	14.3	23.7	133	74	38.0
1401	60787	14 May	23:18	West	8	1	0	13.9	22.6	130	75	33.0
1401	60788	14 May	23:35	West	8	3	0	13.8	20.0	143	84	44.0
1401	60789	14 May	23:38	West	8	0	0	14.2	22.5	133	77	43.5
1401	60790	15 May	00:01	West	8	4	1	14.2	21.7	139	79	35.5
1401	60791	15 May	01:03	West	8	0	0	14.4	22.0	142	82	35.5
1401	60851R	8 June	00:10	East	1	3	0	14.3	23.0	143	85	37.0

[1] Recaptures are indicated with an R after the band suffix.

Table 3. Cassin's Auklets captured in mist nets at Anacapa Island in 1994.

Band Prefix[1]	Band Suffix[1]	Date	Capture Time	Islet	Net Site	BPS	ICS
1313	35976	16 Apr	01:44	East	7	0	4
1313	35979	16 Apr	01:44	East	7	0	2+
1313	35980	16 Apr	02:04	East	7	0	4
1313	35981	16 Apr	02:24	East	7	0	1+
1313	35982	16 Apr	03:06	East	7	0	3
1313	35983	2 May	23:10	East	4	3	1+
-	-	15 May	00:55	West	8	0	1+
-	-	15 May	01:45	West	8	0	1+

[1] A dash indicates that the individual was not banded (see text).

Table 4. Brood patch scores (BPS) of Ashy Storm-Petrels captured in mist nets at Anacapa Island in 1994.

Time Period	No. Captured[1]	BPS 0	BPS 1-2	BPS 3-4	Percent Laid Eggs
15-18 April	20	9	5	4	20.0
2-5 May	21	9	9	3	14.3
14-15 May	9	4	1	4	44.4
Total	50	22	15	11	22.0

[1] Excludes recaptures.

Table 5. Ashy Storm-Petrel recaptures in mist nets at Anacapa Island in 1994.

Band Prefix	Band Suffix	Date Band	BP	Net Band	Time Band	Date Recap	BPS	Net Recap	Time Recap	Recap Nights Later
1401	60701	16 Apr	1+	7	00:29	3 May	0	4	01:38	17
1401	60706	16 Apr	1+	7	01:23	5 May	1+	1	00:40	19
1401	60707	16 Apr	1	7	01:23	6 May	1	6	01:45	20
1401	60711	16 Apr	0	7	02:17	3 May	5[1]	4	02:08	17
1401	60726	5 May	0	6	21:23	14 May	0	8	22:25	9
1401	60752	3 May	1+	4	01:38	3 May	ND	4	03:10	0
1401	60851	2 May	3	1	21:45	3 May	ND	4	02:08-03:10	0
1401	60851	2 May	3	1	21:45	8 June	3	1	00:10	52

[1] A brood patch score of 5 is likely an error on this date and it likely did not have a brood patch.

Table 6. Mist-net capture rates of Ashy Storm-Petrels at Anacapa Island in 1994.

Net No.	Capture Night	Net Hours	Capture Period	ASSP (cap.)	ASSP (recap.)	CPNH[1]	CPHCP[1]
1	4	6.17	5.67	6	0	0.97	1.06
1	8	8.83	4.78	8	1	1.02	1.88
1	11	5.95	-	0	1	0.17	-
2	2	0.90	-	0	0	0.00	-
3	3	6.57	3.65	3	0	0.46	0.82
3	7	2.33	-	1	0	0.43	-
4	5	7.85	-	2	3	0.64	-
5	6	5.83	-	0	1	0.17	-
6	9	7.61	5.54	4	1	0.66	0.90
7	1	8.23	5.37	17	0	2.06	3.17
8	10	5.18	4.07	9	1	1.93	2.46
Total				50	8		

[1] CPNH, captures per net hour; CPHCP, captures per hour within the capture period.

Table 7. Times of captures and observations of Cassin's Auklet at mist net #8 at Rat Rock, West Anacapa Island, 14-15 May 1994.

Time	No. Birds	Notes
20:55	-	Net up; storm-petrel vocalization cassette playing
21:44	1	white-bellied alcid flew by without vocalizing [either Cassin's Auklet or Scripps's Murrelet]
00:11	1	auklet landed in front of the net briefly, then flew back out to sea
00:34	1	auklet calling in flight in distance
00:40	1	small alcid flew into banding area; may have landed [either Cassin's Auklet or Scripps's Murrelet]
00:40-01:00	-	10-20 crevices checked but nothing found
00:55	1	auklet captured; not banded (see Table 3); no wing molt
01:27	1	auklet sitting under net; flushed when approached
01:45	1	auklet captured; not banded (see Table 3); early wing molt
01:45	-	net down

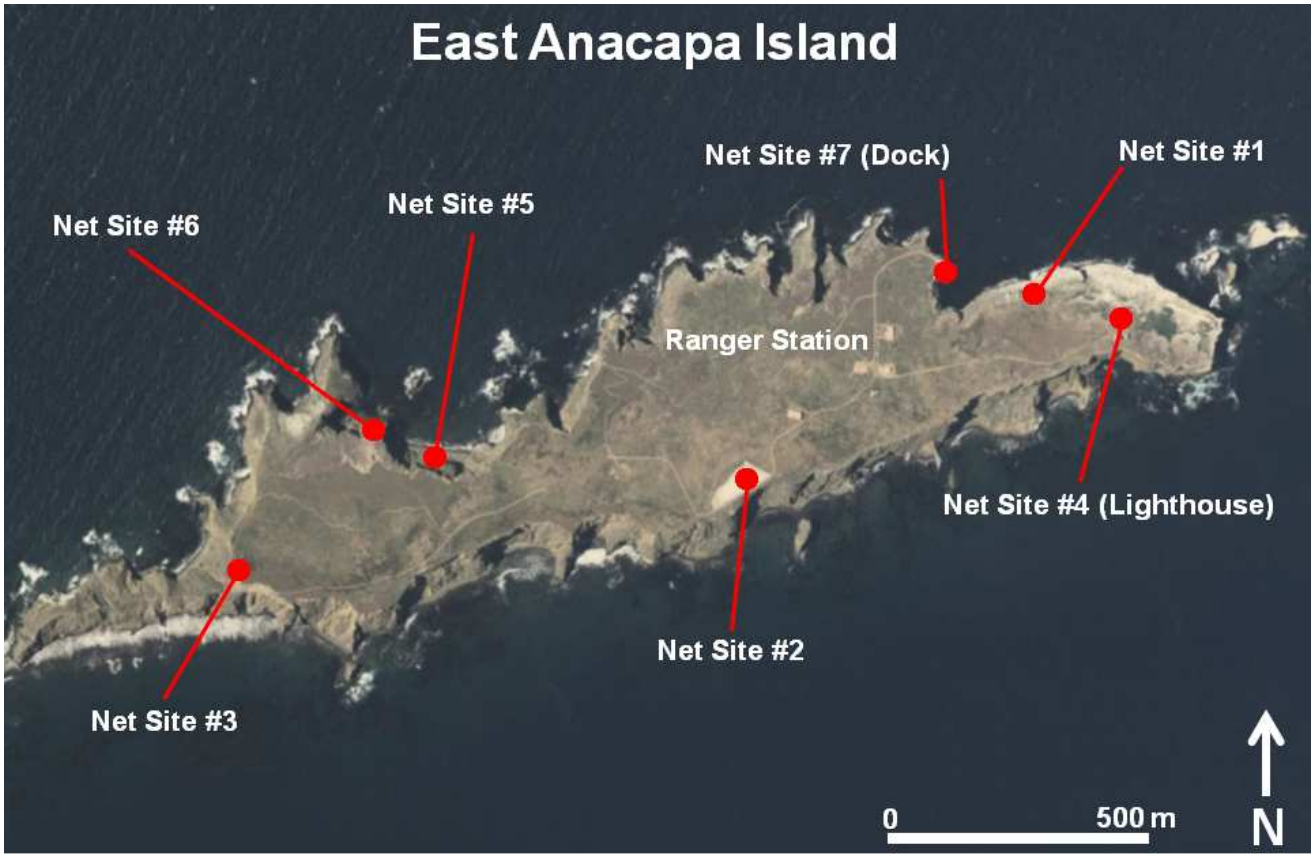

Figure 1. Locations of mist-net sites (#1 to #7) at East Anacapa Island where Ashy Storm-Petrels and Cassin's Auklets were captured in 1994.

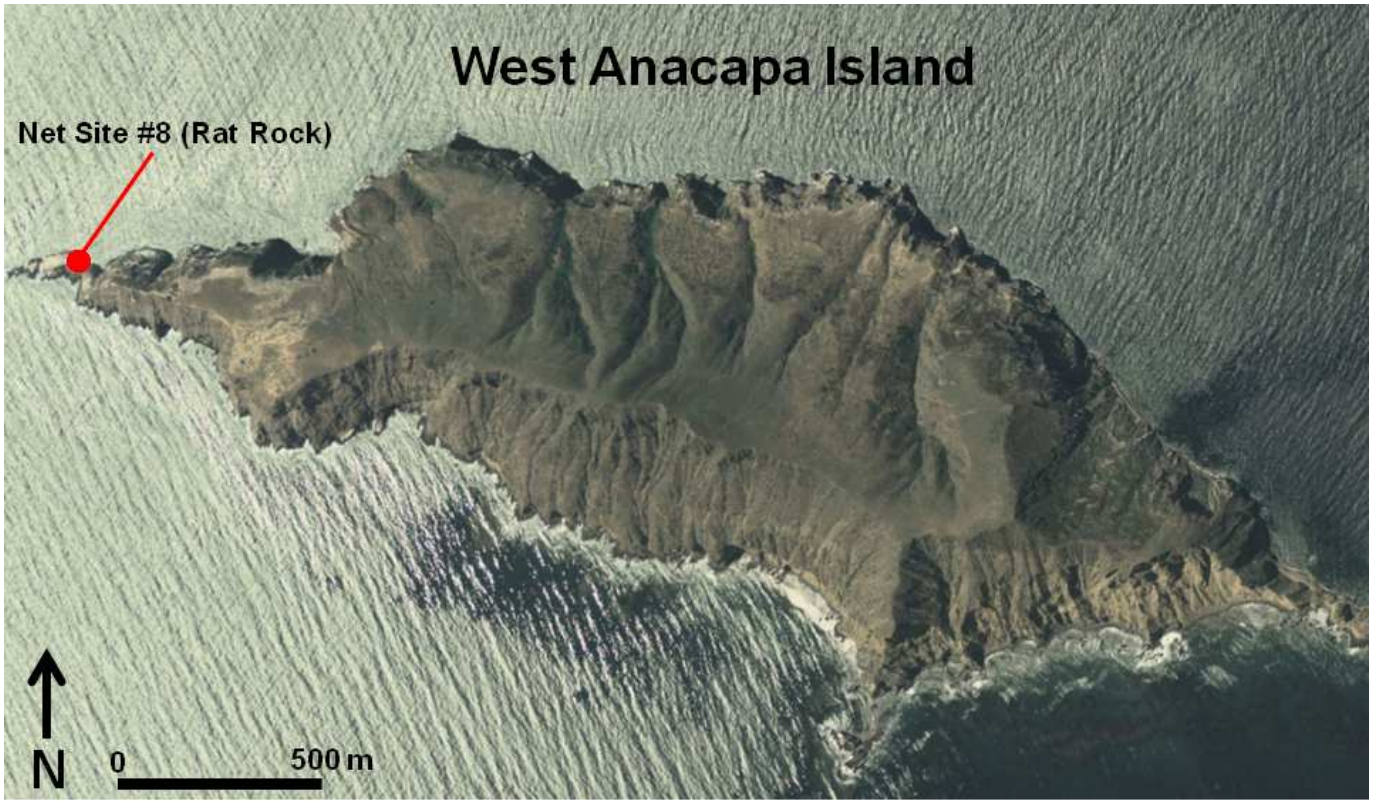

Figure 2. Location of mist-net site #8 at West Anacapa Island where Ashy Storm-Petrels and Cassin's Auklets were captured in 1994.