

Cassin's Auklets, Xantus's Murrelets and Other Crevice-Nesting Seabirds at Santa Barbara Island, California: 2008 Surveys and Historical Status

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EXECUTIVE SUMMARY

- To help develop solid baseline data for measuring the benefits of on-going seabird restoration work at Santa Barbara Island (SBI), California, the California Institute of Environmental Studies (CIES), Carter Biological Consulting (CBC), and Channel Islands National Park (CINP) conducted limited surveys of Cassin's Auklets (*Ptychoramphus aleuticus*), Xantus's Murrelets (*Synthliboramphus hypoleucus*), and other crevice-nesting seabirds at SBI on 14-20 May 2008 (Chapter 1).
- To better understand all factors affecting Cassin's Auklets at SBI over time, CBC collated and re-examined historical information on Cassin's Auklets and impacts to nesting habitats at SBI (Chapter 2). This process has suggested that: a) an historic auklet colony was located on the southeast and west mesas of SBI proper (estimate ~1,000-4,000 breeding birds); b) this historic mesa colony was extirpated between 1899 and 1922 due to feral cat predation and severe alteration of burrow-nesting habitats from farming and ranching, possibly in conjunction with other factors such as low prey availability and high avian predation; c) breeding by small numbers of auklets recorded in 1976-94 at Sutil Island, Elephant Seal Point and other areas likely has occurred since the early 20th century; and d) little data are available to assess breeding status of auklets after 1994.
- No evidence of Cassin's Auklets breeding anywhere at SBI was found during nest searches and spotlight surveys in May 2008, including areas where breeding by small numbers of auklets was recorded in 1976-94 (i.e., Elephant Seal Point, Arch Point, and Sutil Island). This finding was consistent with possible long-term loss of breeding auklets at SBI since 1994, as suspected by several biologists. However, small numbers of auklets may have: a) completed breeding prior to our survey efforts in 2008; b) nested in inaccessible habitats or areas not searched in 2008; or c) foregone breeding in 2008, but continue to attend the colony and breed in certain favorable years.
- Restoration of Cassin's Auklet breeding habitats (with use of social attraction techniques) on mesa and other habitats on SBI proper is necessary to encourage future development of a larger breeding population through: a) retention, growth and expansion of any auklet colonies that may still exist at SBI but were not detected in 2008; and b) future attraction of auklets from other colonies that may then attend and establish breeding sites at SBI.
- Large numbers of Xantus's Murrelets were recorded attending nocturnal at-sea congregations during round-island spotlight surveys (461 murrelets on 15 May and 493 murrelets on 16 May), although these surveys may have been conducted after the period of peak attendance in 2008. Relatively large numbers of murrelet nest sites (n = 42; 52% with incubating adults) were located in cliff, shoreline and sea cave habitats outside the current CINP nest monitoring plots.
- Small numbers of Ashy Storm-Petrel (*Oceanodroma homochroa*) (n = 7) and Pigeon Guillemot (*Cepphus columba*) (n = 17) nests were found at SBI in 2008. Small numbers of Rhinoceros Auklets (*Cerorhinca monocerata*) (n = 2-5) also were observed near the island but did not appear to be breeding.
- Survey efforts in 2008 were limited and additional survey and monitoring efforts are needed in 2009-12 to develop solid baseline data for assessing future population changes of Cassin's Auklets, Xantus's Murrelets, and other crevice-nesting seabirds at SBI.

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Chapter 1

Nest Searches and Spotlight Surveys of Cassin's Auklets, Xantus's Murrelets, and Other Seabirds at Santa Barbara Island, California, in 2008

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INTRODUCTION

The Santa Barbara Island (SBI) group hosts one of the largest and most diverse assemblages of breeding seabirds in the Southern California Bight (Hunt *et al.* 1979, 1980; Sowls *et al.* 1980, Carter *et al.* 1992, 2008a). Eleven seabird species have bred at SBI since 1975-77 when the first complete surveys were conducted (Hunt *et al.* 1979, 1980), including: Ashy Storm-Petrel (*Oceanodroma homochroa*), Leach's Storm-Petrel (*O. leucorhoa*), Black Storm-Petrel (*O. melania*), Brown Pelican (*Pelecanus occidentalis*), Double-crested Cormorant (*Phalacrocorax auritus*), Brandt's Cormorant (*P. penicillatus*), Pelagic Cormorant (*P. pelagicus*), Western Gull (*Larus occidentalis*), Pigeon Guillemot (*Cephus columba*), Cassin's Auklet (*Ptychoramphus aleuticus*), and Xantus's Murrelet (*Synthliboramphus hypoleucus*). In addition, Rhinoceros Auklets (*Cerorhinca monocerata*) and Tufted Puffins (*Fratercula cirrhata*) nested at SBI in the late 1800s and early 1900s (Hunt *et al.* 1979, 1980; Carter *et al.* 1992; McChesney *et al.* 1995). Several of these species have experienced population declines over the past several decades, including: Cassin's Auklet, which was designated a California Species of Special Concern in 2008 (Adams 2008); Xantus's Murrelet, which is a federal candidate species and was recently listed as a state threatened species in 2004; and Ashy Storm-Petrel, which was proposed for federal listing as threatened in 2008.

Long-term seabird monitoring at SBI has been conducted since 1985 by Channel Islands National Park (CINP), Point Reyes Bird Observatory, Humboldt State University, California Institute of Environmental Studies (CIES), University of California Santa Cruz, and others. Much monitoring effort has focused on surface-nesting species (Brown Pelican, Double-crested Cormorant, Brandt's Cormorant, and Western Gull) whose population size, timing of breeding, and reproductive success can be monitored effectively with ground or aerial surveys (Lewis *et al.* 1988; Gress 1995; Carter *et al.* 1996, unpubl. data; Capitolo *et al.* 2008). Crevice-nesting Xantus's Murrelets have been monitored annually for reproductive success and timing of breeding (Drost and Lewis 1995; Schwemm and Martin 2005) and periodically for population size (Carter *et al.* 1992, 1997, unpubl. data; Whitworth *et al.* 2003a, 2005). Other species have not been monitored regularly because: a) they are secretive crevice and burrow nesting species which are active at the colony primarily at night, nest in largely inaccessible habitats, and require specialized monitoring techniques (i.e., storm-petrels and Cassin's Auklet); or b) they require boat surveys which have been difficult to implement along with other land-based monitoring at this remote location (i.e., Pelagic Cormorants and Pigeon Guillemots).

In 2005, the Montrose Trustee Council (MTC) approved a restoration project for enhancing breeding habitats for Cassin's Auklets and Xantus's Murrelets on SBI proper, where populations and breeding habitats of these two species have declined significantly since the late 19th century (Hunt *et al.* 1979, 1980; Murray *et al.* 1983; Carter *et al.* 1992; Drost and Lewis 1995; McChesney and Tershy 1998; Burkett *et al.* 2003; Whitworth *et al.* 2003a; MSRP 2005). Restoration of native vegetation in specific areas on SBI proper was identified by the MTC as the primary restoration technique to be used for these two species. Restoration work by CINP in 2007-08 included on-island native plant propagation in a nursery and outplanting in selected areas (Harvey and Barnes, in prep.). In 2009, additional propagation and outplanting efforts are planned, along with social attraction (i.e., vocalization broadcasting) for Cassin's Auklets.

Prior to expected completion of most restoration work in 2012, the MTC has sponsored efforts to assess the breeding status of Cassin's Auklets and other seabirds at SBI to ensure that: a) adequate baseline data are gathered in 2007-12 for assessing the long-term benefits of restoration to auklets and other seabirds; and b) all information related to the historic Cassin's Auklet mesa colony at SBI are collated and re-examined to provide a complete and up-to-date assessment of past and present factors affecting auklets and their breeding habitats on the island. Of chief concern, a small population of breeding Cassin's Auklets had been found in 1976-77 and 1991 surveys (Hunt *et al.* 1979, 1980; Carter *et al.* 1992) but little evidence of their presence or breeding has been gathered since 1991 (Adams 2008; P. Martin, pers. comm.).

On 14-20 May 2008, CIES, Carter Biological Consulting (CBC), and CINP conducted efforts to develop baseline data on the breeding status of the Cassin's Auklets and other crevice nesting seabirds at SBI, including: 1) nest searches in relatively inaccessible and seldom surveyed seabird breeding habitats in sea caves, offshore rocks, and shoreline and cliff areas, with focus on areas with documented presence in 1991; and 2) nocturnal round-island spotlight surveys to count Xantus's Murrelets and possibly Cassin's Auklets attending at-sea congregations in near-shore waters adjacent to potential nesting areas. Surveys in 2008 were primarily designed to detect the presence or absence of breeding Cassin's Auklets at SBI but valuable information also was collected on other crevice nesting seabirds (i.e., Xantus's Murrelets, Ashy Storm-Petrels, Pigeon Guillemots and Rhinoceros Auklets). In Chapter 1, we present the results of 2008 surveys and provide brief summaries of current and historical breeding by Cassin's Auklets and other species at SBI. In addition, CBC conducted a detailed re-examination of all available historical information on the status of Cassin's Auklets and their on-island conservation issues at SBI in 1863-2001 (see Chapter 2).

METHODS

Study Area

The SBI group (see Fig. 1) is the smallest of the eight California Channel Islands and is located approximately 75 km southwest of Los Angeles. The perimeter of the main island is generally rocky, rugged and steep. The southwest and north-central sides of this island are particularly high and steep, while the east side is characterized by lower rocky cliffs and bluffs. Most of the top of the island is composed of a single large mesa divided into eastern and western portions by a

ridge extending from Signal Peak to North Peak. The east mesa is larger and can be further subdivided into southeast, central-east, and northeast mesa areas. Two major offshore rocks, Sutil Island and Shag Rock, and many smaller rocks are found off the west and north sides of SBI proper, and several sea caves are located along the north and east sides. Living facilities (i.e., ranger residence and researchers' quarters), a campground, storage facilities and a dock are maintained by CINP, but the island is otherwise uninhabited.

Logistics

On 14 May 2008, field personnel (D.L. Whitworth [DLW]; H.R. Carter [HRC]; A.L. Harvey [ALH]; and P.N. Hebert [PNH]) used the CINP vessel *Ocean Ranger* for transportation from Ventura Harbor to SBI. On 20 May, MTC member J. Boyce (JB) arrived by helicopter chartered from Aspen Helicopters (Oxnard, CA). On 21 May, we all used a helicopter to fly from SBI to the Oxnard airport. At-sea spotlight surveys and access to offshore rocks, sea caves, and shoreline areas were performed in a 3.8 m Zodiac[®] inflatable craft powered by a 20 hp outboard engine provided to CINP by MTC. The inflatable craft and personnel were supplied with all required safety equipment.

Nest Searches

Limited searches for nests of nocturnal crevice/burrow nesting seabirds (i.e., Cassin's Auklets, Xantus's Murrelets, Pigeon Guillemots, Rhinoceros Auklets and Ashy, Black and Leach's Storm-Petrels) were conducted from 15-20 May (Table 1; Fig. 2). Nest searches were conducted at: 1) Shag Rock, sea caves A-C at Elephant Seal Point and sea caves D-E at Webster Point on 15 May; 2) sea caves F-G, Barn Owl Cave, and small coves and grottoes on the north and south side of Arch Point on 16 May; 3) Sutil Island on 16-17 May; and 4) upper areas on the main island including the Arch Point cliffs, Buckwheat Patch, west mesa, Badlands, southeast mesa, and southeast Signal Peak slopes on 18 and 20 May. On 15-17 May, nest searches were conducted by DLW and ALH, while HRC and PNH operated the Zodiac, mapped search areas, looked for additional search areas by boat, took photographs, and made general observations. On 18 May, DLW, ALH, HRC and PNH conducted nest searches. On 20 May, DLW, ALH, HRC, PNH and JB conducted nest searches and assisted Xantus's Murrelet nest monitoring at Cat Canyon (Harvey *et al.*, in prep.).

We used small hand-held flashlights to search suitable crevices, sea caves, shrubs and other sheltered sites for evidence of past or current breeding by crevice-nesting seabirds (e.g., incubating or brooding adult; whole unattended eggs; broken eggs [eggshell broken into a few larger pieces located within a confined area and comprising a complete egg]; eggshell fragments [eggshell broken into many small pieces, often scattered and not equaling one complete egg]; hatched eggs; eggshell membranes; chicks). We recorded all observations in field notebooks.

At-Sea Spotlight Surveys

Nocturnal spotlight surveys of near-shore waters were conducted for two main purposes: a) to count Xantus's Murrelets attending at-sea congregations off nesting areas using a standardized protocol; and b) to search for any Cassin's Auklets attending waters off potential nesting areas at

night. The spotlight survey protocol used at SBI in 2008 had been developed at Anacapa Island in 2001 (Whitworth *et al.* 2003b, c), with modification in 2004 (Whitworth *et al.* 2005). Spotlight surveys were conducted from the Zodiac operated by a three-person crew, including a boat driver (HRC), spotlight observer (DLW), and data recorder (PNH or ALH). The driver used a hand-held Garmin GPSmap 76CS Global Positioning System (GPS) receiver to guide the craft at low speeds along the coastline of the island approximately 200-700 m from shore, depending on coastline topography, extensive kelp beds, and offshore rocks (see Whitworth *et al.* 2005). Using a high-intensity spot/flood light (1 million candlepower), the observer slowly passed the spotlight beam along the water across a 90° arc on each side of the bow. The observer called off all murrelet observations to the data recorder who recorded observations into a field notebook. Data recorded included: 1) total number of murrelets seen on the scan; and 2) behavior (i.e., sitting on water, flying, or flushed) of birds observed during the scan. The data recorder also entered a GPS waypoint for each observation. Date, time, location, and conditions (i.e., wind, Beaufort sea state, cloud cover, and moon) were recorded at the beginning of the survey with periodic updates if conditions changed during the survey.

Two complete spotlight surveys circumnavigated SBI (~ 9.5 km) on 15 May (00:29-01:54 h) and 16 May (00:55-02:09 h). The spotlight survey route followed the same waypoints used during earlier surveys at the SBI in 2001, 2002 and 2004.

RESULTS

Nest Searches

CASSIN'S AUKLET – Evidence of recent breeding or colony attendance by Cassin's Auklets was not found anywhere at SBI in 2008, including Sutil Island, Elephant Seal Point, and Arch Point where breeding had been documented in 1976-77 and 1991 (Table 1), although the former auklet breeding area in a large fissure on Elephant Seal Point could not be inspected in 2008 due to nesting Brandt's Cormorants. Possible evidence of past (historic) breeding was found in the Badlands area on the southeast mesa (see Fig. 2; Chapter 2 – Fig. 10) where the eroded remnants of about 5-6 potential nesting burrows of the proper size and orientation (i.e. running sideways into the soil) for Cassin's Auklets were seen in shallow eroded gullies (Fig. 3). However, we could not eliminate the possibility that these holes had been formed by water erosion or deer mice (*Peromyscus maniculatus*) (C. Drost, pers. comm.). Several deep holes (3-4) of unknown origin were also found in deeper eroded gullies in the west mesa area within the main Western Gull colony (see Chapter 2 – Fig. 10). Their size and orientation (mainly downward, likely related to water erosion during rainy periods) suggested that they were not old Cassin's Auklet nesting burrows.

Cassin's Auklet carcasses, wings or keels were not noted at raptor plucking stations in sea caves where numerous Xantus's Murrelet remains were found in 2008 (see below).

XANTUS'S MURRELET – Evidence of breeding by Xantus's Murrelets was found at 42 nest sites in coastline habitats searched in 2008 (Table 1). A total of 22 nest sites with incubating adults were found, including: 9 in sea caves between Elephant Seal Point and Arch Point; 5 in shoreline

habitats and grottoes around Arch Point; 4 on offshore rocks (Sutil Island and Shag Rock); and 4 on upper island cliffs and steep slopes between Arch Point and the Buckwheat Patch. An additional 11 nest sites with hatched eggshell fragments or membranes presumably from the 2008 breeding season were found, including 8 in sea caves and 3 in cliff-shoreline habitats on Arch Point. Broken or abandoned eggs were found in 9 nest sites at various locations.

Abundant evidence of raptor depredation on murrelets was also found at SBI in 2008 (Table 1). Carcasses, wings and keels totaling at least 43 murrelets were found at Elephant Seal Point (11 carcasses in Cave A and 1 carcass in upper Cave B), Barn Owl Cave (28 carcasses/keels), and small grottoes on Sutil Island (3 carcasses). One carcass (i.e., keel and legs recovered) in Barn Owl Cave had been banded (#892-98359) in May 1996 when the bird was captured at sea (Whitworth *et al.* 1997b, 2000; unpubl. data). It was not possible to determine from the carcass remains when murrelets had been depredated.

ASHY STORM-PETREL – Substantial evidence of breeding by Ashy Storm-Petrels was found at SBI proper in 2008, primarily in sea caves on the north side of the island (Table 1). Two active nests were found in Cave A at Elephant Seal Point, two active nests in Cave F between Arch Point and North Peak, and another active nest outside sea caves on the Arch Point cliffs. Two additional sites with hatched or whole eggs were found in Elephant Seal Point Caves A and B (upper).

PIGEON GUILLEMOT – Considerable evidence of breeding by Pigeon Guillemots was found at SBI in 2008, although evidence of active nesting was limited to sea caves along the north side of the main island (Table 1). A total of 14 active nests were found in 5 sea caves, including 6 active nests in Cave C, 5 nests in Cave G, and single nests in Caves A, B (lower), and G. Unattended eggs were also found in two crevice sites on Shag Rock and at single sites in Caves A and G. Additional nests in inaccessible sites were likely, as considerable numbers of guillemots (up to 14) flushed when we entered some caves.

RHINOCEROS AUKLET – On 15 May, a dead adult in alternate (i.e., breeding) plumage was found floating off the north side of the island (Fig. 4). On 16 May, an adult in alternate plumage was seen on the water during the day during nest searches off the south side of Arch Point. This individual seemed weak and was preening heavily, allowing close approach by Zodiac for photographs before diving (Fig. 5).

Spotlight Surveys

CASSIN'S AUKLET – Cassin's Auklets were not observed in near-shore waters during nocturnal spotlight surveys at SBI in 2008 (Table 2). Cassin's Auklets typically do not congregate in near-shore waters off colonies at night, although individual birds have been recorded on occasion off many colonies in southern California and northwestern Baja California during spotlight surveys (Whitworth *et al.* 2005, unpubl. data; Carter *et al.* 2006, 2008a).

XANTUS'S MURRELET – A total of 461 Xantus's Murrelets were observed during the 15 May survey, compared to 493 Xantus's Murrelets observed during the 16 May survey (Table 2; Figs. 6-7). Survey counts did not include one chick seen in a family group swimming away from the main island off Signal Peak at 01:07 h on 15 May. A maximum of 29 murrelets were counted

during one 90° survey scan in Landing Cove.

Murrelets were distributed unevenly in at-sea congregations around the island, with largest numbers observed in Landing Cove, and off Cat Canyon and Signal Peak (Figs. 6-7). Smaller groups or single birds were observed around most of the rest of the island, although no murrelets were seen off the southeast corner of SBI which hosts a relatively large California sea lion (*Zalophus californianus*) rookery. Low murrelet attendance off the rookery likely results from: a) little suitable nesting habitat on the gentle slope in and around the rookery; and b) noisy sea lion bellowing that might interfere with murrelet vocalizing and other social activities at sea. Murrelet distribution was generally similar each night, although fewer murrelets were seen between Shag Rock and Arch Point and greater numbers off Webster Point on 15 May.

Most murrelets (82%; n = 911) were observed sitting on the water, but 15% flushed and 3% were flying when first observed. Proportions of each bird behavior did not differ between nights.

ASHY STORM-PETREL – Eight Ashy Storm-Petrels were observed each night during spotlight surveys (Table 2; Figs. 8-9). Storm-petrels were observed around Webster Point (4 birds) and between Shag Rock and Arch Point (4 birds) on 15 May (Fig. 8). On 16 May, they were more widely distributed, with birds scattered from Cat Canyon around the west and north sides of the main island to Arch Point (Fig. 9). Most observations were single birds, although a group of three birds was seen on 15 May and a group of two birds on 16 May.

RHINOCEROS AUKLET – Two Rhinoceros Auklets were seen each night in near-shore waters during spotlight surveys (Table 2; Figs. 7-8). On 15 May, a pair was observed off Arch Point whereas on 16 May two single birds were observed off Cat Canyon and Webster Point. One member of the pair seen off Arch Point on 15 May and a single bird seen off Cat Canyon on 16 May were in full alternate plumage.

PIGEON GUILLEMOT – Pigeon Guillemots were not observed in near-shore waters during nocturnal spotlight surveys at the SBI on 15 May, although a single guillemot was observed between Sutil Island and SBI proper on 16 May (Table 2; Fig. 9). Guillemots typically do not occur on the water off colonies at night.

DISCUSSION

Cassin's Auklet

Using nest searches and spotlight surveys, no evidence of Cassin's Auklets breeding anywhere at SBI was found in May 2008, including areas where auklet breeding was recorded in 1976-94 (i.e., Elephant Seal Point, Arch Point, and Sutil Island). In fact, the only observation of Cassin's Auklets associated with SBI in 2008 was two birds 2-3 km north of the island seen from a boat while in transit to the island on 14 May. Failure to find auklet nests or detect auklets attending at-sea congregations certainly suggested a current lack of breeding at SBI, but should not be considered definitive proof of cessation of all auklet breeding activity at the island. Small numbers of auklets may have: a) completed breeding prior to our survey efforts in 2008; b)

nested in inaccessible habitats or areas not searched in 2008; or c) foregone breeding in 2008, but continue to attend the colony and breed in certain favorable years. All accessible areas of SBI where auklets were known or suspected to breed were searched, although nesting Brandt's Cormorants on upper areas of Elephant Seal Point and Brown Pelicans in Cat Canyon prevented nest searches in some areas where auklets were known to breed in 1977 and 1991. However, extensive surveys in these former auklet breeding areas conducted during Brown Pelican nest searches in fall 2007 and 2008 failed to yield any evidence of auklet breeding activity (A.L. Harvey, unpubl. data). More extensive efforts are needed throughout the breeding season in 2009-12 to better assess if breeding occurs in these years or in habitats not checked in 2008.

In 1897-99, the southeast and west mesas of SBI proper hosted a "large" Cassin's Auklet colony (Grinnell 1897, Robertson 1903; Chapter 2), and as early as 1863, auklets were so numerous that they "had undermined almost every part of the soft, earthy surface with their burrows" (Cooper [1870] in Howell 1917). Britton (1897) noted that "in a field of *Malva* weed hundreds of burrows contain auklets sitting upon their single white eggs". Between 1899 and 1908-11, this colony was reportedly extirpated due to feral cat predation (Willett 1912, Howell 1917), although other factors such as the effects of extensive farming and ranching on sensitive burrow nesting habitats, low prey availability or high avian predation also may have played roles in population reduction and extirpation (Chapter 2).

Despite reported extirpation on SBI proper by 1908-11, Cassin's Auklets were documented breeding on cat-free Sutil Island in 1911 (Willett 1912) and also may have nested in relatively inaccessible habitats on SBI proper (e.g., Elephant Seal Point and sea caves) at this time (Chapter 2). However, after 1911 the breeding status of Cassin's Auklets at SBI was not properly re-assessed until 1976-77 when nesting was again found on Sutil Island, nests were first discovered at Elephant Seal Point, and a single nest was found at Cat Canyon (Hunt *et al.* 1979). In 1991, similar numbers of breeding auklets were found in similar locations (Carter *et al.* 1992). Auklets were last documented nesting on SBI proper at Elephant Seal Point in 1994 (H.R. Carter, unpubl. data), although auklets were last detected at Sutil Island in 2001 (Chapter 2). Loss of breeding Cassin's Auklets at SBI has been suspected since about 2000 (Adams 2008, pers. comm.; P. Martin, pers. comm.), but little effort has been made to assess auklet breeding status since 1991. The small remnant breeding population at SBI (that apparently survived at least from the early 20th century to 1994) may have recently disappeared, but more work is needed to verify lack of current breeding.

The leading hypothesis for reduction and possible cessation of breeding by auklets at SBI since 1994 is an extended period of poor prey abundance or availability during the breeding season, leading to low reproductive success and poor recruitment (Adams 2008). However, other factors may have contributed to population decline, including: a) organochlorine pollutants that have caused eggshell thinning (Fry 1994, Kiff 1994); b) relatively high mortality from a 1995 winter storm event (Chapter 2; Appendix 1); c) avian predation (including re-established Peregrine Falcons [*Falco peregrinus*]); and d) mortality in oil spills in central California where at least some auklets from southern California disperse in the non-breeding season (Adams 2008). Although some impacts from all these sources can be assumed, specific evidence of extensive effects on auklets from the SBI has not been obtained.

Significant population decline also has been observed over the past 30-40 years at Prince Island (the largest auklet colony in southern California), as well as the South Farallon Islands in central California (the largest colony in California; Carter *et al.* 1992; Lee *et al.* 2007; Adams 2008; Wolf *et al.* 2009). At the Prince Island and Scorpion Rock colonies in southern California, breeding was greatly reduced or ceased completely in 2004-07 following excellent breeding in 1999-2001, although breeding resumed to a relatively high level in 2008 (Adams 2008, unpubl. data). An issue common to all California auklet colonies is the long-term warming trend in the California Current (McGowan *et al.* 1998) which has reduced certain auklet prey resources during the breeding season, resulting in documented reduced reproductive success and recruitment at several colonies, especially in northern current areas (Wolf *et al.* 2009). At SBI, current information on prey resources and foraging distribution are needed to better assess possible changes in prey abundance and availability at this location. Specific mortality factors likely vary among colonies but small colonies (e.g., SBI and Scorpion Rock) are likely to be more susceptible to extirpation from mortality and other factors than are larger colonies (e.g., Prince Island and South Farallon Islands).

Restoration: Restoration of breeding habitats on SBI proper is necessary to encourage future development of a population of breeding auklets that would be less susceptible to loss, especially from periodic population fluctuations in relation to oceanographic changes in the California Current (Ainley *et al.* 1990, Adams 2008). Recent efforts by CINP, supported by the MTC, to restore native vegetation may require decades before suitable auklet breeding habitats are developed. However, it also may take decades before the return of appropriate oceanographic and prey conditions that encourage growth of a large auklet colony. In the interim, it is desirable to restore breeding habitats as much as possible in order to: a) retain any breeding auklets that may still exist at SBI but were not detected in 2008; and b) use social attraction techniques, especially vocalization broadcast, to attract small numbers of auklets from other colonies that may then attend and establish breeding sites at restored areas of SBI. By keeping or building a small local population at the SBI over the next few decades, population growth likely will occur when prey conditions permit. Without restoration efforts, small numbers of auklets still attending SBI may abandon this colony in favor of other more established colonies; or, if no breeding is occurring at present, an excessively long period may elapse before natural recolonization is possible, increasing the chances of permanent colony abandonment.

Future Work: Additional nest searches and at-sea or aerial surveys are needed to better determine the current status of Cassin's Auklets at SBI in 2009-12. Specific efforts to detect auklets at SBI could include: a) *daytime boat or aerial surveys* – out to 10-20 km from the island during the early breeding season (March-May) to detect any birds within foraging range of this colony; b) *dusk boat surveys* - within 5 km of the island during the early breeding season (April-May) when auklets might stage off the colony; c) *post-breeding season nest searches* - after cormorants and pelican chicks have fledged, search for eggshell fragments or other evidence of colony attendance (e.g., carcasses), especially at known historic breeding areas not checked during the breeding season (e.g., upper cave at Elephant Seal Point and Cat Canyon); and d) *mistnetting and vocalization surveys* - at locations with past auklet occurrence in 1991 (e.g., Arch Point, Elephant Seal Point, and Sutil Island).

Xantus's Murrelet

Total numbers of Xantus's Murrelets observed on spotlight surveys in 2008 suggested that SBI may still host the largest colony in California, even though numbers of active nests in monitored plots have declined at least since 1991 and likely earlier (Carter *et al.* 1992; Drost and Lewis 1995; Whitworth *et al.* 2003a; CINP, unpubl. data). Based on the distribution of murrelets in at-sea congregations around the island (Figures 6-7), large numbers of murrelets apparently nest outside CINP monitored plots in relatively inaccessible habitats (e.g., cliffs and sea caves along the north shore of the island between Arch Point and Webster Point and steep cliffs off Signal Peak). Nest searches in 1977, 1991, 1996, 2001-02, and 2004 found numerous murrelet nests on cliffs and slopes in the Arch Point area (Hunt *et al.* 1979; Carter *et al.* 1992; Whitworth *et al.* 1997b, 2003a, 2005), although limited nest searches in 2008 provided some evidence of decline outside monitored plots as well. In 1996 and 2001, respectively, 22 and 20 active murrelet nests were found in roughly comparable areas on the Arch Point cliffs (Whitworth *et al.* 1997b, 2003a). In 2008, only 6 sites with evidence of breeding (3 active sites and 3 sites with hatched or broken eggshell fragments) were found in the same area. At Shag Rock, four active murrelet nests were found in 1996 (Whitworth *et al.* 1997b), versus only one in 2008, with similar search effort. However, only one nest was found at Shag Rock in 1991 when nesting murrelets were first discovered on this rock (Carter *et al.* 1992; see Appendix 1).

Comparison of round-island spotlight survey data in 2001-02 (Whitworth *et al.* 2003b) and 2008 did not show a decrease in numbers of murrelets attending at-sea congregations. In fact, total counts in 2008 (461 and 493 birds) were higher than all but the highest (530 birds) of five comparable counts in 2001-02 (Table 2). However, inadequate numbers of spotlight surveys were conducted in 2001-02 and 2008 ($n = 2-3$ per year) for fully verifying that population numbers had not changed between 2001-02 and 2008. Annual variation in timing of breeding and inherent variability in the number of murrelets attending at-sea congregations each night requires that an adequate number of surveys must be conducted each year to ensure that counts are conducted on nights of peak or near peak attendance. Limited round-island survey data may not have been representative of the total murrelet population in any of these years. Data from more numerous standard surveys conducted on shorter transects along the east side of SBI proper in 2001-02 support this hypothesis (Whitworth *et al.* 2003b). In 2002, murrelet standard survey counts on 16 April (313 birds), 7 May (352 birds), and 8 May (391 birds) were all higher than the maximum round-island survey count (300 birds on 24 April) that year, even though the standard survey transect was much shorter and sampled only the northeast portion of the island. This comparison indicates that round-island surveys must have been conducted on nights of relatively low congregation attendance in 2002.

Observed declines in active murrelet nests within long-term monitored plots at SBI may eventually result in an insufficient number of active nests in these plots for monitoring changes in population size, reproductive success, and breeding phenology. If long-term plots turn out to be inadequate in the near future, an adequate sample of nests ($n \geq 30$) should be located more widely around the island. In 2008, we examined the Arch Point area and identified accessible nests (discovered during earlier work in 1996-2004) that are suitable for monitoring. In 2009-12, more extensive and more frequent nest searches (including multiple visits to active sites) in a wider variety of nesting habitats should: a) increase the number of accessible murrelet nests that

are suitable for monitoring; and b) and provide comparisons of reproductive success in different breeding habitat types on SBI.

Spotlight survey counts and mark-recapture studies should be incorporated into the long-term monitoring program for measuring future changes in the murrelet population at SBI, both for comparison to and as alternatives for nest monitoring. Spotlight surveys and mark-recapture studies may be less biased at indicating overall population change than small monitored nest plots which can be subject to localized effects of breeding habitats, predation, and disturbance. Differences in breeding habitats, reproductive success, and presence of breeding Brown Pelicans have been well documented between Cat Canyon and Nature Trail plots over the last 25 years (CINP, unpubl. data). However, adequate spotlight survey or capture effort must be expended to ensure data are representative of the murrelet population in each year. Because large numbers of murrelets can be captured at sea and many recaptured using the night-lighting technique (Whitworth et al. 1997a,b), mark-recapture studies may provide the best available estimates of population size.

Avian predation, evidenced by the large number of Xantus's Murrelet carcasses found in caves in 2008 (apparent victims of Barn Owls [*Tyto alba*]), occurs in some years and is likely one of the primary factors impacting murrelets at SBI (Drost 1989, Drost and McCluskey 1992, Drost and Lewis 1995). Foraging Barn Owls may be aided by bright artificial lights on boats anchored or fishing off the island. Extremely bright lights from squid boats and their support vessels working the north and east sides of SBI were observed on the night of 14-15 May 2008 (i.e., first night of spotlight surveys). Seabirds often exhibit attraction or repulsion to bright lights at sea or on land. Murrelets can become disoriented, captured or injured aboard brightly lit vessels and structures, particularly on foggy or misty nights (Howell 1910; McClellan 1926; Dick and Donaldson 1978; Carter *et al.* 2000; Montevocchi 2006).

Ashy Storm-Petrel

Nest searches and spotlight surveys confirmed the continued presence of Ashy Storm-Petrels nesting at SBI, although data were not sufficient to estimate the current size of the population. Our discovery of 6 nests at Elephant Seal Point and one nest at Arch Point in 2008 yielded the largest sample of nests ever documented at SBI and has helped verify that a substantial breeding population occurs in largely inaccessible habitats, as indicated through mist-net captures in 1991 (Carter *et al.* 1992). A larger sample of nests requiring substantial search effort would be needed for regular monitoring of storm-petrel reproductive success and breeding phenology at SBI. Small numbers of storm-petrels were observed during spotlight surveys, but these data are likely not suitable for quantifying storm-petrel abundance or population changes. Given the difficulty in finding and monitoring storm-petrel nests at SBI, we recommend that the most effective methods of monitoring changes in population size over time are: a) mark-recapture analyses of mist-net captures of birds throughout the breeding season for periodic measurement of population size, as a general technique for monitoring population changes (Carter *et al.* 1992); and b) analyses of changes in capture rates throughout the breeding season over several years for measuring the degree and rate of population change over time, as a more intensive technique for monitoring population changes. Unfortunately, little effort has been made to assess population trends for Ashy Storm-Petrels at SBI since 1991.

Considering the secretive breeding habits and use of inaccessible nesting habitats by Ashy Storm-Petrels, it is likely that a small breeding population has long inhabited SBI, but went largely undetected prior to the discovery of the first nest in 1976 (Hunt *et al.* 1979). Despite numerous overnight visits and egg collecting at SBI by ornithologists and naturalists between 1897 and 1912 (e.g., Grinnell 1897, Willett 1912, Wright and Snyder 1913), breeding Ashy Storm-Petrels were not documented. Most early accounts fail to even mention the presence of storm-petrels there. Two specimens (MVZ #6168; MVZ #45944) were collected when dozens came onboard a ship (likely attracted to bright lights) while at anchor off SBI proper in April 1904 and Miller (1936) considered that he was “probably quite near a colony preparing to nest”. Little or no effort to document nocturnal seabirds occurred from 1913 to 1966. In 1967, a specific search was made without success, although D. Bleitz was reported to have found them breeding in an earlier visit (DeLong 1967).

On 10 June 1976, the first nest at the SBI group was found on Sutil Island; in addition, a probable nest was found on the main island in 1976 (Hunt *et al.* 1979). Mistnetting in 1976-77 documented 71 individuals (most with brood patches) attending the main island and Sutil Island. The breeding population of SBI was estimated to be 175 pairs (150 for Sutil Island; 40-50 pairs for the main island). In 1991, Carter *et al.* (1992) conducted more intensive mistnetting and captured 393 birds (most with brood patches) on the main island and Sutil Island. The breeding population of the SBI group was estimated at 730 pairs (437 for the main island; 293 for Sutil Island). One nest was found between Arch Point and Spire Point, the first definite record for the main island. On 8 May 1996, an Ashy Storm-Petrel without an egg was found in a potential nest crevice on Shag Rock, likely indicating breeding later in the year on this rock (Carter *et al.* 2008b, unpubl. data).

Rhinoceros Auklet

Historical nesting by Rhinoceros Auklets at SBI was reported by Baird *et al.* (1884), although Howell (1917) doubted this record and no confirmed nests have ever been found at the island (Hunt *et al.* 1979, Carter *et al.* 1992). Four observations of single Rhinoceros Auklets in spring and summer near SBI in 1977-94 (Table 4) probably represented non-breeding adults and subadults that did not return to breeding colonies north of the Southern California Bight and had wintered in the vicinity of SBI (Briggs *et al.* 1987, Mason *et al.* 2007). However, breeding had been noted in 1991-2007 at San Miguel Island, the southernmost known breeding colony of this species (Carter *et al.* 1992, 2008a; McChesney *et al.* 1995). In 2008, larger numbers of Rhinoceros Auklets (2-5 individuals or 1-2 pairs) seen on the water adjacent to potential nesting areas during nocturnal spotlight surveys provided greater evidence of possible breeding at SBI than past observations. However, one bird examined during the day in nearshore waters off Arch Point seemed weak, possibly indicating that other Rhinoceros Auklets might have been present for other reasons. Further surveys, possibly including at-sea captures (Whitworth *et al.* 1997a) to inspect for brood patches (i.e., evidence of breeding), are needed to further investigate possible breeding by Rhinoceros Auklets at SBI.

Pigeon Guillemot

Small numbers of Pigeon Guillemots have been regularly documented breeding at SBI, the southern extent of their breeding range since the late 19th century (Grinnell 1897). As for storm-petrels, observations of Pigeon Guillemots nesting in sea caves in 2008 confirmed breeding at SBI proper where a population of 276 breeding birds was estimated in 1991 based on bird counts (Carter *et al.* 1992). However, the small number of nests found in 2008 was not adequate for assessing the current size or trends of the population. Guillemots congregate during the day on the shoreline and inshore waters at and near breeding areas, with highest numbers usually found at dawn and in the early morning hours (Carter *et al.* 1992, 2008a). They are very rarely seen during nocturnal spotlight surveys at other colonies (D.L. Whitworth, unpubl. data). Early morning counts of birds on shore and in inshore waters are the most effective means of determining changes in population size over time (Carter *et al.* 1992, 2008a), but little effort has been made to conduct adequate surveys for this species since 1991. We did not conduct adequate surveys to estimate population size of Pigeon Guillemots in 2008, but plan to conduct standardized early morning counts during future monitoring at SBI.

Table 1: Evidence of nesting seabirds found during crevice/burrow searches at Santa Barbara Island in 2008. See Fig. 2 for locations of specific search areas.

Date	Search Area	Evidence of Nesting ¹			
		Xantus's Murrelet	Ashy Storm-Petrel	Cassin's Auklet	Pigeon Guillemot
15 May	Shag Rock	1 SIN	None	None	1 site (old egg) 1 site (2 eggs)
15 May	Cave A	2 SIN 1 site (HEF + egg) 2 sites (EF) 11 carcasses (keels)	2 SIN (1w/egg) 1 site (egg)	None	1 SIN 1 site (egg)
15 May	Cave B (lower)	1 SIN 1 site (HEF) 1 site (BE) 1 site (EF)	None	None	1 SIN (w/2 eggs)
15 May	Cave B (upper)	2 SIN 2 sites (HEF) 2 sites (EF) 1 carcass (keel)	1 site (HEF)	None	None
15 May	Cave C	None	None	None	1 SIN 2 SIN (w/1 egg) 3 SIN (w/2 eggs) 7 Adults flushed
15 May	Cave D	None	None	None	None
15 May	Cave E	None	None	None	1 SIN
16 May	Cave F	4 SIN (incl. 1 BE) 1 site (HEF)	2 SIN	None	None
16 May	Cave G	None	None	None	4 SIN 1 SIN (w/1 egg) 1 BE (open site) 14+ Adults flushed
16 May	N. Arch Pt. Cove	1 SIN 1 site (HEF)	None	None	None
16 May	S. Arch Pt. Cove	4 SIN (incl. 1 BE) 1 site (egg) 1 EF (open site)	None	None	None
16 May	Barn Owl Cave	3 sites (HEF) 28 carcasses (keels-wings)	None	None	None
16-17 May	Sutil Island	3 SIN 1 site (BE) 3 carcasses	None	None	None

Table 1: Continued.

Date	Area	Evidence of Nesting			
		Xantus's Murrelet	Ashy Storm-Petrel	Cassin's Auklet	Pigeon Guillemot
18 May	Arch Pt.	3 SIN 2 sites (HEF) 1 site (EF)	1 SIN	None	None
18 May	Buckwheat Patch	1 SIN	None	None	None
18 May	Elephant Seal Cove Cliffs	None	None	None	None
18 May	West Terrace	None	None	None	None
18 May	Badlands	None	None	5 old burrows	None
	Totals	22 SIN 11 sites (HEF) 9 sites (BE or EF) 43 carcasses	5 SIN 1 site (HEF) 1 other site	None	14 SIN 3 other sites

[†] Codes: SIN (adult sitting in nest); HEF (hatched eggshell fragment); EF (eggshell fragment); and BE (broken egg). See methods for definitions of broken eggs and eggshell fragments.

Table 2: Total numbers of Xantus's Murrelets and other seabirds observed on round-island spotlight surveys at Santa Barbara Island, 2001-08.

Date	Xantus's Murrelet	Ashy Storm-Petrel	Cassin's Auklet	Pigeon Guillemot	Rhinoceros Auklet
7-8 May 2001 ^a	196	0	0	0	0
8-9 May 2001 ^a	530	2	0	0	0
21-22 May 2001 ^a	124	0	0	0	0
11-12 April 2002 ^a	199	0	0	0	0
24-25 April 2002 ^a	300	0	0	0	0
14-15 May 2008	461	8	0	0	2
15-16 May 2008	493	8	0	1	2

^aSpotlight survey data from Whitworth *et al.* 2003b.

Table 3: Observations of Rhinoceros Auklets at Santa Barbara Island, California, 1977-94

Date	Time	Location	Plumage	Primary Observer	Source
5 May 1977	day	off island	subadult ¹	R.L. Pitman	LACM 88774
15 July 1982	day	off island	alternate ²	C.A. Drost	McChesney <i>et al.</i> (1995)
11 May 1994	01:00	Landing Cove	alternate ²	H.R. Carter	McChesney <i>et al.</i> (1995)
11 May 1994	08:09	Landing Cove	subadult ³	H.R. Carter	McChesney <i>et al.</i> (1995)

¹ Specimen examined January 2009 by K. Garrett - no facial plumes and no horn (SY or TY *fide* Pyle 2008).

² Facial plumes and horn present (ATY *fide* Pyle 2008).

³ With small horn (SY or TY *fide* Pyle 2008; referred to as "basic plumage" in McChesney *et al.* 1995).



Figure 1. Satellite image of Santa Barbara Island, showing topography and locations of the main island, Sutil Island, and Shag Rock.



Figure 2. Potential seabird breeding habitats examined during crevice/burrow searches at the Santa Barbara Island group in May 2008.



Figure 3. Possible old Cassin's Auklet burrow in the Badlands region of the southeast mesa of Santa Barbara Island proper, 20 May 2008 (Photo by Percy Hébert).



Figure 4. Adult Rhinoceros Auklet in alternate plumage found dead floating on the water off the north side of Santa Barbara Island proper, 15 May 2008 (Photo by Percy Hébert).



Figure 5. Adult Rhinoceros Auklet in alternate plumage on the water off Arch Point, Santa Barbara Island proper, 16 May 2008 (Photo by Percy Hébert). This bird allowed us to approach closely by boat before diving.

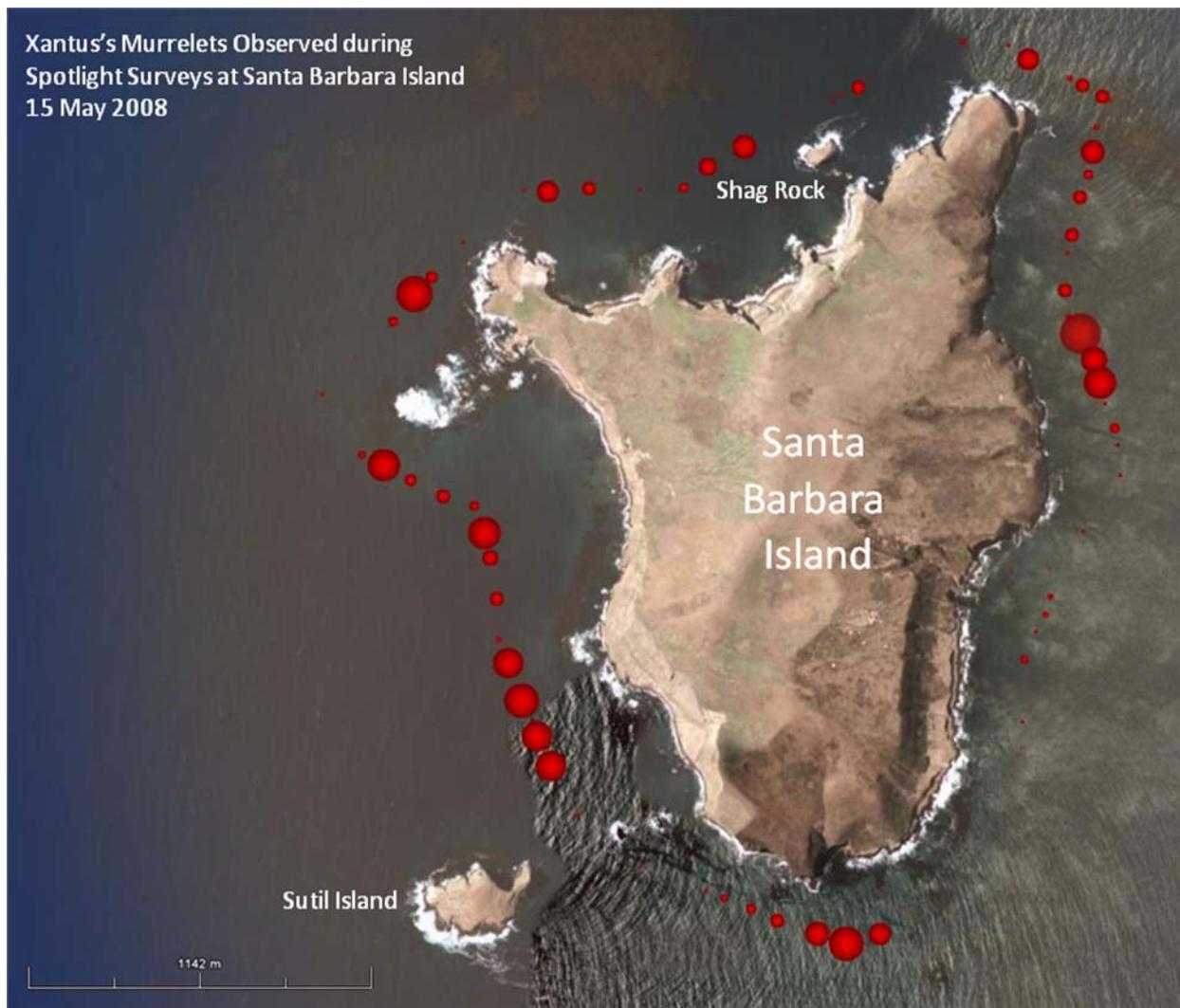


Figure 6. Distribution of Xantus's Murrelets during nocturnal spotlight surveys at Santa Barbara Island on 15 May 2008. The size of the red circles indicates the proportionate number of murrelets seen during a 90° scan, ranging from 1 to 29 birds.

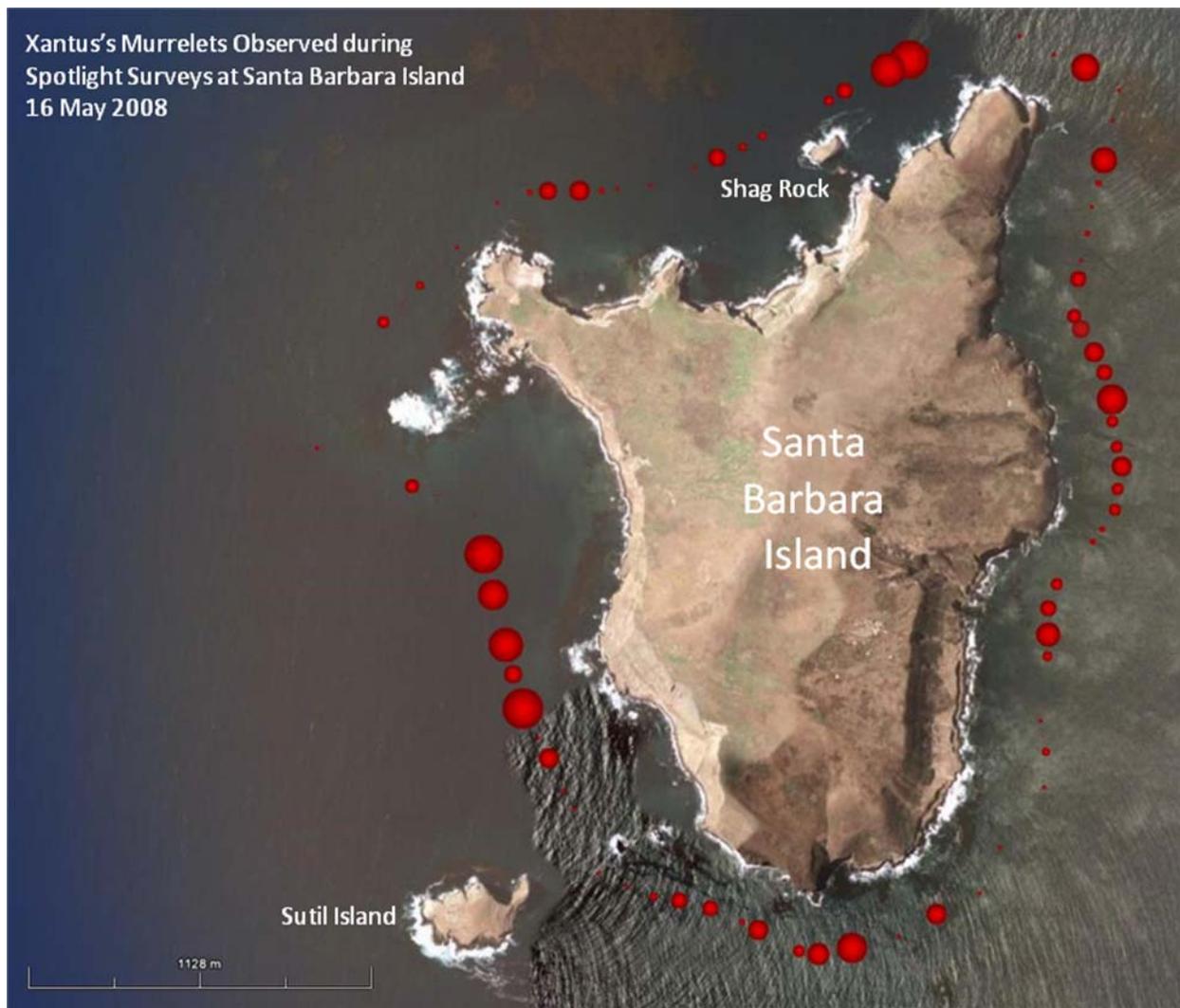


Figure 7. Distribution of Xantus's Murrelets during nocturnal spotlight surveys at Santa Barbara Island on 16 May 2008. The size of the colored circles indicates the proportionate number of murrelets seen during a 90° scan, ranging from 1 to 24 birds.



Figure 8. Distribution of Ashy Storm-Petrels and Rhinoceros Auklets during nocturnal spotlight surveys at Santa Barbara Island on 15 May 2008. The size of the colored circles indicates the proportionate number of birds seen during a 90° scan, ranging from 1 to 3 birds.

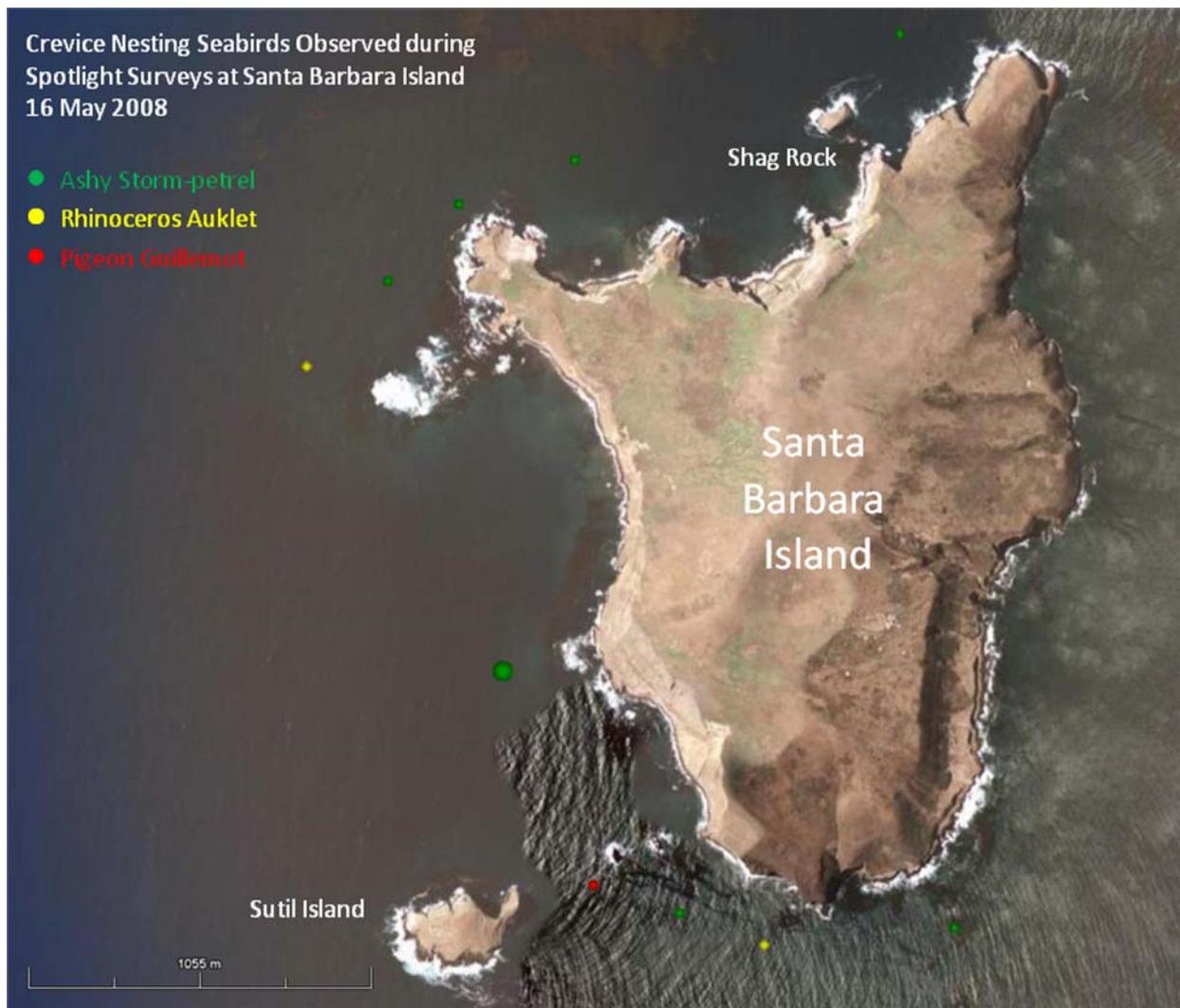


Figure 9. Distribution of Ashy Storm-Petrels, Rhinoceros Auklets, and Pigeon Guillemots during nocturnal spotlight surveys at Santa Barbara Island on 16 May 2008. The size of the colored circles indicates the proportionate number of birds seen during a 90° scan, ranging from 1 to 2 birds.

Chapter 2

Historical Status of Cassin's Auklets at Santa Barbara Island, California, 1863-2001

Harry R. Carter

INTRODUCTION

To assist on-going restoration efforts for Cassin's Auklets (*Ptychoramphus aleuticus*) at the Santa Barbara Island (SBI) group, California, information on the historical breeding status of Cassin's Auklets at this colony and factors affecting breeding habitats was re-examined. Hunt *et al.* (1979, 1980), McChesney and Tershy (1998), and Adams (2008) provided recent summaries of historical literature on breeding Cassin's Auklets at the SBI group in 1863-2001. These summaries relied heavily on past accounts by Willett (1912, 1933) and Howell (1917), and did not provide all available historical details or summarize all available historical information on potential human impacts to the auklet colony. Hunt *et al.* (1979, 1980) and Carter *et al.* (1992) provided details for surveys conducted in 1976-77 and 1991, respectively; however, these unpublished reports are difficult to access and require additional interpretation. Additional unpublished data on Cassin's Auklets at the SBI group also have been gathered by Humboldt State University, Channel Islands National Park, and U.S. Geological Survey in 1994-2001 but most data have not been reported previously.

To better identify and interpret factors affecting Cassin's Auklets and their breeding habitats at the SBI group from 1863 to present, a wider search for historical information (published and unpublished) was conducted to both verify and clarify past summaries and fill information gaps where possible (see Appendix 1). To assist access to past information, summaries and excerpts from pertinent literature were reproduced. Although the historical record is incomplete, this process has resulted in a more complete documentation of past breeding and a better understanding of certain factors affecting Cassin's Auklets and breeding habitats over time. However, changes in ocean conditions and at-sea conservation issues (e.g., oil spills) were not examined which also may have affected auklet reproduction and population size over time. A separate effort is needed to examine changes in ocean conditions over time and to interpret potential impacts on auklets. Given a lack of knowledge of prey resources used at the SBI group, such interpretation will be difficult but careful generalizations likely can be made. Below, a summary of the historical breeding status from 1863 to 2001 is provided, with brief explanations describing how overlooked information or re-interpretation of reported sources have modified the viewpoints outlined in previous literature and past summaries. Additional details supporting this revised status are provided in Appendix 1.

STATUS (1863-1922)

From 1863 to 1899, SBI proper hosted a “large” Cassin’s Auklet colony (Hunt *et al.* 1979, 1980; Appendix 1). In 1863, auklets were so numerous that they “had undermined almost every part of the soft, earthy surface with their burrows” (Cooper in Howell 1917). In 1897, Britton (1897) noted that “in a field of *Malva* weed hundreds of burrows contain auklets sitting upon their single white eggs” and Grinnell (1897) described “the southwest side of the mesa from the top of the bluff to the summit of the hill was crowded with their burrows.” In 1899, Robertson (1903) described the colony as being at “the southern end, where the higher land slopes gradually towards the cove” and Chambers (see Appendix 1) briefly noted a colony of “1,000 holes.” No other detail was provided concerning the exact size and location of this auklet colony. In Appendix 1, it is clarified that this relatively large auklet colony likely occurred on both the southeast and west mesas, including the Badlands area on the southeast mesa (where several possible old auklet burrows were found in 2008 – see Chapter 1) and slopes leading up towards Signal Peak from both southeast and west mesa areas. Using descriptions in historical accounts, the approximate location of the historic auklet colony was outlined (Fig. 10). About 2,000-4,000 burrow entrances may have been present in 1899, depending on what colony areas were actually examined, and a ballpark estimate of 1,000-4,000 breeding pairs was derived for this colony, assuming occupancy of 50-100% (Appendix 1).

In 1908 and 1911, the auklet colony on southeast and west mesas was reportedly extirpated by feral cats, which were abundant at the turn of the century (Willett 1912, Howell 1917; Appendix 1). Willett (1912) reported that: “From the bones and feathers of the birds found all over the island, I concluded that they had been exterminated by the cats which the island is infested.” Howell (1917) stated that: “Since that time [May 1897], cats have been introduced, and in May, 1908, I could find no indications of the auklets’ presence on the island.” Breeding by small numbers of auklets was documented in 1911 on Sutil Island which was cat free (Willett 1912; Appendix 1). However, upon further review of historical documents, insufficient evidence was provided to fully substantiate loss of the mesa colony due solely to cat predation (Appendix 1). It was unclear if all mesa colony areas were examined for breeding; poor food availability may have contributed to either reduced or no breeding in those years; and avian predation may have been responsible for many carcasses observed, especially away from the colony itself. Cats had been introduced before 1863 (Whitney 1865) and may have co-occurred on the island with auklets for several decades. However, later re-introduction of cats also is possible. Large numbers of cats were first noted prior to 1896 (Philbrick 1972) – cats were not introduced after 1897 as stated by Howell. Based on re-examination of historical information, complete loss of the auklet colony due to cat predation alone between 1899 and 1908 was less likely, whereas highly reduced colony size (i.e., decimation) over this period due to cat predation and other factors was more likely. After 1911, the status of this auklet colony was not specifically re-examined until 1976-77 and complete colony loss by 1908-11 was not confirmed (i.e., brief visits in 1912 and 1939 did not visit the historic colony area; Wright and Synder 1913; Sumner and Bond 1939).

Only a few years after 1911, extensive ranching and farming activities in 1916-22 severely altered burrowing habitats at southeast and west mesa areas (Weinman 1978; Daily 1993). Almost all burrows likely were collapsed or removed by ploughing of a large hay field on the

southeast mesa and a large vegetable field on the west mesa, pulling and burning of island vegetation, construction of water ponds on the southeast and west mesas, and intensive grazing by hundreds of sheep throughout the island. Any remaining breeding auklets likely abandoned nesting at the mesa colony and possibly moved to breed in coastal habitats (less affected or unaffected by farming and ranching) or offshore rocks (Sutil Island and Shag Rock) in the SBI group. In addition to reduced recruitment due to cat predation, loss and compaction of soil likely reduced the likelihood of recolonization of the historic colony area after 1922. Lack of any mention of old burrows in 1976-77 and 1991 (Hunt *et al.* 1979; Carter *et al.* 1992) suggested that almost all old burrows no longer existed after the farming and ranching period, although specific searches for old burrows were not conducted. Despite a lack of specific documentation of impacts to these auklet breeding habitats, it seems clear that auklet breeding habitats in this historic colony were essentially destroyed. Although extensive erosion also may have occurred, it is unlikely that all burrows in this large colony would have disappeared due to erosion alone over the 65 year period between 1911 and 1976-77.

While it is not clear exactly when or how this colony was extirpated, this re-evaluation of historical information indicated that a broader and less specific interpretation of colony loss is necessary to account for incomplete or inconsistent information provided in past sources and summaries. To briefly encapsulate this revised status in a sentence, I contend that it is better to consider that: “Between 1899 and 1922, the Cassin’s Auklet colony on southeast and west mesas of SBI proper was extirpated due to feral cat predation and severe alteration of burrow-nesting habitats from farming and ranching, possibly in conjunction with other factors such as low prey availability or high avian predation.” Available information suggests strongly that feral cats and severe alteration of burrow-nesting habitats were major factors involved in colony extirpation; the exact timing of extirpation is not known but occurred at some point between 1899 and 1922. In this re-examination of historical information, occurrences of El Niño events or changes in ocean climate conditions which may have led to low prey availability were not investigated but may have occurred and affected auklets at the SBI group. Further, it should be noted that a large storm kill of Cassin’s Auklets was witnessed in 1903 (February or later) at nearby San Clemente Island where Cassin’s Auklets do not breed, and some or many birds from the SBI group may have been involved (Breninger 1903).

STATUS (1976-77)

In addition to continued nesting on Sutil Island, Cassin’s Auklets were found in a few relatively inaccessible habitats at SBI proper in 1976-77, indicating either: a) partial recovery from past decline or extirpation on SBI proper (Hunt *et al.* 1979, 1980) or b) continued long-term nesting in limited habitats on SBI proper since the early 20th century (Appendix 1). Many auklets (n = 42) were captured and banded at the entrance to a sea cave on Elephant Seal Point where 75 nests were estimated. A single auklet pair also was found nesting in Cat Canyon and 35 pairs were estimated on Sutil Island. No evidence of recolonization of the mesa colony by auklets was obtained, although specific efforts were not made to search for old burrows.

Hunt *et al.* (1979) noted that “At this point, there appears to be little to prevent Cassin’s Auklets from reoccupying Santa Barbara Is. [proper] in their former numbers.” With the removal of the last cat at SBI proper in 1978, this comment apparently suggested that they considered that the

continued presence of small numbers of cats may have prevented recolonization of the southeast and west mesa areas and auklets discovered breeding on the main island in 1977 may have reflected recent recolonization of these areas. However, Hunt *et al.* (1980) noted further that “It is not known whether the small colony found at Santa Barbara Island in 1977 is the result of a relatively new invasion or a remnant of the old population.” Hunt *et al.* (1979, 1980) also did not refer to alteration of burrow-nesting habitats at southeast and west mesa areas due to past ranching and farming, seemed to accept previous statements that cats alone had led to colony loss by 1908-11, and provided little information on the status of cats on SBI proper since 1911. Through re-evaluation of historical information, little or no evidence of large numbers of cats at SBI proper exists after 1922 (Appendix 1). In 1916-22, cats were reduced through poisoning by ranchers that were raising rabbits for pelts (Weinman 1978, Daily 1993). In 1939, Sumner and Bond (1939) observed one cat but thought they were “decidedly abundant” based on scat observed. In 1950, one cat was observed and in 1957 cats were thought to be exterminated during shooting and poisoning of rabbits in 1954-57 (Sumner 1958, Philbrick 1972). In 1978, the last cat was removed (Murray *et al.* 1983). It is most likely that auklets had continued nesting in these relatively inaccessible habitats since the early 20th century and that small numbers of remaining cats did not prevent continued nesting in these areas since at least 1922. It is not clear if auklets bred in these areas prior to 1899 when the large colony was present on the mesa and may have provided nesting habitat for all Cassin’s Auklets breeding in the SBI group. During the 1896-1916 period when cat numbers and predation were higher, auklets may have moved from the mesa colony to inaccessible habitats on offshore rocks and possibly to relatively inaccessible habitats on SBI proper. In 1911, breeding on Sutil Island was first recorded, representing either long-term nesting or recent colonization. All remaining auklets at the mesa colony likely moved to these other habitats or possibly other island groups in southern California, as mesa colony habitats were destroyed by farming and ranching in 1916-22.

STATUS (1991)

Surveys in 1991 failed to document any detectable change in the status of Cassin’s Auklets at the SBI group since 1976-77 (Carter *et al.* 1992). Only small numbers of auklets (~ 66 breeding pairs) were estimated to nest on SBI proper in 1991 in similar locations as in 1977. Auklets were captured in mist nets in three locations on the main island: 1) the entrance to a small cave above Elephant Seal Point where 18 auklets (not including 5 recaptures) were captured over three nights; 2) Arch Point where 4 auklets were captured over 4 nights; and 3) Webster Point where one auklet was captured on one night. On Sutil Island, 16 occupied sites were found and 9 auklets were captured in mistnets over two nights, contributing to an overall estimate of 61 breeding pairs for the islet. A probable auklet nest also was found on Shag Rock.

Carter *et al.* (1992) did not attempt to re-evaluate historical literature and did not assess reasons for similar numbers of auklets in 1976-77 and 1991. However, the lack of increase and use of similar areas noted between 1976-77 and 1991 was consistent with continued nesting in relatively inaccessible habitats since the early 20th century and was not consistent with an increase in auklet numbers after removal of the last cat in 1978 as anticipated by Hunt *et al.* (1979, 1980). No evidence of recolonization of the mesa colony by auklets was obtained, although specific efforts were not made to search for old burrows.

STATUS (1994-2001)

During seabird surveys and studies by Humboldt State University (H.R. Carter and D.L. Whitworth, unpubl. data) in 1994-96, a few observations of Cassin's Auklets were made in the SBI group (Appendix 1). On 13 May 1994, three auklet nests were found at Elephant Seal Point, suggesting continued breeding at this location since 1977 although perhaps in progressively lower numbers. In mid March 1995, a significant winter storm kill led to the deaths of hundreds to thousands of Cassin's Auklets. Several hundred were found dead or moribund on the water beside the SBI group. This storm may have killed tens to hundreds of auklets attending nesting areas on the SBI group prior to egg laying (Hunt *et al.* 1979, Carter *et al.* 1992). This event may have had a major impact on the continued existence of the small local auklet population numbering only 128 breeding pairs (or 256 breeding birds) in 1991. However, given the large numbers affected, most affected birds were from other colonies, likely including late-wintering individuals from colonies outside southern California that were still present in southern California waters in early-mid March 1995. A similar mortality event of Cassin's Auklets was witnessed in 1903 at nearby San Clemente Island where Cassin's Auklets do not breed, and some or many birds from the SBI group may have been involved (Breninger 1903). On 8 May 1996, one possible auklet site (i.e., empty with a strong guano smell) was found on Shag Rock, suggesting continued breeding or site visitation by auklets from 1991 to 1996.

From 1997-2001, little evidence of auklets was recorded at the SBI group during work conducted by Channel Islands National Park and U.S. Geological Survey. On 17 March 1997, a daytime nest search was conducted at Elephant Seal Point by J. Roth (P. Martin, pers. comm.); no nests were found but nesting might not yet have occurred this early in the year and nest searches may not have occurred in those areas where prior nesting was documented. On 21 May 1999, storm-petrel mistnetting was conducted at Elephant Seal Point by S. Wolf, but no auklets were captured or heard (P. Martin, pers. comm.). On the night of 23-24 April 2001, J. Adams (pers. comm.), H. Nevins, and H. Gellerman conducted mistnetting on Sutil Island to evaluate numbers of Cassin's Auklets for a potential radio telemetry project. Two nets were operated between 20:15 and 02:00 h. At 01:05 h on 24 April, they caught one Cassin's Auklet with a dark iris (type 3; probably indicating a subadult [Manuwal 1978]) and without brood patches. Between 01:30 and 02:00 h, they noted a few Cassin's Auklets vocalizing from the direction of the main island but it was not clear if they were flying through the channel that separates Sutil Island from the main island, or were on the water near the island.

By 2001, some biologists have suspected that breeding no longer occurred at the SBI group (Adams 2008; P. Martin, pers. comm.). However, extensive survey effort was needed to detect presence of breeding auklets in 1991 (Carter *et al.* 1992) and only minimal attempts to detect presence had been made since 1991 which were insufficient to assess breeding status.



Figure 10. Approximate locations of historic Cassin's Auklet breeding areas and farming-related water ponds on southeast and west mesas at Santa Barbara Island proper, California.

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Appendix 1.

Re-examination of the Historical Status of Cassin's Auklets breeding on Santa Barbara Island, California, 1863-1996

Harry R. Carter

Introduction

Four recent summaries of information related to Cassin's Auklets (*Ptychoramphus aleuticus*) breeding on the Santa Barbara Island (SBI) group from 1863 to 2001 have been prepared (Hunt *et al.* 1979, 1980; Carter *et al.* 1992; McChesney and Tershy 1998; Adams 2008), which relied heavily on earlier summaries (Willet 1912, Howell 1917). In this appendix, I re-summarized and re-examined available historical information to verify conclusions about the status of this colony over time, including: a) reproducing relevant portions of the four summaries and other literature for greater access from obscure sources and rapid reference; b) checking details in most original sources; c) consulting other available information in major historical sources (e.g., Weinman 1978; Doran 1980; Daily 1993); d) searching additional literature for more information; and e) examining museum records for more information. This collation and re-examination of historical materials is provided below, followed by: a) a revised summary of the history of this colony in 1863-1972; and b) additional comments on 1976-77, 1991, and 1994-96 surveys.

Four Recent Summaries

Hunt et al. (1979):

[p. 212-213; *Santa Barbara Island*] "A Cassin's Auklet egg set (MVZ 1950) was collected by Cooper on Santa Barbara Is. on 26 May 1863. Cooper ([1870] in Howell 1917) found auklets numerous on Santa Barbara Is. in 1863, 'where they had undermined almost every part of the soft, earthy surface with their burrows'. Grinnell (1897) found them breeding in large numbers in 1897: 'The southwest side of the mesa from the top of the bluff to the summit of the hill was crowded with their burrows'. One egg set (MVZ 1950) and nineteen specimens were collected during his visit. Britton (1897), apparently on the same cruise with Grinnell, stated, 'In a field of malva weed [cheeseweed mallow *Malva parviflora*] hundreds of burrows contain auklets sitting upon their single white eggs.' At least 11 sets of auklet eggs (WFVZ uncat.) were collected by H. Robertson on 9 June 1899. Robertson (1903) examined 'a great number of nests and found very few empty ones' at the southern end of the island; he felt that auklets probably nested elsewhere on the island, as well. By May 1908, when Howell (1917) visited the island, no signs of this species were seen. Willett (1912) found only bones and feathers of auklets all over the island during his trip there in June 1911; he 'concluded that they had been exterminated by the cats [*Felis catus*] with which the island is infested.' He did find, however, a small colony of 100 pairs of auklets nesting on an offshore islet (Sutil), where they were safe from the depredations of feral cats. One egg set was collected from this colony on 14 June 1911 (WFVZ 6155). The following year, on 2-3 July 1912, Wright and Snyder (1913) undertook a thorough search of the northwest end of the island and found nothing but the remains of auklets, which they felt were attributable to cats also. No auklets were found by Sumner (1939) and Bond in April 1939, though what may have been some recently worked burrows were seen near the northeast corner of the island. Sumner (1939) also spoke of the 'hordes of exotic house cats' that were still on the island. Banks (unpubl. notes) saw a few auklets in the vicinity of the island and heard what he thought were auklets (murrelets?) [sic] at night from 21-23 February 1964. Hunt and Hunt (1974) saw none in 1972."

[p. 213; *Present Status*] "The Sutil Is. auklet colony still persists. On 27 June 1976, a large downy chick was pulled from a burrow in the loose soil in a saddle area atop Sutil Island. A small number of other burrows were found in the same area and a few were scattered at locations over most of the islet. A total of 35 breeding pairs was estimated for this islet. This is somewhat lower than Willett's (1912) estimate [100 pairs in 1911] and may indicate a slight decline for this species. There is very little soil on the top of Sutil for burrowing; due to the lack of vegetation, a considerable amount of soil may have eroded away over the years. On the main island, 42 Cassin's Auklets were banded from a small colony located in a cave near Elephant Seal Pt. in 1977. This colony had an estimated 75 pairs of breeding auklets. In addition, a single pair of nesting auklets was found in Cat Canyon at the opposite end of the

island. At this point, there appears to be little to prevent Cassin's Auklets from reoccupying Santa Barbara Is. in their former numbers..."

[p. 215; *Habitat*] "The small auklet colony on Santa Barbara Is. was concentrated at Elephant Seal Pt., where auklets burrowed in the soft dirt floor of a large rock crevice. A few nests were also found in natural rock holes, but none were found on the slopes in the gull colony."

[p. 218; *Phenology*] "On Santa Barbara Is., egg laying commenced on 26 March in 1977, and all of the 8 clutches followed initiated prior to 11 April. Most chicks hatched between 30 April and 11 May. However, adults carrying food were captured as late as 22 June, suggesting chicks were still present at this time. Fully-fledged juveniles were captured in mist nets adjacent to the Elephant Seal Pt. colony for the first time on 28 May and thereafter until researchers departed the island in mid-July. Peak activity of auklets in this area was observed on the night of 28 May."

[p. 219; *Reproductive Success*] "No actual instances of predation on auklets, either chicks or adults, were observed during this study. However, both owls and gulls prey upon auklets on Prince and Santa Barbara Islands."

[p. 259; *Ability of Seabird Populations to Recover from Declines*] "Similarly [i.e., like Common Murres *Uria aalge* and Tufted Puffins *Fratercula cirrhata* which also stopped breeding in southern California in the early 20th century], when adult breeding Cassin's Auklets were killed off by cats on Santa Barbara Is., the population failed to recover to its former numbers in over 70 years."

Carter et al. (1992):

[p. 243-44; *Santa Barbara Island*] "At Santa Barbara Island, we counted 31 probably-active Cassin's Auklet sites during April, June and October 1991 counts of Xantus' Murrelet sites: 4 medium sites were found in area 8 (1 crevice with an eggshell fragment near Cat Canyon and 3 burrows near Graveyard Canyon (see Figure 45)); 1 medium burrow was found in area 4 under the arch at Arch Point; 2 medium crevices and 1 burrow were found in area 3 [Arch Point to Elephant Seal Point]; and 23 sites were found in area 2 (13 large crevices were found in the upper accessible areas of Elephant Seal Point while 1 medium burrow and 9 medium burrow/crevices were found in areas accessible by boat [at Elephant Seal Point]). During nocturnal mistnetting for storm-petrels at locations around Santa Barbara Island, we heard vocalizations or captured birds only in three general areas (Table 9, Appendix 4). At Elephant Seal Point, we captured and banded auklets in a mistnet placed at the entrance to a small cave located on the top outer cliff of the point: 3 birds (with incubation patches) were caught on 11-12 April, 9 birds (with incubation patches, including 1 recapture) on 14-15 April, and 11 birds (with incubation patches, including 5 recaptures) on 19-20 May. Using Chapman's (1951) modified Lincoln-Petersen method, we estimated about 26 breeding birds were nesting in this cave. At this cave, auklets rarely vocalized during the night although a few birds could be heard calling sporadically from another cave closer to the water (where 9 sites were found in October 1991 counts). Single auklets were caught in mistnets on 4 nights at Arch Point in April and May and on the night of 21-22 May at Webster Point. This scattering of additional observations away from known breeding sites suggested that small additional numbers nested at scattered inaccessible cliff locations around the island in 1991. To account for this, we added 50% to our otherwise estimate of 88 breeding birds to derive a final estimate of 132 breeding birds for Santa Barbara Island. This estimate was similar to the 150 breeding birds estimated in 1975-1977 (Hunt et al. 1979) when birds were reported in essentially the same areas of the island as in 1991.

At Sutil Island, 81 sites (including all burrows and burrow/crevices) were counted on the upper slope and top areas in October 1991; 127 other sites (including all plant and cliff sites) on the lower slopes and cliffs were treated as Xantus' Murrelet sites (see Xantus' Murrelet account). On 13-14 April, we observed 16 occupied sites on top of the island. We captured and banded 8 birds (71.4% with incubation patches) in a mistnet in the saddle between the two peaks (site 15 on Figure 11). A few birds were heard occasionally after 0200 hours. Only 1 bird was captured on 4-5 June (Table 9, Appendix 4). Using the L correction factor [i.e., 75% occupied], 122 breeding birds were estimated.

At Shag Rock, we found 1 probably-active large burrow/crevice on 22 May 1991. Although they have not been recorded nesting here before, this small rock is located near the northern shore of Santa Barbara Island where auklets nest currently and have nested historically (Hunt et al. 1979)."

McChesney and Tershy (1998):

[p. 337, 340; *Santa Barbara Island*] “Cats were introduced to the main island around 1900. Philbrick’s (1972) report that cats were abundant before 1896 did not provide additional details. Visits in 1897 (Grinnell 1897) and 1899 (Robertson 1903) documented large numbers of breeding seabirds, including a large colony of Cassin’s Auklets. However, by 1908 cats had destroyed the auklet colony (Willett 1912; Howell 1917) and Howell (1917:22) stated that Xantus’s Murrelets were ‘...surely destined to be driven from this locality, as have the auklets, by the cats.’ An eradication program severely reduced the cat population by the 1950s (Sumner 1958), and the last cat was removed in 1978 (Murray *et al.* 1983). During the cat occupation, auklets apparently persisted on adjacent, cat-free Sutil Island (Hunt *et al.* 1981). Murrelets probably persisted on Sutil and the inaccessible cliffs of Santa Barbara Island, and Sumner and Bond (1939) found the remains of a cat-killed murrelet in April 1939. Santa Barbara Island now holds the largest Xantus’s Murrelet colony in the Channel Islands and Cassin’s Auklets nest in small numbers (Hunt *et al.* 1980, 1981; Carter *et al.* 1992). Storm-petrels or other species may have been affected, although the storm-petrels currently nest only in the cliffs.”

Adams (2008):

[p. 206; *Historic Range and Abundance in California*] “Grinnell (1897) and Robertson (1903) documented a ‘large’ colony of Cassin’s Auklets on Santa Barbara Island in 1897 and 1899, but with the introduction of cats ca. 1900 the colony was virtually destroyed by 1908 (Howell 1917).”

[p. 207-08; *Southern California*] “Cassin’s Auklets formerly nested in a “large” colony on Santa Barbara Island (Grinnell 1897, Robertson 1903), but were decimated by introduced cats (*Felis catus*, now extirpated; Hunt *et al.* 1981). Small numbers of auklets appear to have persisted there and on nearby Sutil Island (Hunt *et al.* 1981, Carter *et al.* 1992). Although recent surveys are lacking, it is possible that Cassin’s Auklets no longer breed at Santa Barbara Island (P. Martin, pers. comm. in MSRP 2005). Reasons for lack of recovery (and subsequent possible extirpation) since cats were removed from Santa Barbara Island are not known but may reflect low recruitment to the population during warm ocean climate conditions off southern California (McGowan *et al.* 1998). Additional mortality is likely associated with past oil spills in southern California (e.g., 1969 *Platform A* oil spill, Sept 1997 *Torch* oil spill) and, on the basis of recent evidence for northward postbreeding dispersal (Adams *et al.* 2004a), spills in northern California (i.e., Nov 1984 *Puerto Rican* oil spill, Ford *et al.* 1987; the Feb 1986 *Apex Houston* oil spill, Page *et al.* 1990; and the recently identified *S.S. Jacob Luckenbach* spills)...”

[p. 208-09; *Threats*] “Auklet eggs from the Channel Islands had elevated levels of DDE and evidence indicating eggshell thinning resulting from organic contaminant exposure (Fry 1994, Kiff 1994).”

Clarifications (1863-1972)

1863: In addition to the egg collected, J.G. Cooper also collected at least 3 study skins of auklets in 1863, including two adults (MVZ #4439 [May, possibly 26 May when the egg was collected]; #4440 [1 June]) and one chick (MVZ #4441 [12 June]).

Not reported in past summaries, Cooper also first noted sheep (*Ovis aries*) and cats on SBI proper in 1863. Doran (1980) summarized information from Whitney (1865) as follows: “It is a curious fact that sheep thrive on Santa Barbara, although there is no water there during the summer, or for more than half the year; they appear to get moisture enough from the fogs and the succulent plants on which they feed. Even a cat has succeeded in sustaining life there for four years, living on birds and mice, of which there is an abundance.” In spite of this statement that the cat had been there for four years, it does not seem clear exactly when cats were first introduced before 1863. While one cat was seen in 1863, more could have been present on the island, leading to larger numbers reported in 1897. However, later cats also may have reflected a later re-introduction. It is not clear if these cats preyed on auklets or not in 1863.

1873: Four auklet eggs (USNM #B16635) were collected at “Santa Barbara Island” in 1873 by C.M. Scammon, without details. This visit was not reported in past summaries.

1897: Grinnell and H. Gaylord collected one egg (MVZ #405; not MVZ #1950 as stated in Hunt *et al.* 1979) on 16 May 1897, as well as 3 other egg sets (Willet 1912; see below). Egg set MVZ #1950 correctly refers to the egg set collected by J. Cooper on 26 May 1863. Twelve of 19 study skins collected were located as follows: a) LACM had nine skins collected on 14 May (#5033), 16 May (#5028, #5029, #5030, #5031, #5032, #5034, #5035) and 9 June (#5027); and b) MVZ had three skins collected on 16 May (#31435, #31436, #31437 [chick]).

Not reported in past summaries, Holder (1910: 300-01) noted that at Santa Barbara Island "...One of the most interesting birds here is Cassin's auklet,.....The southwest side of the mesa from top to summit, according to Gaylord, is crowded with their burrows. The birds are not seen during the day, not coming ashore until eight o'clock at night. There are no trees even by courtesy, but mourning doves, bald eagles, horned larks, ravens, Western meadow larks, house finches, Santa Barbara song sparrows, myrtle warblers, magnolia warblers, Townsend's warblers, pileolated warblers, rock wrens, and russet-backed thrushes were observed here by Mr. Horace Gaylord on the Pasadena Academy of Science expedition some years ago, and doubtless many migrating birds stop here. Preying on these birds are forty or fifty cats, the progeny of a pair left here by some fisherman years ago." Horace and Harry Gaylord accompanied Grinnell and Britton to SBI proper in 1897 (Grinnell 1897) but Horace Gaylord also accompanied Robertson to SBI proper in 1909 [see below]. It is not clear what year Horace Gaylord was referring to when describing cats on the island. In any case, 40-50 cats described in 1897 or 1909 likely were progeny of cats present in 1863. As noted by McChesney and Tershy (1998; see above), Philbrick (1972: 344) also reported that "Feral cats were extremely abundant shortly before 1896 (H. Bay Webster interview with Don Meadows, 1940)." Howell (1917) assumed recent cat introduction after 1897, likely based on the lack of cat observations reported by Grinnell (1897) and Robertson (1903). I cannot account for why Gaylord's observations (Holder 1910) of 40-50 cats were not reported in summaries prepared shortly thereafter (Willet 1912, Howell 1917) which described loss of the auklet colony due to cat predation. However, it is likely that Gaylord did not provide sufficient evidence to support this estimate which may have reflected direct observation of only a few cats (C. Drost, pers. comm.).

Grinnell (1897) briefly described the location of the Cassin's Auklet colony in 1897 as follows: "The southwest side of the mesa from the top of the bluff to the summit of the hill was crowded with their burrows." Elsewhere in this report, Grinnell described SBI proper as follows: "It is one and five-seventh miles across on its greatest diameter, and the highest point, the southernmost of the two hills which occupy the center, is possibly 300 feet in altitude....With the exception of the two hills, the top is a smooth mesa, cut on the east side by several short ravines. This mesa supports a rather abundant growth of grasses, weeds, and in the eastern part, scattering low bushes..." Given that Grinnell and his scientific exploring party spent 5 days on this small island, I suspect that they investigated every part of the island and found auklets nesting in both the southeast mesa (including slopes on the west side of this part of the mesa that reach up to Signal Peak, matching the description of the part of the auklet colony visited by Chambers and Robertson in 1899 – see below) and the west mesa (including slopes on the south side of this part of the mesa that reach up to Signal Peak, likely another part of the auklet colony not visited in 1899 but possibly visited in 1909 by Robertson and Gaylord – see below). Grinnell appeared to collectively refer to both southeast and west mesa areas as the "southwest side of the mesa."

1899: Robertson (1903) provided the most detailed description of the Cassin's Auklet colony on the southeast mesa on 9 June 1899. After apparently landing at Landing Cove and climbing up the bluffs to the mesa, they threaded their way "among the gulls' nests and, after examining a few, proceeded to the southern end, where the higher land slopes gradually towards the cove. Here we found a number of auklet burrows and at once went to work." At this time, Western Gulls nested on the outer margins of the mesa nearly the whole way around the island (Grinnell 1897). It is not clear which "cove" was intended but I suspect that either the small cove at Cat Canyon (at the south end of the island) or at Graveyard Canyon (off the southeast side) were intended because these coves are the only coves near the south end. I interpret this description to fit the general colony area on the southeast mesa (see Fig. 10). Apparently, the west mesa area was not visited on 9 June 1899.

At least five Cassin's Auklet egg sets were collected at SBI proper on 4 June 1899 by W.L. Chambers which reflected a separate earlier visit to the colony in 1899, five days before Robertson's (1903) visit on 9 June 1899. This visit has not been reported in past summaries. Two eggs (USNM #B42121, #B42122) were found "in a burrow 2 ft. deep. Dug by birds." One egg (USNM #B42120) was found "in a burrow on side of island in sandy loam 2 ft. deep." One egg (CMN [Canadian Museum of Nature] #E625) was found in "a bare hole in sandy lome 2 ft in. A colony of about 1,000 holes." One egg (EHS – no collection number) had no other notes. The exact location of this colony was

not given, although at least one egg set (USNM #B42120) was found in sandy loam on the side of the island. Pockets of sandy loam soils currently exist along the bluff edge between Cat Canyon and Graveyard Canyon, where a few potential auklet nest sites were found in 1991 (Carter *et al.* 1992). I interpret this colony area to reflect the same southeast mesa area described in 1899 by Robertson; apparently the west mesa area also was not visited on 4 June 1899. The closeness of the two visits in 1899 also suggests that Robertson heard about the first trip and immediately followed it with a second trip that went to this same part of the island. The CMN egg set indicated that numbers of burrow entrances at this part of the colony were fairly large in 1899, although much more than 1,000 burrows could have been present on both southeast and west mesa areas based on Grinnell's 1897 description of wide burrow distribution.

For comprehending the general magnitude of this colony, it is desirable to construct a rough breeding population estimate. However, the 1899 mention of "1,000 holes" is the main numerical information available for forming a rough judgement about the approximate size of this colony. The only other numerical note was hundreds of burrows in one area in 1897 (Britton 1897; see above). To provide a ballpark estimate of this reportedly "large" auklet colony at SBI proper, I used a range of 2,000-4,000 burrow entrances for southeast and west mesa areas combined multiplied by burrow occupancy ranging from 50-100% to derive a rough estimate of about 1,000-4,000 breeding pairs in 1897-99. Use of a minimum of 2,000 burrow entrances assumed that all were counted on the southeast mesa in 1899 and that an equal number were present but not counted on the west mesa. Use of a maximum of 4,000 burrow entrances assumed that only 50% were counted on the southeast mesa and that an equal total number were present but not counted on the west mesa. Burrow occupancy can vary between years and depending on population trends – a minimum of 50% assumed relatively low use and the maximum of 100% assumed full use. The wide range of this rough estimate of 1,000-4,000 breeding pairs reflects much uncertainty about the size of this colony in 1897-99. However, I believe this approach has resulted in the correct order of magnitude of historical colony size.

1908: Howell (1917) noted that "...Since that time [May 1897], cats have been introduced, and in May, 1908, I could find no indications of the auklets' presence on the island" and "House cats have become established there". Howell's account: a) did not say whether he had searched the southeast or west mesas where colonies had been documented; b) made no mention of old burrows or remains of auklets that were present there in 1911 (Willet 1912); and c) provided no description of numbers of cats on the island. Although he provided his impression (possibly influenced by Willet's earlier published impression – see below), Howell did not provide sufficient information for assessing the status of this colony or impacts of feral cats in 1908 and incorrectly stated that feral cats had been introduced between 1897 and 1908, which has been repeated by some subsequent summaries (McChesney and Tershy 1998; Adams 2008).

1909: Robertson (1910) revisited SBI proper on 3 July 1909, along with several other members of the Cooper Club, including H. Gaylord who had visited the auklet colony in 1897 with Grinnell. This visit has not been mentioned in past summaries and no auklet egg specimens were found in museums checked. Little information was recorded, with pertinent portions as follow: "...most of the day was spent on the island where the gull and auklet colonies were examined....On Santa Barbara Island several nesting colonies were visited of both Western Gull and Cassin's Auklet,..." I interpret this wording to reflect that auklet burrows were found in more than one distinct area at Santa Barbara Island, probably on both the southeast and west mesa areas along with nesting gulls in both areas (see 1897 above). While auklet colony areas were visited, it is not clear if any active auklet nests or carcasses were found. However, I doubt that evidence of substantial cat predation was found, otherwise some mention likely would have been made in this account or subsequently by Willett (1912) or Howell (1917).

1911: Willet (1912) noted that "J. Grinnell and H.A. Gaylord took four nearly hatched eggs of this species on Santa Barbara Island, May 16, 1897. At this date the majority of nests found contained young of various ages (Pub. 1, Pasadena Acad. Sci., 1897, 22). On visiting Santa Barbara Island in June, 1911, I found that the old breeding colony of these birds was entirely abandoned. From the bones and feathers of the birds found all over the island, I concluded that they had been exterminated by the cats which the island is infested. On a detached rocky islet about a quarter of a mile from the main island [Sutil Island], I found a colony of about a hundred pairs of Auklets nesting. Nine nests examined on June 14 contained far incubated eggs." In addition to an egg collected on Sutil Island (collector #392), an adult also was collected with it on 14 June 1911 (USNM 415737).

It is not known; a) how many and where bones and feathers were found on the island; b) how many burrows were excavated to conclude that the entire colony on both south and west mesas was exterminated; and c) on what basis

or to what degree Willet thought the island was “infested” with cats. Various other possible conclusions could have been drawn: a) breeding may have ended earlier in 1911 (due to early breeding, poor feeding conditions causing abandonment, or intensive cat predation), without long-term abandonment of the colony; b) Willet may have not found active burrows in the colony that actually were present; c) carcasses found around the island may have wholly or partly reflected avian predation and may have belonged to other nesting areas (e.g., Elephant Seal Point or Sutil Island); and d) while at least one cat may have been seen, given difficulties of determining numbers of cats, Willet may have assumed that many cats were present with little or no direct evidence.

Contrary to past summaries, I have determined that the status of the colony on the main island was not well described in 1911 and the degree of impacts from feral cats were not well established. It seems unlikely to me that this fairly large colony would be completely abandoned due solely to cat predation, given apparent cat presence for many decades on the island and no mention of remains in 1863, 1897, 1908 and 1909. However, the discovery of actively-breeding auklets on Sutil Island in 1911 may have indicated that the colony on the south and west mesas was not active in June 1911 due to cats or other factors, but it is most likely that the colony had been reduced by cats or other factors but had not been completely abandoned.

1912: Wright and Synder (1913) stated: “While approaching the island [on 2 July 1912], we saw many flocks of Cassin’s Auklets, a fact which was hardly to be expected since Mr. George Willet found only a few pairs here the year before...A thorough search of the northwest end of Santa Barbara netted nothing but the wings of those birds whose bodies had been eaten, probably by cats (July 2-3)...”

Wright and Synder did not: a) search south or west mesa areas where the auklet colony had been described in 1987-99; nor b) determine if carcasses found had been killed by cats or by avian predators (e.g., Peregrine Falcons *Falco peregrinus*). Thus, they did not provide much information for assessing the overall status of this colony, although the presence of dead auklets indicated that auklets apparently still occurred on the colony and nearby waters in 1912. Their description of “...many flocks of Cassin’s Auklets” near the island at this time of year also suggested the presence of a moderate-sized breeding colony somewhere at the island.

1939: Sumner and Bond (1939) conducted a brief visit to SBI proper on 14-15 April 1939. They reported as follows:

[p.5; Xantus Murrelet] “A pair of wings of this species was found at the top of the cliff above the sea-lion colony near the northwest corner of Santa Barbara Island. From scats found within a few yards, it appeared that the bird had been killed by a cat.”

[p.5; Cassin’s Auklet] “No birds of this species were seen, but a few burrows near the northeast corner of the island, usually under a species of matted and thorny scrub, were possibly the work of the auklets. None of the burrows was finished or occupied, but evidences of very fresh work were found.”

[p.7; Cat, domestic] “At the head of one of the gullies on the east side of the island, a gray house cat was momentarily glimpsed as it bounded away through the cover. These exotic cats must be decidedly abundant. A large number of their scats were collected. The contents have been determined by the U.S. Biological Survey as follows: (pending) [sic - future efforts are needed to attempt to track down results of these scat analyses]. At one time large colonies of auklets and murrelets were present on the island but none has been recorded in recent years and it is supposed that they have been exterminated by these feral cats. The song sparrows and white-crowned sparrows were abundant in spite of these cats, however. Probably, at the present time, the native white-footed mouse ...forms the principal food of these animals”;

[pp. 7-8; Santa Barbara Island White-footed Mouse] “These animals seemed rather numerous and apparently are in no danger of immediate extermination by house cats...”; and

[p. 12; Summary and Recommendations] “...The need for removal of the hordes of exotic house cats, so that certain threatened species of animal life which constitute a unique feature of the island can return to their original condition, is imperative.”

Sumner and Bond: a) did not visit south or west mesa areas where the auklet colony had previously been described; b) provided only limited, presumptive evidence of a large population of feral cats (i.e., the “large number of their

scats”); and c) provided no direct information on the status of breeding auklets at SBI proper, Sutil Island, or Shag Rock in 1939. Contrary to previous summaries, I did not find sufficient evidence to conclude that large numbers of cats occurred in 1939.

1972: Hunt and Hunt (1974) provided no information to indicate that they had visited the old auklet colony at south or west mesa areas or any other potential auklet breeding areas. They provided no information on the status of breeding auklets in 1972.

Additional considerations (1863-1972)

Colony Location and Burrowing Habitats: Unlike most other Channel Islands (except Anacapa Island), SBI proper was never permanently inhabited by native peoples (although limited periodic hunting occurred) and island fox (*Urocyon littoralis*) were not native to the island and were not introduced by native peoples. Auklets could nest anywhere on the island without concern for larger mammalian predators, including the south and west mesa areas where nesting was recorded. In addition, a thick layer of soil occurs on mesa areas on the upper island which would allow auklets to dig burrows. Description of sandy loam soils used for deep burrowing in 1863 (see earlier) most likely reflected nesting on the west mesa area where such soils are most prevalent at present (C. Drost, pers. comm.). Overall, dry soils on SBI proper have high clay and salt content which are susceptible to erosion (Halvorson *et al.* 1988). Soils on the west mesa tend to be deeper with a greater sand content, whereas soils on the southeast mesa tend to be shallower with less sand content. However, soils on the southeast mesa also reflect: a) greater erosion from highly-altered conditions due to farming, ranching, and reservoir construction than on the west mesa; b) soil loss and alteration in the Badlands area due to past sea lion use (see below) and possibly farming and ranching; and c) channeling of drainage waters from Signal Peak to the southeast mesa reservoir likely reduced the moisture content of soils in some parts of this area. At present, remaining soils suitable for burrowing are most prevalent on the west mesa, with little soil suitable for burrowing in the southeast mesa area. However, around the periphery of the southeast mesa and in canyons, pockets of sandy loam soils and other friable, easily-burrowed soils persist (see Carter *et al.* 1992 and 1899 above; C. Drost, pers. comm.).

Avian Predators: Large numbers of breeding Western Gulls (*Larus occidentalis*), perhaps a few thousand of breeding pairs, were noted over most of the island in 1897 (Grinnell 1897). Since then, at least 1,000 breeding pairs were estimated in 1899, 1939, 1968, 1972, 1975-76 (but lower in 1977-78), and 1991 (Hunt *et al.* 1979, 1980; Carter *et al.* 1992). Peregrine Falcons, Bald Eagles (*Haliaeetus leucocephalus*), Barn Owls (*Tyto alba*), and Common Ravens (*Corvus corax*) also have occurred regularly at the island, although falcons, eagles, and ravens were extirpated as breeding species by the 1960s; the former two species likely were extirpated mainly through the effects of organochlorine pollutants although ravens likely were extirpated through shooting, trapping, or poisoning (Grinnell 1897; Willett 1912, 1933; Howell 1917; Kiff 1980; C. Drost, pers. comm.). In 1863-1911, the auklet colony persisted in association with a large gull colony and several other avian predators which likely led to extensive avian predation. Avian predation may well have been responsible for many of the carcasses found on the island in 1908-1912, contrary to assumptions made by Howell and others.

Badlands (1852): Scammon (1968; first published in 1874) provided a detailed description of sea lion hunting at SBI proper in 1852. During this hunting, he described an unusual sea lion haul out which I refer to the Badlands area of SBI proper, as follows: “...On the south of Santa Barbara Island was a plateau, elevated less than a hundred feet above the sea, stretching to the brink of a cliff that overhung the shore, and a narrow gorge leading up from the beach, through which [California sea lions *Zalophus californianus*] crawled to their favorite resting-place. As the sun dipped behind the hills, fifty to a hundred males would congregate upon the spot, and there remain until the boats were lowered in the morning, when immediately the whole herd would quietly slip off into the sea and gambol during the day...” This careful description indicated that sea lions regularly hauled out on the Badlands area of the lower southeast mesa (see Fig. 10) prior to 1852, with access to the sea through Graveyard Canyon. Scammon also described in gruesome detail how this entire group of sea lions were shot in one hunting foray in 1852. Auklets may have expanded nesting into the Badlands after 1852. The colony may have been increasing during the 19th century and expanded to cover most of the southeast mesa and associated slopes by 1897-99. Halvorson *et al.* (1988) believed that the Badlands area (referred to as the “devastated area”) formed subsequent to farming and ranching but they apparently were not aware of historical literature which described earlier use of this part of the mesa by sealions and avoidance of farming directly in this area.

Ranching and Farming (1916-22): Goats were introduced to SBI proper before 1846 (Philbrick 1972) but little ranching was known in the mid to late 1800s. A. Hyder leased the island for sheep ranching and farming in 1916-22 (Philbrick 1972, Weinman 1978). Only one house stood on the island when the Hyder family arrived in 1916. By 1921, up to 17 people were present, with 11 structures built mainly near Landing Cove. About 300 sheep were first released on the island in 1916 and allowed to roam freely, removing most native vegetation on the island. Associated with a large water reservoir built on the southeast mesa, runoff waters were channeled from the southeast side of Signal Peak. The Hyderys used horses and mules to plow and plant a large hay field (about 150 acres of barley - shipped to the mainland in 1918-22) that covered most of the upper southeast mesa and extended to the south end of the island. Based on a map in Weinman (1978), this hay field occurred mainly to the north of the south pond and west of the Badlands (see Fig. 10). Use of the Badlands area on the eastern side of southeast mesa apparently was avoided, likely because of poor compacted soil due to past use by sea lions. A large reservoir (50-70 feet long and 100 feet wide; see South Pond in Fig. 10) was dug out of the southeast mesa and runoff waters from Signal Peak were channeled into it (Daily 1993:17), increasing soil dryness on the lower slopes and the adjacent southeast mesa. Sheep and horses also watered at or near this reservoir, likely leading to soil compaction and loss of plant cover. On the upper west mesa, a smaller corn and potato field also was planted. Along with this field, a large water pond also was built on the lower slopes (see West Pond in Fig. 10) by piling up soil from adjacent areas (Daily 1993:16). Based on a map in Weinman (1978), this vegetable field occurred near the west pond area (see Fig. 10). For hay and farm fields, land was cleared by pulling out *Coreopsis* bushes, cutting and burning iceplant (*Mesembryanthemum crystallinum* and *M. nodiflorum*), and complete burning of the island. About 2,000 domestic Belgian Hares (*Oryctolagus cuniculus*) were introduced for meat and pelts, but many were eaten by feral cats and eagles. Poison (strychnine) was used to control cat numbers. In 1922 (or later), the Hyder family departed from the island and removed 300 sheep, 12 goats, 4 horses (*Equus caballus*), dogs (*Canis familiaris*), and all buildings. Some cats and rabbits still persisted but apparently had been reduced to low numbers.

During the 1916-22 period, burrowing habitats (i.e., deep moist soil covered with vegetation that allowed for construction of deep burrows, capable of lasting for many years) of this historic auklet colony on the southeast and west mesas were altered and burrows largely destroyed due to various sheep ranching and farming activities. Although no direct documentation of these changes to habitats occurred, the lack of documentation of any area with extensive remains of old auklet burrows in 1976-2008 supported this interpretation. The shrink-swell nature of the clay soils on SBI proper, along highly disturbed soil and vegetation conditions, also has led to relatively high erosion (Halvorson *et al.* 1998) which might have further led to little evidence of the former auklet colonies on the southeast and west mesas.

With this previously unrecognized major change in breeding habitats in mind, various other potential negative or positive impacts to auklets after 1922 mentioned in past summaries (e.g., continued presence of cats in 1923-78, final eradication of cats, re-introduction and eradication of rabbits in 1942-81, loss and return of falcons, loss of eagles, oil spill mortality, eggshell thinning, and ocean climate change affecting prey availability) are less important reasons for lack of recolonization of the southeast and west mesa areas. Adams's (2008) statement that the reason for lack of recovery of the auklet colony was not known must now be revised to consider that at least part of the reason was alteration of burrow-nesting habitats. Possible effects of other factors are less certain. However, although altered, ample areas of deep soil suitable for burrowing still persist on parts of the island.

Cat Control (1941): In 1938, the SBI group was included in the newly-established Channel Islands National Monument, although Arch Point and Signal Peak were reserved for lighthouse purposes. This action preserved the island in its natural (albeit human-affected) state and prevented many commercial, recreational, and military plans for use of the island (Weinman 1978). In April 1939, Sumner and Bond surveyed the island and recommended cat eradication. In 1941, initial efforts to eradicate feral cats (probably by shooting) were undertaken by Ranger Fry and a total of 13 cats were seen (Philbrick 1972). I presume that only a few cats were shot. The outbreak of World War II led to development of a military coastal lookout station at SBI proper from 1942 to 1946 and postponement of further efforts to control or eradicate cats. Cats noted in 1939 and 1941 likely were progeny from survivors after 1922. No one lived on the island from 1922 to 1939, except for the Hyderys who returned to ranch sheep in 1928-29 without a lease. In 1950, only one cat and two rabbits were observed (Philbrick 1972).

Rabbit and Cat Control and Eradication (1954-81): By about 1952, feral New Zealand Red rabbits, introduced during the war, had greatly increased in numbers and had destroyed much native vegetation. A rabbit eradication program using shooting and strychnine poisoning began in October 1954; 600, 2,500, 600, 500, and 62 rabbits were

killed in 1954, 1955, 1956, 1957, and 1958, with less than 25 rabbits thought to remain by 1959 (Sumner 1958; Philbrick 1972; McChesney and Tershy 1998). McChesney and Tershy (1998) did not clearly state that this was a rabbit eradication program and not a cat eradication program. However, some cats may have been poisoned by feeding on poisoned rabbits and cats were thought to have been exterminated in 1957 (Philbrick 1972). However, a few had survived. In 1959, a fire swept over most of the island which resulted in denuding of many areas and only about 30 rabbits remained. The last cat was removed in 1978 (Murray *et al.* 1983) and the last rabbit in 1981 (McChesney and Tershy 1998).

Revised Summary (1863-1972)

After reconsidering original sources and examining new information not provided in four past summaries, information about the breeding colony of Cassin's Auklets on the southeast and west mesas of SBI proper from 1863 to 1972 was summarized as follows:

- 1) Breeding was first documented in 1863. With much suitable burrow nesting habitat and no native island fox, breeding at this location probably reflected the presence of a long-established colony.
- 2) In 1897-1909, a colony of roughly 1,000-4,000 breeding pairs covered most of the southeast and west mesas, although the exact boundaries of the colony were not described.
- 3) By 1908-1911, the auklet colony likely was reduced and possibly extirpated by feral cats. Cats had been noted on the island since 1863 and in relatively large numbers by 1896. Strong evidence of extirpation of the mesa colony by cats was not obtained, but evidence of apparently extensive predation (likely cats and avian predators) was noted. Small impacts to breeding habitats also had occurred from egg and bird collections by ornithologists and naturalists, involving burrow excavations.
- 4) In 1916-22, sheep ranching and farming altered suitable burrowing habitats on the southeast and west mesas. If auklets still bred at this colony by 1916, they abandoned due to farming and ranching over this period. From 1911 to 1972, no evidence of old burrows were found in this historic auklet colony area.
- 5) From 1922 to 1972, colony re-establishment likely was hindered by altered burrowing habitats, even though suitable soil has remained in some areas. Although less important, various other factors also may have contributed to the lack of historic colony re-establishment during this period.

Status in 1976-77

Modern surveys to establish the status of Cassin's Auklets at the SBI group were first conducted in 1976-77 when 110 breeding pairs (or 220 breeding birds) were estimated by the University of California Irvine (Hunt *et al.* 1979, 1980; see above). These surveys established that: a) small numbers of auklets still bred at Sutil Island in similar or slightly lower numbers to 1911 when last surveyed by Willet (1912); b) small numbers of auklets bred at Elephant Seal Point where they had not been described previously; c) the historic colony on the south and west mesas had not been recolonized; and d) little or no recovery of the auklet population had occurred since the early 20th century. Hunt *et al.* (1980) noted that "It is not known whether the small colony found at Santa Barbara Island in 1977 is the result of a relatively new invasion or a remnant of the old population." At Elephant Seal Point, the cave breeding location is on the outer end of the point and is accessible by land, although the entrance faces north (away from land) and cannot be seen from the base of the peninsula, such that naturalists may not have discovered this cave due to its obscure location. Auklets may have recolonized Elephant Seal Point after cats were reduced to low numbers by 1922 or breeding in 1977 reflected continued breeding in low numbers at Elephant Seal Point since the 1800s. Breeding auklets found on Sutil Island in 1976 suggested continued breeding in cat-free habitats in the SBI group since 1911. Overall, a small colony apparently persisted after loss of the main historic colony in the early 1900s. Without prior measurement or description, it is not clear if much soil loss had occurred on Sutil Island since 1911, as possibly thought in 1976 by Hunt *et al.* (1979). Limited information on reproductive success suggested that successful breeding was occurring in 1976-77.

Status in 1991

In 1991, breeding Cassin's Auklets were again surveyed at the SBI group and 128 breeding pairs (256 breeding birds) were estimated by Humboldt State University (Carter *et al.* 1992; see above). These surveys established: a) continued breeding by small numbers of auklets at Elephant Seal Point, Cat Canyon, and Sutil Island between 1976-77 and 1991; b) additional nesting of small numbers of auklets along the north and southeast sides of the main island, especially at Arch Point and Graveyard Canyon, which may not have been detected with possibly more-limited surveys in 1976-77; c) the historic colony on the southeast and west mesas had not been recolonized; and d) estimates at SBI proper and Sutil Island were very similar in 1976-77 and 1991, indicating no major change in population size. Burrow and crevice counts in October 1991 were not conducted at the historic mesa colony area. However, coastal bluffs and bluff tops adjacent to the historic colony were searched, and a few potentially-active burrows were found in the Graveyard Canyon area. Given alteration of burrowing habitat on the southeast and west mesas, small numbers of breeding Cassin's Auklets at the SBI group in 1976-91 appeared to primarily reflect limited remnant suitable breeding habitats in areas outside of the historic mesa colony area. Similar population estimates in 1991 and 1976-77 and apparently successful reproduction in 1977 suggested that small numbers of breeding auklets were self sustaining in 1976-91, although a small decline in numbers also may have occurred between 1976 and 1991. Nesting on Shag Rock was first documented in 1991 but may have occurred historically without documentation due to difficult access of this rock. Limited crevice habitats on this rock prevent more than a few breeding pairs at most.

Status in 1994-96

In 1994-96, scattered unpublished observations of Cassin's Auklets at the SBI group were obtained during studies by Humboldt State University and U.S. Geological Survey, as follows:

1994: On the night of 12-13 May 1994 (23:40-02:40 h), Ashy Storm-Petrel mistnetting was conducted at Elephant Seal Point by P. Martin, S.H. Newman and C. Arnett (H.R. Carter, unpubl. data). Between 01:20 and 02:20 h, 3 Cassin's Auklets were found incubating eggs in nest crevices inside the large cave on top of the point. All three adults were handled briefly by P. Martin but not banded. The first auklet was heard vocalizing at 01:20 h.

1995: On 18-20 March 1995 during the first field trip to attempt radio-marking Xantus's Murrelets (see Whitworth *et al.* 2000), 34 carcasses of Cassin's Auklets (including adults and subadults based on iris coloration – none had incubation patches) were salvaged by H.R. Carter, D.L. Whitworth, J.Y. Takekawa, S.H. Newman, N. Drilling, and E.B. Burkett (H.R. Carter, unpubl. data). These auklets were found dead (fresh or slightly decomposed) or moribund floating on waters near the SBI group; many more floating carcasses were not collected and many live birds also were observed. Several dead or weak auklets were picked up and consumed by Western Gulls (*Larus occidentalis*). This unusual mortality event appeared to reflect impacts from an extended late winter storm that had occurred a few days earlier. On 31 March 1995, carcasses were examined for evidence of mortality factors – no clear cause of death was determined but most birds were emaciated with low body weights and one carcass was oiled on the upper breast. On 6-7 April 1995, 6 live auklets also were observed on the water around SBI proper, apparently left over from the earlier storm event. The overall magnitude of this storm kill was difficult to determine. We are not aware of any other observations of this event and most carcasses likely floated at sea for a few days before they sank or were scavenged without documentation. Hundreds of auklets were involved at minimum and perhaps thousands.

1996: On 8 May 1996, Shag Rock was surveyed by G.J. McChesney for Xantus's Murrelet nests (Whitworth *et al.* 1997b; H.R. Carter, unpubl. data). No nesting auklets were found but one large crevice (~1 m deep) on the east side was empty but had a strong guano smell which may have reflected auklet use.