Monitoring and Restoration of Ashy Storm-Petrels at Santa Cruz Island, California, in 2009

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ABSTRACT

In 2009, the U.S. Fish and Wildlife Service (Arcata Fish and Wildlife Office), Channel Islands National Park, and Carter Biological Consulting were funded by the Montrose Trustee Council to continue implementation of restoration actions and continue gathering baseline population and reproductive data on Ashy Storm-Petrels (*Oceanodroma homochroa*) at Santa Cruz Island, California. At four sea caves and Orizaba Rock, a total of 148 nests (including natural crevices and artificial sites) were found and monitored in 2009 which had a combined reproductive success (i.e., proportion of egglaying sites that fledged chicks, including five sites with replacement eggs laid) of 69%, relatively high compared to baseline data. Artificial nest sites (n = 5) were deployed at Orizaba Rock to supplement artificial sites previously deployed in 2008 (n = 21). Social attraction using vocalization broadcast was redeployed at Orizaba Rock, as done in 2008. Continued increase in colony size with successful reproduction at Orizaba Rock was indicated by: a) two new nests found in 2009 at artificial nest sites; b) nesting at four artificial nest sites where nesting also had occurred in 2008; and c) chicks fledging from four (67%) of six artificial nest sites. Future monitoring will determine the overall degree of success of restoration efforts on Orizaba Rock. Nesting was greatly reduced in 2009 at Cavern Point Cove Caves (i.e. only two nests were found), following heavy predation by island spotted skunks (*Spilogale gracilis amphiala*) in 2008. Traps were deployed in 2009 at Bat Cave, Cave of the Birds' Eggs, and Cavern Point Cove Caves to prevent or reduce further predation of storm-petrels by skunks, but no skunks were detected in these sea caves. Signs were deployed at Bat Cave, Cave of the Birds Eggs, Cavern Point Cove Caves, and Dry Sandy Beach Cave to prevent or reduce unauthorized human access. Greater effort is needed: a) to understand how skunks are periodically accessing sea caves which are located at the bases of steep cliffs; and b) to prevent skunk predation events in the future. Future monitoring will determine if and how colonies at Cavern Point Cove Caves and Bat Cave recover from such major predation events.

INTRODUCTION

Endemic to California and northwestern Baja California, Mexico, Ashy Storm-Petrels (*Oceanodroma homochroa*) have a small global population size (*ca*. 10,000 birds) and breed from Mendocino County (*ca*. 39° N) to Todos Santos Islands (*ca.* 32° N) (Ainley 1995; Carter *et al.* 2008a). The largest known nesting colonies occur at the South Farallon Islands in central California, and at Santa Barbara, Prince, and Santa Cruz Islands in southern California (Ainley *et al.* 1990; Carter *et al.* 1992, *unpubl. data*; Sydeman *et al.* 1998a,b; McIver 2002, McIver *et al*. 2009b). Although nesting was first documented at Santa Cruz Island in 1912, knowledge of population size and distribution of Ashy Storm-Petrels at Santa Cruz Island increased dramatically during 1991-96 surveys by Humboldt State University (Wright and Snyder 1913; Carter *et al.* 1992, 2007). From 1995 to 2002, Humboldt State University also implemented standardized monitoring of population size (using nest counts), reproductive success, breeding phenology, and predation at five locations at Santa Cruz Island, including Orizaba Rock, Bat Cave, Cavern Point Cove Caves, Cave of the Birds' Eggs, and Dry Sandy Beach

Cave (McIver and Carter 1996; McIver 2002; Carter *et al.* 2007). In 2003-05, the U.S. Fish and Wildlife Service (USFWS, Ventura Fish and Wildlife Office) and Carter Biological Consulting (CBC) continued monitoring at these locations (McIver and Carter 2006; Carter *et al.* 2007).

In 2002-05, the Montrose Trustee Council identified several seabird restoration concepts to be implemented with funds obtained through litigation over long-term effects of organochlorine pollutants to wildlife (especially raptors and seabirds) in the Southern California Bight (Montrose Settlements Restoration Program 2005). The need for restoration of Ashy Storm-Petrels at Santa Cruz Island was identified based on: a) apparent loss of small colonies (i.e., no nests were found during 1991-96 surveys) at Painted Cave, Scorpion Rocks, and Gull Island where breeding had been previously documented (Carter *et al.* 1992, 2007, *unpubl. data*); b) contaminant-related eggshell thinning from eggs collected at Orizaba Rock and Cave of the Birds Eggs in 1992, 1996 and 1997 (Fry 1994; Kiff 1994; Carter *et al.* 2008b); c) reduced numbers of nest sites at Orizaba Rock after 1996 possibly due to lights from squid-fishing boats resulting in high avian predation (McIver 2002; Carter *et al.* 2008a); and d) decimation of the Bat Cave colony, the largest known colony at Santa Cruz Island, due to unusual predation by island spotted skunks (*Spilogale gracilis amphiala*) in 2005 (McIver and Carter 2006; Carter *et al.* 2008a).

In 2006, CBC and USFWS were funded by the Montrose Trustee Council to continue nest surveys and monitoring for Ashy Storm-Petrels at five locations at Santa Cruz Island to provide continued baseline data on population size, reproductive success, breeding phenology, and predation for developing a long-term monitoring program for restoration assessments (Carter *et al.* 2007). This baseline information has assisted design of restoration actions and will be used for measuring long-term population changes in response to restoration actions and other natural and anthropogenic factors. Monitoring at Santa Cruz Island also has provided key information on the status of this rare storm-petrel which has declined at Santa Cruz Island and at the South Farallon Islands, but has increased at the Coronado Islands (Sydeman *et al.* 1998b, Carter *et al.* 2006, 2007, 2008a). Prior to 2006, long-term monitoring of Ashy Storm-Petrels was focused at Southeast Farallon Island (Ainley *et al.* 1990; Ainley 1995; Sydeman *et al.* 1998a). A long-term monitoring program for Ashy Storm-Petrels in the Channel Islands, where at least half of the world population of Ashy Storm-Petrels breeds, also was needed as a long-term goal for Channel Islands National Park (CINP) and other state and federal agencies (Carter *et al.* 1992, 2008a).

In 2007, CBC, USFWS (Arcata and Ventura Fish and Wildlife Offices), and CINP were funded by the Montrose Trustee Council to continue monitoring work on Ashy Storm-Petrels at Santa Cruz Island for: a) gathering baseline data on population size, reproductive success, breeding phenology, and predation; and b) developing and testing restoration techniques for larger-scale implementation in 2008 (McIver *et al.* 2008).

In October 2007, the Center for Biological Diversity petitioned the Secretary of the Interior and USFWS to list the Ashy Storm-Petrel as threatened or endangered under the

Endangered Species Act of 1973 (hereafter "Act"). In response to this petition, a 90-day finding was published in May 2008 (USFWS 2008) that stated that listing under the Act may be warranted with initiation of a status review. The status review was published in August 2009 (USFWS 2009), stating that listing the Ashy Storm-Petrel under the Act was not warranted at that time.

In 2008, USFWS (Arcata Fish and Wildlife Office), CINP, and CBC were funded by the Montrose Trustee Council to: a) continue monitoring work to gather baseline data on population size, reproductive success, breeding phenology, and predation of Ashy Storm-Petrels at Orizaba Rock and four sea caves at Santa Cruz Island; b) initiate larger-scale restoration actions, including deployment of artificial nests at Orizaba Rock and Cavern Point Cove Caves and deployment of social attraction equipment (i.e., vocalization broadcasting) at Orizaba Rock.

In 2009, USFWS (Arcata Fish and Wildlife Office), CINP, and CBC were funded by the Montrose Trustee Council to: a) continue monitoring work to gather data on population size, reproductive success, breeding phenology, and predation of Ashy Storm-Petrels at Orizaba Rock and four sea caves at Santa Cruz Island; b) continue social attraction (i.e., vocalization broadcasting) and further deployment of artificial nests at Orizaba Rock; c) deploy skunk traps in sea caves to prevent or reduce further predation of Ashy Storm-Petrels by island spotted skunks; and d) deploy signs at sea caves to prevent or reduce unauthorized human access. In this report, we summarize restoration and monitoring of Ashy Storm-Petrels at Santa Cruz Island in 2009.

METHODS

Nest Monitoring

In June-October 2009, standardized methods (see McIver and Carter 1996, 2006; McIver 2002) were used on monthly field trips to search for and monitor all nests of Ashy Storm-Petrels found in accessible habitats at Bat Cave (BC), Cave of the Bird's Eggs (COBE), Cavern Point Cove Caves (CPCC; comprises two adjacent caves, Cave #4 and Cave #5), Dry Sandy Beach Cave (DSBC), and Orizaba Rock (OR) (Figure 1). Each location was visited for 1-5 hours during each monthly field trip on 15-16 June, 15-16 July, 10-11 August, 10-11 September, and 29-30 October, with the exception of DSBC, which was not monitored in June and July (Table 1). All field trips to and accommodations at Santa Cruz Island were provided aboard the charter boat *Miss Devin*, operated by Ocean Sports Private Charters (Santa Barbara, California). Nesting habitats were accessed from an inflatable boat powered by a 15 or 20 horsepower outboard engine launched from the support vessel.

A storm-petrel nest was defined as a crevice, cavity, or depression containing a whole egg, numerous eggshell fragments (i.e., at least one quarter of an egg which was considered sufficient to ensure that it represented a new egg and did not represent leftover fragments of an earlier egg in the same year or previous years), or a chick. Active nests were defined as containing evidence of an egg laid in 2009. At some nest sites, no direct evidence of egg-laying was found, although a few eggs may have disappeared before our detection. We searched for and examined nests with the aid of headlamps, small flashlights, and maps adapted from Bunnell (1988). Each nest or suspected nest (i.e., in some cases, an adult in incubating position was present and presence of an egg could not be detected) was mapped and marked with an individually numbered aluminum tag. All marked nests were checked until August, except when tags could not be relocated. All potential nesting habitat also was searched at study locations in June to August. After August, only active nests which had not yet fledged were examined in September, October, and November. Laying of first and replacement eggs ceases in August (McIver 2002), such that it is not necessary to search for new nests in September-November.

All birds, eggs and chicks were recorded for each marked nest on each visit. Because storm-petrels can be sensitive to disturbance at nest sites (Ainley *et al.* 1990), we did not handle adults, incubated eggs, or brooded chicks. Approximate ages of chicks were later estimated based on their plumage development (McIver and Carter 1996; McIver 2002). Evidence of predation was recorded and broken eggs, carcasses, and feather piles were removed to facilitate detection of replacement eggs and prevent double counting. Approximate breeding phenology was estimated for each nest (i.e., timing of initiation, hatching, and fledging) using techniques described in McIver and Carter (1997).

Restoration

Artificial nest sites and social attraction equipment were first deployed at OR in 2008 (McIver *et al.* 2009a). A single vocalization broadcast system was used that had been developed previously by the National Audubon Society and has been used widely for social attraction purposes (e.g., Parker *et al.* 2007). The vocalization broadcast equipment in the tote box was wired to one speaker, which was left in place after 2008 in the Upper West Cavern on OR.

In 2009, five additional artificial nest sites were deployed at OR in the Upper West Cavern and Upper East Cavern within 1- 7 m of the speaker to encourage storm-petrels originally attracted to vocalization broadcasts to then spend time in or near artificial site areas. As in 2008, each additional artificial nest site was housed under a single concave cement roofing tile (A.L.L. Roofing and Building Materials Corporation, Ventura, California) that was 36 cm long, 20 cm wide, and 18 cm high (all inside dimensions) and provided sufficient space for a single Ashy Storm-Petrel nest. Heat-sterilized fine pumice gravel (depth 2-3 cm) was spread under each tile to form a suitable floor for each nest site. Rocks were placed at tile entrances to reduce entrance sizes to generally match those of natural sites and prevent access by avian predators. Site entrances also were small enough (see Figure 4.1 in Ainley *et al.* [1990]) to prevent entry by other crevice-nesting seabirds such as Cassin's Auklets (*Ptychoramphus aleuticus*) and Xantus's Murrelets (*Synthliboramphus hypoleucus*) which also nest at OR. One end of each tile was blocked completely by rocks or pieces of cement tile backer boards to provide an enclosed site that mimicked a natural nest crevice and protected the interior of the site from wind. Fine sand was placed around artificial nest sites in an attempt to detect storm-petrel footprints that would indicate site visitation by storm-petrels. At some artificial sites, additional sand was placed at the bottom edges of tiles to prevent or reduce wind inside sites.

Ashy Storm-Petrel Protection

To prevent predation of Ashy Storm-Petrels by island spotted skunks, lethal “body-grip” skunk traps (model 220 Conibear trap, Oneida Victor Inc. Ltd., Euclid, Ohio) were set inside protective wooden boxes (approximate box dimensions: 19 cm x 19 cm x 50 cm) and deployed at BC, COBE, and CPCC (Figure 2a). When open and armed, the jaw-spread of each trap measured approximately 18 cm (7 in). Inside dimensions of each box were wide enough to allow insertion and deployment of an open (i.e., active) trap but minimized space around the edges of each trap to direct a skunk to the trap opening and wire trigger. Stiff wire mesh screening was stapled on both ends of each protective box to prevent entry by crevice-nesting seabirds; screening on one end only allowed entry by skunks but not seabirds (Figure 2b). For odor-based attraction to the trap, each box was baited with one partially-opened can of wet cat food, which was placed (prior to placement of trap within box) inside each box on the opposite side of the trap from the swinging mesh door. Trap boxes were placed near the entrances of caves to try to capture skunks prior to entering the cave and depredating any storm-petrels. Boxes were partly covered with rocks to secure and hide them, and traps were secured to the ground with metal stakes (Figures 2b, 2c). Felt markers were used to write on each box: a) warnings (in English) informing potential tourists that the boxes contained active traps; and b) warnings (in English and Spanish) that boxes were dangerous. Subsequent to deployment, trap boxes were examined on each field trip in 2009 to detect any trapped skunks, ensure proper functioning of traps and boxes, and to replace bait. Traps, protective boxes, and bait were removed from the sea caves during the October field trip.

Human Visitation

Signs prohibiting the entry of sea caves by tourists were deployed at four locations in 2009 (Figures 3a-f). We installed four signs on CINP property: two each at BC (installed on 15 June) and CPCC (18 April and 15 June). Signs deployed on CINP property contained the following language: “Channel Islands National Park / U.S. Department of the Interior / Area Closed / Nesting Seabirds / Disturbance causes mortality / Entering area violates federal law.” Additional signs were provided by TNC to protect storm-petrels in caves on their property; we installed one sign each in COBE and DSBC (both on 30 Oct). Signs deployed on TNC property contained the following language: “The Nature Conservancy / Protecting Nature Preserving Life / Area Closed / Nesting Seabird Habitat / Disturbance causes mortality / Please do not enter.” Signs were mounted directly to large boulders (at CPCC, Cave #5), attached to cinder blocks that were filled with rocks and secured to floors with rebar (at BC, COBE, CPCC intertidal area), or attached to a wooden stake that was driven into the cave floor and supported with rocks (at DSBC).

Data Handling and Descriptive Statistics

When another egg was found in the same nest site where a previous (i.e., "first") egg had been laid but failed, we considered this egg to be a "replacement" egg by the same breeding pair. Due to monthly nest checks and inexact information on when the first egg failed, we could not determine how much time had elapsed after failure of the first egg to ensure sufficient time for formation of the replacement egg. When only one egg was laid in a nest site, we refered to these as "single" eggs. If another egg was found in the same nest site where a previous single egg had been laid and successfully fledged a chick, we considered this egg as a "second" egg from a different breeding pair. First, single, replacement, and second eggs were collectively referred to as "all" eggs. Except for sites with second eggs, the latest egg laid at a nest site within a breeding season (either single or replacement) was referred to as the "last" egg. Hatching success was defined as the percentage of first, single, or second eggs hatched per egg laid for all sites where egg fate was known. Fledging success was defined as the percentage of chicks fledged (from single, replacement, or second eggs) per chick hatched for all sites where chick fate was determined. Reproductive success was defined as the percentage of active nest sites which fledged a chick from single or replacement eggs, with second eggs treated as a separate nest with a single egg for analysis purposes. Since it is based upon nests with hatched chicks, fledging success has the smallest sample size of nests. For hatching, fledging, and reproductive success, we excluded nests for which egg or chick fates were not known. Descriptive statistics are presented for: a) laying, hatching, and fledging dates of first, single, and replacement eggs; and b) hatching success, fledging success, and reproductive success.

RESULTS

Bat Cave

Ashy Storm-Petrel: Forty-eight nests were documented in BC in 2009. Most nests (n = 42) occurred in the "main room." One nest was found in a side passageway and one nest was found in the "slope room," where storm-petrels nested in larger numbers prior to skunk predation in 2005. In addition, 4 nests occurred in crevices under boulders outside of the cave entrance. Hatching success was 81% (n = 48), fledging success was 90% (n = 39), and reproductive success was 75% (n = 47; Table 2). Storm-petrel footprints were observed in fine sand at the top of the slope in the main room, and at the top of the slope in the slope room.

Predation: Three skunk traps were deployed in April 2009 and removed in October 2009, and no evidence that skunks (or seabirds) entered trap boxes was found. No evidence of avian, deer mouse (*Peromyscus maniculatus santacruzae*), or skunk predation was found in 2009.

Xantus's Murrelet: On 15 June, two Xantus's Murrelet nests were found (but not marked) in crevices along the base of the cave wall at the top of the slope in the main room. One nest had one hatched eggshell fragment in a crevice from an egg that appeared to have been laid in 2009; the other nest had one possibly whole, partially buried egg in a crevice which likely had been laid in 2008 or earlier.

Human Disturbance: Signs prohibiting cave entry by tourists were deployed inside both the main room and slope room in June and July 2009 (Figures 3a, 3b). No evidence of human disturbance or non-researcher human visitation was detected in 2009. However, large numbers of kayakers were seen in waters off the entrance to this cave on several occasions.

Cave Wall Collapse: On 11 September, a small 2-3 m section of the cave wall in the main room was found collapsed in the vicinity of a monitored nest site (tag number #530), creating a small (~ 1.5 m^3) rock-rubble pile in front of the site. This collapse occurred between August and September field trips. The nest site occurred in a small cavern formed by the junction of the cave wall and floor, and was likely unaltered by the collapse of rock material from above and in front of the site. A "small gawky chick" (plumage category defined in McIver and Carter 1996) was observed in this site during the August field trip, and no chick or nest tag were found during September or October field trips. Based on the advanced age at last observation (41 days), the chick was considered to have fledged. Evidence of similar small-scale collapses of cliff or cave walls has been observed previously. Larger collapses also occurred outside this cave in 1998 and in the back room of DSBC in 1999 (H.R. Carter and W.R. McIver, *unpublished notes*).

Cave of the Birds' Eggs

Ashy Storm-Petrel: Twenty-nine nests were documented in 2009. Hatching success was 90% (n = 29); fledging success was 81% (n = 21), and reproductive success was 71% (n = 24; Table 2). On 15 June, one broken Ashy Storm-Petrel egg was found greater than 30 cm in front of and not associated with a nearby active nest (tag #765), but cause of egg failure was not determined. This egg was not included in measures of hatching and reproductive success because it was not found in a potential nest site and may have reflected a dump egg or some unusual circumstance.

Predation: One skunk trap was deployed on 15 July 2009 and removed in October 2009, and no evidence that skunks (or seabirds) entered trap boxes was found. No evidence of avian, deer mouse or skunk predation was found in 2009.

Pigeon Guillemot (*Cepphus columba*): Eighteen adult guillemots were observed sitting on the water within the cove adjacent to the cave entrance on 15 June, and 12 adults were observed sitting on the water within this cove on 15 July. Ten nests were documented in 2009; all nests hatched at least one egg and six appeared to fledge at least one chick (Table 4).

Human Disturbance: A sign prohibiting cave entry by tourists was deployed on 30 October (Figure 3c). No evidence of human disturbance or non-researcher human visitation was detected in 2009.

Bald Eagle (*Haliaeetus leucocephalus*): On 11 August at 08:15, a juvenile eagle was observed attacking and killing a juvenile cormorant (*Phalacrocorax* sp.) in the shoreline area outside and adjacent to the cave entrance. The bird, with a wing tag (color blue and number 64) attached to its right wing, perched on the cliff adjacent to the cave and was photographed by R. McMorran (Figure 4).

Cavern Point Cove Caves

Ashy Storm-Petrel: Two nests were documented in Cave #5 in 2009. Hatching success was 50% (n = 2), fledging success was 100% (n = 1), and reproductive success was 50% (n = 2; Table 2). No nests were documented in Cave #4 in 2009.

Predation: Three skunk traps were deployed in April 2009 and removed in October 2009, and no evidence that skunks (or seabirds) entered trap boxes was found. No evidence of avian, deer mouse, or skunk predation was found in 2009. One Common Raven (*Corvus corax*) nest was observed on the cliffs above the caves on 18 April.

Human Disturbance: Signs prohibiting cave entry by tourists were deployed within the cave entrances and in the intertidal area between the two caves in April and June 2009 (Figures 3d, 3e). No evidence of human disturbance or non-researcher human visitation was detected.

Xantus's Murrelet: No nests were found in 2009.

Bats: Bats with long ears and tawny and gray colored fur were observed, as follows: four bats flying inside Cave #5 on 18 April; and one bat flying in Cave #4 on 10 August. We believe that these were Townsend's big-eared bats (*Corynorhinus townsendii*) but identification was not confirmed.

Dry Sandy Beach Cave

Ashy Storm-Petrel: Forty-one nests were documented in 2009. Hatching success was 85% (n = 41), fledging success was 87% (n = 32), and reproductive success was 74% (n = 38; Table 2). Fragments of an Ashy Storm-Petrel egg were discovered not associated with a nest site at the cave's rock pile on 11 August, but we could not tell if the egg had hatched and been removed from the nest site or the egg had been deposited and broken outside of any nest site.

Predation: No evidence of avian or skunk predation was found in 2009. On 10 September, one Pigeon Guillemot eggshell fragment and one-third of an Ashy Storm-Petrel egg were found not associated with potential nest sites, each with apparent chew marks (presumably, mice); however, it is not known if these eggs were depredated or scavenged after possible abandonment.

Human Disturbance: A sign prohibiting cave entry by tourists was deployed within the cave on 30 October (Figure 3f). No evidence of human disturbance or non-researcher human visitation was detected in 2009. On 15 July, two sea kayakers were observed paddling near Ruby Rock, located about 1 km east of Painted Cave. The kayakers likely launched from the charter boat *Truth*, which was anchored nearby. This was our first observation of kayakers near the west end of the island and was indicative of increasing tourism along the west end of the island's north coast.

Pigeon Guillemot: No nests were found in 2009 and no adults were noted on the water outside the cave entrance in August. Guillemots may have bred earlier in the season in the cave or in cliff habitats at the cave entrance.

California sea lion (*Zalophus californianus*): One bull was noted on 10 September; and approximately 30 sea lions were present on 30 October. All sea lions were on the beach by the tide pool upon our arrival, and left the cave as we entered.

Orizaba Rock

Ashy Storm-Petrel Restoration: On 28 March, the vocalization broadcast system was redeployed and activated, and 5 new artificial nest sites were added to 21 pre-existing artificial nest sites (i.e., making a total of 26). The additional artificial nest sites were installed in four areas: a) the floor of the Upper West Cavern (n = 2); b) the floor at the approximate boundary of the Upper West Cavern and Upper East Cavern (n = 1); c) on the ledge (about 2 m long and 1 m deep) in the Upper East Cavern (n = 1); and d) on the floor in the Upper East Cavern (n = 1). Each site entrance was not obstructed by other sites; however, two artificial sites were placed directly in front of, but did not obstruct the entrance of a natural site (tag #279 in the Upper West Cavern).

During each field trip in June to August 2009, vocalization broadcast equipment was tested and determined to be functioning properly. Thus, we are confident that Ashy Storm-Petrel vocalizations were broadcasted nightly from 28 March to 10 August. On 10 August, the solar panel and broadcast equipment were removed, but the speaker in the Upper Cavern was left in place. Similarly, all artificial nest sites were left in place.

Ashy Storm-Petrel Monitoring: During the 28 March visit, all artificial and natural sites in the upper caverns (approximately 60% of all nests at OR) were examined for presence of adult storm-petrels. Two adults were detected at one artificial site (tag #A-853B; – site eventually fledged a chick in 2009) and at least one adult was detected at one natural crevice (tag #749; 1 or more adults heard but not seen in crevice – no evidence of later egglaying in 2009). Natural crevices elsewhere on the rock were not examined during the 28 March field visit. Including natural and artificial sites, 28 nests were documented in 2009. For natural sites, hatching success was 64% (n = 22), fledging success was 75% (n = 12), and reproductive success was 45% (n = 20; Table 2). Ashy Storm-Petrels laid eggs at six artificial sites, including a replacement egg at one site (tag number A-869). Eggs were laid inside four artificial sites (including the replacement egg), and behind and outside of two other sites. All four sites used in 2008 were re-used in 2009. One site deployed but not used for nesting in 2008 was used for nesting in 2009, and one site deployed in 2009 was used for nesting in 2009. Attendance only by an adult storm-petrel (no evidence of egglaying) was observed at one artificial site. Twenty-three percent of available artificial sites in 2009 (n = 26) were used in 2009, compared to 19% in 2008 (n = 21). For active artificial nest sites, hatching success was 67% (n = 6), fledging success was 100% (n = 4), and reproductive success was 67% (n = 6 Table 2). At one artificial nest site (tag #A-869), an incubating adult was "visibly shaking" during nest checks. Both first and replacement eggs at this site did not hatch in 2009.

Human Visitation: On 29 October, a wine cork was found on a rock ledge near the Upper East Cavern, and had likely been discarded by tourists from an upper portion of the rock above this ledge. The cork was found in a conspicuous location, and likely would have been detected on previous nest-monitoring visits; therefore, this visitation by tourists occurred between 10 September and 29 October.

Predation: No evidence of predation of storm-petrels was found in 2009. However, Common Ravens were commonly observed on or near the rock during our nest checks in 2009, specifically: a) two adults roosting on the adjacent mainland on 28 March; b) two adults perched on the rock peak on 15 July; c) three adults flying overhead on 10 September; and d) two adults perched on the rock peak on 29 October, with one departing immediately upon our arrival and one departing only after we climbed to the peak. Three owl pellets (likely Barn Owl [*Tyto alba*]) were found away from storm-petrel nesting areas on the rock, and contained small-mammal hair, mussel debris, and parts of Jerusalem cricket (*Stenopelmatus* sp.) or another invertebrate. One Ashy Storm-Petrel eggshell fragment was observed with possible chew marks (presumably by mice) but we could not determine if mice had taken a viable egg from a nest or had salvaged a hatched, abandoned, or broken egg.

Cassin's Auklet: Three confirmed nests (tags #701, #812, #999) and one probable nest (tag #821B) were observed. Each of these eggs was abandoned before hatch in 2009.

Black Oystercatcher (*Haematopus bachmani*): One empty scrape was found on 15 June.

Western Gull (*Larus occidentalis*): One nest with one egg and two empty scrapes were found on 15 June.

Hatching, Fledging, and Reproductive Success

Hatching, fledging, and reproductive success are summarized in Table 2. Overall reproductive success at all sites (natural and artificial combined) at all locations was 69% (n = 137) (Table 2). Five chicks seemed to exhibit slow growth, based on field observations and analysis of plumage descriptions over the field season. Three chicks exhibiting slow growth (nest tags #818-W at BC; #824-W at BC; #60 at COBE) were observed as missing before possible fledge, and two chicks exhibiting slow growth (nest tags #1046 at BC; #1056 at DSBC) fledged.

Breeding Phenology

Mean dates of initiation, hatching and fledging for first and second eggs in natural and artificial nest sites are summarized in Table 3. In 2009, estimated initiation dates for natural crevices (all locations combined) ranged from 6 May to 27 August for 133 first and single eggs versus 30 April to 26 August for 3 replacement eggs. Initiation dates for artificial nest sites at OR ranged from 26 May to 12 July for first and single eggs. Hatch dates in natural crevices (all locations combined) ranged from 19 June to 5 October for first and single eggs. Hatch dates in artificial nest sites at OR ranged from 9 July to 4 September for first and single eggs. Fledging dates for natural crevices (all locations combined) ranged from 24 August to 11 December for first and single eggs, and fledging dates for artificial sites at OR ranged from 27 September to 27 November for first and single eggs.

DISCUSSION

Monitoring Reproductive Success and Breeding Phenology

Seabird restoration has focused primarily on improving habitat at breeding colonies to encourage attendance and recolonization, plus maintain or increase numbers of breeding birds and reproductive success (e.g., Parker *et al.* 2007). Reproductive success is a key demographic variable needed for assessing population growth conditions and modeling population changes over time. In Ashy Storm-Petrels, variation between locations and years clearly needs to be measured and reasons for variation assessed (Ainley *et al.* 1990, Sydeman *et al.* 1998b, McIver 2002). Breeding phenology also is important for assessing natural factors affecting prey availability and adequacy of survey techniques.

Hatching success (80%; n = 148), fledging success (86%; n = 109), and reproductive success (69%; n = 137) at five locations combined at Santa Cruz Island in 2009 appeared to be greater than in 1995-98, and similar to reproductive success observed in 2005-08 (McIver *et al*. 2009a,b). As in 1995-98 and 2005 (McIver *et al*. 2009b), relatively high reproductive success values in 2009 occurred at COBE and DSBC and relatively low values occurred at OR. In contrast to 1995-97, but as also observed in 2006-08 (McIver *et al*. 2009a,b), reproductive success values at BC in 2009 were relatively high. Recent improved reproductive success (mainly reflecting higher hatching success) is consistent with: a) reduced levels of organochlorine contaminants which may no longer reduce reproductive success of Ashy Storm-Petrels on a population level (Carter *et al.* 2008b); and b) reduced avian predation in 2005-08. However, these reproductive success rates do not include major impacts from unusual skunk predation events at BC in 2005 and CPCC in 2008. Relationships between organochlorine levels and eggshell thickness from eggs collected in 1992-2008 also require further analysis to better evaluate potential past and present effects from these contaminants. While generally higher than observed in 1995-

98 (McIver 2002), reproductive success in 2009 was still relatively low at OR compared to other locations as also noted in 1995-98, but still appeared to be slightly higher than in 2008 (McIver *et al*. 2009a). Fledging success at OR also appeared to be higher in 2009, compared to 2008 (McIver *et al*. 2009a). Nesting conditions at OR are more exposed than at sea caves, potentially affecting colony attendance patterns of storm-petrels, nature and amount of predation, nesting habitat, human disturbance, and effects by squid fishery lights.

Rough ocean conditions resulted in an extended period of about 50 d between the 10-11 September field trip and the 29-30 October field trip. The October field trip was delayed but this also precluded any need for a November field trip. Nest fates and fledging status (as defined in McIver and Carter 1997) could not be determined for nine Ashy Storm-Petrel nests in 2009, because chicks from these nests were not old enough (based on plumage when last observed) for them to be considered fledged without further observation, based on our established criteria. These nine nests represented approximately 8% of nests used to determine fledging success (n = 109) and approximately 6% of nests used to determine reproductive success (n = 137) in 2009. Due to our relatively large sample size, this problem likely did not substantially affect our determinations of fledging and reproductive success. Several observations of slow chick growth were noted in 2009, and may have been related to reduced food availability. However, diet composition or chick weights were not evaluated during this study.

In 2009, breeding phenology at all locations at Santa Cruz Island was protracted, as also found in 1995-98 and in 2005-08 (McIver 2002, McIver *et al*. 2009a). Most eggs were laid in June, most hatching occurred in late July and early August, and most fledging occurred in late September and early October. Compared to 2008, peak fledging appeared to occur later in 2009. Eggs were laid over a relatively short period (101 d) in 2009, similar to 2005 (105 d), rather than over the longer periods noted in 2006, 2007, and 2008 (132 d, 126 d, and 144 d, respectively) (McIver *et al*. 2009a). In 2009, eggs were laid slightly earlier in artificial sites than in natural crevices at OR. The vocalization broadcast system at OR (which was active before and during the incubation period in 2009) also may have facilitated courtship and copulation, leading to slightly earlier egg laying in artificial sites. In general, egg laying dates at all locations at Santa Cruz Island were similar. The mean fledging date for first and single eggs at artificial sites at OR appeared to occur later than the mean fledging date for natural crevices at OR. Similarly, the difference between mean fledging date and mean initiation date was 90 d for natural sites and 122 d for artificial sites. While these results may suggest more protracted incubation and chick-rearing periods at artificial sites, they also may reflect low samples sizes in artificial sites and our rough method of determining phenology. As noted in 2008, the source of nesting pairs using artificial sites or other newly occupied natural sites at OR can not be ascertained without marked birds (McIver et al. 2009a), but likely include primarily subadults and less experienced breeders. Possible prolonged incubation and chick-rearing in artificial sites may reflect inexperienced first-time breeders or less experienced breeders which may neglect eggs more frequently. One bird or pair in an artificial site was observed to exhibit “nervous” behavior (i.e., shivering), possibly suggestive of an inexperienced first-time breeder. Also, the greatest range of time between egg laying and fledging (138 d) occurred at an artificial site at OR (tag #847) that was deployed and first used by storm-petrels in 2009. Such long incubation and long chick-rearing also may reflect first-time breeders.

Restoration at Orizaba Rock

Vocalization broadcast systems with or without other social attractants (e.g., decoys, mirrors) or artificial nesting habitats have been successfully used to attract seabirds to attend and recolonize colonies of Common Murres (*Uria aalge*), Atlantic Puffins (*Fratercula arctica*), Dark-rumped Petrels (*Pterodroma phaeopygia*), Band-rumped Storm-Petrels (*O. castro*), Common Terns (*Sterna hirundo*), Arctic Terns (*S. paradisaea*), and Ashy Storm-Petrels (Kress 1983; Kress and Nettleship 1988; Podolsky and Kress 1989, 1992; Bolton *et al.* 2004; Parker *et al.* 2007; McIver *et al.* 2009a). In 2009 at OR, two major signs of continued success with restoration efforts included continued breeding at four artificial nest sites (that were first used in 2008) and initiation of breeding at two artificial nest sites newly deployed in 2009. Reproductive success also may have been higher in artificial sites (67%, n = 6) than in natural crevices (45%, n = 20), but small samples sizes were involved.

A continued increase in numbers of active nests occurred from 14 sites (all natural) in 2007, to 24 sites (20 natural and 4 artificial) in 2008 (the first year of restoration), to 26 sites (20 natural and 6 artificial) in 2009. Similar higher levels of nesting at OR occurred in 1995-97, with a peak of 27 nests (all natural) in 1996 (McIver 2002). Numbers have increased since 2005 and appear to be essentially recovered to 1995-97 levels due partly to natural recovery and partly to restoration actions. In the future, numbers may continue to increase to even higher levels due to substantial augmentation of the number of potentially suitable nest sites through deployment of 26 artificial sites to date and possible addition of more artificial nest sites in the future. If all 26 artificial nest sites are eventually used and natural nest sites also continue to be used, the OR colony will double in size. However, not all artificial nest sites may be used because some appear to be slightly more suitable than others and the dense arrangement of artificial nest sites (largely necessitated by available substrates) might not allow complete occupancy due to issues related to nest site access and territorial behavior at nest site entrances.

A larger OR colony with a greater proportion of more protected nest sites should have a greater ability to withstand certain anthropogenic impacts (e.g., increased avian predation related to bright lights from squid fishing or other boats, increased predation related to higher populations of avian predators, and increased human disturbance from researchers or non-researchers), reducing the probability of extirpation of this relatively small colony. Predation of storm-petrels by skunks is unlikely at OR, because the offshore rock is detached from the island (~ 30 m) and skunks on the island are not likely to swim to the rock. Larger colony size alone is a great benefit, as long as natural factors affecting breeding remain similar and potential anthropogenic factors are addressed. At OR, artificial nest sites are deep enough (36 cm) to prevent avian predators from reaching incubating adults, eggs or chicks inside the site; in addition, artificial nest sites are high enough (18 cm) to visually hide incubating adults, eggs and chicks behind the site in many cases from avian predators. The crevice-style shape of the nest chamber also encourages incubating adults to stay in place if disturbed. When we peeked into the entrances of artificial sites (with brief use of flashlights) during nest checks, adults did not move, whereas at some natural sites adults moved off eggs and went deeper into the crevice when examined. In addition, less egg breakage may occur during normal incubation or during disturbances in artificial nest sites through provision of a floor made of 2-3 cm of pumice gravel which likely cushions the egg to some extent compared to some natural crevices which have solid rock floors without cushioning. With no evidence of predation and an average proportion of abandoned nests compared to other locations, increased numbers of breeding storm-petrels at OR apparently did not lead to increased predation in 2009. However, predators may not have yet discovered and responded to increased numbers of storm-petrels nesting at OR.

Skunk Predation at Sea Caves

<u>*Bat Cave:*</u> At least two island spotted skunks somehow gained access to BC in 2005, killing at least 70 adult Ashy Storm-Petrels and causing complete reproductive failure of this colony (McIver and Carter 2006). Numbers of active nests were greatly reduced to only 19 active nests in 2006 but have increased since then, as follows: 28 in 2007; 35 in 2008; and 48 in 2009 (Carter *et al*. 2007; McIver *et al*. 2008, 2009a; Table 2). Eighty-eight percent of active nests in BC in 2009 occurred in the main room. Several adult storm-petrels may have escaped skunk predation in the main room in 2005 because: a) breeding occurred in the main room in 2006 but not in the slope room and inner passageways; b) higher cave ceilings and a larger cave entrance in the main room may have allowed some storm-petrels to exit by flying; c) there was more evidence of digging by skunks in the slope room and passageways than in the main room in 2005, indicating greater activity and persistence of skunks in these areas, compared to the main room; and d) due to larger amount of habitat, skunks likely took more time to find and kill storm-petrels in the main room, allowing more time for escape. With survival of some adults evident in 2006 and increasing numbers of storm-petrel nests since 2006, BC appears to be experiencing gradual natural recovery, possibly facilitated by relatively high reproductive success.

<u>*Cavern Point Cove Caves:*</u> At least two island spotted skunks gained access to CPCC in 2008, killing at least 32 adult Ashy Storm-Petrels and causing complete reproductive failure of this colony (McIver *et al.* 2009a). This colony was decimated with only two active nests found in 2009 (tags #54 and #1040 in Cave #5). Few adult storm-petrels apparently escaped skunk predation at CPCC in 2008 because: a) only two nests were found in 2009; b) breeding occurred in Cave #5 which although having a small amount of nesting habitat also had a higher ceiling and entrance, possibly allowing a few adults to escape skunks by flying; c) breeding did not occur in Cave #4 which although having a small amount of nesting habitat also had a lower ceiling and entrance, likely not allowing any adult storm-petrels to escape skunks. Based on few nests at CPCC in 2009, this colony has been almost extirpated due to the skunk predation event in 2008. Future monitoring is needed to determine if this colony recovers or not.

General: Prior to these events in 2005 and 2008, skunk predation of Ashy Storm-Petrels at Santa Cruz Island was not known to occur and had not been documented during monitoring in 1995-2004 (McIver 2002; W.R. McIver and H.R. Carter, *unpublished notes*). In recent years, island spotted skunk population numbers at the island have increased dramatically, possibly in response to reduced numbers of island foxes (*Urocyon littoralis santacruzae*), changes in island vegetation, or a combination of these and other factors (Jones *et al.* 2008). Given the total or near elimination of Ashy Storm-Petrels nesting in a sea cave by one or two skunks, it is highly unlikely that this has been a common occurrence in the past. Future monitoring will allow evaluation of the ability of Ashy Storm-Petrel colonies to recover from such events, as long as these events do not occur more regularly. While island skunk populations remain unnaturally high on Santa Cruz Island, it will be necessary to maintain traps to protect nesting Ashy Storm-Petrels. The island fox population, while still well below historical numbers, is increasing and is thought to be approximately 10 times larger than at the low point in the early 2000s. In 2009, no island skunks were detected or captured in any of the Ashy Storm-Petrel colonies, but continued trapping and monitoring will be necessary to ensure that these caves remain free of mammalian predators in the future.

Avian Predators

During 1995-98 monitoring, Barn Owls were well documented as predators of Ashy Storm-Petrels at Santa Cruz Island, especially at BC, CPCC, COBE, and OR (McIver 2002). However, during 2005-09 monitoring, predation by Barn Owls has been much reduced (McIver *et al*. 2009b; this study). Common Ravens are commonly observed near Ashy Storm-Petrel breeding locations and have been documented in sea caves and at OR (e.g., COBE in 1997 [McIver 2002]; OR in 2009 [this study]), and may prey on storm-petrels. Western Gulls are known predators of Ashy Storm-Petrels at Southeast Farallon Island where both breed together (Ainley *et al.* 1990, Sydeman *et al.* 1998a). At Santa Cruz Island, Western Gulls have not been observed to occur inside sea caves during nest monitoring; however, a few pairs of gulls nest on OR but little evidence of gull predation on seabirds has been found there (McIver 2002). Peregrine Falcons are commonly observed near Ashy Storm-Petrel breeding locations at the bases of steep cliffs (McIver 2002; W. R. McIver, H.R. Carter, and A.L. Harvey, *unpublished notes*), although predation of storm-petrels by falcons at Santa Cruz Island is unlikely due to storm-petrels' nocturnal visitation of breeding colonies.

Ashy Storm-Petrels are not easy for most avian predators to detect, arriving and departing from nest sites and colonies at night. Incubating adults and chicks before fledging age (~80 d) also are generally non-vocal and inactive within their nesting crevices during the day. Near fledging age, older chicks can move outside of nest sites in sea caves but are still non-vocal. A few smaller non-handled chicks also make peeping or begging sounds while we are checking nests but this may reflect minor disturbance to chicks from our activities (e.g., use of flashlights) and does not occur regularly.

Compared to 1995-98, relatively low levels of storm-petrel predation by avian predators (i.e., few carcasses or feather piles) appeared to occur in 2009, as also noted in 2006-08

(Carter *et al.* 2007; McIver *et al.* 2008; 2009a). However, lower numbers of breeding storm-petrels also occurred at BC and CPCC in 2005-08, due to skunk predation events. More work is needed to summarize and assess past predation data for comparison to 2005-08 data. At BC, Barn Owls may have switched to hunting elsewhere, due to the reduction in storm-petrels. Future monitoring of predation during storm-petrel nest monitoring will generally assist our understanding of the frequency and type of predation upon storm-petrels. However, greater effort would be needed to better assess predators through predator surveys and analysis of prey remains at nests and roosts away from storm-petrel colonies.

Human Visitation

Evidence of non-researcher human visitation was documented at OR in 2009, possibly indicating more frequent visitation of OR by tourists, an increase in tourism near this location and at locations further west along the north coast of Santa Cruz Island, or possible interest in the solar panel array that could possibly be viewed from the shallow waters west of OR between the offshore rock and the island. Effects of human visitation on storm-petrel nests at OR were not observed. However, natural and artificial nesting habitats at OR and in sea caves are fragile and prone to movement or collapse if carelessly stepped upon. During the breeding season (April-November), storm-petrel adults, chicks, and eggs within nest sites also are vulnerable to being crushed or disturbed by unaware human visitors. Signs prohibiting cave entry of tourists visiting Santa Cruz Island were deployed at BC, CPCC, COBE, and DSBC in 2009, to prevent disturbance to relatively large numbers of nesting Ashy Storm-Petrels. While human visitation at CPCC and BC has been observed in 1995-97 and 2005-09 (including spring 2009) (McIver *et al*. 2009a, b; this study), no evidence of human presence was found at these sites after signs were deployed in 2009, indicating the signs may dissuade tourists from entering caves. Similar signs are needed at OR.

Restoration Recommendations for 2010-11

We recommend the following restoration work at OR and Santa Cruz Island sea caves in 2010-11:

Artificial Nest Sites at OR

- April 2010-11: refurbish artificial nest sites with gravel, sand, and rocks, as necessary.
- April 2010: Modify artificial sites (that are not observed during that fieldtrip to be occupied by a storm-petrel) by drilling a three-quarter inch (1.9 cm) diameter hole though the roof of each artificial nest site, through which an iButton thermochron will be suspended in June to September 2010 and 2011 to measure internal temperatures of these artificial sites. Artificial sites would be removed temporarily from their gravel pads, if necessary, in order to drill the holes using a battery-operated drill equipped with a masonry bit.
- April 2010: Add 5-10 new artificial nest sites in the lower cavern and in spaces in the upper caverns.

Evaluation of Ashy Storm-Petrel responses to vocalization broadcast and artificial nest sites at OR

- 2010-11: Investigate storm-petrel behavior associated with speakers and artificial nest sites, with the use of motion cameras and acoustic sensors, and compare with behavior at sea caves without social attraction and without artificial nest sites.

Vocalization broadcast at OR

- April-August 2010-11: Deploy and operate the vocalization broadcast system. Shut down and remove part of the system during the August field trip to prevent attraction of non-breeding birds after the egglaying period which may lead to increased predation of inexperienced birds in fall.

Presence of mice at OR and sea caves

- 2010-11: McIver (2002) detected deer mice at BC, CPCC, and DSBC, did not detect deer mice at OR, and concluded that predation of small numbers of eggs by deer mice did not reduce overall hatching success of Ashy Storm-Petrels significantly. However, determining current presence/absence of deer mice at OR will help researchers assess whether deer mice occur there and may be predators of Ashy Storm-Petrel eggs. Deploy rat bait boxes modified to allow and detect the presence of mice and prevent entry by storm-petrels. Contact paper coated with powdered graphite would be placed inside each box to detect mouse tracks. Boxes would be baited with rolled oats and no poison would be used. Boxes would be checked during each visitation; contact paper and bait would be replaced and replenished.

Recruitment of Ashy Storm-Petrels at OR and sea caves

- 2010-11: At present, most recruitment to OR and sea cave colonies is likely derived from locally-fledged chicks, with a few from other colonies. To better understand how the OR colony and sea cave colonies are sustaining themselves over the long term, inject PIT-tags into chicks or attach PIT-tags to chicks to examine future recruitment at artificial and natural sites at OR, and at natural sites in sea caves.

Ashy Storm-Petrel protection at sea caves

- 2010: Develop and implement a long-term storm-petrel protection plan to prevent skunk predation of storm-petrels at CPCC, BC, COBE and DSBC. If a storm-petrel protection plan cannot be implemented at CPCC, remove artificial nest sites from Cave #4 and Cave#5. Artificial sites may encourage some Ashy Storm-Petrels to nest in these caves that otherwise might nest elsewhere.
- 2010-11: Coordinate with other researchers to gather information and develop further studies on population size, distribution, and behavior of island spotted skunks at Santa Cruz Island.
- 2010-11: Coordinate with other researchers to determine routes and methods that island spotted skunks utilize to gain periodic access to sea caves at Santa Cruz Island.

Human visitation at OR and sea caves

- 2010-11: Deploy signs at OR prohibiting human visitation.
- 2011: Develop plan for possible implementation in 2011 for deploying remote camera systems at CPCC and BC to detect and monitor non-researcher human visitation. These sea caves occur in an area with extensive kayaking and occasional cave visitations have been documented. However, it is not clear if visitors land only on the beach or go inside caves where they can damage active nests and fragile nesting habitats. Signs prohibiting cave entry were deployed at these caves in 2009; however to comply with CINP permitting, at each sea cave signs are viewable only after visitors have already landed on the beach or entered the cave. Responses by cave visitors to signs should be documented to verify that signs are working. Inexpensive remote motion sensor camera systems could be deployed in inconspicuous locations (i.e., behind deployed signs or large boulders) within caves and should not be viewable from boats which might attract people. However, if people begin to enter caves, motion sensors attached to the cameras would enable cameras to photograph human visitors. Cameras would be powered by marine batteries, which would be replaced by researchers who would download stored images from cameras each month during nest monitoring visits.

Mist-net Captures at Diablo Rocks in 2010-11

- In 2010-11, develop baseline capture rates, visitation patterns, and population size at Diablo Rocks, another exposed rock colony with associated main island habitats near OR. Ashy Storm-Petrels were documented to breed at this rock in 1994 (Carter et al. 2008; unpubl. data). Knowledge of the status of this colony over time will aid interpretation of restoration and population trends at OR.

Additional Colony Surveys in 2010-11

- Annual nest surveys should be conducted at Diablo Rocks, Shipwreck Cave, and Gull Island (GI) to develop baseline data for assessing trends in numbers of breeding birds in accessible areas at these locations. Ashy Storm-Petrels have been documented to breed at these locations (Carter et al. 1992, 2008; unpubl. data). Mist-net captures at GI in October also should be conducted to help confirm breeding at this poorly-known colony.

Restoration and Monitoring at OR in 2012-17

At OR, the Montrose Trustee Council has decided to fund vocalization broadcasting, maintenance of artificial nest sites, monitoring of artificial and natural nest sites, and other studies through 2011, prior to evaluating what continued efforts are necessary. Regardless of the degree of continuing work, artificial sites should remain on OR after this initial project phase has been completed, with at least one field trip per year in March-April 2012-17 for maintenance prior to egg laying to ensure that artificial nest sites remain suitable for nesting. In most years, maintenance likely will not be required at most sites but, by ensuring that all sites are suitable each year, the maximum number of artificial nest sites will become occupied over time. During this period, the needs and methods for long-term maintenance will be assessed, likely leading to less frequent maintenance of artificial habitat after 2017. Regardless of whether vocalization broadcasting continues after 2011 or not, continued monitoring is imperative in 2012-17 at minimum for: a) documenting the degree of use of artificial nest sites and reproductive success in artificial and natural nest sites at OR; and b) identifying and addressing any anthropogenic factors or changing natural conditions that might be impairing the success of the project at OR. After investing significant effort to restore this colony in 2008-11, a reasonable level of effort is needed in 2012-17 to measure and ensure project success over the remainder of the first decade of restoration efforts from 2008 to 2017. All future commercial, recreational, research, or management activities on or near OR, as well as other colony sites, should be carefully screened for any possible impacts to Ashy Storm-Petrels.

Skunk Trapping at Sea Caves in 2012-17

Given major skunk predation events in 2005 and 2008, we recommend development and implementation of a long-term Ashy Storm-Petrel protection plan to prevent or reduce skunk predation of storm-petrels at CPCC, BC, COBE and DSBC. Continued trapping is necessary at BC, CPCC, and COBE in 2012-17 at least, with deployment in March-April and pickup in October-November at a minimum. Monthly trap checking is preferred to ensure that traps remain operational each month during the storm-petrel breeding season, including resetting any sprung traps and assessing any predation of storm-petrels shortly after this has occurred. At the end of this period, an assessment of the need for further trapping should be conducted, including: 1) an examination of the number of skunks captured and killed in 2005-17; 2) determination of the significance of loss of individual skunks to the Santa Cruz Island population; 3) examination of the efficacy of deployed traps to capture skunks before they kill storm-petrels; 4) an examination of the number of storm-petrels killed by skunks from 2005-17; 5) determination of the significance of loss of individual petrels to each breeding colony and to the Santa Cruz Island population; and 6) an assessment of the ability of storm-petrel colonies to naturally restore themselves after skunk predation events. To complete this assessment, at least one monitoring trip per year is needed to annually assess numbers of nesting storm-petrels in these sea caves in August. After these issues have been addressed, Ashy Storm-Petrel protection efforts should be revised accordingly.

Long-term Monitoring at Sea Caves in 2012-17

Data on population size, reproductive success and breeding phenology of Ashy Storm-Petrels at all five Santa Cruz Island colonies should continue to be gathered as part of a long-term monitoring program that tracks population trends, assists restoration projects, and examines various conservation issues for this rare species in southern California. To date, baseline data on reproductive success have been gathered primarily in 1995-98 and 2005-09. Monitoring should be conducted at OR and four sea caves in 2012-17 at a minimum to gather post-restoration data for the first decade of restoration work. However, longer-term monitoring also is needed to fully measure all population changes related to restoration and other conservation issues over the long term. We recommend that CINP coordinate with TNC and others to include monitoring of Ashy Storm-Petrels at Santa Cruz Island in the CINP seabird monitoring program and search for additional funds necessary to continue this monitoring in the future.

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Table 1. Field trips conducted in 2009 for Ashy Storm-Petrel nest monitoring and restoration, and skunk trapping activities at Santa Cruz Island, California.

Trip Number	**Field Dates**	**Locations**[1]	**Field Staff**	**Support Vessel**	**Main Activities**
2009-01	28 March	OR	B. McIver, L. Harvey, D. Cooper, N. Fox-Fernandez, J. Turner	*Miss Devin*	Deploy artificial sites and vocalization broadcast system
2009-02	18 April	BC, CPCC	B. McIver, L. Harvey, D. Mazurkiewicz	*Miss Devin*	Deploy skunk traps and signs
2009-03	15-16 June	BC, COBE, CPCC, OR	B. McIver, L. Harvey, D. Mazurkiewicz, J. Elliott	*Miss Devin*	Nest monitoring, restoration check, trap check, deploy signs
2009-04	15-16 July	BC, COBE, CPCC, OR	B. McIver, L. Harvey, H. Carter, J. Mason, B. Del Mastro	*Miss Devin*	Nest monitoring, restoration check, trap check, deploy traps and signs
2009-05	10-11 August	BC, COBE, CPCC, DSBC, OR	B. McIver, L. Harvey, H. Carter, G. McChesney, R. McMorran	*Miss Devin*	Nest monitoring, restoration check, remove solar panel/audio equipment, trap check
2009-06	10-11 September	BC, COBE, CPCC, DSBC, OR	B. McIver, H. Carter, L. Halpin, D. Mazurkiewicz	*Miss Devin*	Nest monitoring, restoration check, trap check
2009-07	29-30 October	BC, COBE, CPCC, DSBC, OR	B. McIver, L. Harvey, H. Carter, K. Barnes, M. Carter, S. Thomsen	*Miss Devin*	Nest monitoring, restoration check, remove traps, deploy signs

[1] Abbreviations: BC (Bat Cave), COBE (Cave of the Birds' Eggs), CPCC (Cavern Point Cove Caves), DSBC (Dry Sandy Beach Cave), and OR (Orizaba Rock).

Table 2. Percent hatching, fledging, and reproductive success of Ashy Storm-Petrel nests monitored at Santa Cruz Island, California, in 2009. Locations are coded as in Table 1. Clutches are coded: 1, first and single; and 2, replacement. Sample sizes in parentheses.

		Location							
	Clutch	BC	COBE	CPCC	DSBC	OR[a]	OR[b]	Total[a]	Total[b]
Hatching Success	1	81.3% (48)	89.7% (29)	50% (2)	85.4% (41)	63.6% (22)	64.3% (28)	81.0% (142)	80.4% (148)
	2	50% (2)	0% (1)	-	-	0% (1)	0% (2)	25.0% (4)	20.0% (5)
Fledging Success	All	89.7% (39)	80.9% (21)	100% (1)	87.5% (32)	75.0% (12)	81.3% (16)	85.7% (105)	86.3% (109)
Reproductive Success	Last	74.5% (47)	70.8% (24)	50.0% (2)	73.7% (38)	45.0% (20)	50.0% (26)	68.7% (131)	68.6% (137)

[a] Natural nest sites only; [b] Natural and artificial nest sites.

Table 3. Average timing of breeding (mean ± standard error in days [d]) for Ashy Storm-Petrels at five locations at Santa Cruz Island, California, in 2009. Sample sizes of nests used for phenology calculations are shown in parentheses. Locations are coded as in Table 1. Clutch codes: 1, single and first eggs combined; 2, replacement eggs.

Location	Clutch	Initiation	Hatch	Fledging
BC	1	1 June ± 2.6 d (41)	15 July ± 2.7 d (39)	3 October ± 2.9 d (34)
	2	30 April (1)	13 June (1)	1 September (1)
COBE	1	11 June ± 4.2 d (29)	25 July ± 4.4 d (26)	9 October ± 4.8 d (17)
	2	29 July (1)	-	-
CPCC	1	27 June ± 32 d (2)	9 July (1)	27 September (1)
	2	-	-	-
DSBC	1	23 June± 4.2 (40)	1 August ± 4.1 d (35)	15 October ± 4.8 d (28)
	2	-	-	-
OR[a]	1	23 June 7.3 d (21)	20 July ± 4.4 d (14)	30 September ± 3.2 d (9)
	2	26 August (1)	-	-
OR[b]	1	17 June ± 8.1 d (6)	28 July ± 13.3 d (4)	17 October ± 14.3 d (4)
	2	26 August (1)	-	-
All[a]	1	14 June ± 2.3 d (133)	23 July ± 2.0 d (115)	8 October ± 2.2 d (89)
	2	8 July ± 35.6 d (3)	13 June (1)	1 September (1)

[a] Nest in natural crevices only; [b] nests in artificial sites only.

Table 4. Nesting activities of Pigeon Guillemots at Cave of the Birds' Eggs in 2009.

Nest Number	15 June	15 July	11 August
"A"	2 LGC	0	0
"B"	2 LDC	0	0
"C"	2 MDC	1 FFC	0
"D"	1 MDC	0	0
"AA"	2E	2 MDC	1 FFC
"BB"	2 MFC	0	0
"CC"	2 LDC	0	0
"DD"	2E	2 LDC	1 FFC
tag #821	1 LDC	0	0
tag #839	2 SGC	0	0

[1] Abbreviations: E = egg only, FFC = fully-feathered chick LDC = large downy chick, LGC = large gawky chick, MDC = medium downy chick, MFC = mostly feathered chick, SGC = small gawky chick.

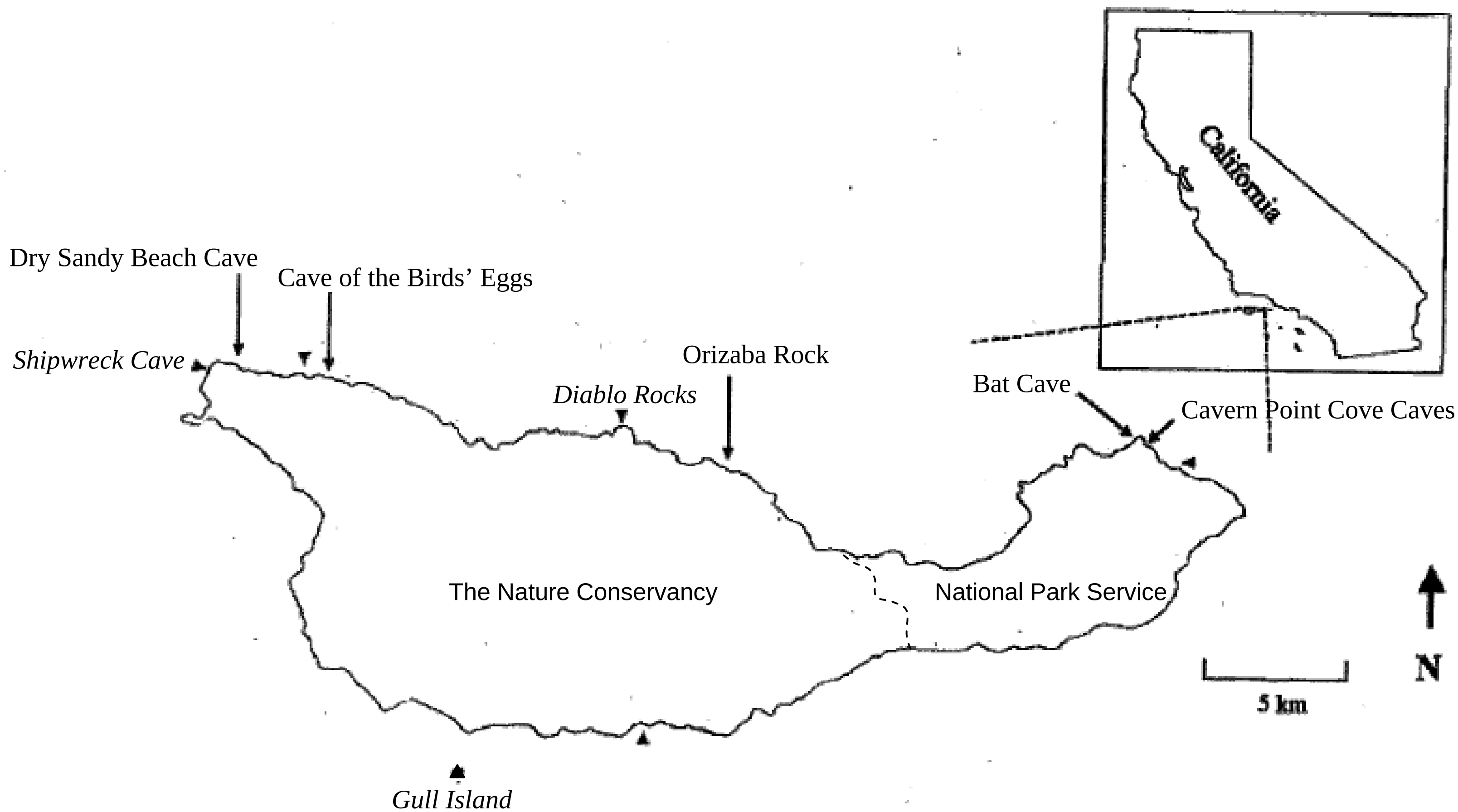


Figure 1. Breeding locations (indicated by arrows) of Ashy Storm-Petrels at Santa Cruz Island, California. Locations at which restoration or nest monitoring activities occurred in 2009 are indicated in plain font; additional locations at which population monitoring is proposed in 2010 are indicated in *italics*.

(a)

(b)

(c)

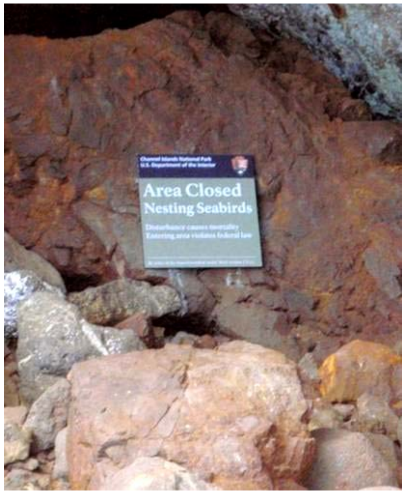
Figure 2. a-c) Body-grip skunk trap (model 220 Conibear trap, Oneida Victor Inc. Ltd., Euclid, Ohio) used to trap island spotted skunks in sea caves at Santa Cruz Island, California, placed within protective box (photos by A.L. Harvey).

(a) Sign in BC “main room”:

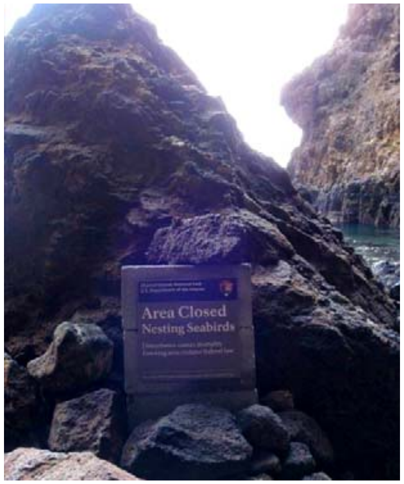
(b) Sign at BC “slope room” entrance:

(c) Sign in COBE:

(d) Sign at CPCC, Cave #5 entrance:



(e) Sign at CPCC, intertidal area:



(f) Sign in DSBC:

Figure 3. Signs prohibiting cave entry by touristswere deployed at BC, COBE, CPCC, and DSBC in 2009. Locations are coded as in Table 1. All photographs by A.L. Harvey except 2b, by L. Halpin.

Figure 4. Photograph of a juvenile Bald Eagle (*Haliaeeatus leucocephalus*) with blue patagial tag "64," perched on cliff adjacent to Cave of the Birds Eggs (34º 04' 22" N; 119º 52' 32" W) on 11 August 2009 (photo by R. McMorran).