

# STATUS OF XANTUS'S MURRELET AND ITS NESTING HABITAT IN BAJA CALIFORNIA, MEXICO

BRADFORD S. KEITT

*Island Conservation, Center for Ocean Health, 100 Shaffer Road, University of California, Santa Cruz, California, 95060, USA*  
(bkeitt@islandconservation.org)

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## SUMMARY

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A preliminary survey was conducted in 1999 to establish the status of the Xantus's Murrelet *Synthliboramphus hypoleucus* in Baja California, Mexico. Seven island groups with prior evidence of breeding (Coronado, Todos Santos, San Martín, San Jerónimo, San Benito, Asunción and San Roque) and two potential breeding islands without prior evidence of nesting (Natividad and Adelaida) were examined. In 2004, additional work was conducted at Afuera Islet off Guadalupe Island. Presence of murrelets was detected through nest searches and by rough estimation of birds in nocturnal at-sea congregations using boat-based and land-based vocalization counts. Vocalizations were heard at six island groups (Coronado, Todos Santos, San Martín, San Jerónimo, San Benito and Guadalupe) and nests were found at four island groups (Coronado, San Jerónimo, San Benito and Guadalupe). Land-based and boat-based vocalization surveys both detected presence or apparent absence of murrelets at potential nesting islands, although boat-based vocalization rates were higher on average. Vocalization surveys cannot readily be converted to breeding population estimates, but overall population size of murrelets in Baja California appears to about 2300 pairs (range: 1000–4000 pairs), similar to previous estimates. Historically, nonindigenous mammals were introduced to most islands in Baja California; recent progress in removing introduced mammals should benefit Xantus's Murrelets.

Key words: Baja California, conservation, nesting habitat, predation, status survey, *Synthliboramphus hypoleucus*, Xantus's Murrelet

## INTRODUCTION

Xantus's Murrelet *Synthliboramphus hypoleucus* is a small alcid that breeds only on islands off southern California, USA, and northwestern Baja California, Mexico (Fig. 1; Drost & Lewis 1995). The bird's small global population, restricted range, population decline, loss of several breeding colonies, human disturbance at remaining colonies and potential mortality from oil spills have raised concerns about the long-term survival of the species (Hunt *et al.* 1981; Carter *et al.* 1992, 2000; Drost & Lewis 1995, McChesney & Tershy 1998; Sydeman *et al.* 1998). Introduced mammalian predators, especially feral cats (*Felis catus*) and black rats (*Rattus rattus*), have caused declines or extirpations at several islands in the United States and Mexico (Drost & Lewis 1995, McChesney & Tershy 1998, Sydeman *et al.* 1998). High levels of predation by native predators (Deer Mouse *Peromyscus maniculatus* and Barn Owl *Tyto alba*) are also affecting the largest US colony at Santa Barbara Island (Murray *et al.* 1983, Carter *et al.* 1992, Drost & Lewis 1995). Xantus's Murrelet is listed as Threatened in California (2004), "highest priority species at risk" by the Waterbird Society, Vulnerable by the International Union for the Conservation of Nature (IUCN), and Threatened in Mexico under Norma Oficial Mexicana NOM-Ecol-059.

Population estimates for Xantus's Murrelets at colonies are imprecise because murrelets breed mainly in steep coastal habitats inaccessible to researchers, and because murrelets arrive and depart from colonies during the night. Colony-based estimates suggest a global population of 5000 to 10000 breeding pairs (Drost & Lewis 1995, Burkett *et al.* 2003). Recent analysis of at-sea survey data yielded an estimate of 37000 birds, including breeding and nonbreeding individuals (Karnovsky *et al.* 2005). Assuming

50%–60% nonbreeders, that estimate was consistent with a global breeding population of 9000 pairs (Karnovsky *et al.* 2005). Colony-based population estimates for Mexico are based mostly on historical accounts or anecdotal observations; no systematic surveys have ever been conducted. Prior work has furnished estimates of 2000–5000 pairs (Drost & Lewis 1995; H. Carter, pers. comm.). Analysis of at-sea surveys during the breeding season indicated that about 11000–12000 birds occur in Baja California, making no correction for birds attending colonies (Karnovsky *et al.* 2005). That estimate also is consistent with 2000–5000 breeding pairs in Baja California, or roughly half of the global population.

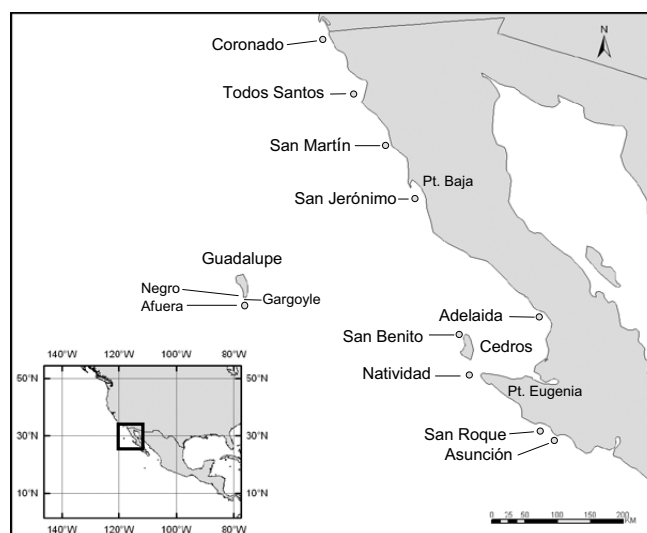


Fig. 1. Map of Xantus's Murrelet breeding islands and other islands surveyed in Baja California, Mexico, in 1999 and 2004.

Because the status of Xantus's Murrelet in Mexico is poorly known—but a large part of the global population probably occurs there—surveying these islands to assess current breeding activity is a priority (Drost & Lewis 1995). Additionally, in light of the recent efforts of Island Conservation (US nongovernmental organization) and the Grupo de Ecología y Conservación de Islas (GECI, a Mexican organization) to remove introduced mammals from islands in northwest Mexico, it is important to summarize the present status of introduced species and threats to Xantus's Murrelets in the region.

From February through July 1999, all Baja California islands with prior evidence of Xantus's Murrelet breeding, except Guadalupe and its offshore islets, were surveyed by the author and others using nest searches and nocturnal vocalization counts. Nest searches on Afuera Islet off the south end of Guadalupe Island were conducted in May 2004. In addition, surveys were conducted in 1999 at two islands without prior evidence of breeding. Cedros, a large island with potential nesting habitat and numerous offshore islets, was not surveyed. At each island, the primary goals were

- to establish presence or absence of breeding Xantus's Murrelets.
- to obtain a preliminary estimate of population size.
- to record introduced predators that may pose a threat to murrelets.
- to assess potential threats to murrelets from human use of the islands.

Additional data collected by the author and by GECI personnel during visits to some islands between 1996 and 2003 are also summarized.

## METHODS

### Study area

Eleven islands or island groups off the west coast of Baja California provide known or potential nesting habitat for Xantus's Murrelet (Fig. 1). Coronado (4 islands), Todos Santos (2 islands), San Martín and San Jerónimo islands are located within the southern region of the Southern California Bight in waters dominated by the California Current. San Benito (3 islands), Cedros, Natividad, Adelaida (also known as Elide), San Roque and Asunción islands are located in a region characterized by persistent winds favorable to upwelling. Intensive upwelling occurs year-round near the coastal prominences of Punta Baja (north of San Jerónimo) and Punta Eugenia (south of Cedros Island) (Parrish *et al.* 1981). Guadalupe, an oceanic island located 250 km offshore, is less influenced by coastal upwelling.

All islands in the region are Mexican federal property with restricted access. Three islands, Natividad, San Roque and Asunción, are located within the nuclear zone of the Vizcaino Biosphere Reserve, a designation affording the highest protected status in Mexico and roughly equivalent to a U.S. national park. Guadalupe Island was designated as a wildlife reserve in 1922, primarily to protect marine mammals. Increased protection was afforded when the island was designated a biosphere reserve in June 2005. A proposal to create a biosphere reserve protecting other islands in the region (Coronado, Todos Santos, San Martín, San Jerónimo, Adelaida, San Benito and Cedros) was submitted to the Mexican government and was officially accepted and distributed for public comment in summer 2005.

### Survey approach

Between February and July 1999, nest searches and vocalization surveys were conducted at nine islands or island groups: Coronado, Todos

Santos, San Martín, San Jerónimo, Adelaida, San Benito, Natividad, Asunción and San Roque (Fig. 1). Although breeding phenology is not well known in Mexico, an attempt was made to survey each island early in the breeding season, when colony attendance and vocal activity is expected to be high. The San Benito Islands were surveyed on three occasions to assess nesting phenology. At Guadalupe, nest searches were conducted on Afuera Islet in May 2004.

### Nest searches

Xantus's Murrelets nest primarily in rock crevices, but also under dense shrubs and in human-created structures (Murray *et al.* 1983, Carter *et al.* 1992). Apparently suitable habitat was searched using handheld flashlights to look into potential nest cavities. Effort was concentrated on crevice habitat, but vegetation was checked opportunistically. In general, search effort was concentrated in scree fields, along the bases and tops of cliffs, and in caves. Some islands, such as San Benito, were searched more thoroughly because of easy access; other islands with large areas made inaccessible by terrain or the presence of breeding pelicans and cormorants, were poorly searched (e.g. Todos Santos and Coronado islands). Nest searches were made during day and night. When a nest was found, nest contents and site characteristics (distance of nest from crevice entrance, crevice dimensions, substrate and distance to ocean) were estimated and recorded. Active and inactive nests were recorded, and the nest totals reported for each island include both categories. Active nests contained adults, chicks or whole, fresh, unattended eggs. Inactive nests contained old egg shells or membranes that indicated nesting in a previous year. When clearly viewable, adult birds at nests were identified to subspecies using facial plumage patterns (Jehl & Bond 1975). The number of person-hours of search effort on each island was recorded.

### Vocalization surveys

Nocturnal attendance and vocalizations by Xantus's Murrelets in at-sea congregations are thought to be associated with nesting activity (Carter *et al.* 1996; Whitworth *et al.* 2002, 2003a; H. Carter, unpubl. data). At Santa Barbara Island, vocalizing was most common in mid-May, coincident with the hatching period (Murray *et al.* 1983). Nightly peaks of vocal activity were evident 2–3 hours after dark (22h00–24h00) and just before dawn (Murray *et al.* 1983). More recent work at several colonies in California detected no consistent peaks in vocalization activity (H. Carter and D. Whitworth, unpubl. data).

Vocalization surveys reveal presence or absence and relative abundance of birds in inaccessible habitats with relatively low cost and effort. They are most valuable where surveys cannot be conducted using other techniques. In 1994–1996, standardized vocalization surveys were used to assess many inaccessible breeding areas that had not been previously surveyed in the Channel Islands, California, and at the Coronado Islands, Baja California (Carter *et al.* 1996; H. Carter, unpubl. data). For each vocal detection in a 15-minute period, time (to the nearest second), direction (to the nearest cardinal region—N, NE, E, etc.) and relative distance (designated near, medium or far) was noted by a designated observer and recorded by an assistant. A vocal detection was defined as a single call or a continuous series of calls separated by less than 5 seconds. During any one survey, a single bird could be responsible for multiple detections, thus the number of detections does not directly indicate the number of birds in the area.

Vocalization surveys in 1999 were conducted in open fiberglass skiffs (7-m with 40–65 hp outboard engines). Boat surveys were

conducted about 100 m from shore with engine off and wind speed < 15 knots. When skiffs were not available, surveys were conducted from shore in areas with little wave noise. Surveys were conducted on all sides of islands if possible. Survey locations were selected using a map, giving priority to coves and areas adjacent to apparently suitable nesting habitat. All survey locations were marked with a hand-held GPS. Most surveys were conducted between 22h00 and 02h00 (PST or PDT), and all surveys occurred between 90 minutes after sunset and 30 minutes before sunrise.

## RESULTS

### Coronado Islands

#### Background

Murrelets are known historically to breed on all four islands. Breeding was first noted in 1893 (Whitworth *et al.* 2003b, Carter *et al.* 2005), and recent estimates (prior to 1999) ranged from 325 to 1125 pairs (Drost & Lewis 1995; Carter *et al.* 1996). Feral cats formerly occurred on North and South islands and are likely responsible for large population declines from historical levels. Cats were removed from both islands (Table 2), and populations may be recovering. Goats and burros were removed from South Island in 2003 (Table 2).

South Island (226 ha, 2.8 km long, 204 m high) supports a small Navy encampment (about 10 personnel) and one permanent lighthouse keeper. North Island (80 ha, 1.6 km long, 136 m high), Middle Island (32 ha, <1.6 km long, 76 m high) and Middle Rock (22 ha, <1.6 km long, 31 m high) are uninhabited. The islands are steep and sparsely vegetated. High-quality scree and boulder field

nesting habitat occurs on all islands, especially along the shoreline, with the east sides of North and South Islands apparently providing the most extensive habitat.

#### 1999 Results

During 11–18 April 1999, eight nests were found and nine vocalization surveys were conducted. Six nests were found in 13.5 person-searching hours (psh) on North Island (0.4 nests/psh). On South Island, two active nests were found in 4 psh (0.5 nests/psh, Table 1). Middle Island and Middle Rock were not searched. Ground searches were conducted on the east side of North Island around the landing cove, upslope through the “amphitheater” to the top ridge and on the lower slopes south of the landing cove. All nests were found on the east side of the island in rocky, talus substrate from about 5 m to 50 m elevation. The best habitat on the North Island appeared to be in the “amphitheater” above the landing cove and just south of the landing, where small caves and natural crevices were abundant. The southern end of North Island also appeared to have excellent habitat, but was not surveyed because of difficult access on foot. All nests on South Island were located in a small boulder field west of the north-end Navy station between 5 m and 20 m above the water. Abundant habitat was also evident in other areas of South Island and on Middle Island and Middle Rock. Two vocalization surveys were conducted by boat at North Island, and four boat and three land surveys were done at South Island. Detection rates at Coronado Islands were higher than at any other location surveyed in 1999, with an average of 180 detections per survey (maximum of 253 detections in the channel between South and Middle islands).

TABLE 1  
Xantus's Murrelet vocalization surveys conducted at islands in Baja California in 1999

Island	Dates visited	Boat surveys				Land surveys			
		n	$\bar{X}$ <sup>a</sup>	SD	Range	n	$\bar{X}$ <sup>a</sup>	SD	Range
Coronado North	12, 17–18 April	2	163	—	158–168	—	—	—	—
Coronado South	11–12, 18 April	4	187	60	109–253	3	148	37	121–191
Todos Santos North	7, 9 April	1	1	—	—	—	—	—	—
Todos Santos South	2–9 April	5	21	16	7–46	4	19	26	0–56
San Martín	21–23 April	—	—	—	—	6	2	4	0–10
San Jerónimo	23–26 April	—	—	—	—	5	31	36	0–86
San Benito East	25–28 February	4	28	16	14–44	2	23	—	11–13
	3–4 May	3	37	12	23–48	—	—	—	—
San Benito West	23–25, 28 February	3	21	18	3–40	8	12	13	0–40
	1–3 May	3	46	33	17–82	3	47	49	27–77
	28 June–3 July	6	2	4	0–10	—	—	—	—
San Benito Middle	26, 28 February	2	14	—	1–28	—	—	—	—
Natividad Island	6–8 May	—	—	—	—	1	0	—	—
San Roque	4–5 March	—	—	—	—	4	0	—	—
Asunción	3–4 March	—	—	—	—	3	0	—	—

<sup>a</sup>Mean detections per survey.

**TABLE 2**  
**Status of Xantus's Murrelets and introduced mammals on islands in Baja California**

Island	Nesting status		Nests this study <sup>a</sup>	Introductions	
	Historical	Current		Species, dates <sup>b</sup>	Current status <sup>c</sup>
Coronado North	Confirmed	Confirmed	6 (1)	Cats 1970s/1980s	Removed 1995/96
Coronado South	Confirmed	Confirmed	2 (2)	Cats 1908	Removed
				Goats	Removed 2003
				Burros	Removed 2003
Todos Santos North	Confirmed	Present	0	Cats 1923, 1970	Removed 1999
				Rabbits	Removed 1999
Todos Santos South	Confirmed	Present	0	Cats 1923, 1970	Removed 1998
				Rabbits	Removed 1998
				Burros	Removed 2003
San Martín	Suspected	Present	0	Cats	Removed 1999
				Rabbits	Died out
San Jerónimo	Confirmed	Confirmed	5 (3)	Cats	Removed 1999
San Benito East	Confirmed	Confirmed	16 (7)	Cats	Removed 1998
				Rabbits 1994–96	Removed 1998
San Benito Middle	Confirmed	Confirmed	3 (3)	Cats	Removed 1998
				Rabbits 1994–1996	Removed 1998
San Benito West	Confirmed	Confirmed	9 (3)	Cats	Died out
				Rabbits 1991	Removed 1999
				Burros	Removed 2004
				Goats	Removed 1998
Cedros	Possible	Not surveyed in this study	—	Goats (1800s)	Present
				Cats	Present
				House mice	Present
				Feral dogs	Present
				<i>Rattus</i> spp.	Present
Natividad Island	Possible	No detection	0	Cats 1900s	Removed 2000
				Goats 1990s	Removed 1997
				Sheep 1990s	Removed 1997
				Dogs 1927	Present <sup>d</sup>
				Ground squirrel <sup>e</sup>	Present
San Roque	Suspected	No detection	0	Roof rats	Removed 1994
				Cats 1970s	Removed 1994
Asunción	Confirmed	No detection	0	Cats	Removed 1994
Guadalupe (main)	Confirmed	Not surveyed	—	Goats (1800s)	Removal in progress
				Cats	Present
				House mice	Present
				Feral dogs	Present
(Afuera)	Confirmed	Confirmed	35 (24)	None	None
(Negro)	Confirmed	Confirmed	Several hundred	None	None
(Gargoyle)	No record	Confirmed	4 (0)	None	None

<sup>a</sup> Total nests found in this study; number of active nests in parentheses.

<sup>b</sup> Approximate dates of historical introduction or earliest record.

<sup>c</sup> Data from Island Conservation database ([www.IslandConservation.org](http://www.IslandConservation.org)).

<sup>d</sup> In March 2002, only three dogs remained on Natividad Island, down from a high of approximately 30 dogs in 1998.

<sup>e</sup> *Ammospermophilus leucurus*.

### Todos Santos Islands

#### Background

Kaeding (1905) reported murrelets as “fairly common on and about” the islands. The first reported nesting was from 1940, when one nest was found and eggs collected (Carter *et al.* 2005). Feral cats were present as early as 1923, and Jehl & Bond (1975) suggested that cats had extirpated murrelets from the island.

South Island (127 ha, 95 m high) is mostly flat on top and ringed by cliffs. North Island (62 ha, 17 m high) is relatively flat-topped with north-side cliffs and beach access along most of the south side. An abalone cultivation facility on South Island housed about 20 personnel in 1999. That facility has since reduced operations, and in 2003 only one caretaker remained. A small illegal lobster fishing camp with two structures on the south end of South Island was removed in 2004 by GECI and the Mexican Navy. North Island has a lighthouse keeper and two Navy personnel. Rabbits and cats were removed from North Island and South Island in 1998. Burros were removed from South Island in 2003 (Table 2).

#### 1999 Results

During 2–9 April 1999, no nests were found in 20 psh, but murrelet presence was detected during 10 vocalization surveys. Terrain on South Island was searched except for cliffs along the east, west and south sides. The base of east-side cliffs was explored by kayak and on foot. Search effort was concentrated in rocky habitat and to a lesser extent in the shrubs on top of the island. There was abundant shrub habitat, but the typical plant structure did not appear to provide enough cover to encourage nesting. On North Island, the north and east coastlines were searched, mainly in rocky habitats. One boat vocalization survey was conducted on North Island and nine surveys (five by boat, four by land) were done at South Island. The range of vocal activity was 0–56 detections per survey. Land and boat surveys averaged 19 and 18 detections, respectively. The survey with 56 detections was a land survey on the east side of South Island, above the fishing camp cove. A boat survey conducted adjacent to this point (three nights and 80 minutes earlier—i.e. 23h00 versus 00h20) had 13 detections.

### San Martín Island

#### Background

Kaeding (1905) reported murrelets as “fairly common on and about” the island and nesting has long been presumed, though historical records of nests are lacking (Carter *et al.* 2005). Jehl & Bond (1975) suggested that feral cats had extirpated murrelets from the island. The island (300 ha, 1.6 km long, 151 m high) is the cone of an extinct volcano and has many lava tubes on its flanks. Steep cliffs occur around the north and west sides; uplands are covered with dense brush and sharp lava boulders. Traversing the island off trail is difficult. There is one fishing camp with about 20 buildings and 5–10 seasonal fishermen.

#### 1999 Results

During 21–23 April 1999, no nests were found in 4.0 psh, but murrelets were detected in vocalization surveys. Search effort targeted the coastline; an intensive survey of the entire island was not conducted because of the rough terrain. Apparently suitable habitat was present around much of the island, including many crevices in lava rocks and in small caves along the cliffs. Cassin's Auklet *Ptychoramphus aleuticus* nests were found in crevices, especially those with some soil, which allowed auklets to modify the nest entrances. Six land-based vocalization surveys were

conducted, results ranging from 0 to 10 detections. The survey with 10 detections was located on the southwest side of the island. No boat-based surveys were conducted. Interestingly, areas where murrelets were heard offshore were adjacent to areas apparently not used by Cassin's Auklets.

### San Jerónimo Island

#### Background

Kaeding (1905) reported murrelets as “fairly common on and about” the island. Breeding was first documented in 1932 when one nest was found and the eggs collected (Carter *et al.* 2005). Jehl & Bond (1975) suggested that feral cats had extirpated murrelets from the island. The island is small and low (67 ha, 1.2 km long, 40 m high) with sandy soil and little vegetation. It supports a large colony of Cassin's Auklets (>10 000 birds; Wolf 2002). A permanent fishing village with about 15 buildings and 30 fishermen is located on the southwest side. In the late 1990s, a guano mining operation displaced a large colony of Brandt's Cormorants *Phalacrocorax penicillatus* and destroyed hundreds of Cassin's Auklet burrows. This activity was subsequently stopped, but cormorants have yet to recolonize. The guano mining operation is unlikely to have significantly impacted Xantus's Murrelets.

#### 1999 Results

During 23–26 April 1999, five nests were found and murrelets were also detected in vocalization surveys. Four nests were located in 8 psh (0.5 nests/psh), three within the fishing village (two under woodpiles and another inside a shack). The other two nests were located in small caves just above the shoreline. Two nests contained adults, two nests had unattended eggs, and one nest had fresh-hatched shell fragments. In addition, six adult birds were seen on the ground at night. All six, plus two incubating birds, were identified as *S. h. scrippsi*. Five land-based vocalization surveys averaged 31 detections, ranging from 0 to 86 detections. Highest vocal activity occurred on the south side of the island, in the cove fronting the village.

### San Benito Islands

#### Background

Historically, breeding was first noted in 1896 (Carter *et al.* 2005); Drost & Lewis (1995) estimated 500 breeding pairs. More than 2 million seabirds of 13 species breed in this island group (Wolf 2002). The three San Benito Islands encompass about 640 ha. The largest, West Island (200 m high), supports a seasonal fish camp with about 35 buildings and up to 70 people at the height of abalone season. The islands are dry, with a combination of scree and sandy soil habitat. All habitat was accessible, excluding some steep cliffs on West Island and places where dense colonies of Cassin's Auklets precluded walking. This location is unique in that both subspecies of Xantus's Murrelet and congeneric Craveri's Murrelets *Synthliboramphus craveri* were thought to breed sympatrically on the San Benito Islands (Jehl & Bond 1975). That conclusion was based on captures of birds near the islands, however; and active nests of *S. h. hypoleucus* and Craveri's Murrelet have not been reported previously.

#### 1999 Results

In 1999, 28 nests were found, and murrelets were detected during 34 vocalization surveys. During 23–28 February, 17 nests were found in 58 psh on all three islands (0.4 nests/psh). During 1–4 May, 11 nests were found in 16 psh. The entire perimeter of West Island was explored, except the steep southwest side near a



small light tower. In the island's interior, 5 psh yielded no nests. All nine nests found on West Island were in rocky crevice habitat on the eastern half. Habitat quality (i.e. presence of rock crevices) appeared lower in the western half and interior of West Island than in the eastern half. The best habitat on Middle Island appeared to be an area of boulder scree at the base of a 15-m cliff on the northeast side. One nest was found in a solitary rock outcrop on the east side of Middle Island, and two other nests, at the base of a 10-m cliff on the north side. Sixteen nests were found on East Island, distributed among all sides of the island. The best habitat and most nests were found in and around the rocky ridge running along the south shore. Two nests contained birds with *S. h. hypoleucus* facial patterns—a nest on West Island containing two chicks (25 February) and another on Middle Island containing an adult on two eggs (3 May). Vocalization counts conducted during 23–28 February, 1–4 May and 28 June–3 July averaged 26 detections per survey. May surveys had the highest average detection rates (43 detections/survey,  $n = 11$ ), compared with 17 detections/survey ( $n = 9$ ) in February and 2 detections/survey ( $n = 6$ ) in June and July. The two surveys with highest detections (one land-based, 77 detections; one boat-based, 82 detections) occurred on consecutive nights on West Island. Both were done on the southeast side of the island, near the main landing cove for the fish camp.

#### Adelaida Island

##### Background

No evidence of historical breeding is known. This small, low-lying rocky islet (5 ha, 12 m high) has no vegetation. A small shack on the east side has been used as a residence by guano miners in the past. Large numbers of California Sea Lions *Zalophus californianus* haul out on the island. The island is covered in a smooth layer of bird guano and feces from the sea lions. Guano mining may resume on Adelaida in the near future (E. Palacios, pers. comm.).

##### 1999 Results

No nests were found on 7 March 1999. No vocalization surveys were conducted. About 200 small burrows were noted on the island. Forty were checked with flashlights, and only one abandoned egg was found, which was not reachable. Based on the solid white color, size and shape of the egg, it was probably from a Cassin's Auklet or storm-petrel (*Oceanodroma* sp.).

#### Natividad Island

##### Background

No evidence of historical breeding is known. The south half of the island consists of stabilized sand dunes that support the world's largest colony of Black-vented Shearwaters *Puffinus opisthomelas* (Keitt *et al.* 2000). Feral cats, present since the early 1900s and removed in 2000, greatly impacted the shearwater colony (Keitt *et al.* 2002, Keitt & Tershy 2003). Cats may have extirpated both murrelets and Cassin's Auklets. The northern half of this moderate-size island (1000 ha, 6.1 km long, 150 m high) is steeper than the more sloping southern half, with numerous drainages cutting into a central plateau in the northern third of the island. Shrub and cactus habitat is common on the northern half. A town of 120 buildings and about 500 fishermen is located on the southwest side of the island. Natividad Island is considered a possible historical breeding site for Xantus's Murrelets (Drost & Lewis 1995).

##### 1999 Results

During 6–8 May 1999, no nests were found in 15 psh, and no murrelets were heard vocalizing at night. Nest search effort was

concentrated on the north end in both shrub and scree habitat. The south end of the island was not searched because past work (see below) had indicated that murrelets did not breed there. One vocalization survey conducted on the middle east coast produced no detections. Murrelet calls were listened for opportunistically while walking at night (11h30–02h00) over a distance of 3 km along the east shore, but no birds were detected. Additionally, during two 4-month seasons of field research by the author (spring and summer of 1997 and 1998), no Xantus's Murrelets were heard. The only murrelet so far encountered on Natividad was a Craveri's Murrelet captured at night on a boat just offshore of the island on 6 May 1997. Photographed in hand, the bird clearly showed the dark underwing linings and facial pattern of a Craveri's Murrelet. It did not have a brood patch and was not yet undergoing primary molt.

#### Asunción Island

##### Background

A dead Xantus's Murrelet and egg were reportedly collected in 1977 (R. Osorio, pers. comm., cited in Drost & Lewis 1995)—the only evidence of historical breeding. This small island (67 ha, 1.2 km long, 50 m high) is relatively barren, with a few California Boxthorn *Lycium californicum* shrubs and other low-lying vegetation scattered across the island. Although uninhabited, the island is visited regularly by fishermen. Feral cats destroyed a substantial colony of Cassin's Auklets in the 1970s (McChesney & Tershy 1998).

##### 1999 Results

On 3–4 March 1999, no nests were found in 8 psh, and no murrelets were heard on three vocalization surveys.

#### San Roque Island

##### Background

Bancroft (1927) reported breeding murrelets on this small island (79 ha, 1.2 km long, 15 m high), although it is unclear whether they were Xantus's or Craveri's murrelets. Historical guano-mining operations likely impacted murrelets. Rats, probably introduced during guano mining, eradicated breeding Cassin's Auklets (McChesney & Tershy 1998).

##### 1999 Results

During 4–5 May 1999, no nests were found in 6.5 psh, and no murrelets were heard during four vocalization surveys.

#### Guadalupe Island

##### Background

Breeding was first reported in 1892 (Carter *et al.* 2005). Nests have not been found on the large main island (26 500 ha, 32 km, 1300 m), which supports a small military garrison (approximately seven personnel) and a fishing cooperative (approximately 70 members). The southern subspecies (*S. h. hypoleucus*) has been documented to breed on two offshore islets: Negro (17 ha, 0.7 km long, 35 m high), with an estimated 200 pairs, and Afuera (68 ha, 1.1 km long, 200 m high), with an estimated 1000–1500 pairs (DeLong & Crossin 1968, Jehl & Everett 1985). No *S. h. scrippsi* have been found breeding at Guadalupe Island. Feral cats, present on the main island since at least 1900, have probably reduced greatly the number of murrelets there. In 1977, Pierson and Riedman reported murrelet carcasses in a cave on the east side of the main island, suggesting that nesting may persist in some places (see Jehl & Everett 1985). In addition, between 2001 and 2003, several cat-killed adult murrelets were found on the south end of the main island (R. Henry, unpubl. data).

### 2003/04 Results

On 16 May 2004, 35 nests were found on Afuera Islet in 2.75 psh (12.7 nests/hour). Nine nests had incubating adults and 15 nests had freshly hatched eggshell fragments. Eleven nests contained abandoned eggs or old eggshells where it was not possible to determine whether eggs had hatched or not. Fifteen of the 35 nests (43%) were located under shrubs. Afuera Islet was the only site where nesting beneath shrubs was encountered in this study. Several hundred old eggs from previous years (i.e. inside and outside of inactive nest sites) were found on Negro Islet just before the 2003 breeding season. Nesting (four inactive sites with abandoned eggs) was noted on Gargoyle Rock, between the south point of Guadalupe Island and El Toro Islet (D. Barton, K. Lundquist & R. Henry, unpubl. data). Frequent vocalizations were heard at the south end of the main island, but no vocalization surveys were conducted.

### Cedros Island

#### Background

No evidence of historical breeding is known. This large island (37 800 ha, 33 km long, 1200 m high) supports a large military base (several hundred personnel) and a town of 3000 people. Predators (e.g. cats, rats, and dogs) limit potential seabird habitat. However, the island's large size and multiple offshore rocks provide abundant habitat that has never been examined for murrelet nesting.

#### 1999 Results

No nest searches or vocalization surveys were conducted.

### DISCUSSION

The status of Xantus's Murrelet in Baja California, Mexico, has been difficult to determine because of the large geographic extent and remoteness of the area, the difficulty of conducting population surveys and insufficient resources. However, heightened interest in assessing population status in Baja California stems from apparent population declines of Xantus's Murrelets elsewhere and increasing threats, both at sea and at breeding islands throughout the species' range (Drost & Lewis 1995; McChesney & Tershy 1998; Carter *et al.* 1992, 2000; Burkett *et al.* 2003). The most important findings from surveys conducted in 1999 and 2004 were these:

- Murrelets currently breed on San Jerónimo Island (based on observed nests) and probably breed on Todos Santos and San Martín islands (based on vocalizations), where it was thought they had been extirpated by introduced mammals (Jehl & Bond 1975, McChesney & Tershy 1998).
- Murrelets continue to breed on Coronado, San Benito and Guadalupe (offshore islets) islands.
- The first nests of the southern subspecies (*S. h. hypoleucus*) were found at the San Benito Islands.

#### Nest searches

Murrelet nests were found on seven of 14 islands searched. Nest detection rates are not direct indices of nest abundance because terrain and habitat affected greatly the results of nest searching. Searching was easiest on the San Benito Islands (27 nests found) and most difficult on San Martín Island (no nests found). Excluding Guadalupe Island (12.7 nests/psh), nest detection rates were similarly low on all islands where nests were found (0.4–0.5 nests/psh) and seemed more affected by terrain than by abundance of birds. Nest detection did not increase directly with the number of vocalization detections at each island. For example,

nest detection was similar (0.5 nests/psh) on South Coronado Island (187 vocalization detections/survey) and San Jerónimo Island (31 vocalization detections/survey). The highest rate of nest detection occurred on Afuera Islet, where previous observers also reported large numbers of breeding murrelets (DeLong & Crossin 1968, Jehl & Everett 1985). Given the high historical estimates and high nest detection rates in this study, the Guadalupe Island area appears to have the largest population of the southern subspecies (*S. h. hypoleucus*) and possibly the largest breeding population of Xantus's Murrelets anywhere (see also Jehl & Everett 1985). At most colonies, nest searches are not useful for estimating the total breeding population of Xantus's Murrelets, but may be used in the most accessible habitats on certain colonies (e.g. Santa Barbara Island; Carter *et al.* 1992). Nest searches are valuable for confirmation of breeding, assessing nesting phenology, assessing subspecific status and verifying the link between near-shore vocalizations and nesting on the adjacent island.

#### Vocalization surveys

Murrelet vocalizations were heard at 12 of 15 islands surveyed. All islands with nests found had vocal activity, and three islands on which no nests were found also had vocal activity (San Martín, Todos Santos North, and Todos Santos South). It has been suggested that vocalization activity occurs only near nesting colonies (Carter *et al.* 1996, Whitworth *et al.* 2002). The fact that vocalizations were heard at all the islands where nests were found supports this assertion. The failure to find nests at other islands with vocalization detections does not refute the connection because of the great difficulty of finding nests in inaccessible habitats. Vocalization detection rates were highest on the Coronado Islands in 1999 and were similar to rates reported at the Coronado Islands and at Santa Barbara Island in 1995 (Carter *et al.* 1996; H. Carter, unpubl. data). Whitworth *et al.* (2003b), using spotlight surveys in 2002, also found large numbers of murrelets at the Coronado Islands. Low rates of vocal detection at Todos Santos Islands suggest that small numbers of birds were breeding in non-searched areas. In fact, nests were found on South Island in 2005 (H. Carter & D. Whitworth, unpubl. data). Unfortunately, correction factors are not available to calculate population size of breeding birds from vocal detection rates. Assuming that a generally positive correlation exists between numbers of vocal detections and breeding population size, the Coronado Islands appear to support the largest colony of *S. h. scrippsi* (see also Whitworth *et al.* 2003b).

Boat-based vocalization surveys tended to have higher detection rates than did land-based surveys on three islands where both were conducted. Boat-based surveys averaged 60.2 detections per survey ( $n = 26$ ), and land-based surveys averaged 39.3 detections per survey ( $n = 20$ ). Because land-based surveys detected equally well the presence or absence of murrelets in nearshore at-sea congregations, this technique may be an effective way to determine murrelet presence without the need for a boat or for long periods of nest searching.

#### Breeding phenology at the San Benito Islands

Drost & Lewis (1995) mentioned potential earlier breeding at the San Benito Islands and other southern colonies. At the San Benito Islands, two nests with apparently freshly laid single eggs (clean eggs showing no signs of extended neglect) were found in late February 1999, indicating that the female was at sea forming the second egg (Murray *et al.* 1983). Nests with young chicks were also encountered, which suggested at least some egg laying had occurred

in early-to-mid January 1999 (incubation lasts 27–44 days according to Murray *et al.* 1983). Murrelet activity was higher in May than in February 1999 judging from nest encounter rates (0.68 per hour versus 0.3 per hour) and vocalization rates (43 detections versus 17 detections per survey). Thus, peak colony attendance may have occurred in March–May 1999, as found for colonies in most years in southern California (Murray *et al.* 1983; Drost & Lewis 1995; Whitworth *et al.* 2003a; H. Carter, unpubl. data). In July 1999, vocalizations had tapered off, and the breeding season was mostly finished, as also found in southern California.

In 2002, the breeding season was well advanced in late March, based on a relatively high proportion of birds with brood patches captured at sea at the San Benito Islands (Whitworth *et al.* 2003c). In 2003, breeding at West San Benito Island began in March and continued through July (Wolf *et al.* 2005). At Afuera Islet in 2003, murrelets showed a phenology similar to that at the San Benito Islands in 2003, with birds arriving at the island in January and first nests found in March (R. Henry, D. Barton & K. Lundquist, unpubl. data). At Afuera Islet in 2004, birds were incubating on 12 May, and numerous nests had fresh-hatched shell fragments, suggesting phenology similar to that seen in 2003. In summary, early breeding by at least some birds occurs in the San Benito Islands in some years, and extensive overlap in the timing of breeding occurs throughout the breeding range in many years.

#### Subspecies of Xantus's Murrelet and Craveri's Murrelet

To my knowledge, the two nests of *S. h. hypoleucus* found on the San Benito Islands are the first nests documented for that location. Previously, the nominate subspecies was surmised to breed on the San Benito Islands, based on the capture of birds in nearshore waters (Jehl & Bond 1975, Drost & Lewis 1995, Whitworth *et al.* 2003c). However, *S. h. scrippsi* was the most frequently encountered subspecies during work at the San Benito Islands in 1999 and 2002 (Whitworth *et al.* 2003c).

Based on at-sea captures and museum specimens, varying ratios of murrelets have been reported for the San Benito Islands:

- 40% *S. h. scrippsi*, 20% *S. h. hypoleucus*, 40% *S. craveri* (n = 17 at-sea captures; DeLong & Crossin 1968)
- 47% *S. h. scrippsi*, 38% *S. h. hypoleucus*, 15% intermediate forms (n = 47 at-sea and museum specimens; Jehl & Bond 1975)
- 61% *S. h. scrippsi*, 32% *S. h. hypoleucus*, 7% intermediate forms (n = 44 at-sea captures; Whitworth *et al.* 2003b)

Since the late 1960s, no Craveri's Murrelets have been documented, and a nest of this species has yet to be found at the San Benito Islands. Past occurrence in this vicinity may reflect postbreeding dispersal from colonies in the Gulf of California. This idea is supported by the relatively late dates of occurrence of Craveri's Murrelets at the San Benito Islands as compared with known breeding phenology in the Gulf of California (DeWeese & Anderson 1975, Carter *et al.* 2005).

#### Introduced mammals

Introduced mammals occurred in the past on at least 12 of the islands surveyed. Murrelet predators (cats and rats) historically occurred on 10 of the islands, and herbivores (rabbits, goats, sheep, burros) occurred on at least five islands (Table 2). Cats and rats are known to prey on adult seabirds (McChesney & Tershy 1998, Keitt *et al.* 2002, Keitt & Tershy 2003), and researchers have found many cat-killed murrelets on Baja California islands. R. Pitman

reported carcasses of 204 murrelets on Coronado North Island in 1989 and 1990 (Carter *et al.* 1996; McChesney *et al.* 2000). B. Tershy and BSK (unpubl. data) collected more than 50 murrelet carcasses on North Coronado Island in 1994. Introduced predators have had an extensive impact on murrelets in Mexico, possibly causing four island extirpations (Asunción, San Roque, Natividad and Guadalupe [main island]) and significant declines in four island groups (Coronado, Todos Santos, San Martín and San Jerónimo). Extirpations and declines appear to have had greater impact on the southern subspecies, *S. h. hypoleucus*. However, additional surveys are needed to verify potential extirpations and to better determine current population sizes.

Since 1994, GECI and other groups have removed introduced mammals from every murrelet breeding island or island group in Mexico except Guadalupe (Table 2). Currently, introduced mammals occur only on the main island at Guadalupe (cat, dog, goat), Cedros Island (cat, rat, goat and others) and Natividad Island (ground squirrel, dog). The eradication of introduced mammals on the islands has greatly reduced the most significant colony-based threat to the Xantus's Murrelet in Baja California, Mexico. Additional surveys are needed to monitor expected population increases.

#### Population estimates

Standard methods to estimate populations of Xantus's Murrelets have not been developed, and many current estimates are based on few data. Data obtained in Baja California in 1999 and 2004 suggest that populations remain similar to those previously estimated (e.g. about 2300 breeding pairs; Drost & Lewis 1995). From observations of birds and nesting habitat in 1999 and 2004, preliminary estimates of breeding populations at island groups are Coronado, 750–1500 pairs; Todos Santos, <50 pairs; San Martín, <50 pairs; San Jerónimo, <100 pairs; San Benito, 300–750 pairs. Including a previous estimate of 1000 pairs for Guadalupe Island, I roughly estimate between 2200 and 4000 breeding pairs in Baja California, Mexico, consistent with other estimates of 2000–5000 pairs (see "Introduction"). However, true population size may exceed these estimates, given

- the large numbers of vocal detections and birds counted by Whitworth *et al.* (2003b) during spotlight surveys at the Coronado Islands;
- a potentially protracted breeding season (January through June) on the San Benito Islands in 1999 (affecting this study); and
- the upper confidence limit on population size derived from at-sea surveys (Karnovsky *et al.* 2005).

#### Future research and conservation actions

Islands on the northwest coast of Baja California provide critical breeding habitat for Xantus's Murrelets. Despite recent efforts to remove introduced mammalian predators and herbivores from some islands, more work is needed. Currently, the main colony-based threats in Mexico are feral cats on Guadalupe Island, the threat of future introductions of cats and rats to nesting islands, and the effect of bright lights at colonies. In addition to direct conservation actions, further research and surveys are needed to develop a better understanding of the breeding biology and status of Xantus's Murrelets on Baja California islands. Future surveys should concentrate on Guadalupe and Cedros islands. Standardized methods for determining population sizes and assessing changes in breeding populations are needed.



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