STATUS REVIEW OF XANTUS'S MURRELET

Report to the California Fish and Game Commission

November 2003

California Department of Fish and Game
The Resources Agency
State of California

State of California
The Resources Agency
Department of Fish and Game

STATUS REVIEW OF XANTUS'S MURRELET *(Synthliboramphushypoleucus)* IN CALIFORNIA

Prepared by

Esther E. Burkett
(Habitat Conservation Planning Branch)

Nora A. Rojek
Annette E. Henry
Marilyn J. Fluharty
(Marine Region)

Lyann Comrack
(South Coast Region)

Paul R. Kelly
(Office of Spill Prevention and Response)

Ann C. Mahaney
and
Kristi M. Fien
(Wildlife and Habitat Data Analysis Branch)

Approved by

Ronald D. Rempel
Deputy Director
Habitat Conservation Division

Habitat Conservation Planning Branch
Status Report 2003-03

November 2003

Suggested Citation for this report:

Burkett, E.E., N.A. Rojek, A.E. Henry, M.J. Fluharty, L. Comrack, P.R. Kelly, A.C. Mahaney, and K.M. Fien. 2003. Report to the California Fish and Game Commission: Status Review of Xantus's Murrelet (*Synthliboramphus hypoleucus*) in California. Calif. Dept. of Fish and Game, Habitat Conservation Planning Branch Status Report 2003-03. 96 pp. + appendices.

Front Cover Photograph by: Darrell L. Whitworth

TABLE OF CONTENTS

Executive Summary (6 pages)

List of Figures

List of Figures
-continued-

List of Acronyms and Abbreviations

BRD	Biological Resources Division
CCAMLR	Commission for the Conservation of Antarctic Marine Life
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
Commission	Fish and Game Commission
CSC	California Species of Concern
Department	California Department of Fish and Game
FESA	Federal Endangered Species Act
FGC	Fish and Game Code
HSU	Humboldt State University
ICEG	Island Conservation and Ecology Group
INRMP	Integrated Natural Resources Management Plan
IUCN	International Union for Conservation of Nature and Natural Resources
MLMA	Marine Life Management Act
MLPA	Marine Life Protection Act
MPAs	Marine Protected Areas
murrelet	Xantus's Murrelet
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
PSG	Pacific Seabird Group
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

List of Appendices

Xantus's Murrelet Status Review
Executive Summary
November 14, 2003

Petition History

On April 16, 2002, the Fish and Game Commission (Commission) received a petition to list the Xantus's Murrelet (*Synthliboramphus hypoleucus*) as a threatened species under the California Endangered Species Act (CESA). The Commission referred the petition to the Department of Fish and Game (Department) for evaluation on April 25, 2002. Based on its review, the Department determined the petition included sufficient information to indicate the petitioned action may be warranted, and recommended that the Commission accept the petition and designate the Xantus's Murrelet as a candidate species pursuant to CESA. The Commission accepted the petition based on the Department's recommendation on October 23, 2002, and provided notice of its findings in the California Regulatory Notice Register designating the Xantus's Murrelet as a candidate species on November 15, 2002.

Following the Commission's action designating the Xantus's Murrelet as a candidate species, the Department solicited information and undertook a status review of the species using the best scientific information available. This report contains the results of the Department's status review, including input from four peer reviewers with expertise on the Xantus's Murrelet, or closely related species. Also included are the Department's recommendations to the Commission regarding a preliminary identification of habitat that may be essential to the continued existence of the species, as well as management activities and other recommendations for the recovery of the species.

Conclusions

The Department recommends listing of the Xantus's Murrelet as threatened due primarily to:

1) Small breeding population size in California (approximately 3,460 breeding birds);

2) Documented population decline of approximately 30% from 1977 to 1991 on Santa Barbara Island; this island supports 51% of the murrelet population in California;

3) Declining occupancy rates at nesting sites on Santa Barbara Island, coupled with low productivity as compared to the closely related Ancient Murrelet (*Synthliboramphus antiquus*);

4) Near extirpation from previously known nesting sites based on historic and current scientific information;

5) Vulnerability to oil spills during the breeding and non-breeding season, within and outside California;

6) Suppression of population growth by a variety of native and non-native predators; and

7) Impacts from artificial light pollution and human disturbance activities, and including cumulative impacts.

Habitat changes associated with human activities, and introduced predators (feral cats and rats) have caused population declines throughout the range of the murrelet. In particular, the Department finds that habitat modification has been severe on Santa Barbara Island due to various human activities (for example, farming, burning, and livestock grazing). Fifty-one percent of the murrelet population in California now nests on this small island of only one square mile in size.

The loss of a large Cassin's Auklet (*Ptychoramphus aleuticus*) colony (a burrow-nesting alcid), and the extinction of the Santa Barbara Island Song Sparrow (*Melospiza melodia graminea*) are indicative of the massive habitat loss that occurred on Santa Barbara Island. A coordinated management effort will be necessary to return the island vegetation and wildlife species to a condition more closely approaching natural conditions.

Rat eradication efforts at Anacapa Island were recently initiated in 2001 and 2002 as part of the *American Trader* Oil Spill Restoration Plan. Murrelets had been limited from occupying suitable habitat on this island because of rat presence and predation. Initial monitoring efforts indicate that rats have been eradicated, and that more murrelets are now occupying the waters around Anacapa Island. Additionally, the number of known nests has increased slightly, and nest success has increased. However, due to the low reproductive rate, low juvenile survival, and high colony fidelity, it may take 10 years or more to see substantial increases in nesting effort and reproductive success at Anacapa Island. If rats were accidentally reintroduced onto the island, then the situation would soon revert to a serious bottleneck to murrelet recovery, without immediate efforts to re-eradicate rats.

Life History, Distribution, Population Trend, and Management Status

The Xantus's Murrelet is a member of the seabird family Alcidae, which includes murres and puffins. Alcids are known for their longevity and low reproductive rate. With few exceptions, alcids must nest on offshore rocks or islands where adult birds are free from predation by terrestrial predators such as rats, cats, and foxes.

Murrelets spend most of their lives at sea foraging for small fish and zooplankton, and only come ashore for breeding purposes. They are nocturnal when attending to their nest sites and lay only 1-2 eggs per clutch, although a replacement clutch can be laid if the first clutch is lost. Nests are located in natural cavities, and under shrubs, especially along or near cliffs. Sea caves are also used for nesting. They have been documented to live up to 15 years in the wild and they usually return to the same island for breeding each year.

The worldwide breeding range of the murrelet is restricted to the Channel Islands of southern California, and small islands along the west coast of Baja California, Mexico. Xantus's Murrelets are known to nest on only 12 islands scattered along 500 miles of coastline. Santa Barbara Island, the smallest of the Channel Islands in size, is the largest current colony in California. Anacapa Island may have been the largest colony in the past, and may become the largest colony in the future. Post breeding and winter distribution is offshore from British Columbia south to Baja California.

Historical accounts and literature from the 1940s indicates that murrelets were more abundant at that time than today. Currently, the murrelet is considered an uncommon species, with only 3,460 breeding birds in California, and approximately 8,310 breeding birds worldwide. Research from the 1970s to 1991 documented a decline in murrelet numbers on Santa Barbara Island of approximately 30%. However, it is difficult to directly compare the studies since different methods were utilized.

More recently, a marked decline has occurred during the past 15 years, continuing the trend noted above, based on murrelet occupancy rates at National Park Service (NPS) nest monitoring plots on Santa Barbara Island. In general, nest site occupancy rates for identified potential nest sites have declined from approximately 35-70%, to less than 30%. A statistical analysis of this data indicates the decline is significant and continuing downward. Another (larger) nest plot monitoring study, outside of, but also including a part of one NPS nest plot, showed a decline of 14% in the number of active nests when comparing 1991 to 2001. Some nest sites on the island have been lost due to reduction in shrub cover; the reasons for this need investigation.

Additionally, based on data collected in the field, murrelet productivity (murrelet chicks per adult pair) is low. Productivity at Santa Barbara Island averaged 0.81 from 1983 -1995. This productivity measure is low compared to Ancient Murrelets that average 1.44 to 1.69 chicks/pair. Low productivity is probably contributing to the Xantus's Murrelet population decline and warrants further investigation.

The small worldwide population size, population declines, and numerous threats have led to special status classification for the murrelet as follows: 1) **"Vulnerable"** (International Union for Conservation of Nature and Natural Resources); 2) **"Species of Special Concern"** (Department of Fish and Game); 3) **"Bird of Conservation Concern"** (U.S. Fish and Wildlife Service); and 4) **"Conservation Priority Species"** (Marine Species of Common Conservation Concern Initiative, North American Commission for Environmental Cooperation). These classifications have proven insufficient to reverse population declines.

Threats

Non-native Mammals The introduction of non-native mammals including sheep, goats, cats, rats, and rabbits is implicated in major declines in several murrelet colonies from the Channel Islands to Mexico. Feral cats prey on adult murrelets and chicks, and rats prey on eggs, chicks, and adult murrelets. Sheep, goats, and rabbits heavily graze the native vegetation and cause vegetation changes, including vegetation loss and changes in plant species abundance and composition. Loss of shrub cover due to overgrazing reduces

nesting opportunities for murrelets. Vegetation change was compounded by the introduction of annual non-native grasses by human activities.

Oil Pollution Like all other alcids, murrelets are extremely vulnerable to oil pollution because, in contrast to more aerial species such as gulls and terns, murrelets spend most of their time at sea swimming on the ocean surface, where oil pollution is concentrated. In southern California, seabird mortality has been documented due to oil spills from offshore platforms, pipelines, tankers, and other military and commercial shipping. Oil shipping lanes pass through murrelet foraging habitat, and numerous oil platforms exist in the Channel Islands area. Some dead and oiled Xantus's Murrelets have been reported on beaches in central California. Murrelets are not easily found during oil spill events due to their distribution away from the coast line, where little carcass recovery activity occurred, at least in the past, and due to at-sea carcass loss due to sinking or scavenging following exposure far offshore. If a large spill occurred in the Channel Islands during the breeding season, when the murrelets are present in greatest numbers, the population could be heavily impacted. They may also be impacted, though to a lesser degree, when they are dispersed both north and south of the Channel Islands during the non-breeding season (approximately mid July through January).

Native Predators Deer mice (*Peromyscus* spp.) are known predators on murrelet eggs, and occasionally they prey on chicks. Deer mice densities on Santa Barbara Island are unusually high, and studies indicate these densities are the highest recorded from published studies in North America. A study on Santa Barbara Island concluded that 44% of murrelet eggs laid were consumed by mice. Barn Owl (*Tyto alba*) densities track the population pattern of deer mice, lagging just slightly behind the peaks. Up to 30 Barn Owls have been noted on Santa Barbara Island during peak mouse periods. Barn Owls are significant predators of adult murrelets. It is estimated that an average of 57 murrelets were killed per year from 1982-1987. Peregrine Falcons (*Falco peregrinus*) have been extirpated from the Channel Islands as breeders since 1955 due to DDT effects. They have only recently returned as breeding birds in the late 1990s. Because peregrines are known predators of Xantus's Murrelets, falcon predation is potentially an emerging threat.

Artificial Light Pollution Murrelets, like many other nocturnal seabirds, are attracted to lights at night. Once attracted, the blinding lights often cause birds to collide with the vessel. In turn, this may cause immediate death, or more commonly, injuries or oil-contamination on board that may lead to later death at sea after escape or release by humans. Small amounts of vessel lighting have been documented to cause parent-chick separation in the Channel Islands, though *temporary* separation may not cause chick mortality. Chicks will die if *permanently* separated from their parents after departing nesting sites as they are dependent on their parents for an extended period of time. Increased lighting near breeding colonies, for example by commercial squid fishing boats, may contribute to increased predation of murrelets by Barn Owls and Western Gulls (*Larus occidentalis)*. Bright lights may also disrupt courtship and breeding activities. A variety of vessels in the Channel Islands utilize artificial lights that could impact murrelets.

Human Disturbance at Colonies Human visitation to nesting areas can result in habitat degradation, nest site destruction, and nest or colony abandonment. Park visitors at Santa Barbara Island need to be reached with educational materials so that they avoid straying

off the trails. The Department is already working with NPS and others on educational materials as part of the Anacapa Island rat eradication effort. Interagency cooperation is necessary to design management solutions for protection of murrelet nest sites, including sea caves and offshore rocks.

Oceanographic and Prey Changes Murrelets forage widely in the Southern California Bight and prey on numerous species of fish and zooplankton. Prey items include various life stages of Northern anchovies (*Engraulis mordax*), but also include larval Pacific sauries (*Cololabis saira*), rockfish (*Sebastes* sp.), juvenile Bluefin Driftfish (*Psenes pellucidus*) or Medusafish (*Icichthys lockingtoni*), sand lance (*Ammodytes* sp.), and zooplankton. In general, murrelets are probably capable of foraging opportunistically on a variety of both small fish and zooplankton prey. Total zooplankton (including salps and jellyfish) in southern California waters declined by 80 percent between the 1950s and the early 1990s, but the overall decline was largely due to reductions in salps and jellyfish, species that are not known to be murrelet prey items. Declines in larval anchovies have also been documented, but Xantus's Murrelets may be able to "prey-switch" from northern anchovies to Pacific sardines (*Sardinops sagax*). The magnitude of the sardine population increase since 1983 was greater than the corresponding decline in northern anchovy, which may mitigate the loss of anchovy in the diet of murrelets. Murrelet reproduction is affected by prey availability, as with most seabirds. The Department believes prey decline may be a factor in murrelet population decline, but more studies are needed.

Military Operations/San Clemente Island San Clemente Island is used as a Department of Defense U.S. Navy (US Navy) training facility. A small breeding population of 10-50 pairs of Xantus's Murrelets is known from the island. In the past, sea stacks and rocky shores where murrelets could nest have been used as military targets. There is a "Sea Test Range" for military activities in the Channel Islands area, and studies of radio-marked murrelets from Santa Barbara Island showed high overlap between murrelet foraging distribution and areas of the test range. The US Navy recently completed their Integrated Natural Resources Management Plan (INRMP) for San Clemente Island in May 2002. Xantus's Murrelets were specifically identified in the INRMP and measures to protect murrelets were described. Impacts to murrelets from military activities are poorly known, but the Department will continue to work with the US Navy to further the conservation of the murrelet.

Bycatch in Fisheries Xantus's Murrelets have been reported as bycatch in drift gill nets off the coast of British Columbia while other murrelets have been taken in various set and drift gill net fisheries with mesh sizes ranging from 2.75 to 9 inches. While Xantus's Murrelets have not been reported as bycatch in California set and drift gill net fisheries, bycatch may be occurring due to the size of the mesh used. In 2003, an observer program was initiated for the white seabass (*Atractoscion nobilis*) fishery, but no bird species were documented as being taken. At this time, the Department needs additional data to determine the extent of potential impacts. However, even a chronic low level of bycatch could be a problem for the species when considered in the context of population decline and on going impacts from other factors. The Department believes bycatch in fisheries may have a minor effect on murrelet populations, but more information is needed.

Recommendations

The Department recommends that the Commission add Xantus's Murrelet to the list of threatened species.

Interagency coordination should be established with the goal of stopping, and then reversing the population decline of the murrelet. Protection and enhancement of existing nesting colonies and protection of the marine environment essential to the continued existence of the species are important.

Management recommendations for recovery and conservation are outlined in the status review report. An interagency team should be developed to prioritize the management recommendations, and to develop additional recommendations.

The team should work to implement the management recommendations, and develop new recommendations as needed. Non-governmental organizations should also be included in murrelet conservation efforts.

Status Review of Xantus's Murrelet in California
Report to the Fish and Game Commission
November 14, 2003

Introduction

Petition History

On April 16, 2002, the Fish and Game Commission (Commission) received a petition from the Pacific Seabird Group (PSG) to list the Xantus's Murrelet (*Synthliboramphus hypoleucus*) as a threatened species under provisions of the California Endangered Species Act (CESA). The proposed listing included both subspecies of the Xantus's Murrelet, *S.h. scrippsi* and *S.h. hypoleucus*. The Commission reviewed the petition for completeness, and pursuant to Section 2073 of the California Fish and Game Code (FGC), referred the petition to the Department of Fish and Game (Department) on April 25, 2002, for evaluation. The Department had a 90-day period to review the petition and make one of the two following findings:

- Based upon the information contained in the petition, there was sufficient evidence to indicate that the petitioned action may be warranted and the petition should be accepted and considered; or
- Based upon the information contained in the petition, there was not sufficient evidence to indicate that the petitioned action may be warranted, and the petition should not be accepted and considered.

The Department requested a 30-day extension to complete the evaluation and recommendation. At the Commission meeting on June 20, 2002, in South Lake Tahoe, the Department received the extension for consideration of the petition.

The Department found that the information in the petition was sufficient to indicate the petitioned action may be warranted, and recommended the Commission accept the petition. At the Commission meeting in Santa Barbara on October 23, 2002, the Commission received the Department's evaluation report, recommendation, and public testimony, and the petition was accepted by the Commission. On November 15, 2002, the Commission published a Notice of Findings in the California Regulatory Notice Register declaring Xantus's Murrelet a candidate species, thereby starting the candidacy period and the one year status review process. A candidate species is defined as a native species or subspecies of bird, mammal, fish, amphibian, reptile, or plant the Commission has formally noticed as being under review by the Department for addition to either the list of endangered species or the list of threatened species. The Commission also adopted a special order pursuant to FGC Section 2084 to provide for incidental take under specific circumstances of Xantus's Murrelet during the candidacy period.

Department Review

This report, pursuant to FGC Section 2074.6, details the Department's review and recommendations to the Commission regarding the proposed listing of the Xantus's Murrelet as a threatened species under CESA. The discussion and analysis set forth below is based on the best scientific information available. The Department's recommendation about whether the petitioned action is warranted is also addressed. Further, this status review identifies habitat that may be essential to the continued existence of the species and suggests management activities and other recommendations for recovery of the species.

The Department contacted affected and interested parties, invited comment on the petition, and requested any additional scientific information that may be available, as required under FGC Section 2074.4. The Department produced a public notice (Appendix A1) and distributed it by mail on March 2, 2003, to as many affected and interested parties as was practicable. Appendix A2 contains a list of individuals, organizations, and agencies contacted. Newspapers that published the public notice on March 2, 2003 are shown in Appendix A3.

In an attempt to obtain and review all available information on Xantus's Murrelets, Department staff contacted various scientists and researchers outside the Department for all available information. Information collected by and provided to the Department by the scientific community is vital to the completeness of this review. In addition, the Department provided a draft version of its status review to several qualified experts for Peer Review. The list of scientific experts and their Peer Review comments to the Department regarding Xantus's Murrelet are shown in Appendix B.

All four peer reviewers supported the Department's recommendation for listing the Xantus's Murrelet as a threatened species. We considered all of the peer review comments received, and most of their comments have been incorporated into this report. In some cases, we were unable to incorporate the information or respond to particular questions, because we needed more information in order to properly address the issue at hand, or discussion with experts was needed before definitive conclusions could be drawn. Additionally, there are some areas where additional research is needed before definitive conclusions can be drawn.

Finally, the Commission and Department received two letters commenting on the listing petition and the status of the Xantus's Murrelet as a candidate species under CESA (Appendix C).

Life History

The Xantus's Murrelet (murrelet) is a member of the family Alcidae, which includes murres, puffins, guillemots, and the extinct Great Auk (*Pinguinus impennis*).

Most members of the alcid family are black above and white (or light brown/black) below, and they are sometimes referred to as "penguins of the north" due to similarities with penguins, both in plumage characteristics and excellent diving ability. Their legs are set far back on their body, giving them an upright stance on land, and making walking awkward. In flight, their wingbeats are rapid and shallow. However, they are swift underwater, using their wings to propel themselves forward in search of prey, a trait known as "pursuit diving".

Alcids are known to be long lived, and to have a low reproductive rate, laying only 1-2 eggs per clutch (depending on the species), and usually not breeding until 3-4 years old or more. The average life span of many alcids is over ten years (Gaston and Jones 1998). Xantus's Murrelets have thus far been documented to live up to 15 years old in the wild (Carter et al. 1992). Age of first breeding and adult survival rates (from year to year) are unknown for the Xantus's Murrelet. Population parameters from a closely related species, the Ancient Murrelet (*S. antiquus*), have been used in population modeling (Sydeman et al. 1998).

A low reproductive rate, as is the case with most alcids, can make it difficult for populations to recover quickly from impacts. This will be discussed more fully in the Population Trend section of this report.

Alcids are known to have high fidelity to their breeding colonies, meaning they often return to breed at the same "colony" where they were born (breeding islands or offshore rocks). Another term for this trait is "philopatry", defined as the tendency of an organism to stay in or return to its home area. Additionally, once the birds begin breeding, they sometimes return to the same specific nest site year after year. Colony fidelity has been demonstrated for the Xantus's Murrelet from studies conducted on Santa Barbara Island (Hunt et al. 1979, Murray et al. 1983). The murrelets were even observed following a consistent path to their nest site (Drost and Lewis 1995).

The Xantus's Murrelet is a small alcid, measuring only 23-25 cm (9-10 inches or less) from tip of bill to tip of tail. An adult bird fits easily into the outstretched hand of an adult human. They are cleanly marked, black above and white below in breeding plumage (Figure 1). Though they molt into a winter plumage, it is not distinct from breeding coloration except by close inspection (Drost and Lewis 1995). Murrelets weigh approximately 167 g (6 oz.) (Murray et al. 1983). Their small body size makes them vulnerable to a broad array of predators.

During daylight hours, murrelets spend most of the time foraging and resting at sea. After dusk and before dawn, during the breeding season, they congregate and vocalize on the waters below their island nesting areas (Murray et al. 1983). Their nesting activities are nocturnal, and they limit all land-based activities, except incubation, to hours of darkness.

Murrelets typically begin arriving in the vicinity of breeding colonies in December and January (Murray et al. 1983, Gaston and Jones 1998). During this time, birds engage in courtship activities on the water and irregularly make nocturnal visits to nest sites (as early as two months before laying eggs but usually during the two to three weeks before egg-laying). Egg-laying is unsynchronized but typically peaks from mid-March to mid-April (Gaston and Jones 1998).

Timing of nesting is variable between years, with egg-laying recorded as early as mid-February and as late as mid-June. Relaying has been reported for birds that lost their first eggs. By the end of July, murrelets are uncommon on or near the islands, as adults with newly hatched young disperse rapidly from breeding areas (Hunt et al. 1979, Murray et al. 1983).

The murrelet has a typical and maximum clutch size of two eggs, which are laid about eight days apart. The two-egg clutch constitutes 45% of the adult female's weight. The first egg is left unattended in the nest until the second egg is laid. Incubation begins after the second egg is laid, and lasts an average of 34 days (range 27-44 days, Murray et al. 1983). Both sexes share incubation duties, and mates relieve one another every two to four days. Eggs are sporadically left unattended during incubation while the adults forage at sea, a condition known as "egg neglect". This leaves the eggs vulnerable to predation by mice and rats.

Murrelet chicks are highly precocial (newly hatched young are covered with down and fully active), and fledge (leave the nest) at 1-2 days after hatching. Their coloration matches the adult pattern (Figure 2).

These secretive alcids nest primarily in rock crevices or small caves along or near cliff ledges (Figures 3a and 3b), but also under shrubs and ground vegetation, and occasionally under man-made debris (Hunt et al. 1979). They can also be found nesting in sea caves along the shore of some islands. There is no evidence that Xantus's Murrelets dig their own burrows (Drost and Lewis 1995).

Chick departures occur exclusively at night, presumably to reduce predation by gulls. Chicks are normally escorted from the nest by both parents on the night of departure. Parents typically lead the chicks down the slope for a short distance before flying out to sea. Left on their own, the chicks make their way directly to the cliff edge where they jump, or get blown off the cliff into the surf below. The chicks may be guided to sea by calls from their parents or other murrelets. The family unit moves rapidly away from the nesting island (perhaps to help reduce gull predation), and remains together at sea for an unknown time (Hunt et al. 1979, Murray et al. 1983).

Intensive studies on the murrelet did not begin until 1975, and two landmark studies covered the period of 1975-1979 (Hunt et al. 1979, Murray et al. 1983). Prior to that time, researchers were primarily interested in breeding

distribution and relative numbers, taxonomic status, and the collection of eggs, young, and adult birds for scientific study and museum specimens. However, the field notes and publications from this early work provide important baseline information to help assess the current status of the murrelet.

The closest relative ("congener") to the Xantus's Murrelet is Craveri's Murrelet (*Synthliboramphus craveri*) that nests in southern Baja California and the Gulf of California (Jehl and Bond 1975). However, little is known of this southern murrelet. Ancient Murrelets are another closely related small alcid; they also nest on the ground in burrows or rocky areas, lay 2 eggs, and have precocial young (Gaston and Jones 1998, and others). Ancient Murrelets nest on offshore islands in the western Pacific Ocean from Japan and eastern Siberia, to Alaska and British Columbia. These murrelets have been well studied for many years, thus, they provide an important key to better understanding the life history of the secretive, and lesser-studied Xantus's Murrelet. Another closely related alcid is the Japanese Murrelet *(S. wumizusume*). This endangered species has a small population size, restricted range, and many similar threats in Japan.

Food habits of the murrelet are discussed in the Threats/Oceanographic and Prey Changes section of this report.

Range and Distribution

A number of studies have documented the range and distribution of the murrelet, including both subspecies, *S.h. scrippsi* and *S.h. hypoleucus* (Jehl and Bond 1975, Hunt et al. 1979, Winnett et al. 1979, Briggs et al. 1987, Carter et al. 1992, Drost and Lewis 1995, Howell and Webb 1995, Keitt 2000, McChesney and Tershy 1998, McChesney et al. 2000, Whitworth et al. 2000, Spear et al. 2003, Whitworth et al. 2003a and others). Breeding season distribution has been more intensively studied than the non-breeding season, and nesting colonies have been more intensively studied than the at-sea aspects of murrelet range and distribution.

Range and Distribution of the Two Subspecies

The two subspecies differ in facial plumage, bill size, and range (Jehl and Bond 1975, Drost and Lewis 1995). The *S.h. scrippsi* subspecies breeds from the northern Channel Islands south to the San Benito Islands, in Baja Mexico, while *S. h. hypoleucus* breeds primarily at Guadalupe Island and the San Benito Islands off Baja (Figure 4). Some murrelets on the San Benito Islands exhibit an intermediate plumage type between these two subspecies (Jehl and Bond 1975). A recent study of murrelets at the San Benito Islands provides the following, based on at-sea captures of birds at night (Whitworth et al. 2003a): 1) All three plumage types (*S.h. scrippsi, S. h. hypoleucus,* intermediate) were captured in March 2002; 2) Proportions of each

plumage type in the captured samples (61%, 32%, and 7%, respectively) were not dissimilar from proportions in museum specimens (47%, 38%, and 15%, respectively) examined by Jehl and Bond (1975), with *S.h. scrippsi* predominant, and the intermediate plumage type relatively rare; and 3) The 2002 captured sample indicated that the morphological differences between subspecies persist at the San Benito Islands where the two races occur together.

However, there is some evidence that *S.h. hypoleucus* breeds in the Channel Islands in small numbers. A nest site of *S.h. hypoleucus* was found on Santa Barbara Island (Winnett et al. 1979), and *S.h. hypoleucus* have been captured on the water at night during the breeding season as follows: a) 1 bird near Scorpion Anchorage at Santa Cruz Island on 9 July 1994; and b) 2 birds near Seal Cove at San Clemente Island on the nights of 12-13 May 1994 and 3-4 May 1996 (H.R. Carter, unpubl. data). Additionally, *S.h. hypoleucus* occurs in U.S. waters in the fall, at least in some years.

Worldwide Distribution

The worldwide breeding range of the Xantus's Murrelet is restricted to the Channel Islands and the west coast of Baja California, Mexico. All California colonies of murrelets are located in the Channel Islands (Figure 4). Xantus's Murrelets have a geographically restricted breeding range of only 12 nesting islands scattered along 500 miles of coastline (Figure 4).

Importance of Santa Barbara Island

Santa Barbara Island, the smallest of the Channel Islands, is the most important colony for Xantus's Murrelet in California at this time. Fifty-one percent of the California Channel Islands population of murrelets utilizes this small island of only 2.6 km^2 (1 square mile) in size. The next largest breeding colony, Anacapa Island, is located 64 km (40 miles) to the northwest of Santa Barbara Island. In the past, numbers of breeding Xantus's Murrelets at Anacapa Island may have been equal to or larger than Santa Barbara Island (McChesney et al. 2000). These islands are discussed in detail in the Population Trend and Threats sections of this report.

At-sea Distribution

Post breeding and winter distribution covers a large geographic area (Figure 5) (Jehl and Bond 1975, Briggs et al. 1987, Drost and Lewis 1995, Karnovsky et al. 1996, Gaston and Jones 1998:207, Whitworth et al. 2000, Spear et al. 2003 and others). The most recent summary of murrelet distribution at-sea is described in Spear et al. 2003, and summarized here. In general, during the breeding season, murrelets that nest in the Channel Islands are concentrated in the Southern California Bight, though the degree of overlap with birds from the Coronados Islands needs more study.

During the non-breeding season, murrelets (presumably from both Baja colonies and the Channel Island colonies) are more dispersed, and occur primarily from northern California to southern Baja California. The area of highest concentration during the non-breeding season was off northern Baja California from about 28°N to 31°N. Moderate numbers were noted off the Oregon coast, decreasing to lower numbers up to northern Vancouver Island, British Columbia.

Similar to the findings of Briggs et al. (1987) and Karnovsky et al. (1996), Xantus's Murrelets were most abundant over the upper continental slope, and at distances of 25-150 km (16-93 miles) from shore. When dispersed from breeding areas, murrelets also preferred warmer, lower salinity waters characteristic of the California Current. This pattern was consistent within any given year regardless of large scale conditions (Spear et al. 2003).

Other Factors Affecting Range and Distribution

The Island Fox (*Urocyon littoralis*), state-listed as threatened, is present on the six larger Channel Islands, but does not occur on the two small islands, Anacapa and Santa Barbara. Most historic accounts of murrelet breeding locations in the Channel Islands refer to Anacapa and Santa Barbara islands. Island foxes eat a wide variety of foods, including insects and berries, and are also known to eat birds and bird eggs (Laughrin 1977: 59). Thus, it appears the presence of the fox limits the distribution of the murrelets to some extent (Hunt et al. 1979, H.R. Carter, pers. comm.). On islands where foxes and murrelets are found, for example, Santa Cruz and San Miguel, the murrelets nest in steep cliffs or on offshore rocks that foxes cannot access. In general, seabird biologists infer that foxes limit the distribution of murrelets in the Channel Islands (Hunt et al. 1979, Sowls et al. 1980, Drost and Lewis 1995). Studies in Alaska and British Columbia also show that introduced foxes have a major impact on the survival of ground-nesting seabirds (Bailey and Kaiser 1993).

Hunt et al. (1980:454) stated: "*Another factor of paramount importance affecting the distribution and numbers of seabirds breeding in the Channel Islands is the presence of the Island Fox...Generally, all of the marine birds breeding in the Bight nest on the small, fox-free islands of Santa Barbara and Anacapa or are crowded onto tiny rocks and islets offshore of the other main islands*". There was only one exception noted by Hunt et al. (1980), and that was relative to gulls and cormorants on San Nicolas Island. However, Xantus's Murrelets are not known to breed on San Nicolas Island.

Abundance

There are a number of studies that contain a comprehensive overview of the murrelet, and emphasize the current rarity of the species on a worldwide scale (Jehl

and Bond 1975, Hunt et al. 1979, Hunt et al. 1980, Drost and Lewis 1995, Gaston and Jones 1998).

The Xantus's Murrelet is a rare species with a limited breeding range. In fact, it is one of the rarest seabirds in the North Pacific. A recently published book on the alcid family concurs with this assessment (Gaston and Jones 1998), and other scientists have also concurred and recommended formal protection measures (Drost and Lewis 1995, Sydeman et al. 1998). In this report, the term "rare" is used in the familiar dictionary meaning of the term ("seldom occurring or found, uncommon") and not in any legal context or conclusion under state law.

Bent (1919) found that the Xantus's Murrelet "... *is now well known as a fairly common bird about the rocky islands from southern California along the west coast of Lower California at least as far as Magdalena Bay.*" He quotes A. Howell to describe the population status of the species:

"*A few years ago [about 1908] they were very rare...[at Los Coronados Islands], but at present they are almost abundant. Their case is somewhat similar on Santa Barbara and Anacapa Islands, California, for at the latter place during May, 1913, Mr. van Rossem found them to be fairly common. Hence it would seem that the species is increasing in numbers at the northern end of its range.*" It is quite likely that egg collectors were becoming more familiar with what time of year and in what habitats to find murrelet eggs at the Los Coronados, Santa Barbara, and Anacapa Islands, such that true population increase may not have been occurring at this time.

An important reference containing information on the historic population levels of California's bird populations is the classic Grinnell and Miller's (1944) "The Distribution of the Birds of California." In this reference, the Xantus's Murrelet is described as "*fairly common*" to even "*common, locally.*" Bailey (1921) refers to the species as "... *frequently seen in the Santa Barbara Channel at all seasons.*"

The quote by Howell, that murrelets are "increasing" shortly after the turn of the century (at Los Coronados and Anacapa), and the Grinnell and Miller (1944) reference to murrelets being "fairly common" to even "common", stand in contrast to more current scientific publications that conclude murrelets are rare and declining. Therefore, the Department believes a decline of some unknown magnitude occurred, from historic levels, and more recently from the mid 1970s to the present.

The Department has reviewed the available information on murrelet abundance and concludes that the Xantus's Murrelet is a rare or uncommon species, with only 3,460 breeding birds under California's jurisdiction (Tables 1 and 2). For comparison, the Marbled Murrelet (*Brachyramphus marmoratus*), another alcid in California (which nests in old-growth trees) is listed under both the California and federal endangered species acts, as endangered and threatened, respectively. The Marbled Murrelet was

both state and federally listed in 1992. At that time, the population in California was estimated at approximately 2,000 birds, based on limited survey effort. Marbled Murrelets are currently estimated to number from 3,500-6,400 birds in northern California and southern Oregon, based on a statistically rigorous at-sea sampling protocol; smaller populations exist in central California (USFWS 1997, Bentivoglio et al. 2001, USFWS 2003). Marbled Murrelet populations in California continue to decline due to a wide variety of impacts, including two recent oil spills in northern California (California Department of Fish and Game 2001).

The Department believes there is sufficient scientific information to indicate the Xantus's Murrelet is now a rare or uncommon species that has declined from historic population levels. The evidence for decline from "common" and "abundant" to "rare" will be discussed in detail in the Population Trend section, below.

Population Trend

Population trend information for Xantus's Murrelets from the Channel Islands to Mexico has been described by various researchers (Howell 1910, Jehl and Bond 1975, Hunt et al. 1979, Hunt et al. 1980, Murray et al. 1983, Everett and Anderson 1991, Carter et al. 1992, Drost and Lewis 1995, Gaston and Jones 1998, McChesney and Tershy 1998, Sydeman et al. 1998, Keitt 2000, McChesney et al. 2000, Wolf et al. 2000). The Department has reviewed this information and finds sufficient scientific information to indicate population decline has occurred and continues at present. Additional information on population trend that was evaluated by the Department is discussed below and in the Threats section of this report.

There is evidence for population declines from historic levels at breeding sites for the murrelet in Mexico (for example, due to feral cat (*Felis catus*) predation on the Coronados), and for Anacapa and Santa Barbara Islands in the Channel Islands. Numerous non-native mammals that have occupied known murrelet nesting islands throughout their range are identified in Table 2 in the petition. Studies throughout the world have documented that non-native predators, particularly rats (*Rattus* sp.) and cats can have negative effects on seabird populations (Moors and Atkinson 1984, Everett and Anderson 1991, Springer et al. 1993, Burger and Gochfeld 1994, Bertram 1995, Seto and Conant 1996, McChesney and Tershy 1998, Drever and Harestad 1998, Seto et al. 2001, Sowls and Rauzon 2001, Keitt 2000, Keitt et al. 2002, in review). The Department believes that murrelets have declined from this unnatural pressure for which they have not evolved effective defenses. A prominent book on the alcid family supports this conclusion:

"…. the effects of mammalian predators, introduced either deliberately or accidentally, have probably had a much greater impact on auk populations world-wide"; "Those that have been most affected by our activities are the southern murrelets: …Xantus' …all at present endangered or threatened in one way or another".; "It is

certain that the majority of auk populations are smaller, in many cases much smaller, than they would have been a few centuries ago" (Gaston and Jones 1998:18-19).

The exact magnitude of the murrelet population declines cannot be determined because the early studies on murrelets were primarily natural history trips, consisting of field notes and specimen collection (early naturalists often collected eggs, chicks, and adults for museum specimens). Such specimens are labeled and catalogued in natural history museums and educational institutions, and provide historical background on the occurrence and abundance of many species. Published notes in reputable scientific journals also exist to cross reference with the specimen collections. In this way, biologists can discern that a particular notation on the absence of a species may not be valid, because the visit did not occur at the right time of year, or proper time of day to document a particular species. Careful reading and interpretation of such published notes is important to draw the proper conclusions.

Early naturalists did not approach wildlife population assessment from a statistical perspective. Their main goal was to describe the distribution and relative abundance of native animals, and to document new species. Therefore, the interpretation of historic population declines is based on scientific reasoning, analysis of facts, and best available scientific information.

Historical Context for Santa Barbara Island Murrelet Population Trend

Santa Barbara Island has received the most study, and because most (51%) Xantus's Murrelets in California now nest there, the following background is important to put population dynamics and decline into the proper context. One conclusion that can be drawn from looking at the historic accounts is that the murrelet population has been unstable due to perturbations brought on by humans. Alcid reproduction may vary year to year due to fluctuations in food supply, but their island nesting sites normally remain stable and are often relatively predator free in a natural state (as in rocky offshore islands utilized by Common Murres (*Uria aalge*)). Introducing non-native predatory mammals (cats and rats) into such an environment, and coupling that impact with non-native grazing mammals (sheep, rabbits, goats), is a recipe for instability and population decline (Burger and Gochfeld 1994). Many seabird populations do not normally undergo drastic population swings, but it appears murrelets on Santa Barbara Island have, due to human influences. The Department has prepared a timeline of human impacts on Santa Barbara Island (Figure 6), and the associated impacts to native vegetation and wildlife species.

Effects of humans (including introduced mammals) on island nesting species can be dramatic, for example, a Cassin's Auklet (*Ptychoramphus aleuticus*) colony was nearly extirpated from the island by feral cats by 1908, and has never recovered (Howell 1917:22, Hunt et al. 1979, H. R. Carter, pers. comm.). Cassin's Auklets are small, nocturnal, burrow-nesting alcids with some similarities to murrelets; however,

these auklets usually excavate their own burrows. Grinnell found them breeding in large numbers on Santa Barbara Island in 1897: "*The southwest side of the mesa from the top of the bluff to the summit of the hill was crowded with their burrows*" (Grinnell *in* Hunt et al. 1979). Another observer in 1897 noted: "*In a field of malva weed hundreds of burrows contain auklets sitting upon their single white eggs*" (Britton *in* Hunt et al. 1979). But by May of 1908, no signs of the species were seen (Howell *in* Hunt et al. 1979). A later trip to the island in 1911 revealed only bones and feathers of auklets all over the island, and the observer stated: "*...concluded that they had been exterminated by the cats with which the island is infested*" (Willett *in* Hunt et al. 1979). In 1991, auklets persisted in small numbers on the offshore islet of Sutil Island near the southwest end of Santa Barbara Island and in bluffs at Elephant Seal Point (Carter et al. 1992). Recently, auklets have not been found at either location and may no longer breed at Santa Barbara Island (H. R. Carter, pers. comm., via J. Adams and P. Martin, pers. comm.). Vegetation and soil changes from non-native grazing mammals and past agricultural practices likely led to a large historical decline with no chance for natural recovery.

Another species that suffered from the changes induced by humans was the federally endangered Santa Barbara Island Song Sparrow (*Melospiza melodia graminea*), known only from Santa Barbara Island, and officially declared extinct in 1983 by the U.S. Fish and Wildlife Service (Fed. Register Vol. 48, No. 198, Oct. 12, 1983). Since the 1959 fire which severely altered most of the island, no sparrows had been observed (Figure 6). The sparrows were known to be closely affiliated with the native giant tree-sunflower shrubs (*Coreopsis gigantea*) on the island (Sumner *in* Stewart et al. 1974). The coreopsis shrubs were heavily damaged by the 1959 fire. One observer described the fire effects as follows: "*It burned nearly all the vegetation from the water's edge on the east shore of the island to the crest of the ridge where it was halted by the strong winds from the west slope...Two-thirds of the island was denuded right down to mineral soil...*" (Sumner in Stewart et al. 1974).

It has been well documented that sheep (Schuyler 1993), goats (Coblentz 1980), and rabbits (Sumner 1959; Appendix D in this document) have modified the native vegetation on various Channel Islands. On Santa Barbara Island, these changes have probably reduced nesting opportunities for murrelets through reduction in shrub cover. The change in vegetation may also have caused an increase in deer mouse numbers on Santa Barbara Island (Murray et al. 1983); the petition made note of this as well (see Threats section for discussion on deer mice (*Peromyscus maniculatus* sspp.). Seeds of the introduced grasses on Santa Barbara Island are an important food source for the native deer mice (Murray et al. 1983).

The population of murrelets on Santa Barbara Island has apparently never fully recovered from a drastic decline caused by feral cats. Between 1897 and 1908, cats were introduced onto Santa Barbara Island. There is little data on the size of the murrelet population prior to the introduction of cats, but Sumner *in* Sowls et al. (1980)

states: *"At one time large colonies of auklets and murrelets were present on the island, but none have been recorded in recent years and it is supposed that they have been exterminated by these feral cats".* It is very unlikely that Xantus's Murrelets were extirpated but their population was likely reduced and limited to habitat with low cat predation.

In summary, it appears that murrelets (and auklets) were fairly abundant prior to European settlement and the introduction of sheep, goats, cats, and rabbits. A decline then began due to vegetation changes induced by the non-native grazers, intensive agricultural practices, and abnormal predation levels by cats. A slight recovery of murrelets may have occurred on Santa Barbara Island once the cats and rabbits were reduced and removed. However, both cats and rabbits were not entirely eliminated from Santa Barbara Island until some time in the late 1970s (Stewart et al. 1974, Hunt et al. 1979, Drost and Lewis 1995). Rats are not documented to have been introduced onto Santa Barbara Island, as noted in Table 2 of the petition.

More Recent Evidence for Population Decline at Santa Barbara Island

Hunt et al. (1979) conducted field work on Xantus's Murrelets at Santa Barbara Island from 1975 to 1978. They surveyed for murrelet nests in "accessible" areas during the breeding season, with extrapolation to inaccessible areas. They also conducted at-sea surveys on vessels to count murrelets along transects radiating out from Santa Barbara Island. Similarly, in 1991, Carter et al. (1992) conducted nest searches on Santa Barbara Island to document potential nest sites and extrapolate to other inaccessible areas; this work did not include at-sea surveys. Carter et al. (1992) surveys were undertaken in an effort to assess murrelet population size in 1991 but methods probably were only roughly comparable to those used earlier by Hunt et al. (1979, 1980). It is difficult to assess exactly how comparable these methods were due to poor description of count methodology used in the 1970s (Carter et al. 1992).

Sydeman et al. (1998) reviewed the work of both previous researchers (Hunt and Carter), made some adjustments to the occupancy correction factors used in 1991 (note: these adjustments may or may not be valid), and derived a smaller number of breeding birds than Carter et al. (1992; Table 1).

Further, Sydeman et al. (1998) conducted a population viability analysis for the Santa Barbara Island population and concluded: *"Xantus' Murrelets on SBI declined by as little as 2.51% ... or more than 5.29 % ... per year from 1977 to 1991."* The report also states *"This population is in danger of extinction and should be considered endangered. Given current population parameters and predation rates, the population faces a 30% probability of reaching quasi-extinction within 20 years under the most favorable scenario...."* He derived population parameters from the Ancient Murrelet, because most population parameters for Xantus's Murrelets are not known. The

Department considers this approach reasonable due to many similarities between the two species. Appropriate caveats were included in the Sydeman et al. (1998) analysis.

An important aspect of the Sydeman et al. (1998) population viability analysis is the determination that a reduction in adult mortality alone is unlikely to produce a stable murrelet population. Instead, they noted, improvement in reproductive success (reduction in egg predation) would also be required to produce a stable population. Factors affecting adult, chick, and egg survival were discussed earlier, and are further discussed in the Threats section of this report.

The Department has carefully reviewed this information for Santa Barbara Island, along with more current information not included in the petition (Humboldt State University (HSU), unpubl. data; National Park Service (NPS), unpubl. data). The Department finds that murrelet populations have declined on Santa Barbara Island, possibly up to 72% from 1977-1991 (from 3,000 to 847 breeding birds), as presented in Sydeman et al. (1998:45). But due to the difficulties discussed above relative to safely accessing nest sites and determining occupancy rates, and based on more recent murrelet survey work that will be discussed below, it appears more likely that the population declined to a lesser degree during this period (approximately 30%).

We consider the following statements by Carter et al. (1992) to be important, relative to the earlier, higher population estimates by Hunt et al. (1979): "*In either case, the population is much smaller than previously reported.*" and "*We consider the current population size to be very low.*" For Santa Barbara Island proper, excluding the two offshore rocks, Carter et al. (1992) estimated 1,402 breeding birds. This is in contrast to the wide range of breeding murrelets (2,000-10,000) reported in Hunt et al. (1979) (Table 1). The estimate from the Hunt et al. (1979) effort was later revised to 3,000 breeding murrelets for Santa Barbara Island, or 3,180 if both offshore rocks are included (Hunt et al. 1980).

Carter et al. (1992) also mentioned that the murrelet population may have been stable between 1977 and 1991, but a later publication with Carter as a lead author (Carter et al. 2000) states: "*...a 1991 survey found lower numbers of murrelets than in the 1970s*" and cites Carter et al. (1992). When questioned on this point, H.R. Carter (pers. comm., July 2002), stated that he believed the data indicated a decline had occurred, though the exact magnitude could not be determined.

Department review of this information by both Hunt and Carter indicates both parties made their best attempts to accurately survey this secretive seabird. This is based on the amount of detail and documentation that is contained in both reports. However, techniques to estimate population size were different, estimates may not be fully comparable, inter-annual variability may be involved, and earlier techniques were not well described (Carter et al. 1992). We agree with Carter that the at-sea work conducted by Hunt is difficult to extrapolate to population size given the many

assumptions that must be made; however, the at-sea data does provide useful information in a relative degree to the nest site based population estimates. As noted by Carter et al. (1992), one extrapolation presented in the Hunt et al. (1979) document was for 20-21 March 1976, where 103 murrelets were counted on the water from a research vessel, on murrelet survey transects near Santa Barbara Island. Hunt et al. (1979) then used this number to extrapolate to the rest of the ocean environment surrounding the island, where vessel based surveys did not occur. From that method, he derived an estimate of 2,741 murrelets; these numbers likely served as a check for Hunt et al. (1979) to narrow the range of the murrelet population estimate for the island.

Apparently, Murray et al. (1983) used the higher end population estimates from Hunt et al. (1979), and stated 6,000-10,000 murrelets bred at Santa Barbara Island during the 1976-1978 breeding seasons. No detailed methods were provided as to how this estimate was obtained, except for the following: "*We searched all accessible areas each year for murrelet nests. In 1978 we measured distances to nearest conspecific neighbors and to the ocean at all study sites for which we could safely reach the cliff edge and/or nearest neighbor.*" It appears that because Hunt was a co-author on the Murray et al. (1983) paper, the consensus was to utilize the higher population estimate based on the 1976-1978 field work. However, it appears doubtful that up to 10,000 breeding murrelets could occupy an island as small as Santa Barbara under the existing state of modified/reduced native vegetation and high deer mouse and predator abundance. That would be seven-fold greater than the 1,402 breeding birds estimated by Carter et al. (1992). While 10,000 murrelets may be feasible for pre-European influence, a population decline from 10,000 to 1,402 does not appear likely given the relatively short 14 year time span between 1977 and 1991. Therefore, it seems reasonable to rely on the 1977 estimate of 3,000 breeding birds (Hunt et al. 1979, Hunt et al. 1980), and to contrast it with the estimate of 1,544 breeding birds from Carter et al. (1992). As noted in the petition, the 1,544 breeding bird estimate for 1991 includes Shag Rock and Sutil Island, the large rocks just offshore from Santa Barbara Island (Table 1).

Because the two island nest count methods are not directly comparable between 1977 and 1991, two other population indicators are important, and corroborate a population decline, as discussed below.

Nest Site Occupancy at Santa Barbara Island

Nest site monitoring work on murrelets is conducted yearly at two nest plots on Santa Barbara Island, Nature Trail and Cat Canyon (Figures 7-9). This intensive effort to monitor breeding success provides an important data set to help assess population status, as noted in the petition. Biologists visit each marked nest site in the two study areas approximately once per week to check nest status (Wolf et al. 2000) (Figure 3b). This work is ongoing, and has been conducted annually since 1985 by NPS biologists and contract biologists. Based on this field work, nest site occupancy rates at the

monitored nest plots on Santa Barbara Island have been declining since 1985 (Figure 10a). In general, occupancy rates fluctuated between 35 and 70 percent up until the mid 1990s, and have since declined to 30 percent or less (Wolf et al. 2000, P. Martin, NPS, draft, unpubl. data). The Department has conducted a statistical analysis (linear regression) on this data which indicates a statistically significant negative trend at both study sites ($p<.05$). The results of another statistical test (ANCOVA) indicates that the slopes (negative trend lines) between the two sites are not significantly different ($p<.05$) from each other, and that percent occupancy is significantly higher ($p<.05$) in the Cat Canyon site. This indicates both sites are moving in a similar negative trend downward, and the statistical model predicts a continued pattern of decline. Transformation of the data (two arcsine square root) to stabilize variances also results in a statistically significant ($p<.05$) negative trend at both study sites (Figure 10b).

In the Nature Trail study area, shrubs have been in decline which is rendering the habitat unsuitable for murrelets due to lack of cover at nest sites (Ingram and Jory-Carter 1997, Wolf et al. 2000). Thus, one would expect a decline in occupancy rates. This, however, is not the case with the Cat Canyon site where most of the monitored nests are in cliff/crevice habitat types (Wolf et al. 2000, H.R. Carter, pers. comm.). Cat Canyon is also located further from potential human disturbance sources, compared to the Nature Trail site which is located near the NPS visitor center. What happens to the displaced birds from the Nature Trail site is unknown. Most alcids have high colony site fidelity, and Xantus's Murrelets have shown evidence of this as well, as noted in the petition (Murray et al. 1983). Thus, they may not breed until suitable sites become available or they may be forced to seek nesting sites elsewhere. Also, some of the nesting adults could have died from various mortality factors.

Productivity Measures for Murrelets on Santa Barbara Island

Another indicator of population decline is productivity, a measure of nest success. Productivity at Santa Barbara Island averaged 0.81 hatchlings (murrelet chicks) per adult pair from 1983 -1995; summarized by Sydeman et al. (1998). This productivity measure is low compared to the Ancient Murrelet, a species very similar to the Xantus's Murrelet. Ancient Murrelets average 1.44 to 1.69 chicks/pair (Gaston and Jones 1998). Craveri's Murrelets also have higher productivity estimates ranging from >1 - 1.5 (DeWeese and Anderson 1976, Tershy *in* Gaston and Jones 1998). However, work on Craveri's Murrelets has been very limited, and the data are not directly comparable to Xantus's Murrelets because standard techniques with adequate sample sizes have not been used. The Department considers the low productivity for Xantus's Murrelets to be of concern, especially when compared to Ancient Murrelets. Further studies are needed in this regard. More recent estimates of productivity for Xantus's Murrelets need to be evaluated once they become available.

For the Ancient Murrelet, productivity values of 1.44 - 1.69 are sufficient to maintain a stable population, even with high adult mortality. In fact, in order to survive

in the face of high adult mortality, a high reproductive rate is needed, and requires the potential to rear more than one offspring per year (Gaston 1990). Gaston (1990:1009) cites three studies indicating that the Ancient Murrelet has the highest adult mortality (or lowest estimated annual survival) that has been observed for any other alcid, or any other pelagic seabird. The Department believes Xantus's Murrelet populations are subject to similar population growth constraints. The population viability analysis (Sydeman et al. 1998) and the actual field data collected on Xantus's Murrelets, as discussed above, provides scientific support for this conclusion. Additional supporting information is contained in the Threats section of this report.

Recent Studies at Santa Barbara Island

Recent work in the Channel Islands by HSU researchers has led to revised population estimates for all of the Channel Islands. These detailed maps are the result of different types of survey effort over a number of years as described in Figures 11 through 18. Changes in sampling techniques did not substantially change the estimated number of murrelets on Santa Barbara Island or the other Channel Islands.

Additionally, H. R. Carter and others returned to Santa Barbara Island during the 2001 breeding season to reassess the nesting population of murrelets, and provide a comparison to the 1991 effort by Carter et al. (1992). This large nest plot monitoring study occurred outside of, but also included a part of one NPS nest plot (Nature Trail), and showed 14% lower numbers of active nests when comparing 1991 to 2001 (Whitworth et al. 2003c).

Population Trend on Anacapa Island

Based on the information summarized below, the Department finds evidence of population reduction of murrelets at Anacapa Island from historic levels. There is sufficient scientific information to indicate that higher densities of murrelets existed under more pristine conditions, prior to the introduction of non-native mammalian predators (rats and cats). This finding is supported by the extensive but *unoccupied* habitat that is present on Anacapa (McChesney et al. 2000). The majority of this habitat has not been utilized by the birds due to the presence of rats. This situation is only beginning to change at this time due to the recent (2001-2002) implementation of a rat eradication program (some degree of rat control also occurred in several years during the 1980s through NPS efforts). Xantus's Murrelets did not evolve with rats or cats, thus, they have few behavioral defenses against them. The historical and current condition of Anacapa Island is briefly discussed below.

In the past, Xantus's Murrelets were considered "not uncommon" on Anacapa Island (Howell 1917). Two separate papers, Hunt et al. (1979) and McChesney et al. (2000) listed the many documented egg collections for this species from Anacapa

Island by early egg collectors, thus providing evidence of former abundance of murrelets. These egg sets were collected up until 1929. There is the possibility that additional eggs were collected and were never reported, because egg collecting was a form of scientific investigation and hobby during that era.

As was noted previously, it is also well documented by present day seabird biologists that non-native mammals can have serious impacts on nesting seabirds (see previous discussion under Population Trend, and also the Threats/Non-native mammals section of this report). Thus, it is reasonable to conclude that murrelet populations (and nesting success) have declined considerably on Anacapa Island due to impacts from non-native mammalian species including sheep, cats, rats, and rabbits. Impacts from these non-native species include vegetation loss, ecological changes in vegetation type, disruption of predator/prey guilds, burrow destruction, and predation (Banks 1966, Bakker 1971, Hunt et al. 1980, Murray et al.1983, Burger and Gochfeld 1994, Bertram 1995, McChesney and Tershy 1998, Keitt 2000, and others).

Black rats (*Rattus rattus*), were introduced to Anacapa sometime between the mid-1800s and early 1900s, and became common and widespread. In 1963 and 1964, the black rat was described as "abundant" on portions of Anacapa Island (Banks 1966).

A small number of cats that were present on West Anacapa Island between the 1930s and mid-1970s likely impacted murrelets and other seabirds (McChesney and Tershy 1998). Cats have been documented as effective predators of many different seabird species; one example of their abilities is noted here (W. Everett, pers. comm., June 2002):

"*A couple of years ago Mark Rauzon and I were working at a large Sooty Tern (Sterna fuscata) colony out on Wake Atoll. We went out late one night and counted over 10 feral cats marauding through the colony attacking birds. The next morning we counted 300 killed terns, and another 35 or so that had been mauled and were unable to fly. They were just slowly dying in the tropical sun. I had to euthanize them rather than let them suffer.*"

On Guadalupe Island, cats were known to prey on both the Guadalupe Storm-Petrel (*Oceanodroma macrodactyla*) and the Leach's Storm-petrel (*Oceanodroma leucorhoa)*, and cat predation is mainly blamed for the extinction of the endemic Guadalupe Storm-Petrel, last seen in 1912 (Jehl and Everett *in* McChesney and Tershy 1998). Additional evidence on the effects of cat predation on seabirds is cited in McChesney and Tershy (1998).

A comprehensive review of non-native predators and seabird colonies concludes: "... *alien predation has been the key factor in the reduction or extinction of more seabird populations in historic times than any other factor.*" (Moors and Atkinson 1984). Another paper on seabird distribution and predation pressure resulted in a

similar conclusion (Springer et al. 1993): *"All of the murrelets and auklets nest only on islands and inaccessible mainland capes, probably to escape terrestrial mammals. Also, they nest underground to escape avian predators. These strategies proved successful until terrestrial mammals were introduced to many of the islands."*

An extensive rat removal project for Anacapa Island was initiated recently with the first poison bait drop occurring in December 2001 on East Anacapa Island, and the second occurring in November 2002 on Middle and West Anacapa. This project is one aspect of the American Trader oil spill restoration plan, and is designed to benefit murrelets and other seabirds (American Trader Trustee Council 2001). Monitoring for murrelet population changes to assess the success of the rat removal program is occurring, and preliminary results indicate a slight increase in the number of nesting murrelets, and an increase in nest success (Hamer et al. 2003, Whitworth et al. 2003b). Thus, it appears murrelets can respond with increased reproductive effort when non-native rats are removed from nesting colonies.

The PSG petition noted the following (page 9): *"Based on the low murrelet populations currently found at many islands, it appears that, over the years, impacts to murrelets have been great. Although recent and planned eradication efforts likely will lead to increases in murrelet numbers, the murrelet's low reproductive rate (mean = 0.813 hatchlings per pair at Santa Barbara Island; Sydeman et al. 1998) and high philopatry (if they are like most other alcids) likely will lead to slow natural recovery."* As was noted earlier in this report, research studies support colony fidelity (philopatry) for the Xantus's Murrelet, similar to other alcids (Hunt et al. 1979, Murray et al. 1983).

The Department finds there is sufficient scientific evidence of murrelet population reduction at Anacapa Island from historic levels. This is supported by recent research indicating substantial suitable but unused habitat, evidence of rat predation on murrelet eggs in accessible and relatively inaccessible habitats, and past evidence of larger numbers of murrelets at Anacapa Island (McChesney et al. 2000, Whitworth et al. 2003; H.R. Carter, pers. comm.). More recent research also supports this conclusion (Hamer et al. 2003, Whitworth et al. 2003b). Further discussion on rat impacts can be found in the Threats/Non-native mammals section of this report.

Population Trend in Mexico

A striking illustration of probable population decline is presented in the petition on page 6 and reads as follows:

"At Los Coronados Islands, Howell (1910) considered murrelets abundant on all 4 islets, and an abundance of murrelet eggs collected by numerous observers (now mostly at the Western Foundation of Vertebrate Zoology, Camarillo, California) in the early – to mid-twentieth century also indicated a very large colony there. By 1989-1990, R. Pitman (pers. comm.) roughly estimated this colony was reduced to only 10% of

potential because of feral cat predation". Mr. Pitman is a noted marine biologist who conducted the early murrelet work with G. Hunt and others (Hunt et al. 1979, Hunt et al. 1980). Another researcher believes the level of decline is somewhat overstated because even in 1995 there were indications of fairly large numbers of murrelets associated with the Coronados Islands (H.R. Carter, pers. comm.). However, Carter concurs that cats did indeed reduce murrelet numbers at the Coronados, though precise estimates of the decline are not available.

Research efforts in Mexico by the Island Conservation and Ecology Group (ICEG) and others have been fairly substantial (Jehl and Bond 1975, Everett and Anderson 1991, McChesney and Tershy 1998, Keitt 2000). Recent work was conducted by HSU and ICEG in spring 2002 at the San Benitos Islands (Table 2; Whitworth et al. 2003a). In general, populations are still under threat from introduced mammals and human disturbance, and population declines have been inferred (Jehl and Bond 1975, McChesney and Tershy 1998, Keitt 2000). In some cases, as at Todos Santos, ICEG personnel removed predators, but residents soon brought them back to the island (Keitt 2000). Currently, there is very little evidence of nesting at Todos Santos, San Martin, and San Geronimo (Table 2; McChesney and Tershy 1998, Keitt 2000). Additionally, there is no evidence of murrelet nesting activity at Natividad, San Roque, or Asuncion Island, and murrelets may never have bred there. Current population estimates are needed for Guadalupe Island. The world population size may be much smaller than currently thought, if only small numbers of murrelets occur at Guadalupe Island.

In spring 2002, HSU researchers noted hundreds of murrelets present in the waters around the Coronados while conducting spotlight surveys (Table 2; H. R. Carter and D. Whitworth, unpubl. data). As noted above, some murrelet recovery may have occurred after cat removal, but these large numbers also indicate the population was not severely reduced. If concerted conservation actions can be implemented on these islands, the potential for substantial population increase exists at the Coronados.

Population Trend Summary

The Department has carefully reviewed the scientific information described above. We believe there is sufficient scientific information to indicate population decline has occurred and continues at present, from the Channel Islands to Mexico.

Xantus's Murrelet numbers have declined substantially from historic levels, though the exact magnitude of the decline is not known and has not been quantified (however, the Department believes it could be quantified based on a series of assumptions and known information). Currently, the best available scientific information from more recent studies indicates a decline of approximately 30%, and possibly up to 72%, from 1977 to 1991, and a 14% decline in active nest sites between 1991 and 2001 on Santa Barbara Island (Hunt et al. 1979, Carter et al. 1992, Sydeman

et al. 1998, Whitworth et al. 2003c). More recent studies and unpublished information from the National Park Service indicates the decline is continuing (Figure 10b; NPS, P. Martin, draft unpubl. data, Wolf et al. 2000). Compared to historical accounts, murrelet populations have also declined substantially on Anacapa Island.

We also researched other plant and wildlife species on the Channel Islands in order to document indications of detrimental habitat change that may have led to population declines in Xantus's Murrelets. The Department believes that the substantial influence of humans and associated non-native species (cats, rats, rabbits, goats, and sheep) provides strong evidence of habitat change, increased predation rates, and land use practices that negatively affected Xantus's Murrelets. This is most noticeable on Santa Barbara Island where more information exists. Other species negatively affected by the land use changes induced by humans include Cassin's Auklets, Santa Barbara Island Song Sparrow, and an endangered plant, the Santa Barbara Island live-forever (*Dudleya traskiae*) (Figure 6).

One source of uncertainty between the mid 1970s and 1991 population estimates of the Xantus's Murrelet on Santa Barbara Island results from the difficulties of surveying for a small nocturnal species nesting in steep, difficult-to-access terrain. Differences in the field techniques also make direct comparisons difficult. However, the declining nest site occupancy rates over a 19 year time period noted for Santa Barbara Island (Figure10b) provides a compelling case for population decline. Additionally, since 1994, several new survey techniques have been utilized by HSU, including vocalization surveys, spotlight surveys, and ornithological radar surveys (Figures 11-18). These intensive studies have helped discover the full extent of the breeding distribution of the Xantus's Murrelet in the Channel Islands but newer methods have not provided data at Santa Barbara Island that were inconsistent with the 1991 estimate. The Department is currently working with researchers to determine the best method(s) to utilize for assessing population size and monitoring murrelets in the Channel Islands.

Factors Affecting the Ability of the Population to Survive and Reproduce

Growth and decline of wildlife populations are driven by survival and mortality rates of adults, subadults, and juveniles, and reproductive success. Therefore, it is clear that threats which cause high adult mortality (for example, rat predation and oil spills), and high nest failure (for example, rat and deer mice predation on eggs), directly affect the ability of the population to survive and reproduce. The threats to murrelets are discussed in detail, below, in the Threats section of this report. Some additional factors affecting the murrelet population are first briefly summarized.

Small Population Size and Island Environments

The murrelet breeding population is highly concentrated. About 82% of the world population breeds on only five islands/island groups (Santa Barbara, Anacapa, Los Coronados, San Benitos, and Guadalupe). Figure 4 depicts the extremely limited breeding range of the murrelet on a worldwide scale. This level of concentration, along with small world population size (4,970 - 11,650 breeding birds), makes the species more vulnerable to localized catastrophes. Additionally, island environments are especially vulnerable to catastrophic influences. We provide the following quotes as supporting scientific information relative to population effects and catastrophes:

"The relatively small land areas of islands result in small populations of organisms that tend to be more vulnerable to extinction than those on continents" (MacArthur and Wilson *in* National Research Council 1995:30).

"*Because island biotas already have lost so many populations and species and land resources are so limited, conservation programs on islands face an extraordinary challenge to maintain conditions that will allow the long-term survival of existing species*" (National Research Council 1995:39).

"*Catastrophes are extreme forms of environmental variation that suddenly and unpredictably reduce the population size.*" Additionally, "*... it is clear that, on the basis of chance alone, larger populations will have an increased likelihood of some individuals surviving this type of event*" (National Research Council:131).

The latter quote refers to *natural* catastrophes. In the case of the murrelet, an example could include a series of El Niño oceanographic events, coupled with large winter/spring storm events that could reduce or disperse fish and zooplankton prey. This would negatively affect murrelet nest success and survival due to inadequate energy reserves. An *unnatural* example would include significant oil spill mortality that would suddenly reduce population size.

In summary, scientific principles indicate that murrelets are especially vulnerable to extinction due to small population size. This is partly due to the uniqueness of their island environments (small geographic land area). This condition naturally leads to a lower likelihood of surviving catastrophic events. Human induced impacts (cat and rat predation, habitat modification, oil spill mortality, artificial light pollution) only exacerbate the problem and ultimately affect the ability of the population to survive and reproduce.

Human-altered Nature of Murrelet Nesting Sites

There are numerous non-native mammals that affect the ability of murrelets to survive and reproduce (Moors and Atkinson 1984, Burger and Gochfeld 1994,

McChesney and Tershy 1998). A careful review of the scientific literature makes it clear that murrelets have existed, and in some places continue to exist in highly altered ecosystems where natural processes have been disturbed (for example, Santa Barbara Island, see Figure 6). Though murrelets still exist at all known historical colonies, their numbers probably are greatly reduced from historic levels (see earlier discussion under Population Trend).

A further example of the human-altered nature of the Channel Islands ecosystem is the declining population of Island Foxes from excessive Golden Eagle (*Aquila chrysaetos*) predation. In an effort to protect the foxes, the Golden Eagles are being removed, because they did not historically nest on the Channel Islands. Bald Eagles (*Haliaeetus leucocephalus*) are being reintroduced, and their presence should restrict Golden Eagles, thus reducing Golden Eagle predation on foxes and allowing for fox recovery. The Bald Eagle was eliminated as a breeding bird on the Channel Islands, as was the Peregrine Falcon (*Falco peregrinus)*, due to the effects of DDT contamination (see discussion on peregrines in Threats section of this report).

Two other seabirds, the Tufted Puffin (*Fratercula cirrhata*) and the Common Murre have also been impacted on the Channel Islands, for reasons not well understood. Common Murres and Tufted Puffins have only recently returned to the Channel Islands in very small numbers (H.R. Carter, pers. comm.). Human impacts are suspected to have played a role in the decline of these two alcids (Hunt et al. 1979, Hunt et al. 1980).

Summary

The Department believes there is sufficient scientific information to indicate that many factors are negatively affecting the ability of the population to survive and reproduce. Additionally, as was noted earlier, the murrelet is naturally limited from occupying or expanding to the larger Channel Islands (San Miguel, Santa Cruz, Santa Catalina, and San Clemente) due to the presence of the Island Fox.

Threats

Threats to the murrelet have been divided into major and minor categories to help identify their degree and immediacy. Four major threats (non-native mammals, oil pollution, native predators, and artificial light pollution), and four minor threats (human disturbance at colonies, oceanographic and prey changes, disturbance and mortality from military operations, and bycatch in fisheries) have been identified and are discussed below. At this time, there is no information to suggest disease or competition are significantly affecting murrelet population viability, though these aspects of murrelet life history have not been well studied.

McChesney and Tershy 1998). A careful review of the scientific literature makes it clear that murrelets have existed, and in some places continue to exist in highly altered ecosystems where natural processes have been disturbed (for example, Santa Barbara Island, see Figure 6). Though murrelets still exist at all known historical colonies, their numbers probably are greatly reduced from historic levels (see earlier discussion under Population Trend).

A further example of the human-altered nature of the Channel Islands ecosystem is the declining population of Island Foxes from excessive Golden Eagle (*Aquila chrysaetos*) predation. In an effort to protect the foxes, the Golden Eagles are being removed, because they did not historically nest on the Channel Islands. Bald Eagles (*Haliaeetus leucocephalus*) are being reintroduced, and their presence should restrict Golden Eagles, thus reducing Golden Eagle predation on foxes and allowing for fox recovery. The Bald Eagle was eliminated as a breeding bird on the Channel Islands, as was the Peregrine Falcon (*Falco peregrinus)*, due to the effects of DDT contamination (see discussion on peregrines in Threats section of this report).

Two other seabirds, the Tufted Puffin (*Fratercula cirrhata*) and the Common Murre have also been impacted on the Channel Islands, for reasons not well understood. Common Murres and Tufted Puffins have only recently returned to the Channel Islands in very small numbers (H.R. Carter, pers. comm.). Human impacts are suspected to have played a role in the decline of these two alcids (Hunt et al. 1979, Hunt et al. 1980).

Summary

The Department believes there is sufficient scientific information to indicate that many factors are negatively affecting the ability of the population to survive and reproduce. Additionally, as was noted earlier, the murrelet is naturally limited from occupying or expanding to the larger Channel Islands (San Miguel, Santa Cruz, Santa Catalina, and San Clemente) due to the presence of the Island Fox.

Threats

Threats to the murrelet have been divided into major and minor categories to help identify their degree and immediacy. Four major threats (non-native mammals, oil pollution, native predators, and artificial light pollution), and four minor threats (human disturbance at colonies, oceanographic and prey changes, disturbance and mortality from military operations, and bycatch in fisheries) have been identified and are discussed below. At this time, there is no information to suggest disease or competition are significantly affecting murrelet population viability, though these aspects of murrelet life history have not been well studied.

Bald Eagles are known to prey upon Xantus's Murrelets at Santa Catalina Island (H.R. Carter, pers. comm., via D. Garcelon). Reintroduction of eagles to the northern Channel Islands may lead to greater predation on Xantus's Murrelets. However, at this time, the Department has no information to indicate that Bald Eagles are an imminent or significant threat to murrelets.

The cumulative impact of these threats is an important consideration, and this was noted in the petition on page 13. The petition states: "*Although murrelet mortality from native predators may be viewed as a "natural" situation, the impact of such mortality must be considered as a factor additive to such "unnatural" mortality from anthropogenic sources and non-native animals. The so-called "naturalness" of current predation levels from native predators also must be assessed carefully, since long-term ecosystem changes (e.g., plant communities) likely have led to changes in predator populations and ecology. Thus, levels of predation may be much higher than they were historically.*" The Department supports this view, and we believe there is sufficient scientific information as was discussed and cited in the Population Trend section of this report. Further scientific information to support additive population effects is found in a comprehensive review paper on seabirds and predation (Burger and Gochfeld 1994:43). These authors state: "*The main point is that naturally occurring predators have not been implicated in eliminating major populations, although they may be important to relict populations reduced by other factors.*"

Threats can be additive and help to exacerbate population decline. For example, because the first egg of a murrelet clutch is left unattended until shortly after the second egg is laid, this provides an opportunity for mouse or rat predation on the unattended egg. Such a scenario is particularly important given the presence of a non-native predator, such as the black rat, or if mouse population density if high. As was noted earlier, there is substantial scientific literature on the negative effects of rat predation (see Population Trend section of this report).

Direct mortality of murrelets from oil spills, rat predation, or Barn Owl predation has a more obvious effect on population growth than human disturbance factors that do not result in direct mortality. However, consistent disturbance can reduce energy reserves by causing murrelets to move further or more often than they would normally, and disturbance can also result in nest abandonment. Murrelet eggs/nest sites could be unintentionally destroyed by human foot traffic, especially in sea caves where light levels are low and natural debris serves to camouflage nest sites.

Major Threats

Non-native Mammals

Rats are known to consume eggs, but also adults, and occasionally chicks of various seabirds throughout the world (Bertram 1995, Seto and Conant 1996, Drever

and Harestad 1998, and others). Rats are well documented as causing population declines in seabirds (Springer et al. 1993, Bertram 1995, Seto and Conant 1996, McChesney and Tershy 1998, Seto et al. 2001, Sowls and Rauzon 2001, Ogle 2002, and others). Table 2 in the petition also documents the extensive presence of introduced rats and other non-native mammals at known murrelet breeding sites from California to Mexico. The Department is involved in a rat eradication program at Anacapa as a member of a trustee council, charged with carrying out and monitoring the results of the Anacapa restoration plan. A council was formed as a result of settlement of the American Trader oil spill case.

The rat removal at Anacapa Island may result in the eventual restoration of a potentially large murrelet colony (McChesney et al. 2000). The restoration of significant numbers of breeding murrelets on Anacapa Island via the rat removal project holds great promise. In other parts of the world, success stories are beginning to emerge as biologists undertake rat control projects. For example, rat eradication on Midway Atoll was initiated in 1994. Bonin Petrel (*Pterodroma hypoleuca*) colonies responded to rat control by increasing their reproductive success from zero to a high of 83%. Christmas Shearwater (*Puffinus nativitatis*) numbers have also increased dramatically since rat eradication (Seto and Conant 1996, Seto et al. 2001). Intensive predator management work in New Zealand has also produced positive results for the extremely rare Taiko Petrel (*Pterodroma magenta*) (Ogle 2002).

The lag time for substantial seabird response may be at least 6 years based on the Midway Atoll example, and longer (10-15 years or more) for highly endangered birds, such as the Taiko Petrel. Response time will depend on the extent of the eradication effort, the size of the seabird population at the time of predator control, and many other variables that can affect seabird population growth (for example, reproductive rate, mortality factors, food supply, weather, and the presence of other predators).

Given that alcids have high colony fidelity, there will likely not be a large influx of murrelets from other colonies to capitalize on a rat-free nesting environment. Thus, it may take 10 years or more to see substantial increases in nesting effort and reproductive success for murrelets at Anacapa Island.

Additionally, as was noted in the petition on pages 9-10, rats could be accidentally reintroduced onto Anacapa Island or other Channel Islands, thus, a management plan to combat future introductions is needed. Appendix E of this report contains two items: 1) a copy of an August 15, 1994 letter from the Pacific Seabird Group to the NPS expressing the need for a contingency plan for accidental rat introductions, along with other conservation suggestions; the reply letter back from the NPS is also included; 2) a copy of a July 26, 2000 letter from the Pacific Seabird Group to the U.S. Fish and Wildlife Service in support of the rat eradication effort at Anacapa Island.

Oil Pollution

There is the potential for injury and mortality to murrelets in the case of an oil spill or chronic oiling events. A few dead oiled Xantus's Murrelets have been reported on beaches in central California (Carter et al. 2000). Other than these few birds, there are no other known mortalities for Xantus's Murrelets from oil spill events. Seabird mortality from the 1969 Santa Barbara oil spill was not well investigated. However, coastal areas around Anacapa and Santa Cruz Islands were oiled in the January-May period when murrelets attend nocturnal at-sea congregations beside colonies. Some or many murrelets from these colonies probably were killed (Carter et al. 2000).

The Department considers it probable that another spill will occur in the Channel Islands area, given the volume of vessel traffic, military activities, and the existence of numerous oil platforms (Figure 19). Murrelets forage over a wide area in the Channel Islands, and have been documented to travel mean distances of 62 -111 km (39 – 69 miles) from Santa Barbara Island during the breeding season (Figure 20; Whitworth et al. 2000). When the existing oil extraction facilities and shipping lanes are compared with known murrelet foraging locations, the potential for severe impact to murrelets from a large spill event is evident (Figure 21). The natural oil seeps in the Southern California Bight are not considered a severe threat to the murrelets because most of the seeps occur nearshore, while the murrelets are most commonly found further offshore, nearer the Channel Islands (Figure 21).

In addition to threats from an acute large oil spill, Xantus's Murrelets are also at risk from chronic oil pollution associated with illegal discharges from tank washings and oily bilge waste. Such discharges typically occur in shipping lanes or farther from shore, which increases the probability of harm to Xantus's Murrelets (Hampton et al. 2003).

Because oil spills can occur due to accidents, it is difficult to predict when the next spill event might occur. The Department believes that oil pollution constitutes a potential threat to Xantus's Murrelets. The support for this position is further outlined below.

Factors Affecting the Ability to Document Mortality of Xantus's Murrelets During Oil Spill Events

There are two main reasons why Xantus's Murrelet carcasses have a low likelihood of being documented during a spill event:

1) Offshore habitat use by murrelets, where less oil spill response occurred, at least in the past.

2) At-sea carcass loss due to sinking or scavenging following exposure far offshore.

Additionally, recent studies by the Department's Office of Spill Prevention and Response have confirmed that small-bodied bird carcasses, such as murrelets, are hard to recover, relative to larger carcasses, along coastal beaches due to a fairly rapid scavenging response by predators. It is also recognized that searchers have greater difficulty finding smaller (vs. larger) carcasses, even on beaches. The conclusion from the Department's scavenging study is supported by the lack of beached murrelets ever collected by the Beach Watch Program, from 1993-1999 (pg. 12 in the petition). If a spill were to occur in the Channel Islands area today, the Department's response would be much more intensive than it was prior to formation of the Office of Spill Prevention and Response.

Background on Seabirds and Oil Development in the Southern California Bight

The 1969 Santa Barbara oil spill event ushered in the beginning of studies on the effects of oil on seabirds. In the mid 1970s, the first major biological investigation into Channel Island seabird populations and ecology was initiated (Hunt et al. 1979). That study was funded specifically to analyze the potential impacts from oil development and oiling of seabirds, because the danger to seabirds was recognized.

A 1980 summary of potential oil spill impacts to murrelets noted: *"Because Xantus' Murrelets, like other alcids, spend a lot of time on the water and dive for food, they are vulnerable to oil spills. Location of spills in the California Bight during the breeding season would be the most critical, ..."* (Sowls et al. 1980).

Oil Pollution Summary

The potential for oil spill impacts to murrelets is striking (Figure 21), and was noted in a definitive paper on the subject (Carter et al. 2000). Additionally, as noted earlier, murrelets are at risk from chronic oiling in the marine environment (Hampton et al. 2003). If a spill event occurred during the murrelet breeding season, the result could cause extirpation or extinction, depending on the size of the spill. Two recent spills in California have caused harm to endangered Marbled Murrelets in northern California; both of those spill events were accidents. Xantus's Murrelets were likely affected by the American Trader oil spill that occurred in southern California in 1990, even though no carcasses were recovered. Accordingly, part of the restoration plan for that spill includes the rat eradication program at Anacapa Island to benefit Xantus's Murrelets and other seabirds (American Trader Trustee Council 2001).

One potential mitigating factor relative to oil spill risk is that double-hulled tankers are currently being phased in. There are other various preventive measures that have been initiated in the recent past (*e.g.*, various technologies to reduce the amount of oil spilled at a platform or from a pipeline, and the evolution of segregated ballast tanks to reduce the amount of chronic oil discharge).

Native Predators

Barn Owl

Barn owls (*Tyto alba*) are well documented as predators on adult Xantus's Murrelets (Murray et al. 1983, Drost and Lewis 1995, Wolf et al. 2000), though their usual prey is small mammals and rats (Bent 1961:145-148, Marti 1992). An intensive six-year (1982-1987) study by Charles Drost on Santa Barbara Island provides a framework for evaluating the relationship between owls, murrelets, and deer mice (Drost *in* Drost and Lewis 1995). For additional discussion of the owl/deer mice relationship, see the Deer Mice section, below.

High numbers of owls (21-33 individuals) have been counted on Santa Barbara Island in some years. Even the low counts of 4-7 owls seem to represent an unusual situation for such a small island. Owl densities are not known to be this high based on published literature (Marti 1992). In southwestern Scotland, Barn Owls reached a density of 5.1 pairs per 10 square kilometers, during years when the prey base was abundant (Taylor et al. *in* Marti 1992). That density converts to only 1.3 Barn Owl pairs for Santa Barbara Island (the island is approximately 1 square mile in size, or 2.6 square kilometers). If the owls are not all nesting on Santa Barbara Island, they are probably coming from the mainland, or other islands, to forage on the abundant deer mice and other prey, including murrelets. Barn Owls are known to fly and forage over water, though few studies have investigated their maximum foraging distance (Mueller 1979, Marti 1992, Lehman 1994). In New Jersey, radio marked adult owls traveled a maximum distance of 3.5 miles (5.6km) from roost to hunting areas (Hegdal and Blaskiewicz *in* Marti 1992). Immature owls can disperse up to 1,180 miles (1900km) from the site where they were born (Soucy *in* Marti 1992). Santa Barbara Island is located 61 km (38 miles) from the mainland coast.

As described later in the Artificial Light Pollution section of this report, owls may be attracted to lights for foraging. A statement contained in Wolf et al. (2000) documents owl attraction to lights on Santa Barbara Island: "*Barn Owls, in particular, are attracted to light sources at night*" (personal observation, S. Wolf and J. Roth). However, details of these observations were not provided in the report.

In another example, owls may have utilized artificial lights when foraging at Lihue Airport on the island of Kauai, Hawaii. Studies at the Lihue Airport on Barn Owls and other birds were initiated in order to alleviate bird strikes (collisions) with aircraft.

An unusually high number of Barn Owls were present at the airfield from March to April 1992. Four owls were normally observed, but as many as 19 were noted on one survey. A rodent survey was conducted at the airfield that showed a virtual absence of rodents compared to adjacent fields. The owls (which were introduced onto the island by humans) were shot to avoid additional collisions with aircraft, and stomach analyses revealed crickets (*Gryllida* sp.) in the diet, which is unusual for Barn Owls (Bent 1961:145-148, Marti 1992, U.S. Dept. of Agriculture 1996). At this same airport, the threatened Newell's Shearwater (*Puffinus auricularis newelli*) is known to be attracted to the airport lights, and juveniles must be retrieved when they become disoriented by the lights and land on the airfield (U.S. Dept. of Agriculture 1996).

However, raptor expert P. Bloom (pers. comm.) thought that Barn Owls were probably not attracted to lights per se, based on his many years of field experience with Barn Owls in particular, and Marti (1992) makes no mention of it. In order to better understand if Barn Owls will take advantage of artificial light sources, P. Bloom recommended further study, including studies on Barn Owl predation effects and densities on Santa Barbara Island. He also admitted he was unfamiliar with Barn Owl ecology in offshore environments. P. Bloom also noted that if Peregrine Falcons were present, they would prey on Barn Owls and perhaps help reduce their numbers. Barn Owls are primarily nocturnal, while falcons are diurnal, but both species can be active at dawn and dusk. A California database on peregrine food habits has never documented Barn Owls as a prey item (J. Linthicum, pers. comm.). Therefore, falcon presence may not significantly affect owl numbers.

Though Barn Owls are primarily nocturnal, they do not necessarily avoid light, as indicated by a nest site that was located in a steel range light on a tower in the Savannah River in Georgia. A picture of this nest site is contained in Bent (1961: Plate 27); the tower was surrounded by water. "*The nest was in a steel box about 2 feet square, with part of the west side open to the sun, under the light, and was liberally carpeted with pellets. The keeper of the light says the owl has nested there for about four years*" (I.R. Tomkins *in* Bent 1961:142).

Barn owls are also known for taking excess prey and not consuming it. The excess prey can number from 30-50 (Marti 1992), and as high as 189 individual prey items (Wallace *in* Marti 1992). The excess prey is stored in the nest site during incubation and early brooding of young owls. There is no conclusive evidence that food storing occurs outside the breeding season, but captive individuals often hide excess uneaten prey (Bunn et al. *in* Marti 1992). An example of prey storage for a seabird species taken by owls provides the following details: "...*I visited Castle Rock, a large rock which lies off Crescent City, California, and which supports an extensive rookery of sea birds. There was an old cabin on the Island which had fallen partly to ruin. Under a built-in wooden bedstead was the nest of a Barn Owl ...The area covered by the bed was three inches deep with the feathers, wings and bodies of Beal Leach Petrels...* [sic] [Leach's Storm-Petrels]...*These little birds were evidently so easily*

caught that there were numbers of bodies with only the heads removed, and I collected for study three specimens with hardly a feather misplaced. A good number of the bodies of the petrels were rotting and inhabited by fly larvae..." (Bonnot 1928).

Drost and Lewis (1995) thought barn owl predation did not have a significant effect on murrelets. They stated: "Even though Barn Owl predation on murrelets at Santa Barbara Island may be high, there is no evident effect on long-term population size; numbers in years following heavy predation are not significantly different from numbers in years following light predation" (Drost and Lewis 1995).

However, this statement seems to contradict other statements in Drost and Lewis (1995), for example:

- "*Barn owls and Peregrine Falcons are the most important native predators on [murrelet] adults at breeding colonies.*"
- "*Heavy predation by Barn Owls has been noted on Santa Barbara Island.*"
- "*In heavy predation years (when mice are rare), owls have killed over 130 adult murrelets, representing nearly 10% of the nesting population on the island.*"

In summary, some of the conclusions of Drost and Lewis (1995) may no longer be valid, based on more recent work indicating murrelet population decline (Sydeman et al. 1998, Carter et al. 2000, Wolf et al. 2000, NPS unpublished data, 2002). Population modeling by Sydeman et al. (1998) indicated owl predation might be sufficient to cause a decline in the Santa Barbara Island population of murrelets.

Deer Mice

Native deer mice have been documented as preying heavily on Xantus's Murrelet eggs, and they are also known to eat unattended chicks (Murray et al. 1983, Drost and Lewis 1995). An intensive study by Murray et al. (1983) on Santa Barbara Island documented that 44% of murrelet eggs laid were consumed by mice.

National Park Service biologists annually monitor the murrelet nest sites at the two nest study plots on Santa Barbara Island (Cat Canyon, Figure 8), and Nature Trail, Figure 9) as described in the Population Trend section of this report. Biologists examine the eggs for evidence of mouse predation, and a protocol has been set up for collecting this data since the 1980s. As was noted in the Population Trend section, occupancy rates have been declining at these two study sites from 1985-2002 (Figures 10a and 10b).

The Department found evidence that the deer mouse situation on Santa Barbara Island is highly unusual (Drost and Fellers 1991), and may indeed cause predation rates on murrelets to be higher than would normally be expected. As noted by Sydeman et al. (1998), this level of predation appears too high to sustain the murrelet

population on Santa Barbara Island. This is based on inferred population parameters for the Xantus's Murrelet, from the closely related Ancient Murrelet. The Department believes that serious consideration of potential control of deer mice may be necessary to conserve the Xantus's Murrelet. A more recent study on the mice by the NPS (Schwemm and Coonan 2001) confirms the results of the Drost and Fellers (1991) work. The details of the mouse population cycles on Santa Barbara Island are summarized below.

The deer mouse population followed a pattern of multi-annual increase to high numbers, followed by a sharp decline to much lower numbers, with peaks separated by three of four years (Drost and Fellers 1991). This type of cycle is highly uncharacteristic for deer mice, based on most published literature. Density of deer mice very rarely reaches the levels recorded at Santa Barbara Island; information presented in Drost and Fellers (1991) indicates the deer mice numbers on Santa Barbara Island are the highest recorded from published studies in North America (an order of magnitude greater than typical deer mouse densities). They found no evidence that deer mice are cyclic and in such high densities on other island situations in North America. In fact, they found no indication that island isolation is characteristically associated with cyclic population behavior. A review by Tait and Krebs *in* Drost and Fellers (1991), suggested at least a five-fold difference between peak and low numbers is characteristic of cycles, and the difference between highs and lows on Santa Barbara Island is over 25 times.

The two most plausible reasons for the high numbers of deer mice on Santa Barbara Island are the relative lack of competition and the depauperate assemblage of predators on the island (Drost and Fellers 1991). Because the deer mice occupy the shrubby habitat in higher densities than the more open grasslands, this puts the deer mice right where the murrelets nest, in the shrubby habitat. The shrubby habitat is utilized by the murrelets for cover from predators and thermal regulation. The mice seek this same cover, also for protection from the same primary predator, the barn owl.

The resident barn owl population has shown a pattern of increase, peak, and decline which tracks the population pattern of deer mice. Peak numbers of up to 25 owls have lagged slightly behind corresponding peaks in the mouse population. After deer mouse declines, barn owl numbers decreased to lows of seven (1984-85) and four (winter 1988) individuals (Drost and Fellers 1991).

A complex interaction of rainfall patterns and associated vegetation response leads to population changes in deer mice and barn owls on Santa Barbara Island (Drost and Fellers 1991). Whether such highly unusual cycles existed prior to human induced changes in vegetation on the island remains an important, unanswered question.

Peregrine Falcon

The petition raised a concern that increased predation pressure by peregrines on Xantus's Murrelets may occur given the recent reappearance of breeding peregrines on Santa Barbara Island, and other Channel Islands. This concern is probably valid, because peregrines are known predators of Xantus's Murrelets (Howell 1910, Bent 1961, Huey *in* Kiff 1980; B.J. Walton, pers. comm., in the petition).

At this time, the Department found no information to indicate that Peregrine Falcons are an imminent or significant threat to murrelets. However, the potential for peregrines to impact murrelets is supported by the scientific literature. Because of the potential for peregrines to negatively affect murrelet populations, some elements of their biology are described below, including history of their abundance in the Channel Islands. Peregrine Falcon predation is potentially an emerging threat.

Peregrines are known to prey chiefly on birds, and there are reports of at least 22 species of birds being taken on the Channel Islands and Los Coronados Islands (Kiff 1980). Bent (1961:53-54) noted a very long list of bird prey items, including murrelets; it was also noted that "*...on the seacoast and islands, these hawks live almost exclusively on the smaller sea birds.*" A peregrine nest site examined on Los Coronados Islands in 1924 contained 12 bird species, and included at least 42 pairs of wings of Xantus's Murrelets (Huey *in* Kiff 1980:664). An extreme example of peregrine predation pressure on Ancient Murrelets is noted from British Columbia. Researchers stated that, in a year, a family of peregrines (two adults and four young) will kill about 1,000 Ancient Murrelets (Nelson and Myres *in* Kiff 1980).

The following discussion on peregrine extirpation is drawn from a comprehensive summary of historical changes in raptor populations in the Channel Islands, including the Los Coronados Islands (Kiff 1980). Historically, peregrine falcons were resident and breeding on all the Channel Islands. Up until the 1940s, virtually all authorities considered the peregrine to be at least fairly common on the Channel Islands, and at least 20 pairs of peregrines are thought to have been resident. But, in the two decades following 1945, a catastrophic decline occurred in California peregrine populations. Available information indicates the peregrine was extirpated from the Channel Islands by 1955. It is now acknowledged that the pesticide DDT was the main reason for this decline. DDT was first used widely in the United States in 1947. The principal metabolites of DDT are referred to generically as DDE, known for causing eggshell thinning in populations of bird-eating and fish-eating wild birds. Eggshell thinning led to reproductive failure for the peregrine, and affected many other species as well (Kiff 1980).

Because peregrines were extirpated from the Channel Islands as breeders by 1955, and only recently reappeared in 1996 at Santa Barbara Island, Xantus's Murrelet populations have not been under intensive predation pressure from the falcons for

approximately 41 years. This period of peregrine absence is likely longer than the life span of a Xantus's Murrelet. While murrelets have instinctive predator avoidance behaviors, such behaviors are naturally fine-tuned in response to exposure and interaction with predators. Thus, a period of adjustment is likely underway at present, as murrelets adapt to the return of a natural predator.

Seabird researchers in Washington State have documented both positive and negative effects of the peregrine falcon population recovery. Studies on seabirds that breed on Tatoosh Island have indicated that falcons prey heavily on some species (and may cause population declines), but falcons may help other seabird populations to increase by controlling northwestern crows (*Corvus caurinus*). These researchers state that caution is in order when undertaking programs to augment peregrine populations, because many seabirds are already under a variety of threats (oil spills, human disturbance, El Niño events) and thus may not be able to withstand falcon predation (Paine et al. 1990).

Peregrines are also documented as a predator of two endangered species of seabirds that nest in California, the California Least Tern (*Sterna antillarum brownii*) (Keane 2001), and the Marbled Murrelet (USFWS 1997:55, Burkett et al. 1998). Once prey species are reduced in number from historic levels, and subject to numerous other threats (as is the case with the Least Tern and Marbled Murrelet), then predation effects can serve to exacerbate population declines (Fancher 1992, USFWS 1997:54-55, Keane 2001).

Artificial Light Pollution

Artificial light pollution is a threat to the survival of the Xantus's Murrelet, particularly at breeding sites. Xantus's Murrelets are nocturnal in their activities at colonies. Nocturnal seabirds are active at night (main theory is to avoid predation), and as such are adapted to night-time conditions. No studies have been done to try and quantify the extent of the problem, but the impacts of light attraction may be of a chronic and serious nature, as there are many sources of artificial lighting in the waters around and on the islands used by this murrelet.

This species is attracted to light and in particular to lighted vessels (Howell 1910, Jehl and Bond 1975, Hunt et al. 1979, Whitworth et al. 1997). Small amounts of vessel lighting have been documented to cause parent-chick separation in the Channel Islands (B. Keitt, P. Kelly, G. McChesney, and M. Naughton, pers. comm.), though temporary separation at night may not result in mortality.

Other sources of lighting, including flashlights and lanterns in breeding colonies can be a problem, particularly for chick disorientation. As early as 1910, Howell noted: [Xantus's] "Murrelets are also attracted by light, as is the case with so many of the nocturnal sea-birds, and I have had them enter my tent thru the front flap and under the

sides at night when my lantern was lighted." Chicks will die if separated from their parents after departing nesting sites as they are dependent on their parents for an extended period of time at sea (Gaston and Jones 1998).

The Pacific Seabird Group documented their concern over vessel lights as an attractant to murrelets in a letter dated August 15, 1994 (Appendix E). Item nine on an attachment to that letter reads: "*Investigate and implement policies to control unnecessary use of bright deck lights by boats anchored at Santa Barbara Island.*" The current state of the science on seabirds and artificial lights is discussed below.

Artificial night-lighting has been shown to cause disorientation in birds of many different species and has been documented to result in birds becoming exhausted due to continual attraction and fluttering near lights, or birds colliding with lighted structures, resulting in injury or immediate death (Bretherton 1902, Verheijen 1958, Herbert 1970, Avise and Crawford 1981, Fedun 1995, Bower 2000). Verheijen (1958) also noted that "birds can be captured with light." Since that time, the scientific community has actually used artificial lights as a technique for capturing birds for research purposes. This technique to disorient birds, allowing easy capture, has been used for a variety of species and reported in the literature, including several species of waterfowl (Cummings and Hewitt 1964, Bishop and Barratt 1969), Trumpeter Swans (*Cygnus buccinator*) (Drewien et al. 1999), Common Eiders (*Somateria mollissima*, a sea duck) (Snow et al. 1990), Double-crested Cormorants (*Phalacrocorax auritus*) (King et al. 1994), Marbled Murrelets (Burkett et al. 1998; and others), and Leach's and Fork-tailed Storm-petrels (*O. furcata*) (Williams et al. 2000). In the Channel Islands, this technique has been used to capture Xantus's Murrelets for radio telemetry studies (Whitworth et al. 1997, Carter et al. 2000).

Seabird attraction to man-made lights, including lighthouses and ship lights, has been noted worldwide, particularly among the Alcidae, as well as among the Procellariiformes (which include albatrosses, petrels, shearwaters, storm-petrels and diving-petrels) (Howell 1910, McLellan 1926, Miller 1936, Verheijen 1958, DeLong 1967, DeLong 1968a, DeLong 1968b, DeLong and Brownell 1968, Manuwal 1974, Jehl and Bond 1975, Byrd et al. 1978, Dick and Donaldson 1978, Hunt et al. 1979, Reed et al. 1985, Reed 1987, Telfer et al. 1987, Cherel et al. 1994, Bertram 1995, Carter et al. 1996, Cherel et al.1996, Whitworth et al. 1997, Chardine and Mendenhall 1998, Ryan and Watkins 1999, Carter et al. 2000, Weimerskirch et al. 2000). Fog or low cloud cover has been noted to make the attraction problem worse.

The attraction of seabirds to lights of commercial fishing vessels has been noted in observer programs for longline fisheries (Cherel et al.1994, Cherel et al. 1996, Ryan and Watkins 1999, Weimerskirch et al. 2000). Mitigation measures for reducing seabird bycatch in the longline fisheries from several countries acknowledge that birds are attracted to lights and require minimal vessel light use at night for this reason. For example, the Commission for the Conservation of Antarctic Marine Living Resources

(the organization that regulates Antarctic fisheries) implemented Conservation Measure 29/XIX, which includes the following measure: "During longline fishing at night, only the minimum ship lights necessary for safety shall be used" to decrease incidental seabird mortality (From the Conservation Measures and Resolutions adopted at CCAMLR-XIX, available on the web site, www.ccamlr@ccamlr.org).

For rare or declining seabirds, artificial night-lighting close to breeding sites can significantly contribute to further decline. This type of impact has been particularly well-documented for two nocturnal seabird species in Hawaii, the threatened Newell's Shearwater and the endangered Hawaiian Dark-rumped Petrel (*Pterodroma phaeopygia sandwichensis*) (Byrd et al. 1978, Simons 1984, Reed et al. 1985, Reed 1987, Ainley et al. 1997, Telfer et al. 1987, Podolsky et al. 1998). Fatal light attraction to fishing vessels has been documented as contributing to the decline of Ancient Murrelets on Langara Island, British Columbia (Bertram 1995).

In addition to light attraction and disorientation, the breeding activities of nocturnally active seabirds can be altered by lighted conditions. Studies have shown that nocturnal seabird species display highly reduced activity levels on moonlit nights when they are apparently more susceptible to predation, and that levels of colony attendance are inversely proportional to increasing light levels (Manuwal 1974, Storey and Grimmer 1986, Watanuki 1986, Jones et al. 1990, Klomp and Furness 1992, Keitt 2003, in review). These studies also show that nocturnal species do not return to colonies, and to their nests, until the sun and moon set; thus on full moon nights, the amount of time of total darkness and access to their nests for incubation shift changes and for departure of chicks to sea is very limited. Therefore, it is reasonable to expect that successive nights of high artificial light levels on and around breeding colonies would disrupt the normal nesting activities of murrelets, which could result in nest abandonment, increased mortality of eggs and/or chicks, and increased predation rates of adults that do return during lighted conditions.

While all types of island lights and lighted vessel activity may affect Xantus's Murrelets, the largest potential for impact during the breeding season is from the market squid fishery at the Channel Islands. This is due to the fishery's current reliance on the use of light boats to attract squid for night-time fishing. These light boats use higher wattages of light than other types of boats in the area (average wattage of 22,500 watts; legal maximum since May 2000 is 30,000 watts), thus if they are close to breeding sites of murrelets during the breeding season, the potential does exist for interactions with the light boats or altered behavior in breeding colonies. Total squid landings and number of vessels participating in the fishery in southern California has increased since the 1970s, and squid fishing occurred off Santa Barbara Island during the murrelet breeding season in 1999 (Figure 22).

The petition cites data collected by the Channel Islands National Park on Santa Barbara Island that higher mortality rates of Xantus's Murrelets by nocturnal predators

occurred in 1999, which correlates with squid fishing near the colonies. The petition states that murrelet kills by Western Gulls (*Larus occidentalis*), which are normally a diurnal species, were noted in 1999. Western Gulls are documented to prey on Xantus's Murrelets (Oades 1974, Hunt et al. 1979, Murray et al. 1983). Park staff also noted that Western Gulls were more active at night when squid lights were on in 1999. Other studies have shown that gull activity and predation does increase with lighted conditions (Nocera and Kress 1996, Keitt 2003, in review).

An increased mortality rate of murrelets due to predation by Barn Owls was also recorded (Channel Island National Park, unpublished data). Data on Barn Owl predation for Santa Barbara Island show the highest recorded murrelet mortality rate occurred in 1999 (Figure 23), however, 30 owls were estimated to be present on the island that year, which is higher than other years when owl surveys were conducted. Deer mice numbers were exceptionally low in 1999 as part of the low phase of their cycle (Schwemm and Coonan 2001). Thus it is difficult to determine if increased owl predation rates in 1999 correlates with lighted conditions or unusually high owl presence. More murrelets may have been killed because there were fewer mice for the owls to prey on. But, as noted in the petition, high nest abandonment was recorded in the murrelet study plot closest to the most intense fishing activity at Santa Barbara Island and researchers did observe owl attraction to lighted areas (Wolf et al. 2000).

The Commission adopted measures effective 31 May 2000 that required light shields and a maximum light wattage of 30,000 watts on market squid fishing vessels in an effort to reduce light pollution in the Channel Islands. Since that time, the Department has not collected any data from the market squid fishery as to its potential impacts to Xantus's Murrelets or other seabirds, as there has been no observer program for the fishery, and no studies have been conducted on the effectiveness of the light shield and wattage limitation regulations. Likewise, with respect to the order by the Commission authorizing limited incidental take during the candidacy period (Appendix H), the Department did not have sufficient staff to monitor the situation during 2003. The Department received one complaint of lighted vessels working on the south side of East Anacapa Island during the breeding season (April 2003). Researchers noted that the area the lighted vessels were in has the densest at-sea congregation of murrelets at Anacapa Island (D. Whitworth, pers. comm.). Also, the Department's draft Market Squid Fishery Management Plan examines several seabird closure options in the Channel Islands that would benefit murrelets. A decision on the preferred option for the plan is pending until it is scheduled at a Commission meeting and considered.

Based on the above, artificial night-lighting, particularly close to the breeding sites of Xantus's Murrelets in the Channel Islands, has a reasonable potential to cause the following impacts on this species:

- Disruption of courtship activities due to disorientation and distraction in nearshore waters.

- Colony-site and individual nest abandonment.

- Increased predation rates of breeding adults as they leave/return to nests, and of chicks has they depart the nests for the sea by increasing the visual abilities and activity levels of predators.

- Decreased nest attendance, and as a result decreased egg incubation and possible egg/chick mortality due to reluctance of parents to return to the colony under "moonlight" types of conditions (predator avoidance).

- Chick-adult separation at fledging state due to disorientation.

- Direct collision of birds with vessels resulting in injury or direct mortality. In addition, if breeding individuals are affected, this will result in egg/chick mortality due to nest abandonment.

Minor Threats

Human Disturbance at colonies

Interagency cooperation is necessary in order to protect murrelets and other seabirds that nest in sea caves and offshore rocks. The Department is already working with NPS and others on educational materials as part of the Anacapa Island rat eradication project. In order to minimize disturbance to nesting murrelets, it would be beneficial to develop educational materials to discourage park visitors from straying off-trail on Santa Barbara Island. The Department, NPS, and other interested parties should continue to work together to design management solutions for protection of murrelets. Measures that could be used to assure nest sites are protected from direct and indirect human disturbance include increased signs on the islands, visitor orientation lectures, signs on buoys, educational leaflets, and press releases.

Oceanographic and prey changes

Very few studies have been conducted on murrelet food habits. Limited diet data were obtained from stomach analysis of 22 murrelets collected at-sea near Santa Barbara Island during the 1977 breeding season (Hunt et al. 1979). Larval Northern Anchovies *(Engraulis mordax)* were the predominant species in the samples, comprising nearly half of the total volume of samples analyzed. Larval Pacific Sauries (*Cololabis saira*) and rockfish (*Sebastes* sp.) were also taken. Elsewhere, unidentified crustaceans (known as zooplankton) (Howell 1910), and sand lance (*Ammodytes* sp.)

have been noted as prey items (Los Angeles Co. Museum # 105851 *in* Drost and Lewis 1995).

More recently, results from 10 murrelets collected at-sea in May 2002 between Anacapa and Santa Cruz Islands revealed subadult and adult Northern Anchovies (n=2 stomachs), juvenile Bluefin Driftfish (*Psenes pellucidus*) or Medusafish (*Icichthys lockingtoni*) (n = 2 stomachs), and euphausiids (*Thysanoessa spinifera*) (n =3 stomachs) (Hamilton et al. 2003).

Xantus's Murrelets forage widely in the Southern California Bight (Figure 20), and prey on numerous species of zooplankton and fish. However, more studies on Xantus's Murrelet food habits are needed. For comparison, studies on other alcids are helpful: 1) Marbled Murrelets appear to be opportunistic feeders with a high capability for "prey-switching", based on prey availability (reviewed in Burkett 1995); 2) Ancient Murrelets seem to rely more on zooplankton prey (Gaston and Jones 1998); and 3) Craveri's Murrelets eat many species of non-larval fish, and squid (DeWeese and Anderson *in* Gaston and Jones 1998). Thus, in general, Xantus's Murrelets are probably capable of foraging opportunistically on a variety of both small fish and zooplankton prey (Carter et al. 2000, Hamilton et al. 2003).

Cassin's Auklets feed on zooplankton, and the auklet population on Southeast Farallon Island has shown a decline attributed to decreases in food availability and shifts in prey resources (Pyle 2001). The decline in Cassin's Auklets at the Farallon Islands may also be related to high gull predation (Carter et al. 1992). Lately, the auklet population appears to be on the increase at the Farallons coincident with a recent increase in zooplankton occurrence near the Farallons (W. Sydeman, pers. comm.). These changes indicate the complex relationships that exist between seabirds, their predators and prey, and the physical environment.

Xantus's Murrelet distribution at sea may have changed between the mid 1970s and the mid 1990s (Whitworth et al. 2000), although it is unclear if this was related to prey availability. There is considerable natural variability in interannual abundance and species composition of zooplankton in the Southern California Bight. For example, total zooplankton (including salps and jellyfish) in southern California waters declined by 80 percent between the 1950s and the early 1990s (Roemmich and McGowan 1995), but a major component in the overall decline was reductions in salps and jellyfish. Zooplankton species that may comprise prey items for Xantus's Murrelet such as icthyoplankton, euphausiids, and copepods showed comparatively little change in combined abundance during the same period. However, high variation in abundance of the euphausiid *T. spinifera*, a known murrelet prey item, makes any trend very difficult to discern; the surface aggregating behavior of euphausiids also makes sampling and determination of trend difficult (Brinton and Townsend 2003).

In southern California, larval northern anchovies appear to be undergoing population decline (Figure 24), but Xantus's Murrelets may be able to "prey-switch" from northern anchovies to Pacific Sardines (*Sardinops sagax*). Although the recent recovery of Pacific sardine biomass has not reached the level of the 1930s (Conser et al. 2002), the magnitude of the sardine population increase since 1983 was greater than the corresponding decline in northern anchovy (Jacobson et al. 1995), which may mitigate the loss of anchovy in murrelet diet.

Declines in fish stocks are likely driven by a combination of factors including fishing pressure, natural long and short term oceanic cycles, and perhaps even global warming. The frequency of warm events in the marine environment has increased since 1977 off the West Coast of North America (McGowan et al. 1998). Seabird reproduction is known to be affected by prey availability from studies worldwide. Thus, this aspect of murrelet ecology needs further investigation.

Military Operations/San Clemente Island

San Clemente Island is used as a Department of Defense U.S. Navy (US Navy) training facility. A small breeding population of 10-50 pairs of Xantus's Murrelets is known from the island (Figure 16; Carter et al. 1992, H.R. Carter, unpubl. data, May 2002). Murrelet eggshell fragments have also been documented on an offshore rock near Seal Cove (Drost and Lewis 1995, H.R. Carter, unpubl. data).

Sheep ranching occurred on the island between 1850 -1934. The US Navy gained control of the island in 1934 and canceled the grazing leases. Twenty-two new facilities were constructed on the island from 1935 - 1936. During World War II, the island was used for bombing exercises. From 1950 -1951, the first underwater test ranges were developed. Currently, 500 personnel are stationed on the island, but numbers can swell to 1,000 periodically. The US Navy conducts some operations at night around the island, and Seal Cove is sometimes used as an anchorage. In the past, sea stacks and rocky shores have been used as military targets.

The US Navy recently completed their Integrated Natural Resources Management Plan (INRMP) for San Clemente Island in May 2002. The INRMP will provide a framework to manage natural resources on the island for the next five years, while still preserving the military mission at the installation. Xantus's Murrelets were specifically identified in the INRMP and some measures to protect the murrelets and other species were described, for example: 1) Establish a standardized monitoring program for birds to track seabird occurrence and trends; 2) Focus surveys on sea stacks around the island to determine use by seabirds; 3) Focus surveys on listed species and species of concern (including the Xantus's Murrelet); 4) Develop a standard format and database to collect and maintain records of bird observations on the island; 5) Identify and limit disturbance to sea stacks and rocky shores potentially used by seabirds; 6) Do not use sea stacks or known colony locations as military

targets; 7) Avoid high-intensity artificial light near murrelet breeding sites; 8) Survey shorelines for use by cats and rats and continue efforts to remove feral predators from the island; and 9) Develop an all-Island approach to rat and cat management.

The petition noted that military activities in the Sea Test Range have increased over the last two decades (part of the Sea Test Range is depicted in Figure 3 in the petition). It also pointed out that studies of radio-marked murrelets from Santa Barbara Island showed high overlap between murrelet foraging distribution and areas of extensive Sea Test Range use (Carter et al. 2000, Whitworth et al. 2000). However, the petition listed military operations as a minor threat, and noted that the extent of impacts to murrelets is unknown. The Department concurs with this assessment, and will continue to work with the US Navy to further the conservation of the murrelet. The INRMP described above should prove useful to the enhancement of murrelet nesting opportunities on San Clemente Island.

Bycatch in fisheries

The petition lists bycatch in commercial fisheries, particularly in gill net fisheries, as a minor threat to Xantus's Murrelets. The Department is not aware of any documented occurrences of Xantus's Murrelet bycatch in fisheries other than the one account cited in the petition (off British Columbia, Carter et al. 2000). Whether mortality of Xantus's Murrelets in fishery bycatch is occurring and/or contributing to the decline of the species is difficult to assess given the lack of data.

Alcids have been reported as bycatch in commercial fisheries, particularly in gill net fisheries. While the diving depth of the Xantus's Murrelet is unknown, all alcid species pursue their prey underwater, using their wings for swimming, which makes them vulnerable to entrapment in fishing nets (Piatt and Nettleship 1987). From our review of the available information, it appears bycatch may be a threat to the murrelet. The basis for this conclusion is discussed below.

Closely related alcid species [including the Marbled Murrelet, Ancient Murrelet, and Japanese Murrelet, which are similar in size to a Xantus's Murrelet] have been recorded as bycatch in gill net fisheries for salmon (*Oncorhynchus* spp.), flying squid (*Ommastrephes bartrami*), white croaker (*Genyonemus lineatus*), and Pacific herring (*Clupea pallasi*), along the west coast of the United States (including California), and including: Alaska, British Columbia, the Bering Sea, Japan, Taiwan, and Korea (Ainley et al. 1981, Carter and Sealy 1984, Carter and Erickson 1988, DeGange and Day 1991, Johnson et al. 1991, Ogi et al. 1991, DeGange et al. 1993, Piatt and Gould 1994, Bertram 1995, Carter et al. 1995, Carter et al. 2002). The mortality of Ancient Murrelets in salmon gill nets close to the breeding colony on Langara Island, British Columbia has been suggested as a significant contribution to the decline of this species on that island (Bertram 1995). Gill net mesh sizes used in these fisheries ranged from 2.75 inches to 9.0 inches.

The petition states that the white seabass (*Atractoscion nobilis*) set and drift gill net fishery may capture Xantus's Murrelets. The Department currently has little data on bycatch from this fishery as observations have not occurred for some time, since the fishery moved offshore and closer to the Channel Islands. However, this past summer (2003) the National Oceanic and Atmospheric Administration's Fisheries (NOAA Fisheries) observer program initiated observations in the white sea bass fishery (D. Petersen, pers. comm.). Twenty white sea bass sets (set and drift) were observed in southern California (June/July 2003) and no birds were entangled. NOAA Fisheries will continue to place observers on vessels using small mesh drift and set gill nets (D. Petersen, pers. comm.). The Department has not yet been fully briefed on the extent of this program, and the specific geographic areas where the observers are working.

The White Seabass Fishery Management Plan (2002) lists determining accurate estimates of bycatch as one of its research needs goals (Final Plan, chapter 7, page 12). The plan acknowledges that "it is necessary to investigate these interactions, particularly with regard to pinnipeds, birds, and sea turtles through an at-sea observer program." Around the Channel Islands where the murrelet breeds, white sea bass fishing effort has declined over the past ten years (CDFG, unpublished data) and the fishery is closed during part of the murrelet's breeding season, from 15 March to 15 June. But the main fishing season occurs from mid-June through July (CDFG, unpublished data), which coincides with murrelets foraging out at-sea with their dependent chicks. Until the observer program has been in place for a few years, it will be difficult to assess if take of Xantus's Murrelet is occurring in this fishery; but the potential exists given that the mesh size of 6-7 inches used in the fishery can entangle a murrelet-size bird, and that the fishery is concentrated in the Southern California Bight, where the species forages through most months of the year.

Other set and drift gill net fisheries currently operating in California which could potentially take a murrelet-size bird include white croaker (mesh size 2.75 inch), California barracuda (*Sphyraena argentea*) (3.5 inch), rockfish (*Sebastes* spp.) (4.5 inch), bottom shark (6 to 8.5 inch), soupfin shark (*Galeorhinus galeus*) (6.5 to 11 inch), and California halibut (*Paralichthys californicus*) (8.5 inch). In addition, white sea bass drift gill nets (small mesh size ranging from 6 to 7 inch) have historically been used to fish at the surface for yellowtail (*Seriola lalandi*), and recently for certain tuna species (*Thunnus* spp.) along central and southern California (B. Read, Department of Fish and Game, and Campbell, Forney, and Smith, NOAA Fisheries, pers. comm.).

Radio telemetry studies of Xantus's Murrelets captured at Santa Barbara Island indicate that this species is a long-distance forager while breeding, traveling a mean distance of 111 km (68 miles) from the island (Whitworth et al. 2000). During the non-breeding season, this species can be found up to, and occasionally beyond 200 km (124 miles) offshore along the entire California Coast and elsewhere in its range (Spear et al. 2003). Therefore, Xantus's Murrelets are found in waters where gill net fishing occurs.

Carter et al. (2000) suggest that it is unlikely that large numbers of Xantus's Murrelets are killed in gill nets. This may be partly due to the observation that murrelets do not aggregate in large numbers for foraging and do not appear to forage when staging in the evenings in large numbers near breeding sites. In addition, incidental capture close to the islands is not likely to occur because gill net use has been prohibited (since 1994) within one mile or in waters less than 70 fathoms deep (whichever is less) around the Channel Islands (FGC section 8610.2, as part of the Marine Resources Protection Act of 1990).

However, given the low estimated population size of Xantus's Murrelet and all of the other threats to the species, a chronic low level of bycatch could be a problem for the species. The Japanese Murrelet, an endangered species with estimated population size of less than 4,000, has been documented as bycatch in high-seas drift nets (Piatt and Gould 1994). This species has very similar biology to the Xantus's Murrelet, with breeding restricted to a few sub-tropical islands and birds generally moving northward after breeding, offshore in warmer waters. An observer program found a low but persistent rate of mortality in post-breeding areas that may be contributing to the species decline (Piatt and Gould 1994).

Summary of Threats

The Department finds sufficient scientific information to indicate that the identified threats have the potential for contributing to decline in murrelet populations. Peregrine Falcon predation on murrelets is potentially an emerging threat. The Department believes Bald Eagle predation may pose a problem in the future, but more information is needed.

Impact of Existing Management Efforts

The petition contains numerous statements indicating the inadequacy of existing management efforts: 1) lack of observer programs on squid fishing and gill net vessels; 2) park visitors have not been prevented from accessing sea caves or offshore rocks where murrelets nest; 3) lack of monitoring as to effect of light shields on squid vessels; 4) inadequate protection of nesting areas; 5) full extent of military operations and potential impacts to murrelets is unknown; 6) no attempt has been made to quantify the numbers and disposition of birds landing aboard brightly lit vessels and oil platforms near murrelet colonies; 7) no detailed studies have been conducted on the impacts of non-native mammals to murrelet populations; and 8) lack of a management plan to combat future rat introductions.

The petition also states "*An assessment of the true impacts of the many threats described here is further exacerbated by the lack of data collected by state and federal government agencies.*"

Carter et al. (2000) suggest that it is unlikely that large numbers of Xantus's Murrelets are killed in gill nets. This may be partly due to the observation that murrelets do not aggregate in large numbers for foraging and do not appear to forage when staging in the evenings in large numbers near breeding sites. In addition, incidental capture close to the islands is not likely to occur because gill net use has been prohibited (since 1994) within one mile or in waters less than 70 fathoms deep (whichever is less) around the Channel Islands (FGC section 8610.2, as part of the Marine Resources Protection Act of 1990).

However, given the low estimated population size of Xantus's Murrelet and all of the other threats to the species, a chronic low level of bycatch could be a problem for the species. The Japanese Murrelet, an endangered species with estimated population size of less than 4,000, has been documented as bycatch in high-seas drift nets (Piatt and Gould 1994). This species has very similar biology to the Xantus's Murrelet, with breeding restricted to a few sub-tropical islands and birds generally moving northward after breeding, offshore in warmer waters. An observer program found a low but persistent rate of mortality in post-breeding areas that may be contributing to the species decline (Piatt and Gould 1994).

Summary of Threats

The Department finds sufficient scientific information to indicate that the identified threats have the potential for contributing to decline in murrelet populations. Peregrine Falcon predation on murrelets is potentially an emerging threat. The Department believes Bald Eagle predation may pose a problem in the future, but more information is needed.

Impact of Existing Management Efforts

The petition contains numerous statements indicating the inadequacy of existing management efforts: 1) lack of observer programs on squid fishing and gill net vessels; 2) park visitors have not been prevented from accessing sea caves or offshore rocks where murrelets nest; 3) lack of monitoring as to effect of light shields on squid vessels; 4) inadequate protection of nesting areas; 5) full extent of military operations and potential impacts to murrelets is unknown; 6) no attempt has been made to quantify the numbers and disposition of birds landing aboard brightly lit vessels and oil platforms near murrelet colonies; 7) no detailed studies have been conducted on the impacts of non-native mammals to murrelet populations; and 8) lack of a management plan to combat future rat introductions.

The petition also states "*An assessment of the true impacts of the many threats described here is further exacerbated by the lack of data collected by state and federal government agencies.*"

The Department believes most of the above assertions to be true. Exceptions include the following: 1) In 2003, observations were initiated on small mesh gill net vessels targeting white seabass (under an observer program by NOAA Fisheries, see Threats section of this report); 2) NPS is currently in the process of considering protection of murrelets in sea caves since the petition was received by the Department and USFWS; 4) Murrelets are provided a small degree of protection in some of the Channel Island Marine Protected Areas (described below under the Marine Protected Areas section of this report; 7) The impact of non-native mammals is being investigated via the Anacapa Island rat removal project; and 8) There is now a draft plan for controlling future rat introductions (as one aspect of the American Trader restoration plan).

In regard to lack of data collection by government agencies, the NPS and others have conducted annual monitoring of murrelets since at least 1984 on Santa Barbara Island. Surveys for deer mice, and vegetation monitoring are also being conducted by NPS, but different study efforts need to be integrated into a large, long-term monitoring effort and study. The Department also acknowledges that annual monitoring reports should be completed, shared, and discussed in a more timely manner, in order to take effective action and conserve the murrelet. Further, the Department and federal agencies have contributed funds or in-kind services (for example, Department aircraft and vessels) to help carry out various murrelet research projects since at least 1995. However, based on the many threats identified to the Xantus's Murrelet, and because of evidence of population decline, it is clear that increased management efforts would be beneficial.

Overview

The Department is unaware of any approved or operative management plan for the Xantus's Murrelet in the Channel Islands. Nest monitoring protocols exist, but funding to continue the annual seabird monitoring program has been reduced due to other demands on NPS resources, and NPS has looked to the Department and other sources for funding support for murrelet monitoring.

The murrelet is partially protected, or considered under a number of classifications or current management activities, as described below, though this list is not all-inclusive. However, the Department believes formal protection is warranted in order to restore populations, and provide appropriate mitigation for impacts.

a) International Union for Conservation of Nature and Natural Resources (IUCN)

The following language is taken from the IUCN web site:

This species has been upgraded to Vulnerable because there have been several actual or near colony extinctions, and introduced predators are causing declines in

some of the remaining nine colonies. Conservation action is beginning to have some positive effects and the continuing eradication of introduced predators from existing colonies, the discovery of new colonies, and/or the recolonization of former colonies may result in a downlisting back to Near Threatened.

A taxon is Vulnerable when it is not Critically Endangered, or Endangered, but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the IUCN criteria. The following web site has a list of the criteria: http://www.redlist.org/info/categories_criteria.html#critical.

The status codes for the murrelet are: VU B1+2de, C1. The status of the murrelet was last evaluated in 2000. A summary of that evaluation is as follows:

- VU: Vulnerable

- B: Extent of occurrence estimated to be less than 20,000 km^2 or area of occupancy estimated to be less than 2000 km^2, and estimates indicating any two of the following:

    - B1: severely fragmented or known to exist at no more than ten locations.
    - B2: Continuing decline, inferred, observed or projected, in any of the following:

    - d) number of locations or subpopulations

    - e) number of mature individuals

- C1: Population estimated to number less than 10,000 mature individuals and:
    - An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer.

b) Federal Endangered Species Act (FESA)

In 1994, the U.S. Fish and Wildlife Service (USFWS), in response to a 1992 petition to list the species as Endangered under the Federal Endangered Species Act, determined that listing the murrelet was warranted but was precluded by other, higher priority actions. In 1994, PSG advised the Department and USFWS of their concern for the status and vulnerability of the murrelet (Appendix F).

The USFWS has acknowledged receipt of a petition for federal listing of the Xantus's Murrelet. In a letter dated June 12, 2002, the USFWS notified the petitioners (PSG) that they anticipated making an initial finding in fiscal year 2003 as to whether the petition presents substantial information indicating that the action may be

warranted. However, at this time, no final or published actions have been taken by USFWS on the murrelet petition.

c) USFWS Birds of Conservation Concern (BCC) 2002

In 2002, the USFWS produced a newly revised list of bird species that warrant special management attention. Criteria for evaluating whether a species warranted inclusion on the list included population trend, threats, distribution, abundance, and area importance. Consultation with species' experts was also used for some bird species. The new list is titled: "Birds of Conservation Concern 2002" (USFWS 2002). The Xantus's Murrelet is included on this list, and was also included on the former list (Migratory Nongame Birds of Management Concern, 1995). The intent of the new BCC document is to focus attention on those bird species of greatest conservation need so that actions can be taken (research, management, protection, etc.) in coordination with state, other federal, private organizations, and research partners, to address threats and manage for healthy populations.

The federal Fish and Wildlife Conservation Act (as amended) mandates the USFWS to "identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act of 1973". The species on the BCC list are currently priority species for management by the Migratory Birds and Habitat Programs branch of USFWS in Portland, Oregon. This type of federal status has helped to provide some funding for research on the Xantus's Murrelet in the past. An example is the Sydeman et al. (1998) document that summarizes threats to the murrelet population.

There are 3 different geographic scales utilized in the BCC document for which species are ranked, and the Xantus's Murrelet occurs on the list at each of these three scales. The geographic areas are briefly discussed below, from smallest to largest:

North American Bird Conservation Initiative (NABCI) Regions:

This area includes central and southern California and part of Baja, California, and includes the breeding range of the murrelet in the Channel Islands. This area is known as Bird Conservation Region #32. The web site for NABCI states: "As integrated bird conservation progresses in North America, Bird Conservation Regions should ultimately function as the primary units within which biological foundation issues are resolved, the landscape configuration of sustainable habitats is designed, and priority projects originate" (http://www.nabci-us.org/map.html#32).

USFWS Pacific Region (Region 1):

The Pacific Region includes California, Idaho, Nevada, Oregon, Washington, Hawaii, and the Pacific Islands. The BCC document states: "The USFWS Region lists will be useful to USFWS administrators and biologists, other Federal and State agencies within a Region, and their partners and cooperators".

National:

The National list encompasses the United States in its entirety, including island "territories" in the Caribbean and Pacific. The National list should be viewed as a barometer of the status of continental bird populations, providing an "early warning" of birds that may decline to levels requiring protection under the federal Endangered Species Act, unless additional conservation measures are taken.

d) California Species of Concern (CSC)

The CSC selection is an administrative one, used by the Department and others for those species determined to be in decline, and possibly in need of listing under the California Endangered Species Act. Xantus's Murrelet was selected as a species of special concern by the Department in 1992. This has helped to provide some funding for murrelet research in the Channel Islands.

The CSC list is intended to alert agencies, land managers, biologists, and academia about the declining status of species to encourage research and special management efforts.

e) Marine Species of Common Conservation Concern Initiative

A North American Commission for Environmental Cooperation was formed between the United States, Canada, and Mexico as part of the North American Agreement on Environmental Cooperation, in the North American Free Trade Act in 1993. One of its initiatives is to conserve biodiversity across shared ecosystems by identifying priority species for conservation, recovery objectives, and potential collaborative actions the three countries can take to ensure the conservation of these species. The Marine Species of Common Conservation Concern Initiative has identified high priority species for conservation action. Xantus's Murrelet is one of six seabird species identified as a conservation priority. Recovery objectives and conservation actions have not been defined at this time.

In August of 1993, the American Ornithologists' Union sent letters to the U.S. Fish and Wildlife Service and the Ecology and Utilization of Natural Resources Department of Mexico in support of measures to restore biodiversity to several islands

off the western coast of Mexico, and to remove non native predators that threatened several seabird species (Appendix G).

f) Marine Protected Areas

Marine Protected Areas (MPAs) are one of the strategies used to conserve marine resources. MPAs prohibit all or some types of take within specific geographic areas. The Fish and Game Commission recently adopted the Department's proposed plan for 12 new MPAs in State waters within the boundaries of NOAA's Channel Islands National Marine Sanctuary (Sanctuary), and implementation occurred in April 2003.

The Sanctuary encompasses the waters that surround the islands of Anacapa, Santa Cruz, Santa Rosa, San Miguel, and Santa Barbara, from the shoreline to 6 nautical miles offshore (Figure 20). The adopted plan represents 19 percent of State waters within the Sanctuary and includes 132 square nautical miles in ten no-take State Marine Reserves, and 10 square nautical miles in two limited-take State Marine Conservation Areas. Maps and descriptions of MPAs can be viewed on the Department's web site: http://www.dfg.ca.gov/mrd/channel_islands/index.html.

A single no-take MPA exists on Santa Catalina Island. This small area is located at the Wrigley Institute for Environmental Studies on the north side of the island. Additional MPAs in State waters, including the other Channel Islands of Santa Catalina, San Clemente, and San Nicolas, could be created through the Marine Life Protection Act's (MLPA) MPA process. The Department is the lead agency charged with implementing the provisions of the MLPA. However, the MLPA MPAs will probably not be created or implemented for at least a few years. A draft recommendation is due to the Fish and Game Commission in January 2005, and a final plan must be adopted by December 2005. Although several working groups have been established to develop recommendations for MPAs as part of the implementation of the MLPA, meetings of these groups have been temporarily suspended due to budget constraints.

The creation of MPAs near Xantus's Murrelet breeding habitat and foraging areas has the potential to reduce threats from human disturbance, artificial light pollution from fishing activities, and possibly fishery bycatch by reducing the number of fishing vessels operating in these areas. However, the level of reduction depends on the level of existing fishing effort in the area and MPAs being situated adjacent to murrelet breeding habitat as well as the individual restrictions of each MPA. It also depends on the level of non-consumptive boating, which is not generally restricted, in the areas.

The recently implemented Channel Islands MPAs, for instance, do not prohibit access and allow for non-consumptive activities, transit, and anchoring that could disturb breeding Murrelets. In addition, the new MPAs do not provide protection from other types of threats to Xantus's Murrelets, such as, non-native and native predators,

oil spills, prey availability, and other human activities. Other existing MPAs, however, prohibit not only take but also access. For example, the existing Brown Pelican (*Pelecanus occidentalis californicus*) Fledgling area on Anacapa Island prohibits all access during certain periods. This type of restriction significantly reduces threats from human disturbance.

The creation of no-take areas could cause fishing activities to be displaced and become more concentrated in other areas. If these other areas are important murrelet habitats, the establishment of the MPA could potentially increase threats from fishing activity. However, based on analysis of fishing activities completed during the Channel Islands MPA designation process, it is not expected that displaced fishing effort from these MPAs will create concentrations of activity that would impact resources.

The recently implemented Channel Islands MPAs were designed for the protection of marine habitats and ecosystems, not specifically seabird breeding areas. Thus, little of the waters surrounding important breeding habitat for the Xantus's Murrelet are protected from fishing boat activity and only seven of the 12 recently adopted MPAs are adjacent to portions of Xantus's Murrelet breeding sites. For example, at Santa Barbara Island, the most important breeding island for the Xantus's Murrelet in the Channel Islands, the Santa Barbara Island State Marine Reserve only protects approximately one-fourth of the waters offshore the island (the south-east side), and about one-fifth of the shoreline. Additionally, two of the seven MPAs allow some form of take by commercial and/or recreational fishermen, further reducing their potential for protection from disturbance.

Conclusions

The Department believes there is sufficient scientific information to indicate that the petitioned action is warranted due to a variety of threats: 1) Small breeding population size in California (approximately 1,730 pairs); 2) Documented population decline of approximately 30% from 1977 to 1991, and a 14% decline in the number of active nests for a large nest monitoring plot from 1991 to 2001, on Santa Barbara Island; 3) Declining occupancy rates at nesting sites on Santa Barbara Island, coupled with low productivity as compared to the closely related Craveri's Murrelet and Ancient Murrelet; 4) Near extirpation from previously known nesting sites based on historic and current scientific information; 5) Vulnerability to oil spills and chronic oiling during the breeding and non-breeding season, within and outside California; 6) Suppression of population growth by a variety of native and non-native predators, and possibly due to prey decline; and 7) Impacts from artificial light pollution and human disturbance activities. The cumulative impact of these factors is also an important consideration.

Murrelets were almost extirpated from their former stronghold at Anacapa Island (Hunt et al. 1980; McChesney et al. 2000, Whitworth et al. 2003b), and the fact that this near extirpation is occurring at the same time as documented population declines on

Santa Barbara Island indicates a species in trouble with a substantial loss in breeding habitat. Individual alcids do not commonly shift their breeding activities from one island to another. In fact, alcids are known for fidelity to their breeding areas, even to individual breeding sites or nests. A widely distributed murrelet population, with sufficient numbers to withstand natural fluctuations in predator and prey numbers is the ideal scenario for population viability. Lacking that buffer against environmental change and catastrophes, and adding human impacts can be disastrous for a species like the murrelet, with low reproductive potential.

The Department believes there is sufficient scientific information to warrant listing as threatened. In particular, the small breeding numbers concentrated in few geographic locales (12 nesting islands scattered along 500 miles of coastline), current indications of breeding decline in California at the largest colony on Santa Barbara Island, potential mortality from oil spills and chronic oiling, high predation rates, and the naturally low reproductive rate presents a particularly troubling combination of factors. The restoration of Anacapa Island as a breeding site holds promise for the species, though it may take 6-10 years or more to demonstrate a substantial population increase. Given the historic and current decline in breeding numbers at Santa Barbara Island (the current stronghold for the murrelet in California), and the high predator numbers (Barn Owls and deer mice), there is an immediate need for concerted conservation action for the species.

Essential Habitat

Nesting and marine habitat essential to murrelets has been investigated by many researchers (Hunt et al. 1979, Briggs et al. 1987, Carter et al. 1992, Drost and Lewis 1995, Gaston and Jones 1998, McChesney and Tershy 1998, Carter et al. 2000, Whitworth et al. 2000, Hamilton et al. 2003, Spear et al. 2003 and others).

Murrelets need protected nest sites on offshore islands, free from human disturbance and excessive predation. The birds select nest sites in natural cavities along or near steep cliffs, within sea caves, or on offshore rocks associated with some of the Channel Islands. Additionally, murrelets nest under adequate shrub cover. In general, concealment of the nest site is necessary.

Xantus's Murrelets are small and vulnerable to predation; their main defenses are nocturnal behavior at the nest site, and difficult to access, highly concealed nest sites. The impact of predators was discussed under the Population Trend and Threats sections of this report.

Because murrelets spend much of their lives at sea, adequate food resources (fish and zooplankton) must be available to sustain the birds through the non-breeding season and to assure sufficient energy reserves for breeding activities. The incubation shift for each member of the pair averages three days (Murray et al. 1983). If prey

availability is very low, murrelets may neglect their eggs on occasion. If prey availability is insufficient, murrelets may never incubate or may abandon their eggs. Whenever eggs are left unattended, they are subject to predation by mice or rats.

Murrelets range over a wide area of the marine environment during the non-breeding season (Figure 5). Thus, it is important for them to have safe foraging and resting habitat, and to avoid mortality and injury from oil spills, gill netting, and artificial light pollution.

Pursuant to Fish and Game Code Section 2074.6, the Department is required to make a preliminary identification of the habitat that may be essential to the continued existence of a species being considered for listing. Because murrelets are now reduced in number compared to historic times, have a limited natural distribution, are subject to many threats, and are currently in decline at the largest colony (Santa Barbara Island), the Department currently identifies all existing occupied habitat as essential to the continued existence of the species. Some suitable but unoccupied habitat exists (for example, Anacapa Island), and this habitat is essential to securing the continued existence of murrelet populations in the Channel Islands. This is especially true given the low number of pairs utilizing Anacapa Island at this time, and given the existing population decline at Santa Barbara Island, the largest murrelet colony.

A careful review of Figures 11-18 reveals the highly limited nesting habitat available to the murrelet in California's jurisdiction. Murrelets nest on just six of the eight California Channel Islands, and in extremely limited locales on four of those six islands (Santa Cruz, San Miguel, Santa Catalina, and San Clemente). On these latter two islands, the population estimates do not exceed 125 pairs of birds, combined.

Additionally, as was noted above in the Conclusions section of this report, alcids are known for fidelity to their breeding areas, even to individual breeding sites or nests. Therefore, one would not expect the birds to shift easily between colonies should threats emerge at one site. For these reasons, a widely distributed murrelet population, with sufficient numbers to withstand natural fluctuations in predator and prey numbers is the ideal scenario for population viability. The low reproductive potential of murrelets also dictates the need for sufficient population size at each colony in order to be safely buffered from environmental change and catastrophes.

Recommendations

The Department provides the Commission with the recommendations set forth below pursuant to FGC Section 2074.6. This FGC Section directs the Department to include in its status review recommendations for management activities and other recommendations to aid in recovery of the species. The Department believes its

recommendations highlight a number of actions that will help to conserve the murrelet and direct recovery activities.

Interagency coordination should be established with the goal of stopping, and then reversing the population decline of the murrelet. Protection and enhancement of existing nesting colonies and protection of the marine environment essential to the continued existence of the species are important.

Additional management recommendations for recovery and conservation are outlined below. An interagency team should be developed to prioritize these recommendations, and to develop additional recommendations if necessary. Non-governmental organizations should also be included in murrelet conservation efforts.

Appendix E of this report contains a letter from the Pacific Seabird Group dated August 15, 1994, with an attachment listing fourteen items to help in murrelet conservation. The Department supports these conservation measures, particularly items 2, 7, 12, and 14, with slight modifications as noted:

2. Conduct a thorough survey for nesting murrelets on all the Channel Islands, and refine and improve survey techniques. Utilize spotlight surveys to supplement population estimates, and to account for murrelets nesting in inaccessible habitat areas. Make results of survey work available to all interested parties in a timely fashion, to allow for evaluation of results and input on any further survey or monitoring work. Existing data sets should be compiled into one document to establish benchmarks.

7. Current and past use of artificial habitat by murrelets on Santa Barbara Island should be investigated, summarized, and published. Additional artificial habitat should not be considered until the effectiveness of existing and past structures can be understood. The feasibility of this technique as a long term management option needs analysis.

12. Initiate research to investigate the significance of mouse and owl predation on Xantus's Murrelets on Santa Barbara Island. This research should likely include Anacapa Island as well because now that rats have been eliminated from Anacapa, the native deer mouse population will increase (there is evidence this is occurring at this time).

Any program of predator management (deer mice and Barn Owl) to increase productivity of murrelets on Santa Barbara Island would have to be undertaken with the greatest of care, due to the delicate nature of the climate, vegetation, and faunal relationship (Sydeman et al. 1998). Such a controlled experiment may be in order to test the reproductive response of the murrelets and reverse the population decline. The Department supports convening a team of experts and managers (including NPS representatives) to explore this potential management action.

14. Organize annual meetings on the status and conservation of Xantus's Murrelet with representatives from NPS, USFWS, US Navy, NOAA, ICEG, PSG, HSU, U.S. Geological Survey-Biological Resources Division (USGS-BRD), the Department, other researchers, and interested parties.

Additional Management Recommendations by the Department

1. Information and educational materials should be developed to inform various park visitors of the Xantus's Murrelet, and other sensitive resources. The materials should provide guidance on methods to avoid disturbance.

2. To provide the murrelet with optimal nesting habitat, support efforts to restore the ecological balance to the nesting islands utilized by this rare seabird to the greatest extent practicable. Attempts by NPS to restore and monitor native vegetation and plant associations should continue. Concurrently, native wildlife (particularly murrelets, deer mice, Barn Owls, Bald Eagles, and Peregrine Falcons) should be monitored for response to the shift toward more natural conditions, as existed before European arrival to the Channel Islands.

3. A radio telemetry study of Barn Owls would be useful to document their nesting locations, foraging patterns, and foraging range. Capture, banding, and recapture of owls would also provide an assessment of owl density. An intensive food habits study should also be undertaken, and all owl nest sites and roost sites should be mapped.

4. Documenting the extent of Xantus's Murrelet mortality on Santa Barbara Island should become a routine part of the annual seabird monitoring program. All known peregrine and owl roost and nest sites should be visited to quantify murrelet remains and other prey. Falcon nesting sites need to be found and mapped.

5. The Department should continue outreach efforts into Mexico in order to help assure the conservation of murrelets in both California and Mexico. If California were to lose a substantial portion of murrelets due to a catastrophic oil spill, the proximity and health of the Mexican populations of murrelets (particularly Coronados birds) may prove useful to help restore California's loss (see Threats section, Oil Spills).

The petition also identified some key management needs, and the Department supports these recommendations:

1. NPS needs a management plan to combat future rat introductions on the Channel Islands (a draft plan has recently been produced as part of the American Trader Restoration Plan).

2. Predator management (mice and barn owls) on certain islands may be necessary to restore murrelet populations.

3. Work to support establishing an observer program to assess the extent of murrelet bycatch in certain fisheries with the potential to affect Xantus's Murrelet.

4. Strong consideration should be given to squid fishing closure areas during the breeding season off Santa Barbara, Anacapa, and San Miguel islands (note in Figure 20 that there are existing Department ecological reserves around these 3 islands). The petition also noted that any benefits of the light shields had not been evaluated.

The Department notes that protection of murrelets from artificial light pollution involves other users in the marine environment, not just the squid fishery. The Department should work closely with land managers and many constituent groups to address disturbance and artificial light pollution impacts to murrelets. As noted earlier, information and educational materials should be developed to inform various user groups of actions they can take to minimize disturbance to murrelets. The Department could also evaluate and make recommendations to the Commission regarding protective measures similar to those set forth in Appendix H that could reduce impacts of lighting and disturbance on Xantus's Murrelet. Overall, monitoring and enforcement of existing closure areas could also be improved.

5. NPS needs to close or restrict visitor access to sea caves where murrelets nest.

6. Removal of rats from Anacapa Island is a high priority (the island is apparently rat-free at this time, but constant vigilance will be necessary to maintain the island in this condition).

7. Removal of non-native mammals from several Baja California Islands is needed (this activity is on-going by ICEG).

8. Murrelet nesting areas must be protected.

9. Peregrine predation on murrelets has been little studied, indicating a need for more research in this area.

An important reference cited in the petition is McChesney et al. (2000), research that was partly funded by the Department. The report summarizes the history of Anacapa Island with special reference to a habitat assessment for the murrelet, compilation of historical information (including documented murrelet egg collections), and impacts from introduced rats. McChesney et al. (2000) contains four

recommendations to better protect and restore the murrelet and other seabird populations at Anacapa Island.

The recommendations are:

1. Black rats should be eradicated from Anacapa Island (this project is underway).

2. Additional baseline information should be gathered on population levels and trends of murrelets and other crevice-nesting species on Anacapa Island (this project is underway).

3. The National Park Service should develop a plan to severely reduce the likelihood of future introductions of rats and other non-native mammals to Anacapa Island (a draft plan has recently been produced as part of the American Trader Restoration Plan).

4. Identify and reduce impacts to murrelets and other seabirds from other threats. The threats identified included oil pollution and bright lights from boats.

   The Department also supports these recommendations.

Recommendation on Listing Status

The Department of Fish and Game recommends that the Commission list the Xantus's Murrelet as threatened. The Department recommends threatened status, rather than endangered for the following reasons:

1. Direct habitat destruction or modification, in California, is not as serious a threat for Xantus's Murrelet as it is for other endangered species such as the Marbled Murrelet. While habitat destruction and modification was an important factor historically, it does not appear to be a significant factor today in California, especially given the fact that most nesting islands are managed by NPS and some restoration programs are in progress. However, the Department notes that biologists on Santa Barbara Island have suggested that human foot traffic may be a factor in the decline of shrub nesting habitat for murrelets, in some locales. This potential impact needs further investigation.

2. If nesting habitat can be protected from human disturbance and alteration, and predators can be controlled at levels that allow for suitable reproductive output, the potential for increases in nesting success, and as a result increases in murrelet populations is likely (for example, the Coronados Islands, and Anacapa Island, where the murrelets may be increasing in response to removal of non-native predators). However, at this time, predation pressure remains one of the main threats to the continued existence of the species.

3. There is the potential that murrelets could utilize artificial structures for nesting habitat to help increase reproductive output. This may serve as an interim measure until habitat can be returned to more natural conditions, including normal densities for native prey populations. However, in general, the Department does not support utilizing artificial burrows as a long term management tool due to the management burden associated with the upkeep of such artificial devices, and because it runs contrary to ecosystem restoration. Also, until it can be shown that such a management strategy would prove useful, it remains untested on a large scale. Competition for nest boxes from other species (for example, Cassin's Auklets) may also become a factor affecting their usefulness as a long term management tool.

4. While murrelet population numbers are substantially reduced from historic levels, and declining on Santa Barbara Island, their numbers appear sufficient to allow recovery if proper management actions are taken. It is imperative that all affected public agencies work closely together to reverse the current population decline.

5. The Department found no information indicating disease, overexploitation, or competition as significant factors affecting murrelet population viability. We found only one instance of competition, where it appeared that a Pigeon Guillemot (*Cepphus columba*) displaced an incubating murrelet and took over the nesting site (D. Whitworth, pers. comm.) Of these three factors, the Department considers disease to be in need of investigation. According to Wildlife Veterinarian Dr. Scott Newman (pers. comm.), based on inference from recent research results from other marine bird species, there is the potential that murrelets could be affected by West Nile Virus, and biotoxins from algal blooms, in addition to other diseases. Additionally, there is also an emerging interest in the effects of pollution in the marine environment and its effect on wildlife. Murrelets could be vulnerable given the amount of urban runoff that enters into the marine environment of the Southern California Bight. However, until more information is gathered, the Department cannot infer that these factors pose a significant threat to the continued existence of murrelet populations.

There are two main threats that indicate listing as endangered has some merit, and both of these fall in the category of "human-related activities" threatening the continued existence of the species:

6. The potential for a large oil spill during the breeding season in the Channel Islands area (causing large-scale murrelet mortality).

7. The potential for rats to become reestablished on Anacapa (or established on other nesting islands), and agencies having insufficient funds to take action in the future. It was the restoration plan for the American Trader oil spill that made

the rat eradication effort possible on Anacapa Island; whether it would have happened without this major funding source is questionable.

Based on consideration of the seven points outlined above, and the previous discussion and conclusions in this report, the Department believes listing as threatened is appropriate at this time. Listing the species as endangered at this juncture is not warranted because the Xantus's Murrelet does not appear to be "...in serious danger of becoming extinct throughout all or a significant portion of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease" (FGC Section 2062). However, the Department finds that the murrelet is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by CESA.

Regulatory Standard for Listing

The regulatory standard for the Commission's determination provides that, "[a] species shall be listed as endangered or threatened... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors:

1. Present or threatened modification or destruction of its habitat;
2. Overexploitation;
3. Predation;
4. Competition;
5. Disease; or
6. Other natural occurrences or human-related activities.
(14 CCR § 670.1(i)(1)(A))

Therefore, the Commission is required to list a species as "endangered or threatened" if one or more of the above-mentioned factors pose a serious danger or threat to the continued existence of the species. If the standard in section 670.1 is met, then the Commission will ultimately determine the level at which listing is appropriate.

FGC section 2062 defines an endangered species as one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease". FGC section 2067 defines a threatened species as a species "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by [CESA]."

The Commission will base its decision whether to list on the Department's Status Review, other scientific reports that are submitted and any other public comments and submissions it receives. The Commission may review all of the pertinent information

and conclude that listing is warranted, but at a level different than that recommended by the Department or requested by the petitioners.

Alternatives to the Petitioned Action

Alternatives to the petitioned action include: a) List as endangered; and b) Decline to list.

List as Endangered

The Commission could exercise its discretion and list the Xantus's Murrelet as an endangered species under CESA. The legal protection afforded species listed under CESA as endangered or threatened, however, is the same. Likewise, under the California Environmental Quality Act (CEQA), heightened scrutiny of potential impacts is required for certain species regardless of whether they are an endangered, rare or threatened species. (*e.g.*, CEQA Guidelines, 15065, 15380.) Finally, sources of potential funding for recovery, protection, and research for endangered species are generally the same as those for a threatened species.

Decline to List

If the Commission determines that listing is not warranted, the murrelet will revert to the unlisted status that it held prior to the petition filing. As a California Species of Concern, the murrelet may be afforded some protection under CEQA. The Department will continue to act as the trustee agency for the State's fish, wildlife and plant resources. In this role, the Department will review and comment on impacts to murrelets and recommend mitigation measures for these impacts as part of the CEQA review process, including any internally-generated CEQA documents such as fishery management plans.

Should the Commission decline to list, incidental take permitting requirements set forth in FGC 2081(b), and other protective measures under CESA, would not apply. Existing federal and State research permit requirements that existed prior to the petition filing will, however, remain in place. For example, the Department will continue to require Scientific Collecting Permits and Letter Permits for research projects that involve take of murrelets. Researchers would also be required to obtain the appropriate federal permits for work involving take of murrelets.

In the absence of a listing decision by the Commission, the Department would also continue to participate in and support a variety of programs designed to benefit murrelets. Many of the Department's existing or planned management efforts, conducted in cooperation with other entities include:

Rat eradication at Anacapa Island under the American Trader Restoration Plan.

Research and monitoring studies funded through the State's Tax Check-off Program, or USFWS Section 6 grant program.

Development of information and educational materials for various user groups.

Working with various State and federal agencies, and private groups (for example, ICEG and PSG) to help conserve murrelets.

Protections Resulting from Listing

It is the policy of the state to conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat (FGC Section 2052). If listed, the murrelet will receive protection from unauthorized take under the CESA, making the conservation, protection, and enhancement of the murrelet and its habitat issues of statewide concern. Project proponents will be subject to the prohibitions on take and other proscriptions in CESA that are punishable under State law. The Department may authorize exceptions to the prohibitions in CESA under certain circumstances. However, the impacts associated with authorizing an activity that will involve take of murrelets will be minimized and fully mitigated according to State standards.

Listing this species increases the likelihood that state and federal land and resource management agencies will allocate funds towards protection and recovery actions. With limited funding and a growing list of threatened and endangered species, priority is usually given to species that are listed. As an example of this benefit, in 2003, due to the murrelet's candidacy status and the federal petition for listing, USFWS Section 6 research funds were awarded to the Department to aid in recovery efforts for the murrelet.

Literature Cited

Ainley, D. G., A. R. DeGange, L. L. Jones, and R. J. Beach. 1981. Mortality of seabirds in high-seas salmon gill nets. Fishery Bulletin, 79(4):800-806.

Ainley, D. G., R. Podolsky, L. DeForest, and G. Spencer. 1997. New insights into the status of the Hawaiian petrel on Kauai. Colonial Waterbirds, 20(1):24-30.

American Trader Trustee Council. 2001. Final restoration plan and environmental assessment for seabirds injured by the American Trader oil spill. Report of the American Trader Natural Resource Trustee Council, U.S. Fish and Wildlife Service, California Department of Fish and Game, and National Oceanic and Atmospheric Administration.

Avise, J. C. and R. L. Crawford. 1981. A matter of lights and death. Natural History, 90(9):6-14.

Bailey, F. M. 1921. Handbook of Birds of the Western United States. Houghton Mifflin Company, New York.

Bailey, E.P. and G.W. Kaiser. 1993. Impacts of introduced predators on nesting seabirds in the northeast Pacific. Pp. 218-226 *in* The status, ecology and conservation of marine birds of the North Pacific (K. Vermeer, K.T. Briggs, K.H. Morgan and D. Siegel-Causey, eds.). Canadian Wildlife Service Special Publication, Ottawa.

Bakker, E.S. 1971. An island called California. An ecological introduction to its natural communities. Univ. of Calif. Press, Berkeley/Los Angeles/London. 484 pages.

Banks, R.C. 1966. Terrestrial vertebrates of Anacapa Island, California. Trans. of the San Diego Soc. of Natural History. Vol. 14, No. 14: 173-188.

Bent, A.C. 1919. Life Histories of North American Diving Birds. U.S. Natl. Mus. Bull. 107.

Bent, A.C. 1961. Life Histories of North American Birds of Prey, Part 2. Dover Publications, Inc. New York. 482 pages.

Bentivoglio, N., J. Baldwin, D.E. Mack, T. Max, S. Miller, K. Nelson, C.J. Ralph, M. Raphael, C. Strong, C. Thompson, K. Ostrom, and R. Wilk. 2001. Northwest Forest Plan, marbled murrelet effectiveness monitoring. Draft data summary report, U. S. Fish and Wildlife Service, June 15, 2001. 79 pages.

Bertram, D. F. 1995. The roles of introduced rats and commercial fishing in the decline of ancient murrelets on Langara Island, British Columbia. Conservation Biology, 9(4):865-872.

Bishop, R. A. and R. Barratt. 1969. Capturing waterfowl in Iowa by nightlighting. Journal of Wildlife Management, 33:959-960.

Bonnot, P. 1928. An outlaw barn owl. Condor 30(5): 320.

Bower, J. 2000. The dark side of light. Audubon, 102(2):92-97.

Bretherton, B. J. 1902. The destruction of birds by lighthouses. The Osprey, 1(5):76-78.

Briggs, K.T., W.B. Tyler, D.B. Lewis, and D.R. Carlson. 1987. Bird communities at sea off California: 1975-1983. Studies in Avian Biology No. 11.

Brinton, E. and A. Townsend. 2003. Decadal variability in abundances of the dominant euphausiid species in southern sectors of the California Current. Deep-Sea Research II 50: 2449-2472.

Burger, J. and M. Gochfeld. 1994. Predation and effects of humans on island-nesting seabirds. Pp. 39-67 *in* (D.N. Nettleship, J. Burger, and M. Gochfeld, eds.). Seabirds on Islands: threats, case studies, and action plans. Bird Life Conservation Series No. 1.

Burkett, E.E. 1995. Marbled Murrelet food habits and prey ecology. Pp. 223-246 *In* Ralph, C.J., G.L. Hunt Jr., M.G. Raphael, J.F. Piatt, (eds.). Ecology and conservation of the Marbled Murrelet. Gen. Tech. Rep. PSW-GTR-152. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 420 pages.

Burkett, E. E., H.R. Carter, J.Y. Takekawa, S. Newman, and R.T. Golightly. 1998. Movement patterns and habitat preferences of marbled murrelets in Central California: a radio telemetry study. Pacific Seabirds. Vol. 25, No. 1. Spring 1998, pg. 24.

Byrd, V., J. Sincock, and T. Telfer. 1978. The status of Newell's Manx Shearwater, a threatened species. Pacific Seabird Group, 5:80.

California Department of Fish and Game. 2001. The status of rare, threatened, and endangered animals and plants of California. Annual Report for 2000. Resources Agency, Department of Fish and Game. 226 pages.

Carter, H. R. and S. G. Sealy. 1984. Marbled murrelet mortality due to gill-net fishing in Barkley Sound, British Columbia. Pages 212-220. In D. N. Nettleship, G. A. Sanger and P. F. Springer (editors). Marine birds: their feeding ecology and commercial fisheries relationships. Canadian Wildlife Service Special Publication.

Carter, H.R. and R. A. Erickson. 1988. Population Status and Conservation Problems of the Marbled Murrelet in California, 1892-1987. Calif. Dept. of Fish and Game, Nongame Bird and Mammal Section Report, December 1988. Job II.B.2. 51 pages and appendices.

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

Carter, H. R., M. L. C. McAllister, and M. E. Isleib. 1995. Mortality of marbled murrelets in gill nets in North America. Pages 271-283. In C. J. Ralph, G. L. Hunt, M. G. Raphael, and J. F. Piatt (editors). Ecology and conservation of the marbled murrelet. Gen. Tech. Rep. PSW-GTR-152. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture. 420 pp.

Carter, H. R., D. L. Whitworth, W. R. McIver, J. B. Bulger, and G. J. McChesney. 1996. Survey of Xantus's Murrelets (*Synthliboramphus hypoleucus*) and other marine birds at Islas Los Coronados, Baja California Norte, Mexico, on 23-25 April 1995. Unpublished final report, National Biological Service, California Science Center, Dixon, California.

Carter, H. R., D. L. Whitworth, J. Y. Takekawa, T. W. Keeney, and P. R. Kelly. 2000. At-sea threats to Xantus' Murrelets (*Synthliboramphus hypoleucus*) in the Southern California Bight. Pages 435-447. *in* D. R. Browne, K. L. Mitchell and H. W. Chaney (editors). Proceedings of the fifth California Islands symposium. U. S. Minerals Management Service, Camarillo, California.

Carter, H.R., K. Ono, J.N. Fries, H. Hasegawa, M. Ueta, H. Higuchi, J.T. Moyer, L.K. Ochikubo Chan, L.N. de Forest, M. Hasegawa, and G.B. van Vliet. 2002. Status and Conservation of the Japanese Murrelet (*Synthliboramphus wumizusume*) in the Izu Islands, Japan. J. Yamashina Inst. Ornithol. 33:61-87.

Chardine, J. and V. Mendenhall. 1998. Human disturbance at Arctic seabird colonies. Technical Report No. 2 from the Conservation of Arctic Flora and Fauna, Circumpolar Seabird Working Group.

Cherel, Y., H. Weimerskirch, and G. Guhamel. 1994. Interactions between longline vessels and seabirds in Kerguelen waters and a method to reduce seabird mortality. Abstract from unpublished report. Centre d'Etudes Biologiques de Chize' and Centre National de la Recherche Scientifique, Beauvoir-sur-Niort, France.

Cherel, Y., H. Weimerskirch, and G. Guhamel. 1996. Interactions between longline vessels and seabirds in Kerguelen waters and a method to reduce seabird mortality. Biological Conservation, 75:63-70.

Coblentz, B.E. 1980. Effects of feral goats on the Santa Catalina Island Ecosystem Pp. 167-170 *in* (D.M.Power, ed.) The California Islands: proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History, Santa Barbara, California.

Conser, R.J., K.T. Hill, P.R. Crone, N.C.H. Lo, and D. Bergen. 2002. Stock assessment of Pacific sardine with management recommendations for 2003. *In*: Pacific Fishery management Council. 2003. Status of the Pacific Coast coastal pelagic species fishery and recommended acceptable biological catches. Stock assessment and fishery evaluation - 2003.

Cummings, G. E. and O. H. Hewitt. 1964. Capturing waterfowl and marsh birds at night with light and sound. Journal of Wildlife Management, 28:120-126.

DeGange, A. R. and R. H. Day. 1991. Mortality of seabirds in the Japanese land-based gillnet fishery for salmon. The Condor, 93:251-258.

DeGange, A. R., R. H. Day, J. E. Takekawa, and V. M. Mendenhall. 1993. Losses of seabird in gill nets in the North Pacific. Pages 204-211. In K. Vermeer, K. T. Briggs, K. M. Morgan, and D. Siegel-Causey (editors). The status, ecology, and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication, Ottawa.

DeLong, R. L. 1967. Preliminary report, Eastern Area Cruise 11, April 20 - May 5, 1967, Guadalupe Island survey. Unpublished report, Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington, D.C.

DeLong, R. L. 1968a. Preliminary report, Eastern Area Cruise 40, 26-29 April 1968, San Benito Islands, Baja California. Unpublished report, Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington, D.C.

DeLong, R. L. 1968b. Preliminary report, Eastern Area Cruise 42, 20-23 June 1968,Guadalupe Island. Unpublished report, Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington, D.C.

DeLong, R. L. and R. L. Brownell, Jr. 1968. Preliminary Report, Birds of Islas San Benito, Eastern Area Cruise 42. Unpublished report, Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington, D.C.

DeWeese, L.R. and D.W. Anderson. 1976. Distribution and breeding biology of Craveri's Murrelet. San Diego Soc. Nat. Hist., Trans. 18(9):155-168.

Dick, M. H. and W. Donaldson. 1978. Fishing vessel endangered by crested auklet landings. Condor, 80:235-236.

Drever. M.C. and A.S. Harestad. 1998. Diets of Norway rats, *Rattus norvegicus*, on Langara Island, Queen Charlotte Islands, British Columbia: Implications for conservation of breeding seabirds. Canadian field-naturalist. Vol. 112(4) 676-683.

Drewien, R. C., K. R. Clegg, and R. E. Shea. 1999. Capturing trumpeter swans by night-lighting. Wildlife Society Bulletin, 27(1):209-215.

Drost, C. A., and D. B. Lewis. 1995. Xantus' Murrelet (*Synthliboramphus hypoleucus*). *In* The Birds of North America, No. 164 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Drost, C.A. and G.M. Fellers. 1991. Density cycles in an island population of deer mice, *Peromyscus maniculatus*. Oikos 60: 351-364.

Everett W.T. and D.W. Anderson. 1991. Status and conservation of the breeding seabirds on offshore Pacific islands of Baja California and the Gulf of Mexico. Pages 115-139 *in* J. Croxall [ed.], Seabird status and conservation; a supplement. ICBP Technical Publication 11.

Fancher, J. M. 1992. Population status and trends of the California least tern. Trans. Western Section of the Wildl. Soc. 28:59-66.

Fedun, I. 1995. Fatal light attraction. Journal of Wildlife Rehabilitation, 18(3):10-11.

Gaston, A.J. 1990. Population parameters of the Ancient Murrelet. Condor 92:998-1011.

Gaston, A. J., I. L. Jones. 1998. The Auks, Alcidae. Oxford University Press Inc., New York, New York. 349 pp.

Grinnell, J. and A. Miller. 1944. The Distribution of the Birds of California. Pacific Coast Avifauna Number 27, Cooper Ornithological Club, Berkeley, California.

Hamer, T.E., S.M. Schuster, and H.R. Carter. 2003. Radar monitoring of Xantus's Murrelets (*Synthliboramphus hypoleucus*) at Anacapa Island, California, in 2003 After Eradication of Black Rats (*Rattus rattus*). Unpublished report, Hamer Environmental L.P., Mount Vernon, Washington. 36 pages.

Hamilton, C., H.R. Carter, and R.T. Golightly. 2003. Diet of Xantus's Murrelets in the Southern California Bight. Draft report to California Department of Fish and Game, July 7, 2003. 10 pages.

Hampton, S., P.R. Kelly, and H.R. Carter. 2003. Tank Vessel Operations, Seabirds, and Chronic Oil Pollution in California. *In press*: Marine Ornithology (from an oil symposium at the 2002 meeting of the Pacific Seabird Group, Santa Barbara, CA.).

Herbert. A. D. 1970. Spatial disorientation in birds. Wilson Bulletin 82(4):400-419.

Howell, A. B. 1910. Notes from Los Coronados Islands. Condor 12:184-187.

Howell, A. B. 1917. Birds of the islands off the coast of southern California. Pacific Coast Avifauna Number 12, Cooper Ornithological Club, Hollywood, California.

Howell, S.N.G. and S. Webb. 1995. A guide to the birds of Mexico and Northern Central America. Oxford University Press, Oxford. 851 pages.

Hunt, G. L., Jr., R. L. Pitman, M. Naughton, K. Winnett, A. Newman, P. R. Kelly, and K.T. Briggs. 1979. Reproductive ecology and foraging habits of breeding seabirds, *in* Summary of marine mammal and seabird surveys of the Southern California Bight area 1975-1978. Vol. III - Investigators' reports. Part III. Seabirds - Book II. Final Report for the Bureau of Land Management. March 1979. 399 pages.

Hunt, G.L., R. L. Pitman, and H.L. Jones. 1980. Distribution and Abundance of Seabirds Breeding on the California Channel Islands. Pp. 443-459 *in* (D.M.Power, ed.) The California Islands: proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History, Santa Barbara, California.

Ingram, T. 1992. Seabird monitoring in Channel Islands National Park, 1990. Channel Islands National Park Natural Science Report CHIS-92-001.

Ingram, T., and D. Jory Carter. 1997. Seabird monitoring, Channel Islands National Park, 1991-1992. Channel Islands National Park Technical Report 97-02.

Jacobson, L.D., N.C.H. Lo, S.F. Herrick, Jr., and T. Bishop. 1995. Spawning biomass of the northern anchovy in 1995 and status of the coastal pelagic fishery during 1994. National Marine Fisheries Service, Southwest Fisheries Science Center. Admin. Rep. LJ-95-11. 47 pages.

Jehl, J. R. and S. I. Bond. 1975. Morphological variation and species limits in murrelets of the genus *Endomychura*. Transactions of the San Diego Society of Natural History, 18(2):9-23.

Johnson, D. H., T. L. Shaffer, and P. J. Gould. 1991. Incidental catch of marine birds in the North Pacific high seas driftnet fisheries in 1990. Pages 473-483. In Burgner, R. L., G. Ito, W. Shaw (editors). Proceedings of the International Pacific Fisheries Commission Symposium on biology, distribution, and stock assessment of species caught in high seas driftnet fisheries in the North Pacific Ocean, 4-6 November 1991. Tokyo, Japan.

Jones, I. L., A. J. Gaston, and J. B. Falls. 1990. Factors affecting colony attendance by ancient murrelets (*Synthliboramphus antiquus*). Canadian Journal of Zoology, 68:433-441.

Karnovsky, N.J., D.G. Ainley, N. Nur, and L. B. Spear. 1996. Distribution, abundance and behavior of Xantus' Murrelets off northern California and southern Oregon. Pacific Seabirds, Vol. 23, No. 1. Spring 1996, page 38.

Keane, K. 2001. California least tern breeding survey, 1999 season. Calif. Dep. Fish and Game, Habitat Conservation Planning Branch, Species Conservation and Recovery Program Report 2001-01, Sacramento, CA 16pp. + appendices.

Keitt, B. S. 2000. Status of the Xantus' Murrelet (*Synthliboramphus hypoleucus*) on the islands of Baja California, Mexico. Unpublished report, Island Conservation and Ecology Group, Davenport, California. http://www.islandconservation.org

Keitt, B. S. 2003. In review. Nocturnal behavior reduces predation pressure on Black-vented Shearwaters. Submitted to: Marine Ornithology, 2003.

Kiff, L. F. 1980. Historical changes in resident populations of California Islands raptors. Pp. 651-673 *in* (D.M.Power, ed.) The California Islands: proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History, Santa Barbara, California.

King, D. T., K. J. Andrews, J. O. King, R. D. Flynt, and J. F. Glahn. 1994. A night-lighting technique for capturing cormorants. Journal of Field Ornithology, 65(2):254-257.

Klomp, N. I. and R. W. Furness. 1992. Patterns of chick feeding in Cory's shearwaters and associations with ambient light. Colonial Waterbirds, 15(1):95-102.

Laughrin, L.L. 1977. The Island fox: A field study of its behavior and ecology. Ph.D. dissertation. Univ. of Calif., Santa Barbara. 83 pages.

Lehman, P.E. 1994. The Birds of Santa Barbara County, California. Univ. of Calif., Santa Barbara, Vertebrate Museum. 337 pages.

Manuwal, D. A. 1974. The natural history of Cassin's auklet. Condor, 76:421-431.

Marti, C.D. 1992. Barn Owl. *In* The Birds of North America, No. 1 (A. Poole, P. Stettenheim, and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

McChesney, G.J. and B.R. Tershy. 1998. History and status of introduced mammals and impacts to breeding seabirds on the California Channel and Northwestern Baja California islands. Colonial Waterbirds 21:335-347.

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

McGowan, J.A., D.R. Cayan, and L.M. Dorman. 1998. Climate-Ocean variability and ecosystem response in the northeast Pacific. Science Vol. 281:210-217.

McLellan, M. E. 1926. Expedition to the Revillagigedo Islands, Mexico, in 1925, VI., the birds and mammals. Proceedings of the California Academy of Sciences, 15(11): 279-322.

Miller, L. 1936. Some maritime birds observed off San Diego, California. Condor, 38:9-16.

Moors, P.J. and I.A. E. Atkinston. 1984. Predation on seabirds by introduced animals, and factors affecting its severity. Pp. 667-690 in J.P. Croxall, P.G. H. Evans, and R. W. Schreiber (eds.), Status and conservation of the world's seabirds. ICBP Technical Publication No. 2.

Mueller, H.C. 1979. Over-water flights of barn owls. Bird-Banding Vol. 50(1).

Murray, K.G., K. Winnett-Murray, Z.A. Eppley, G.L. Hunt, Jr., and D.B. Schwartz. 1983. Breeding biology of the Xantus' Murrelet. Condor 85: 12-21.

National Research Council. 1995. Science and the Endangered Species Act. National Academy Press, Washington, D.C. 271 pages.

Nocera, J. J. and S. W. Kress. 1996. Nocturnal predation on common terns by great black-backed gulls. Colonial Waterbirds, 19(2):277-279.

Oades, R. D. 1974. Predation of Xantus' murrelet by western gull. Condor, 76:229.

Ogi, H., A. Yatsu, H. Hatanaka, and A. Nitta. 1991. The mortality of seabirds by driftnet fisheries in the North Pacific. Pages 499-518. In Burgner, R. L., G. Ito, W. Shaw (editors). Proceedings of the International Pacific Fisheries Commission Symposium on biology, distribution, and stock assessment of species caught in high seas driftnet fisheries in the North Pacific Ocean, 4-6 November 1991. Tokyo, Japan.

Ogle, M. 2002. Chatham Island Taiko Final Report 2000/2001. Tuku Field Centre, New Zealand. 15 pages.

Paine, R.T., J.T. Wootton, and P.D. Boersma. 1990. Direct and indirect effects of peregrine falcon predation on seabird abundance. Auk 107(1): 1-9.

Piatt, J. F. and D. N. Nettleship. 1987. Incidental catch of marine birds and mammals in fishing nets off Newfoundland, Canada. Marine Pollution Bulletin, 18(6B):344-349.

Piatt, J. F. and P. J. Gould. 1994. Postbreeding dispersal and drift-net mortality of endangered Japanese murrelets. The Auk, 111(4):953-961.

Podolsky, R., D. G. Ainley, G. Spencer, L. Deforest, and N. Nur. 1998. Mortality of Newell's shearwaters caused by collisions with urban structures on Kauai. Colonial Waterbirds, 21(1):20-34.

Pyle, P. 2001. Age at first breeding and natal dispersal in a declining population of Cassin's Auklet. Auk 118(4):996-1007.

Reed, J. R. 1987. Polarizing filters fail to reduce light attraction in Newell's shearwaters. Wildlife Society Bulletin, 15:596-598.

Reed, J. R., J. L. Sincock, and J. P. Hailman. 1985. Light attraction in endangered procellariiform birds: reduction by shielding upward radiation. Auk, 102:377-383.

Roemmich , D. and J. McGowan. 1995. Climatic warming and the decline of zooplankton in the California current. Science Vol. 267, pages 1324-1326.

Ryan, P. G. and B. P. Watkins. 1999. Seabird bycatch in the Patagonian toothfish longline fishery at the Prince Edward Islands: 1998-1999. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) report. CCAMLR, Hobart, Australia.

Schuyler, P. 1993. Control of feral sheep (*Ovis aries*) on Santa Cruz Island, California. Pp. 443-452 *in* (F.G. Hochberg, ed.) Third California Islands Symposium: Recent advances in research on the California Islands. Santa Barbara Museum of Natural History, Santa Barbara, California.

Schwemm, C.A. and T. J. Coonan. 2001. Status and ecology of deer mice (Peromyscus maniculatus subsp.) on Anacapa, Santa Barbara, and San Miguel Islands, California: Summary of monitoring 1992-2000. Technical Report 01-02.

Seto, N.W.H., N. Hoffman, and B. Casler. 2001. Rat eradication on Midway Atoll National Wildlife Refuge: a success story with petrels and shearwaters. Pacific Seabirds. Vol. 28, No. 1, Spring 2001, page 52.

Seto, N.W.H. and S. Conant. 1996. The effects of rat (*Rattus rattus*) predation on the reproductive success of the Bonin Petrel (*Pterodroma hypoleuca*) on Midway Atoll. Colonial Waterbirds 19(2): 171-185.

Simons, T. R. 1984. A population model of the endangered Hawaiian dark-rumped petrel. Journal of Wildlife Management, 48(4):1065-1076.

Snow, W. D., H. L. Mendall, and W. B. Krohn. 1990. Capturing Common Eiders by night-lighting in coastal Maine. Journal of Field Ornithology, 61(1):67-72.

Sowls, A. L., A.R. DeGange, R. Anthony, J. W. Nelson, and G.S. Lester. 1980. Catalog of California seabird colonies. FWS/OBS-37/80. Washington, DC: U.S. Fish and Wildlife Service, Biological Services Program; 371 pages.

Sowls, A.L. and M. Rauzon. 2001. Can Kiska's auklets survive the rat menace? Pacific Seabirds. Vol. 28, No. 1. Spring 2001, page 53.

Spear, L.B., D.G. Ainley, H.R. Carter, K.D. Amey, L.T. Ballance, K.T. Briggs, R.G. Ford, G.L. Hunt Jr., N.J. Karnovsky, C. Keiper, J.W. Mason, K.H. Morgan, R.L. Pitman, and C.T. Tynan. 2003. At-Sea Distribution, Abundance and Behavior of Xantus's Murrelets. Draft report to Calif. Dept. of Fish and Game, August 2003.

Springer, A.M., A.Y. Kondratyev, H. Ogi, Y.V. Shibaev and G.B. van Vleit. 1993. Status, ecology, and conservation of *Synthliboramphus* murrelets and auklets. Pages 187-201 *in* Vermeer, K., K.T. Briggs, K.H. Morgan, and D. Siegel-Causey (eds.), The Status, Ecology, and Conservation of Marine Birds of the North Pacific. Special Publication, Canadian Wildlife Service, Ottawa, Ontario.

Stewart, R. M., J.Smail, W.C. Clow, and R.P. Henderson. 1974. The status of the Song Sparrow and Bewick's Wren on San Clemente Island and Santa Barbara Island, California. Pt. Reyes Bird Obs. Report to U.S. Fish and Wildlife Service. 45 pages.

Storey, A. E. and B. L. Grimmer. 1986. Effect of illumination on the nocturnal activities of Manx shearwaters: colony avoidance or inconspicuous behaviour? Bird Behaviour 6:85-89.

Sumner, L. 1959. The battle for Santa Barbara! Outdoor California. January, Vol. 20, No. 1, pages 4-7.

Sydeman, W. J., N. Nur, and P. Martin. 1998. Population viability analyses for endemic seabirds of the California marine ecosystem: the Ashy Storm-Petrel (*Oceanodroma homochroa*) and Xantus' Murrelet (*Synthliboramphus hypoleucus*). Unpublished report, Point Reyes Bird Observatory, Stinson Beach, California.

Telfer, T. C., J. L. Sincock, G. V. Byrd, and J. R. Reed. 1987. Attraction of Hawaiian seabirds to lights: conservation efforts and effects of moon phase. Wildlife Society Bulletin, 15:406-413.

U.S. Department of Agriculture. 1996. Wildlife hazard management at Lihue airport (LIH). Environmental Assessment Report. Animal and Plant Health Inspection Service, Animal Damage Control. December 20, 1996. 25 pages.

U.S. Fish and Wildlife Service. 1997. Recovery Plan for the threatened Marbled Murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Oregon. 203 pages.

U.S. Fish and Wildlife Service. 2002. Birds of Conservation Concern 2002. Division of Migratory Bird Management, Arlington, Virginia. 99 pages. [Online version available at http://migratorybirds.fws.gov/reports/bcc2002.pdf].

U.S. Fish and Wildlife Service. 2003. Marbled Murrelet Effectiveness Monitoring, Northwest Forest Plan, 2002 Annual Summary Report. Northwest Forest Plan Interagency Regional Monitoring Program. September 2003. 27 pages.

Verheijen, F. J. 1958. The mechanisms of the trapping effect of artificial light sources upon animals. Netherlands Journal of Zoology, 13:1-107.

Watanuki, Y. 1986. Moonlight avoidance behavior in Leach's storm petrels as a defense against slaty-backed gulls. Auk 103:14-22.

Weimerskirch, H., D. Capdeville, and G. Duhamel. 2000. Factors affecting the number and mortality of seabirds attending trawlers and long-liners in the Kerguelen area. Polar Biology, 23:236-249.

Whitworth, D. L., J. Y. Takekawa, H. R. Carter, and W. R. McIver. 1997. A night-lighting technique for at-sea capture of Xantus's Murrelets. Colonial Waterbirds, 20(3):525-531.

Whitworth, D. L., J. Y. Takekawa, H. R. Carter, S. H. Newman, T. W. Keeney, and P. R. Kelly. 2000. Distribution of Xantus' Murrelet *Synthliboramphus hypoleucus* at sea in the Southern California Bight, 1995-97. Ibis 142: 268-279.

Whitworth, D.L., B.S. Keitt, H.R. Carter, G.J. McChesney, J.W. Mason, W.R. McIver, and A.J. Hebshi. 2003a. Preliminary assessment of the status of Xantus's Murrelets (*Synthliboramphus hypoleucus*) at the San Benito Islands, Mexico, in March 2002. Unpublished report, Humboldt State University, Department of Wildlife, Arcata, California; and Island Conservation and Ecology Group, University of California, Santa Cruz, California. 21 pages.

Whitworth, D.L., H.R. Carter, R.J. Young, E. Creel, W.R. McIver, F. Gress, and S. Fangman. 2003b. Monitoring of at-sea congregations and nest success of Xantus's Murrelets (*Synthliboramphus hypoleucus*) at Anacapa Island, California, in 2000-02, prior to eradication of Black Rats (*Rattus rattus*). Unpublished report, Humboldt State University, Department of Wildlife, Arcata, California (prepared for the American Trader Trustee Council). 47 pages.

Whitworth, D.L., H.R. Carter, R.J. Young, E. Creel, G.J. McChesney, and P. Martin. 2003c. Change in Breeding Population Size of Xantus's Murrelets (*Synthliboramphus hypoleucus*) at northeastern Santa Barbara Island, California, 1991-2001. Unpublished report, Humboldt State University. 13 pages.

Winnett, K.A., K.G. Murray, and J.C. Wingfield. 1979. Southern race of the Xantus' Murrelet breeding on Santa Barbara Island, California. Western Birds 10:81-82.

Williams, J. C., L. Sharf, and G. V. Byrd. 2000. Ecological monitoring methods of the Aleutian Islands Unit, Alaska Maritime National Wildlife Refuge. U.S. Fish and Wildlife Service Report, U. S. Fish and Wildlife Service Report, Alaska Maritime National Wildlife Refuge, 00/01. Adak, Alaska.

Wolf, S., J. E. Roth, and W. J. Sydeman. 2000. Population size, phenology and productivity of seabirds on Santa Barbara Island, 1999. Unpublished report, Point Reyes Bird Observatory, Stinson Beach, California.

Personal Communications and Data Sources

Bloom, Peter. Private Raptor Consultant, Santa Ana, CA.
(Phone conversation, summer of 2002).

Campbell, Cathy. NOAA Fisheries. Washington, D.C.
(Provided information directly to Nora Rojek, Department Biologist).

Carter, Harry R. Humboldt State University, Richmond, British Columbia, Canada.
(Numerous contacts throughout 2002 and 2003).

Everett, William. Xantus's Murrelet Technical Committee, La Jolla, CA.
(Email correspondence, June 24, 2002).

Forney, Karin. NOAA Fisheries. Santa Cruz, CA.
(Provided information directly to Nora Rojek, Department Biologist).

Keitt, Brad. Island Conservation Ecology Group. Santa Cruz, CA.
(Numerous contacts throughout 2002 and 2003).

Linthicum, Janet. Santa Cruz Predatory Bird Research Group. Santa Cruz, CA.
(Email correspondence, summer 2002).

Martin, Paige. National Park Service, Ventura, CA.
(Phone conversations and email correspondence, summer of 2002. Provided murrelet nest site occupancy data directly to Esther Burkett, Department Biologist).

McChesney, Gerry. USGS-BRD/HSU. Dixon, CA.
(Phone conversations and email correspondence, summer 2002).

Naughton, Maura. USFWS, Migratory Bird and Habitats Program. Portland, OR.
(Email correspondence, 2002).

Newman, Scott. Wildlife Trust. Palisades, New York.
(Email correspondence October 2003).

Petersen, Don. NOAA Fisheries. Southwest Regional Office, Long Beach, CA.
(Email correspondence October 9, 2003).

Smith, Paul E. NOAA Fisheries, Southwest Fishery Science Center. La Jolla, CA.
(Provided data directly to Annette Henry, Department Biologist).

Smith, Susan. NOAA Fisheries, Southwest Fishery Science Center. La Jolla, CA.
(Provided data directly to Annette Henry, Department Biologist).

Sydeman, William. Point Reyes Bird Observatory, Stinson Beach, CA.
(Numerous contacts throughout 2002 and 2003).

Torres, Steven. Calif. Dept. of Fish and Game, Sacramento, CA.
(Conducted the statistical analyses on murrelet nest site occupancy data from NPS).

Whitworth, Darrell. Calif. Institute of Environmental Studies, Davis, CA./Humboldt State University, Arcata, CA. (Email correspondence, 2002-2003).

Table 1. Population Estimates for Xantus's Murrelets on Santa Barbara Island, California. From fieldwork or analyses conducted between 1975 - 2002.

Source	Number of Breeding Birds **Range**	Number of Breeding Birds **Point Estimate** or **Average**	**Basis for Population Estimate**
Hunt et al. 1979	2,000 – 10,000	6,000	Based on field work from 1975 -1978; on island nest counts and extrapolation to unsearched (inaccessible) areas, and at sea surveys.
Hunt et al. 1980	___	**3,180***	Based on the same field study as Hunt et al. 1979.
Murray et al. 1983	6,000 – 10,000	8,000	Methods not fully described, appears to be based on Hunt et al. 1979 results.
Carter et al. 1992	___	**1,544***	Based on field work in 1991; on island nest counts and extrapolation to unsearched (inaccessible) areas.
Sydeman et al. 1998	___	847	No field work involved; reworked Carter et al. 1992 by applying a different occupancy rate for unsearched (inaccessible) areas.
H. Carter, unpubl. data, May 2002**	1,000 – 2,500	**1,750***	Based on at-sea spotlight surveys at night, on island nest counts, assessment of available habitat, at-sea vocalization surveys, and at-sea captures of murrelets.

* The Department considers these estimates the most reliable for determining population trend. These population estimates include murrelets on the two offshore rocks, Shag Rock and Sutil Island, associated with Santa Barbara Island.

** Population estimate based on compilation of best available data from fieldwork conducted during 1991 – 2002.

Table 2. Estimated breeding population size (number of breeding birds) of Xantus's Murrelets by island or island group with documented nesting (adapted from 10 April 2002 Pacific Seabird Group listing petition for Xantus's Murrelet).

Island	Population	Survey Methods[1]	Source
California Channel Islands, U.S.A.			
San Miguel Island	100-600	1,2	H.R. Carter (unpubl. data, May 2002)[2]
Santa Cruz Island	200-600	1,2	H.R. Carter (unpubl. data, May 2002)[2]
Anacapa Island	400-1200	1,2,3,4	H.R. Carter (unpubl. data, May 2002)[2]
Santa Barbara Island	1,000-2,500	1,2,3,4	H.R. Carter (unpubl. data, May 2002)[2]
Santa Catalina Island	50-150	1,2,4	H.R. Carter (unpubl. data, May 2002)[2]
San Clemente Island	20-100	1,2,4	H.R. Carter (unpubl. data, May 2002)[2]
(U.S.A. subtotal)	1,770 - 5,150 breeding birds **(average of 1,730 pairs)** (42% of world population in USA)		
Baja California, Mexico			
Los Coronados Islands	1,500-2,500	3	H.R. Carter and D. Whitworth, unpubl. data
Todos Santos Islands	50-250	1,2	Keitt 2000
San Martin Island	50-250	1,2	Keitt 2000
San Geronimo Island	100-500	1,2	Keitt 2000
San Benito Islands	500-1,000	3	Whitworth et al. 2003
Guadalupe Island	1,000-2,000	1	R.L. Pitman & W.T. Everett (pers. comm.)
(Mexico subtotal)	3,200 - 6,500 breeding birds **(average of 2,425 pairs)** (58% of world population in Mexico)		
World Total	**4,970 - 11,650 breeding birds (average of 4,155 pairs)**		

[1] 1 = Nest and/or habitat survey; 2 = Vocal detection survey; 3 = Spotlight survey; 4 = At-sea captures of murrelets.

[2] Carter's unpublished estimates of numbers of breeding Xantus's Murrelets in the Channel Islands, California, in this table and Figures 11-18 reflect rough ranges of possible breeding population estimates derived from various 1991-2002 survey data (*i.e.*, ground-based surveys [Santa Barbara], vocalization surveys [all islands], spotlight surveys [Anacapa and Santa Barbara only], and nest searches in accessible areas [all islands]) and general habitat assessments, with rough adjustments. At most colonies, traditional survey techniques to estimate population size are not feasible and only rough population estimates are possible with available data (H.R. Carter, pers. comm.).

Figure 1. Adult Xantus's Murrelet; note the black feathering extending below the eye, indicative of the *Synthliboramphus hypoleucus scrippsi* subspecies.

Figure 2. Downy young Xantus's Murrelet at fledging stage, 2-3 days old.

California Department of Fish and Game photographs by Debra Hamilton.

Figure 3a. East side of Santa Barbara Island, looking northerly toward Landing Cove. These cliffs provide nesting habitat for Xantus's Murrelets.

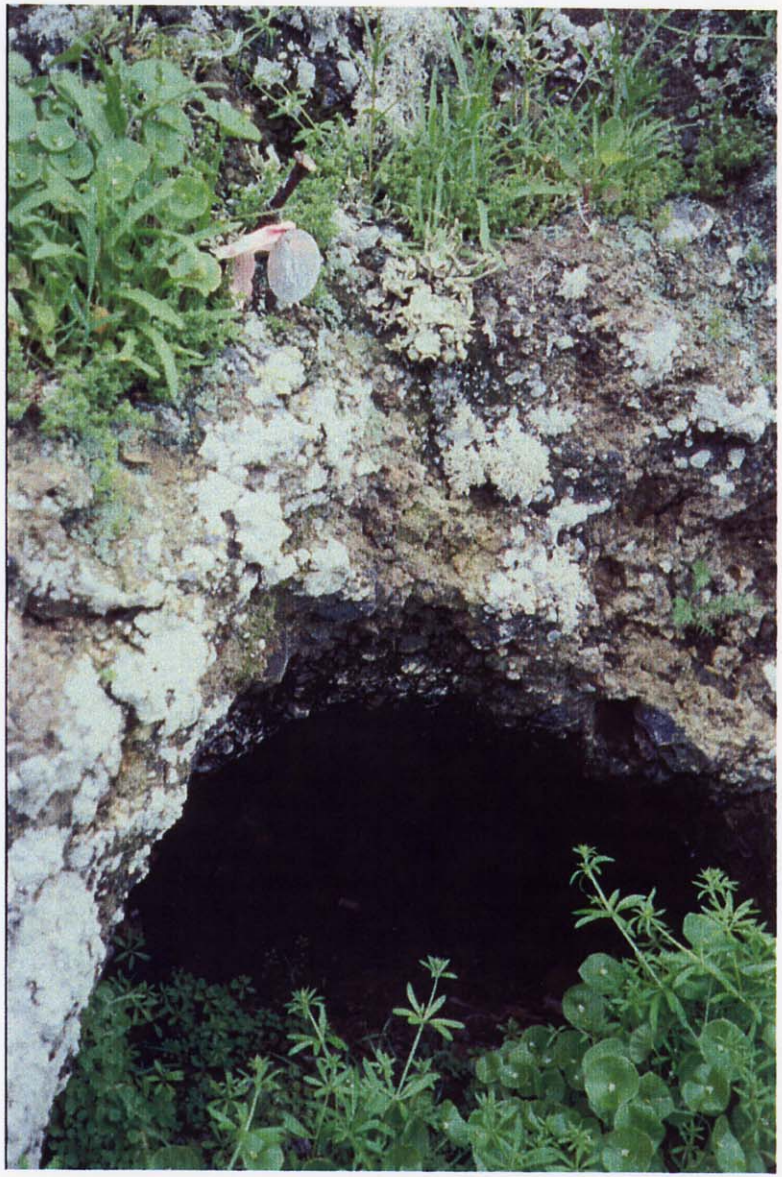

Figure 3b. Nesting site of Xantus's Murrelet on northeast side of Santa Barbara Island. Permanent nest marker for monitoring nest success is located to the upper left of this cave site.

California Department of Fish and Game photographs by Esther E. Burkett.

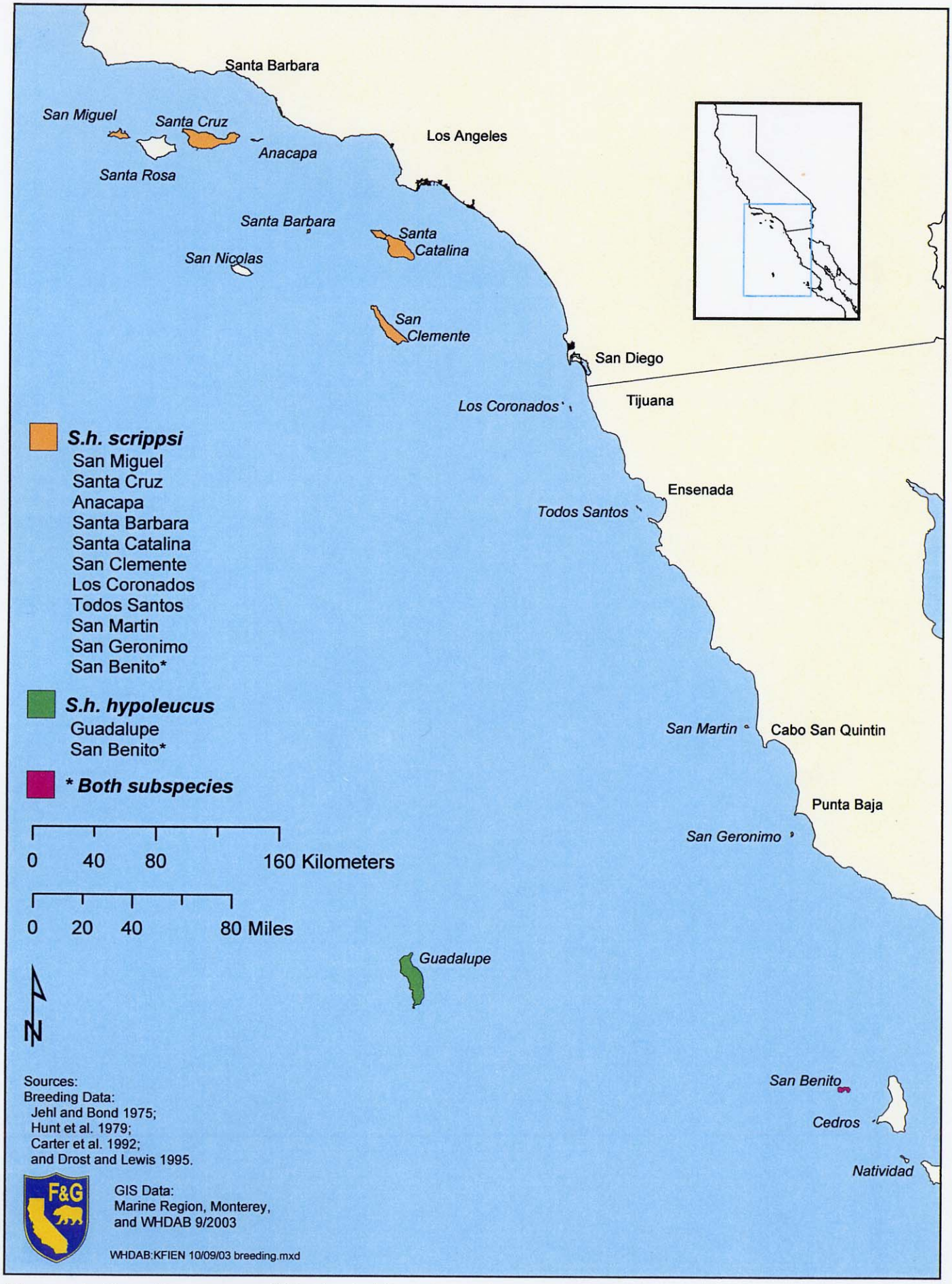

Figure 4. Breeding range of Xantus's Murrelet, subspecies *S.h. scrippsi* and *S.h. hypoleucus* (data sources noted on map).

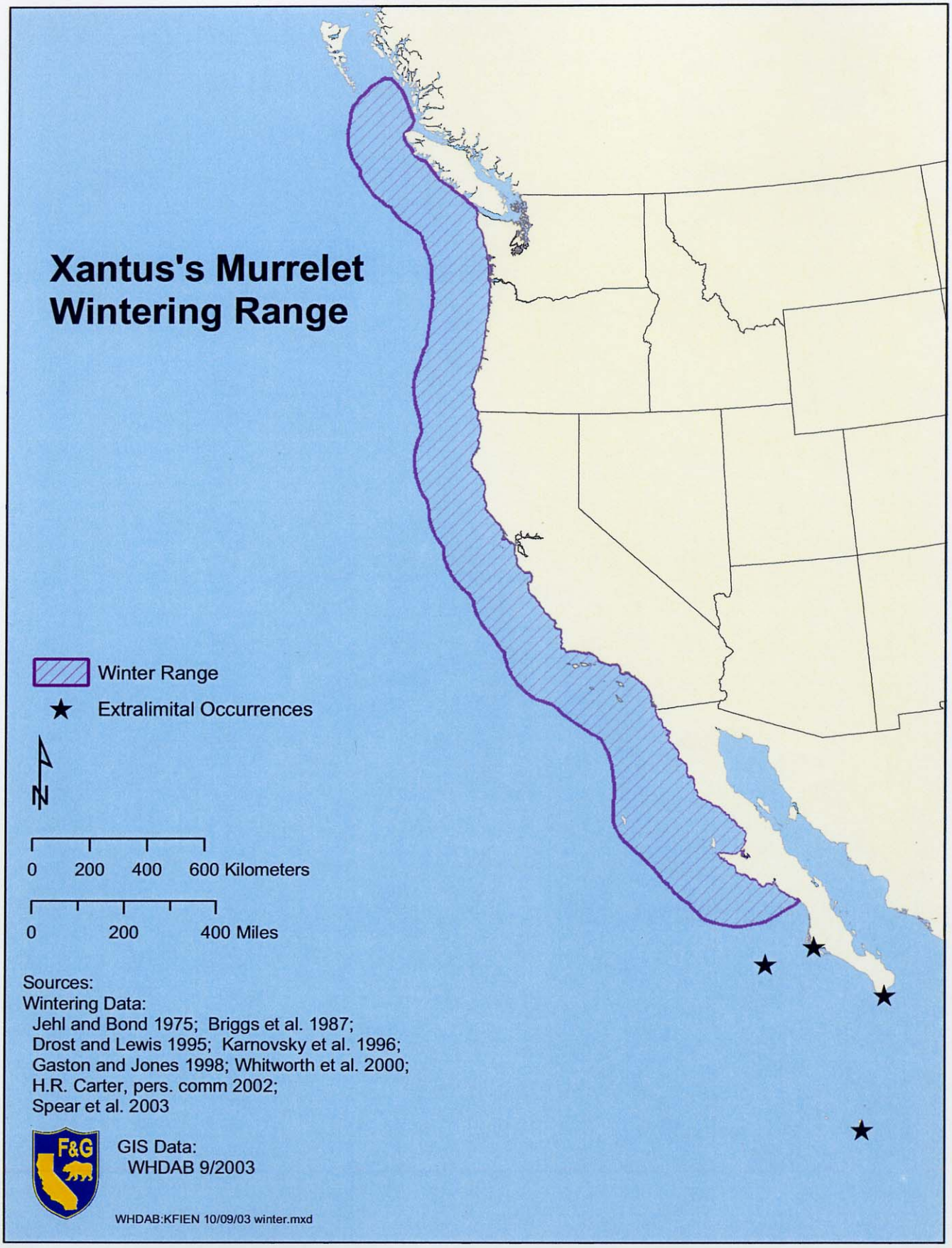

Figure 5. Winter distribution of Xantus's Murrelets including extralimital records in Baja, California (data sources noted on map).

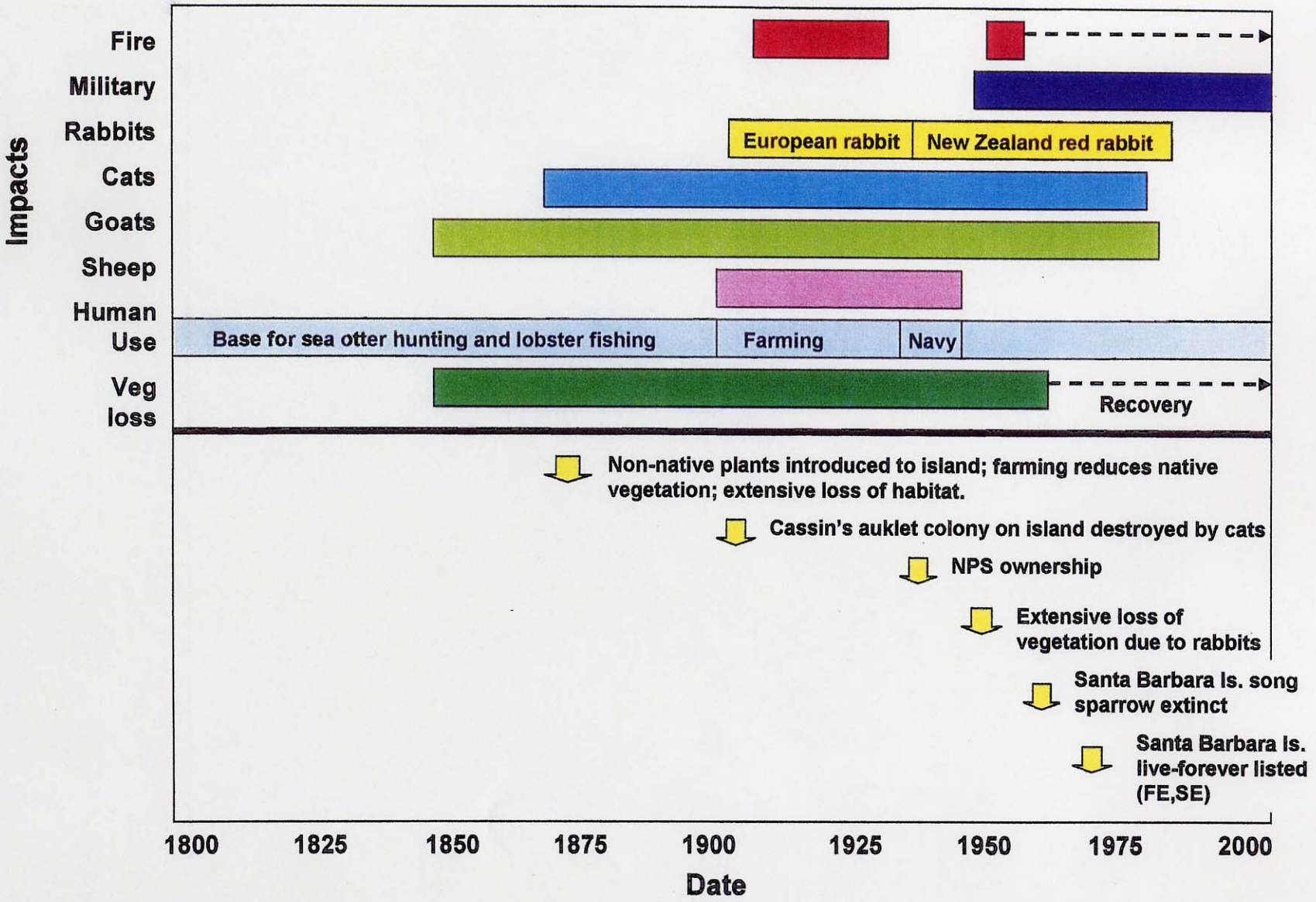

Figure 6. Impacts to native species on Santa Barbara Island (from Stewart et al. 1974, Sumner 1959, Hunt et al. 1979; endangered plant, Santa Barbara Island live-forever (*Dudleya traskiae*) 43 Federal Register 17916; April 26, 1978).

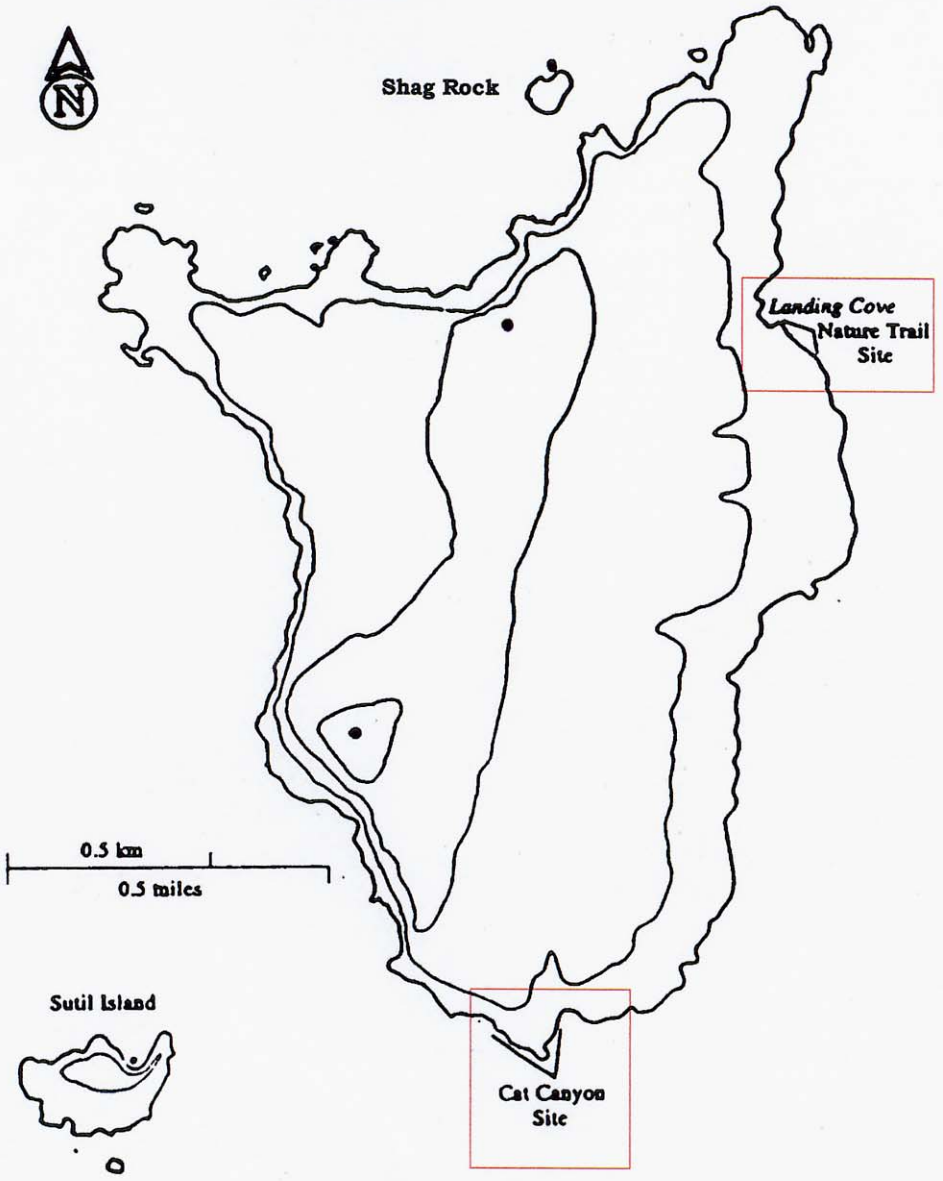

Figure 7. Xantus's Murrelet nest monitoring sites on Santa Barbara Island. The Nature Trail site is located on the northeast part of the island, and Cat Canyon is located on the south end of the island.

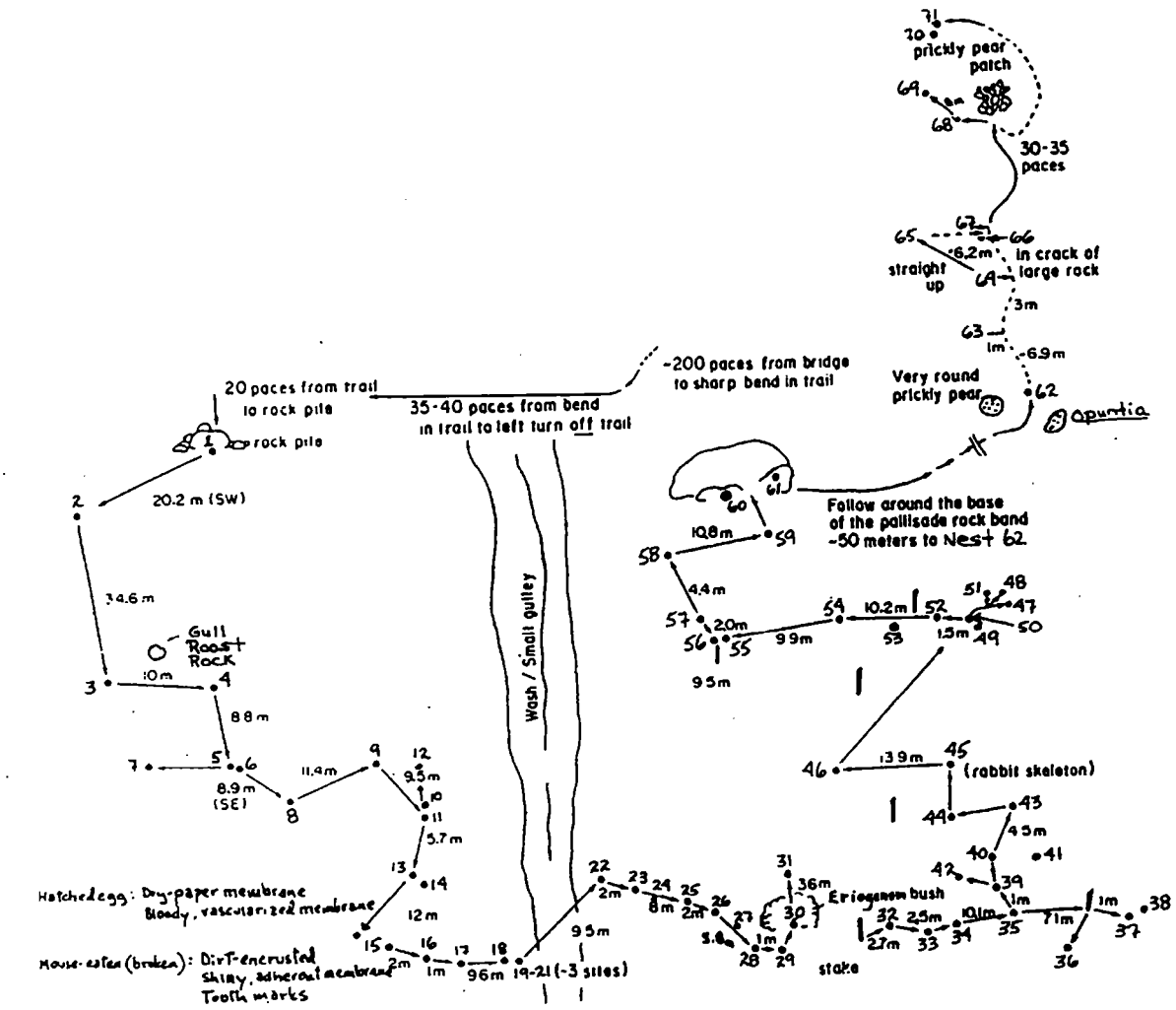

Figure 8. Detailed map of Xantus's Murrelet nest sites monitored at the Cat Canyon site, Santa Barbara Island.

(from Ingram 1992; Channel Islands National Park 1990 Seabird Monitoring Report)

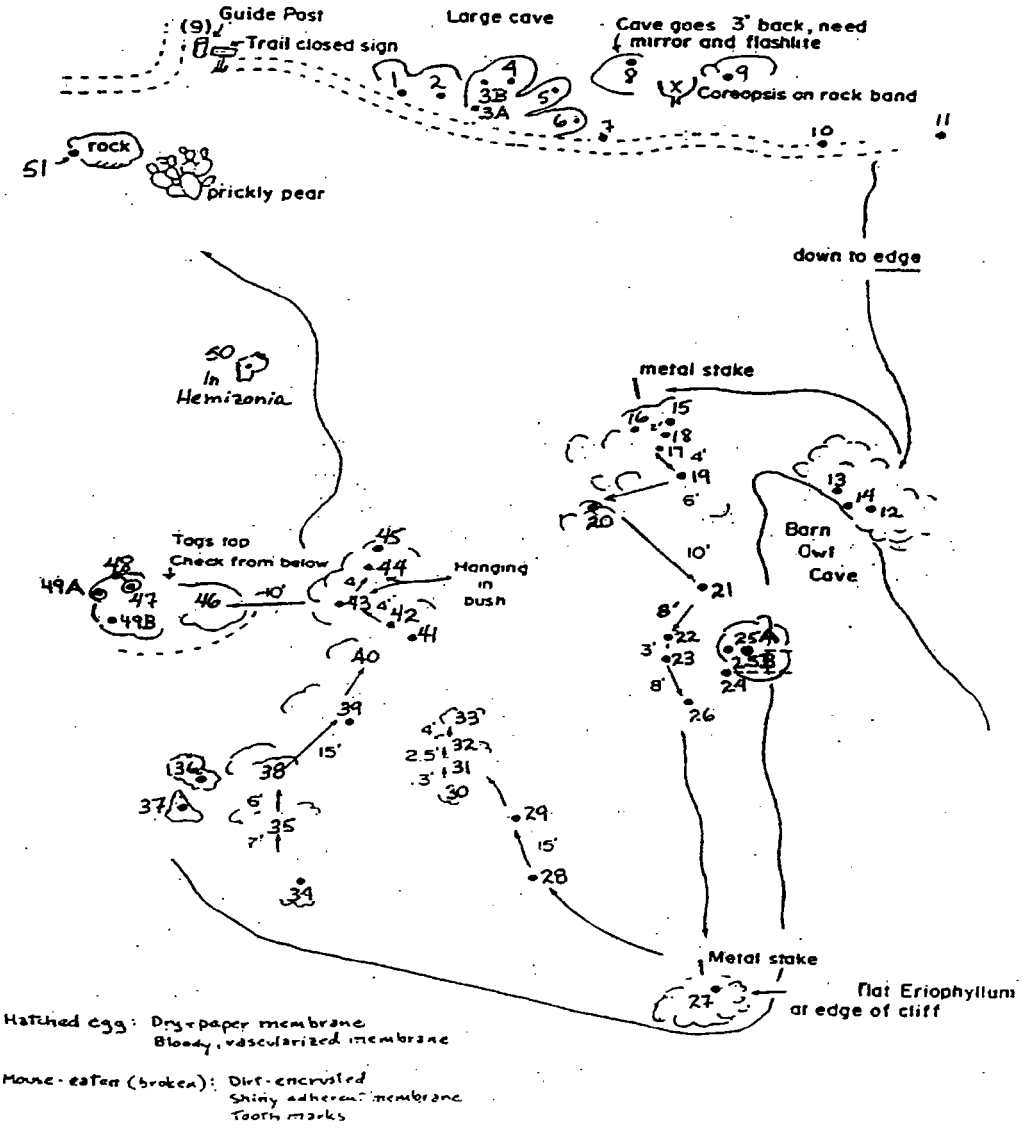

Figure 9. Detailed map of Xantus's Murrelet nest sites monitored at the Nature Trail site, Santa Barbara Island.

(from Ingram 1992; Channel Islands National Park 1990 Seabird Monitoring Report)

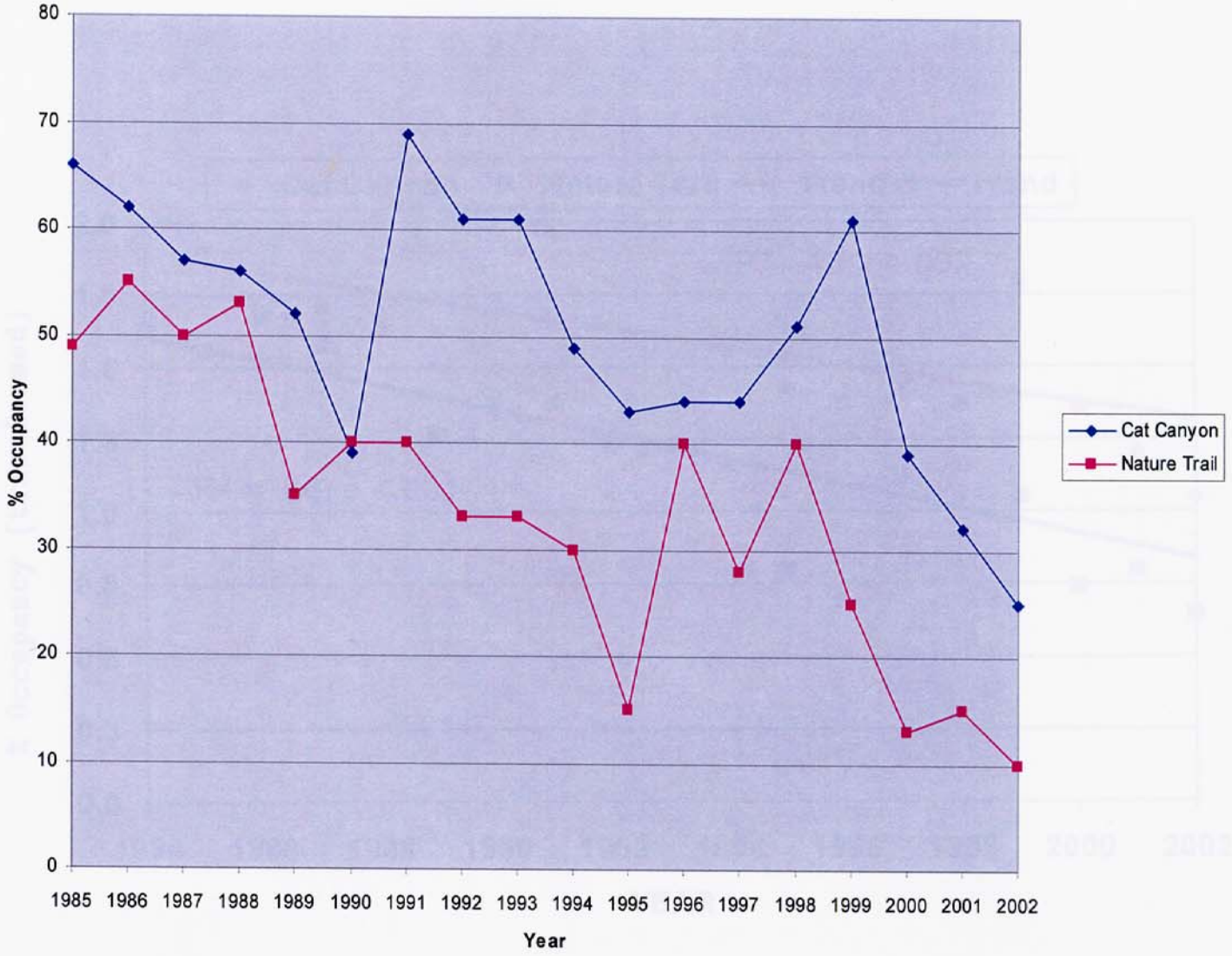

Figure 10a. Xantus's Murrelet Nest Site Occupancy, 1985-2002, at Cat Canyon and Nature Trail Study Sites on Santa Barbara Island (from Paige Martin, NPS, unpublished data, subject to revision before final).

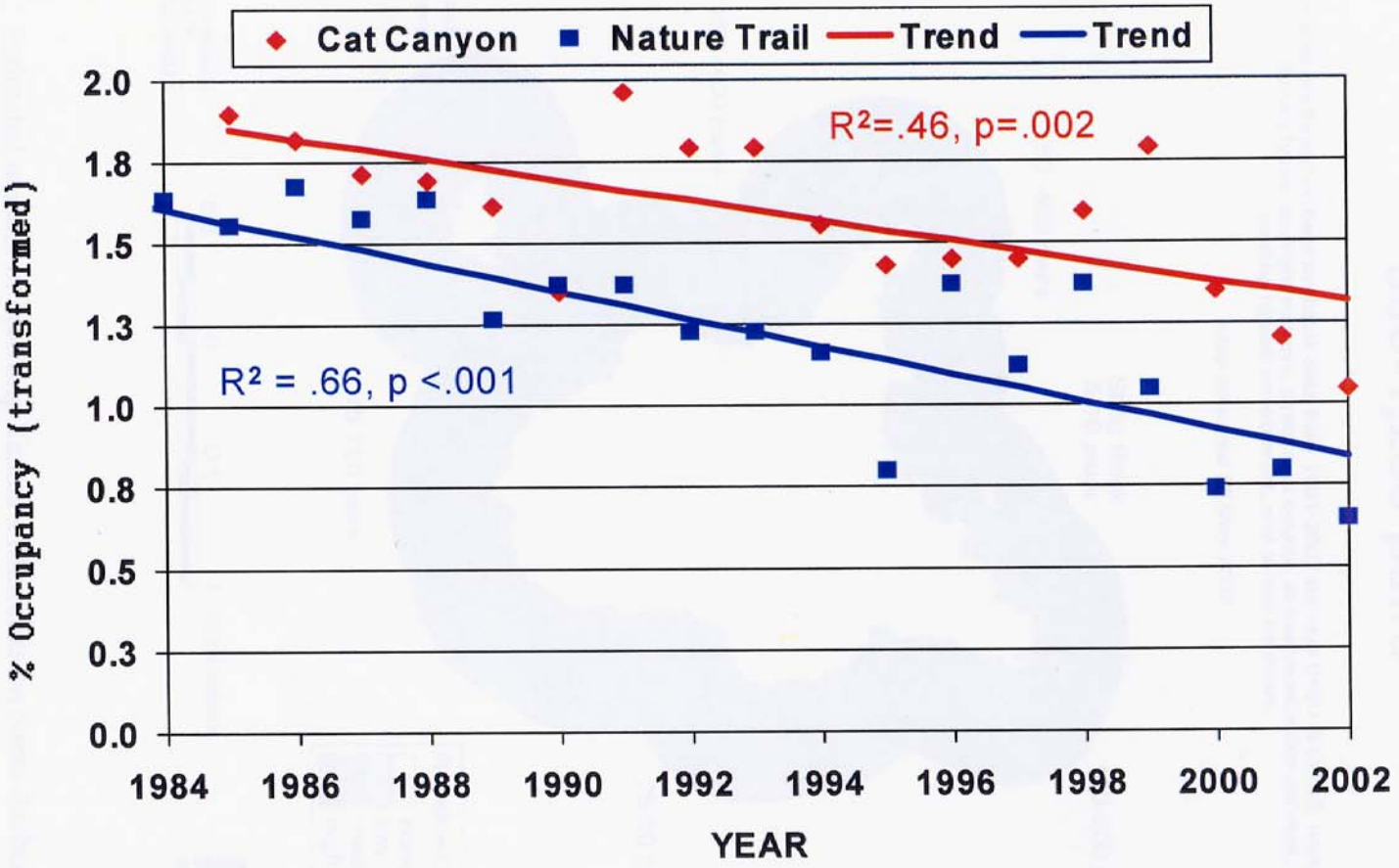

Figure 10b. Xantus's Murrelet Nest Site Occupancy, 1984-2002, at Cat Canyon and Nature Trail Study Sites on Santa Barbara Island (from Paige Martin, NPS, unpublished data, subject to revision before final; data from Figure 10a transformed (2 arcsine square root) for statistical analysis).

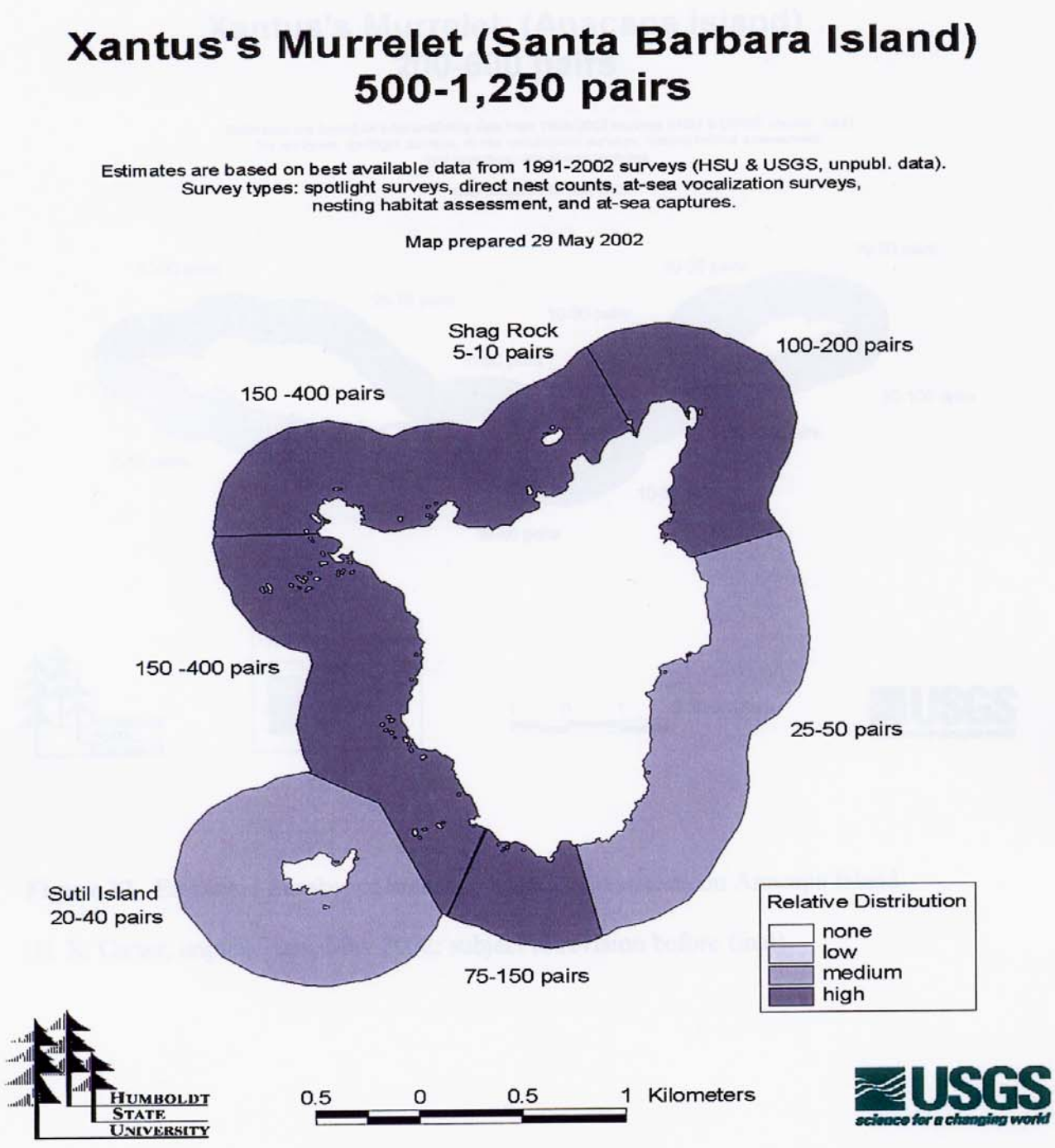

Figure 11. Estimated number of breeding Xantus's Murrelets on Santa Barbara Island.

(H.R. Carter, unpubl. data, May 2002; subject to revision before final).

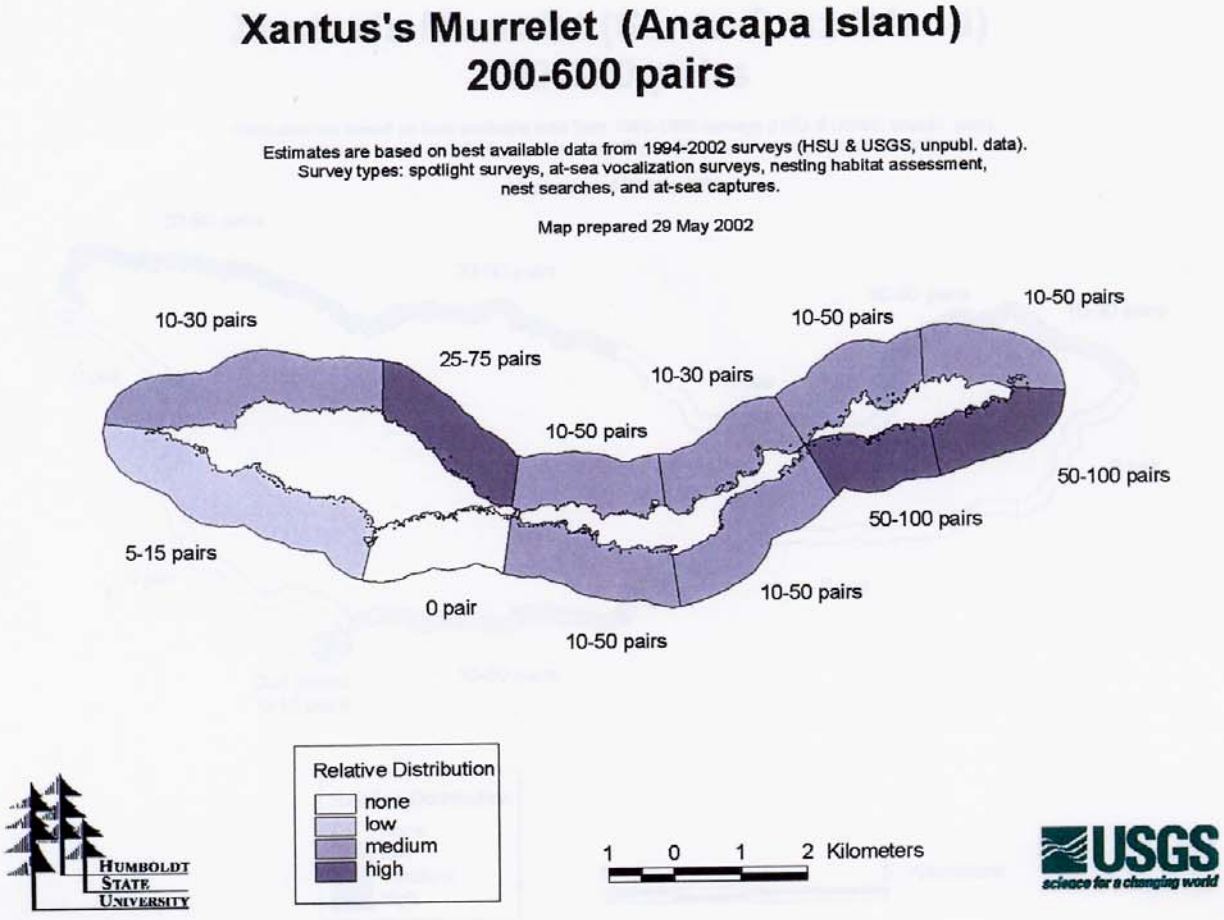

Figure 12. Estimated number of breeding Xantus's Murrelets on Anacapa Island.

(H. R. Carter, unpubl. data, May 2002; subject to revision before final).

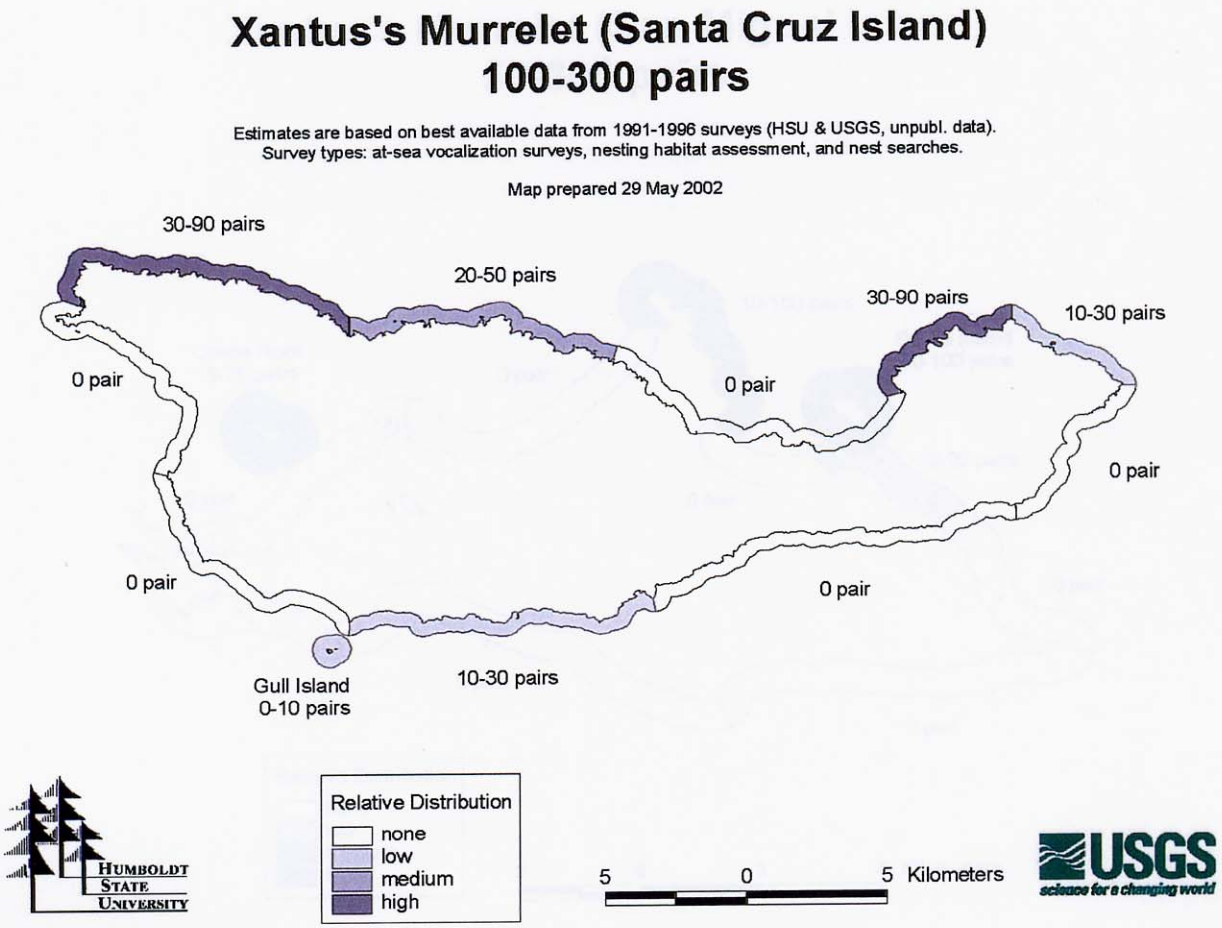

Figure 13. Estimated number of breeding Xantus's Murrelets on Santa Cruz Island.

(H.R. Carter, unpubl. data, May 2002; subject to revision before final).

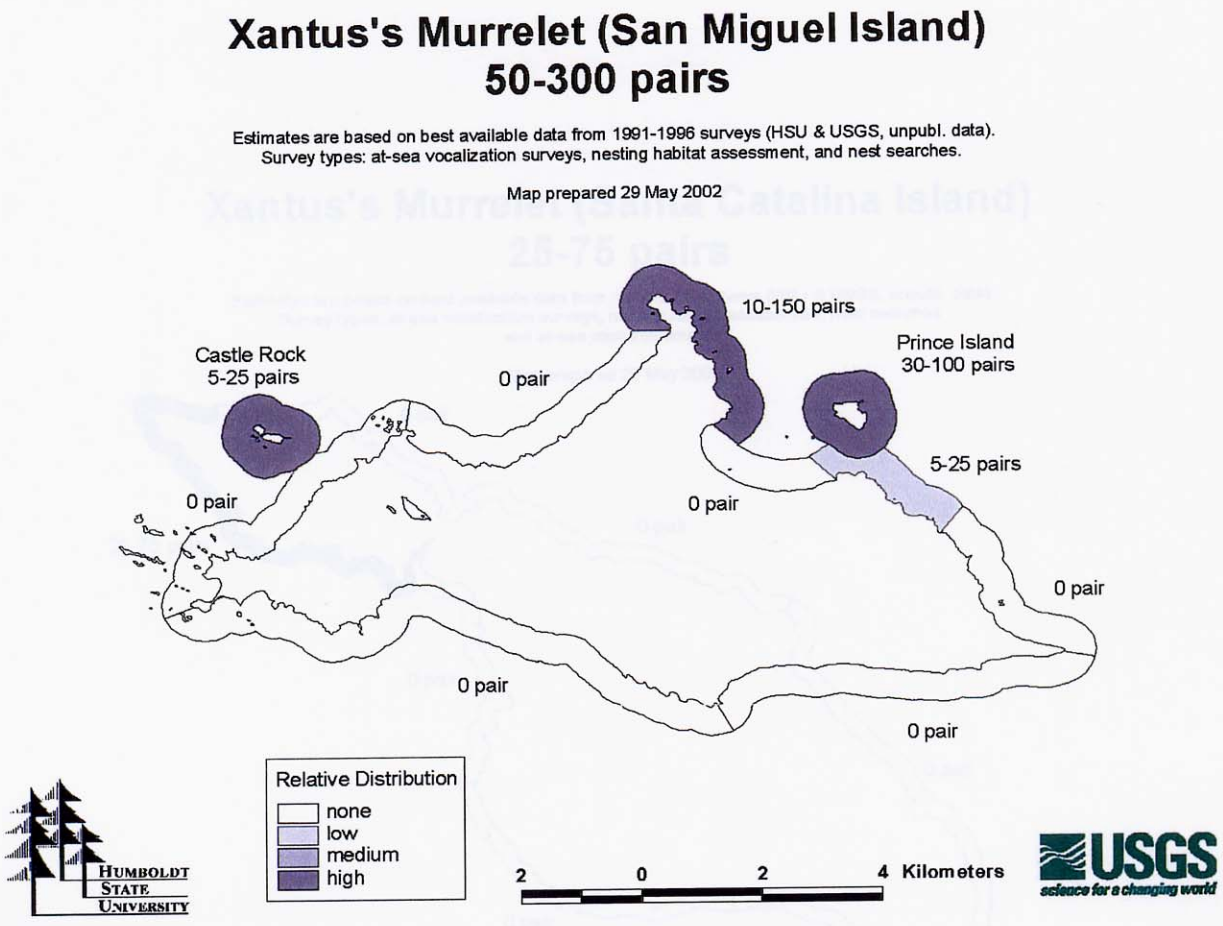

Figure 14. Estimated number of breeding Xantus's Murrelets on San Miguel Island.

(H.R. Carter, unpubl. data, May 2002; subject to revision before final).

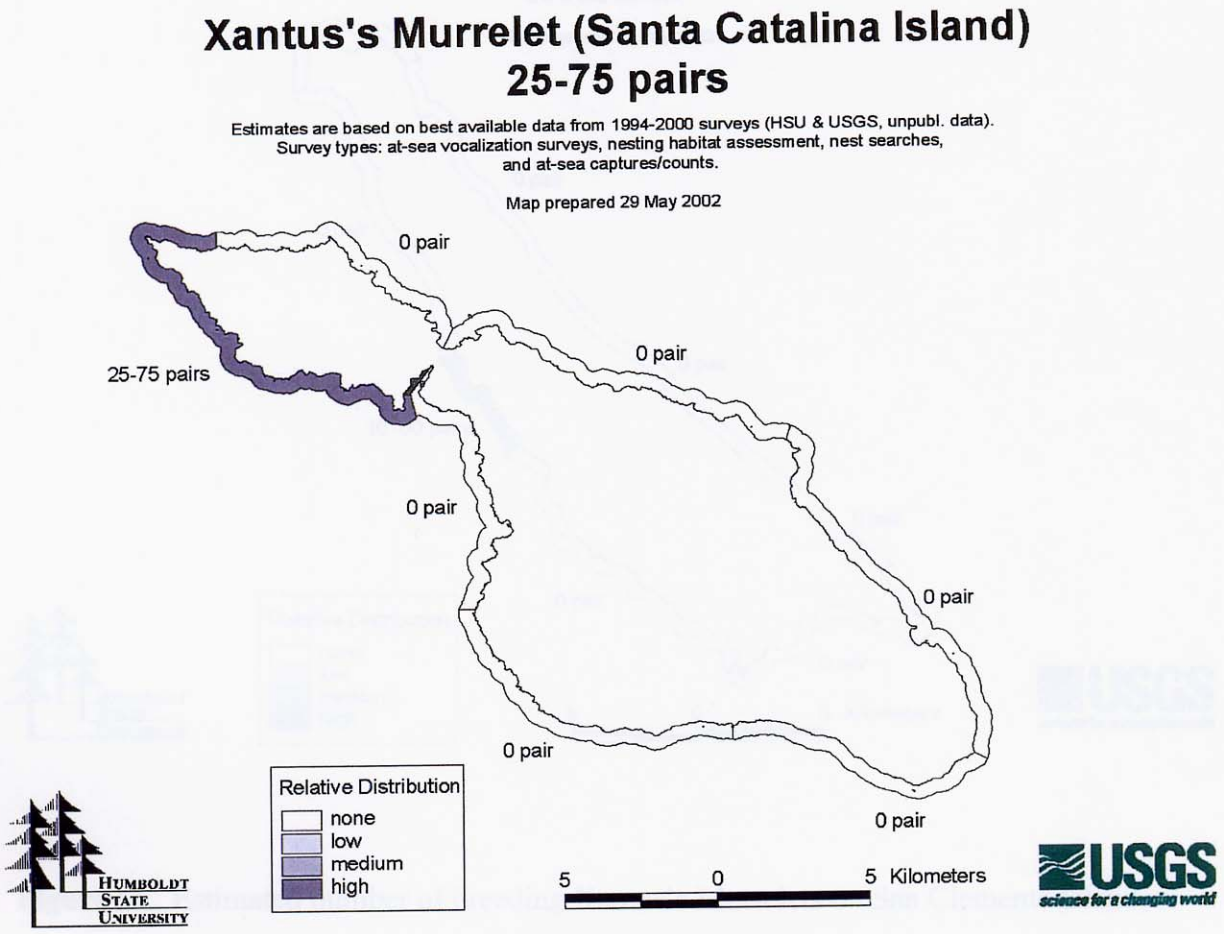

Figure 15. Estimated number of breeding Xantus's Murrelets on Santa Catalina Island. (H.R. Carter, unpubl. data, May 2002; subject to revision before final).

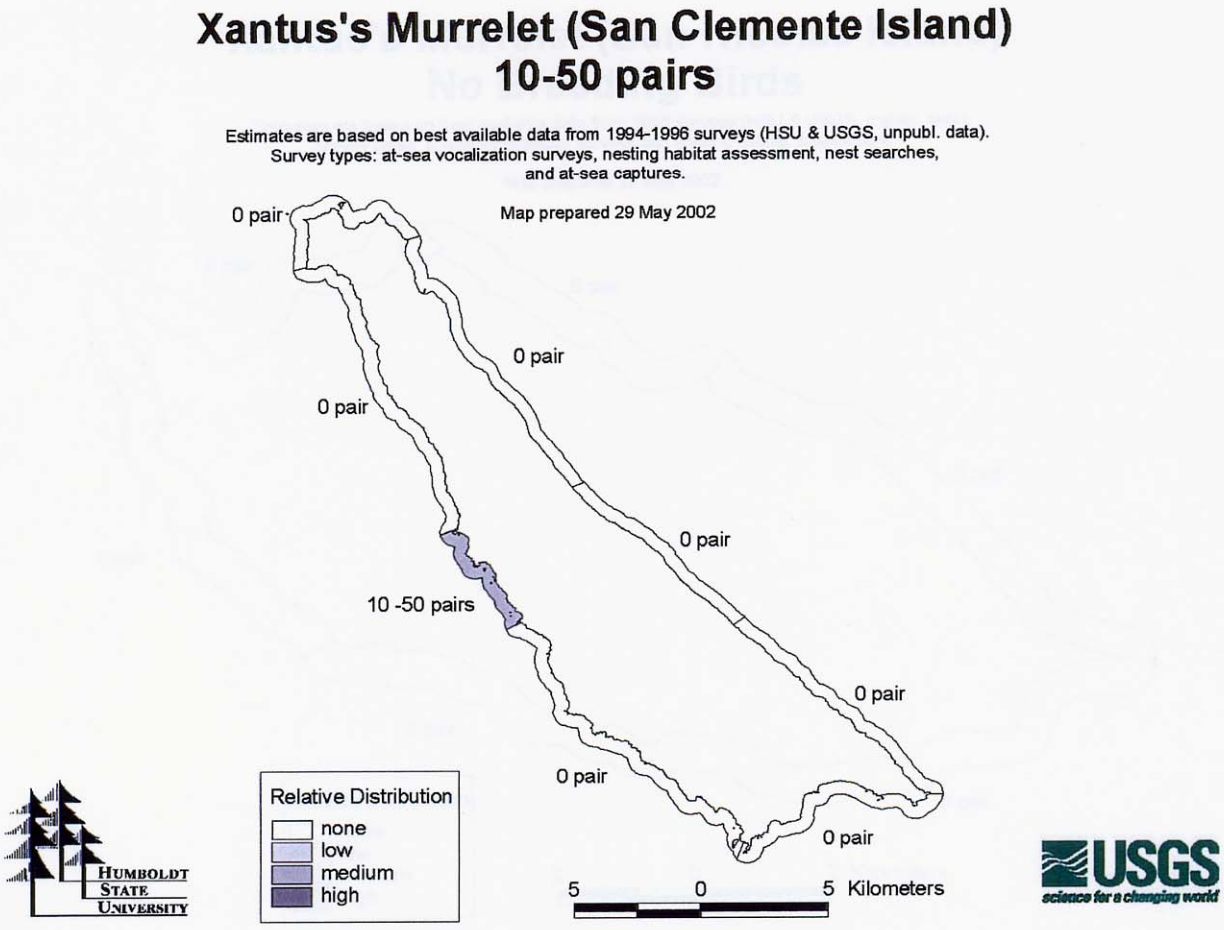

Figure 16. Estimated number of breeding Xantus's Murrelets on San Clemente Island.

(H.R. Carter, unpubl. data, May 2002; subject to revision before final).

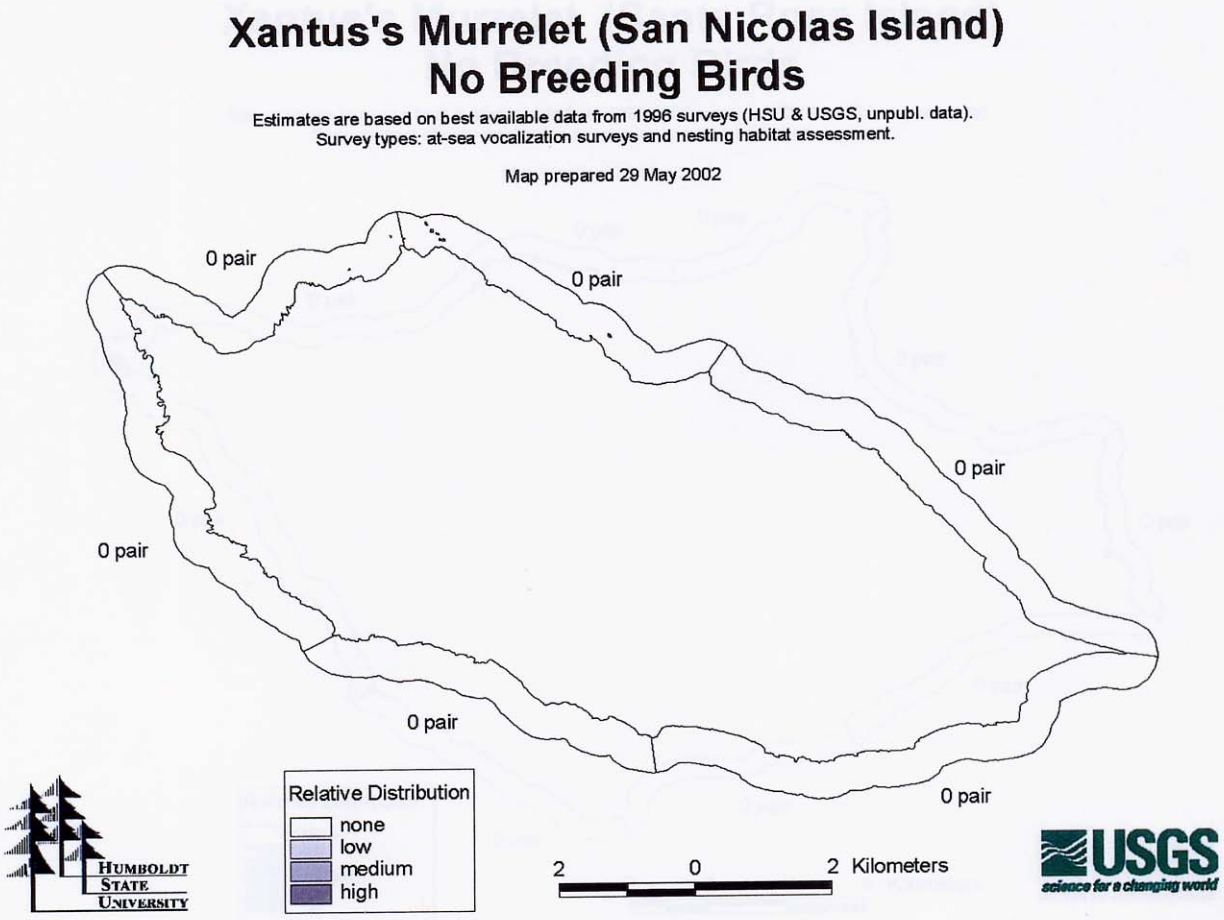

Figure 17. Estimated number of breeding Xantus's Murrelets on San Nicolas Island. (H.R. Carter, unpubl. data, May 2002; subject to revision before final).

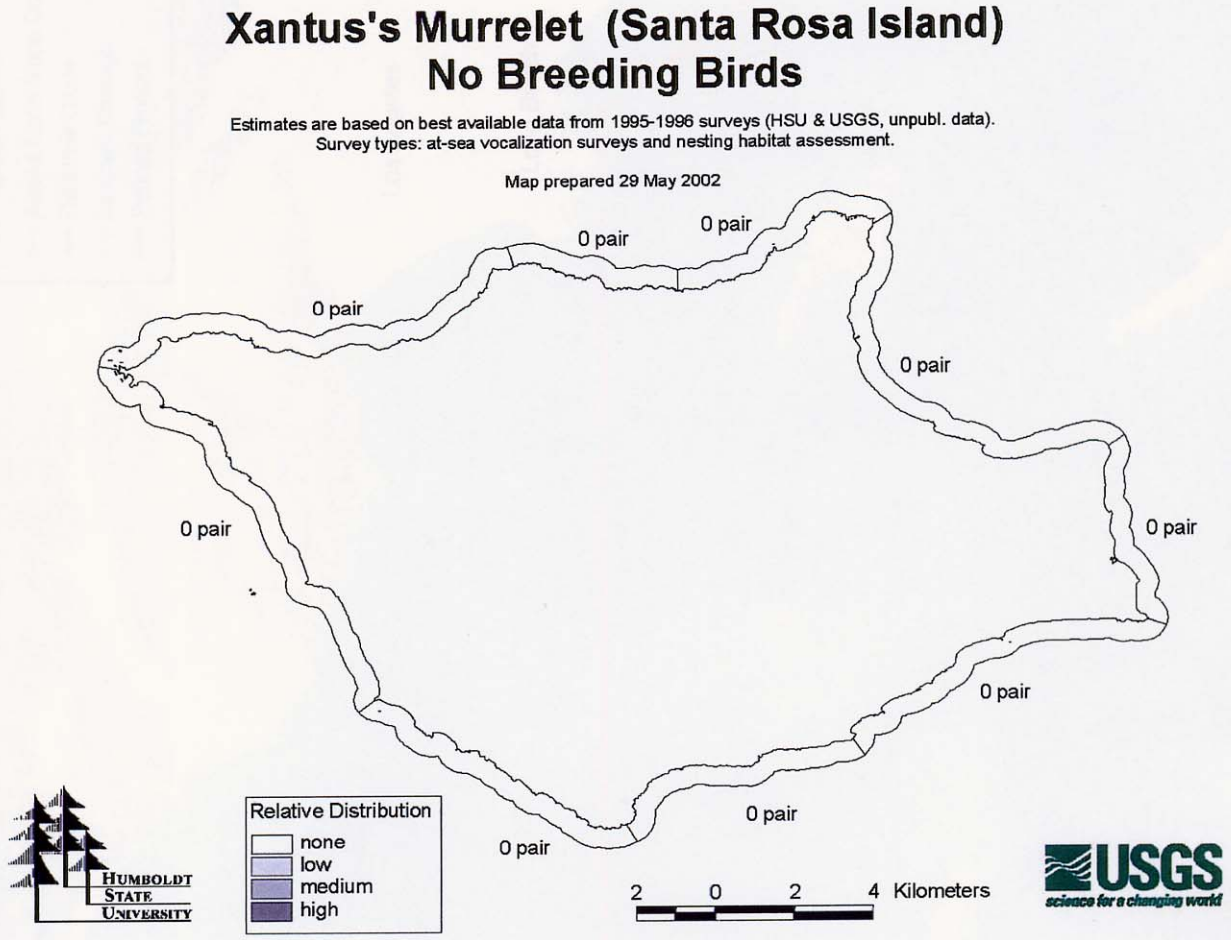

Figure 18. Estimated number of breeding Xantus's Murrelets on Santa Rosa Island (H.R. Carter, unpubl. data, May 2002; subject to revision before final).

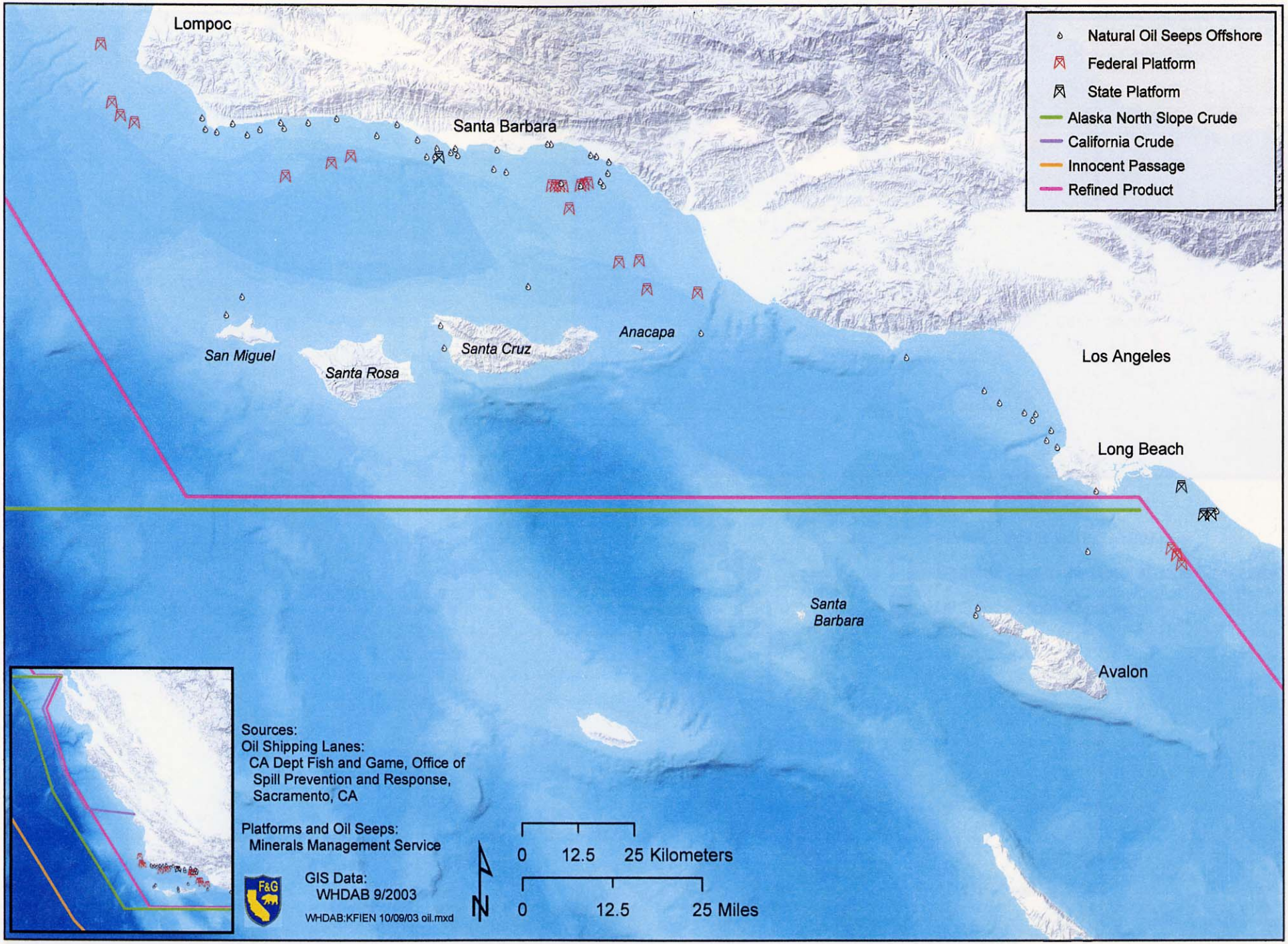

Figure 19. Oil-related activity around Channel Islands National Marine Sanctuary and Department Ecological Reserves (modified from Carter et al. (2000). Note that "Innocent Passage" refers to legal transit through waters that are part of a country's territory).

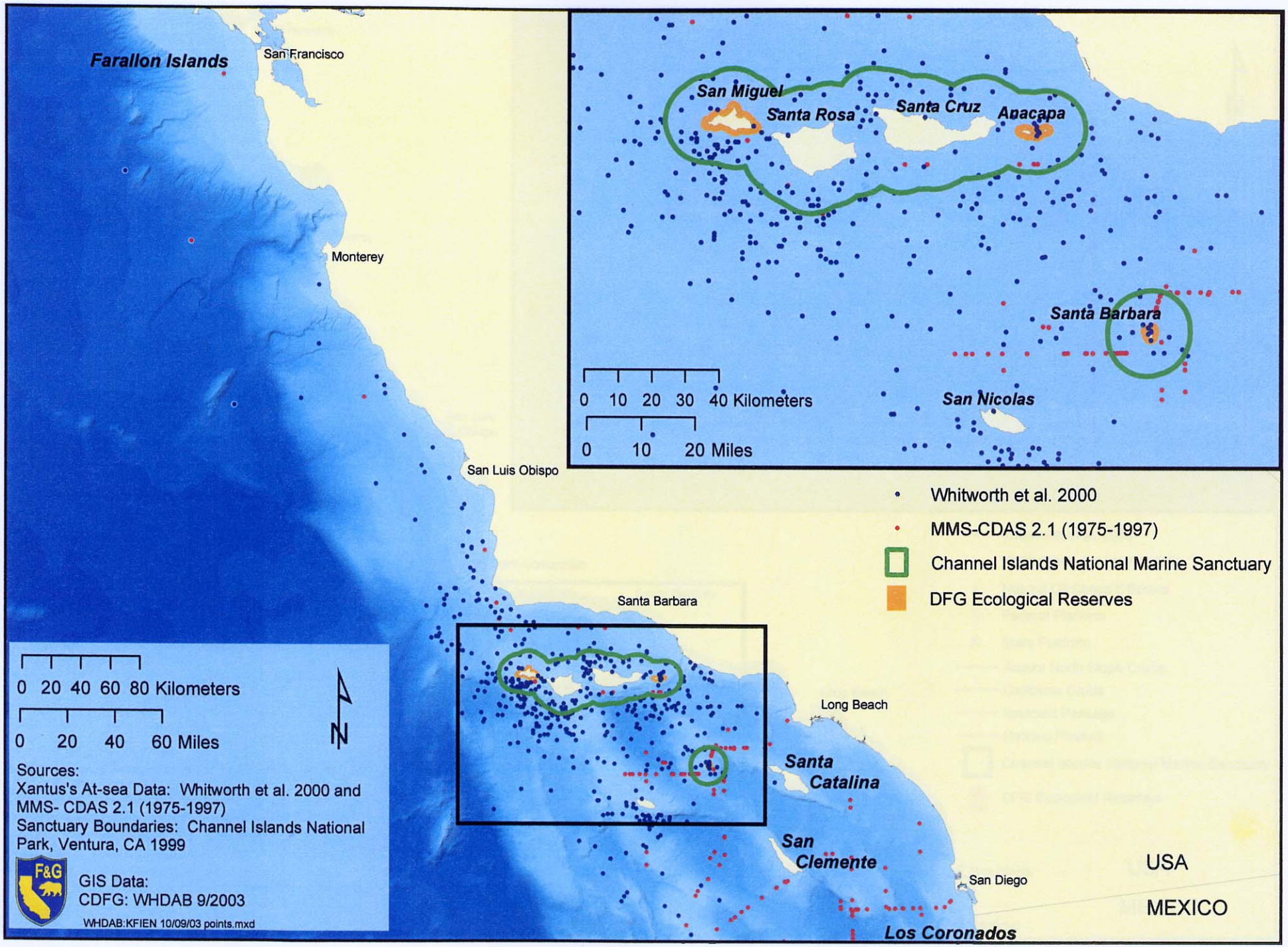

Figure 20. At-sea distribution of Xantus's Murrelets from radio-marked birds, and plane and vessel surveys (data sources noted on map).

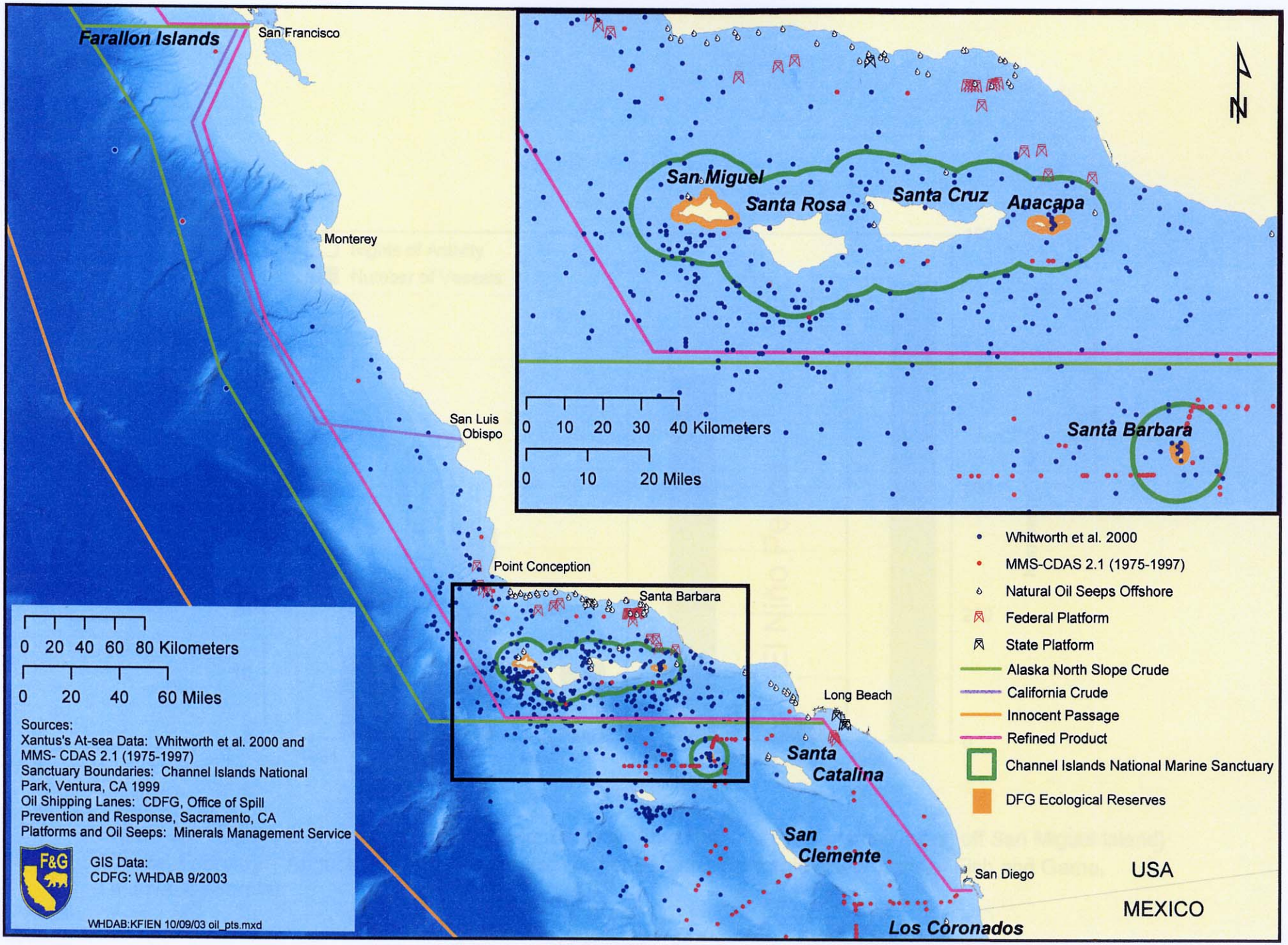

Figure 21. Xantus's Murrelet locations at-sea shown in relation to oil-related activity (data sources noted on map).

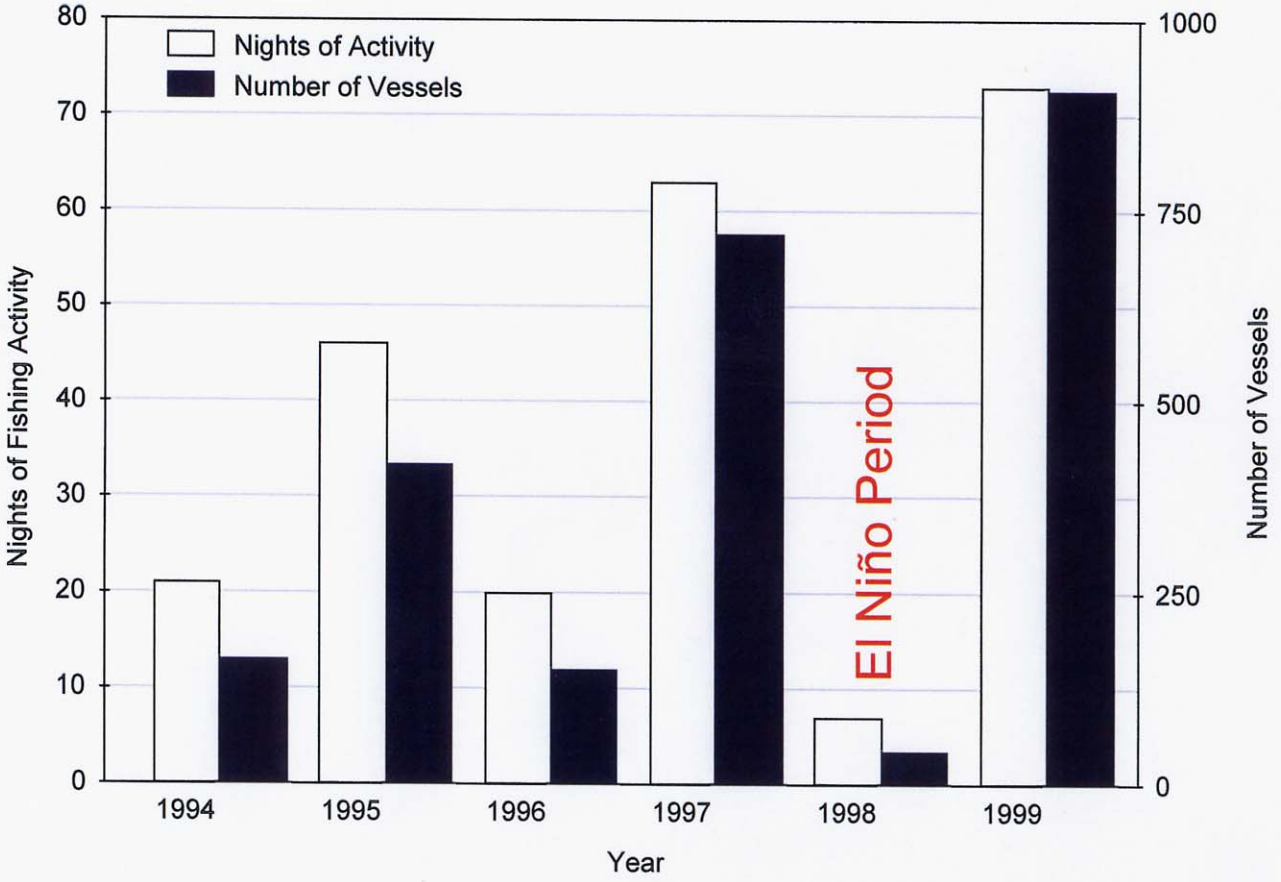

Figure 22. Light activity from vessels at Santa Barbara, Anacapa, and Prince (small island off San Miguel Island) Islands, February – August, 1994-1999 (data from Annette Henry, California Department of Fish and Game, La Jolla, California).

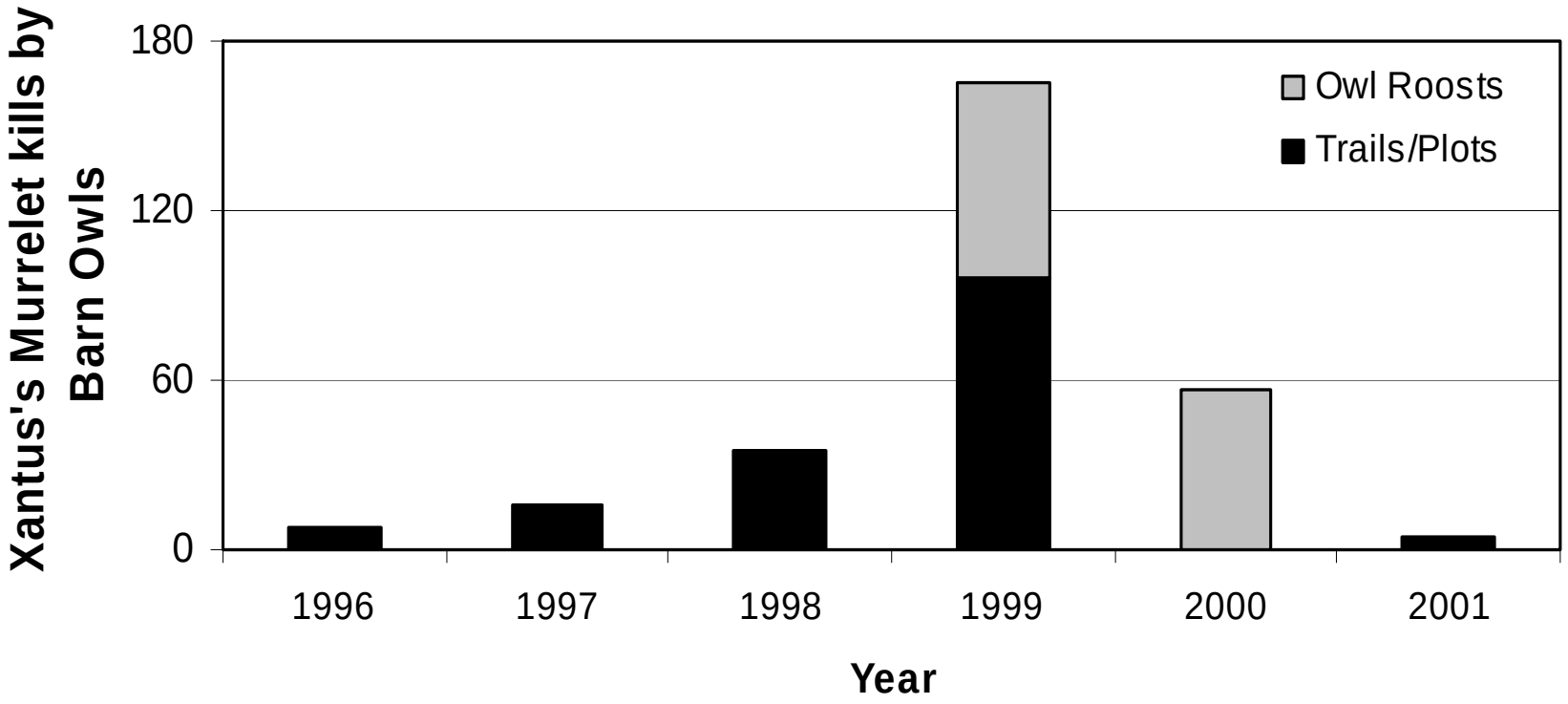

Figure 23. Total number of Xantus's Murrelets found dead, and attributed to Barn Owl predation, on Santa Barbara Island from 1996 to 2001. Murrelet carcasses were collected by biologists along trails, and in murrelet nesting plots, while conducting nest monitoring field work. In 1999 and 2000, owl roosts were also searched and murrelet carcasses were collected.

Data Source: Paige Martin, National Park Service, unpublished data.

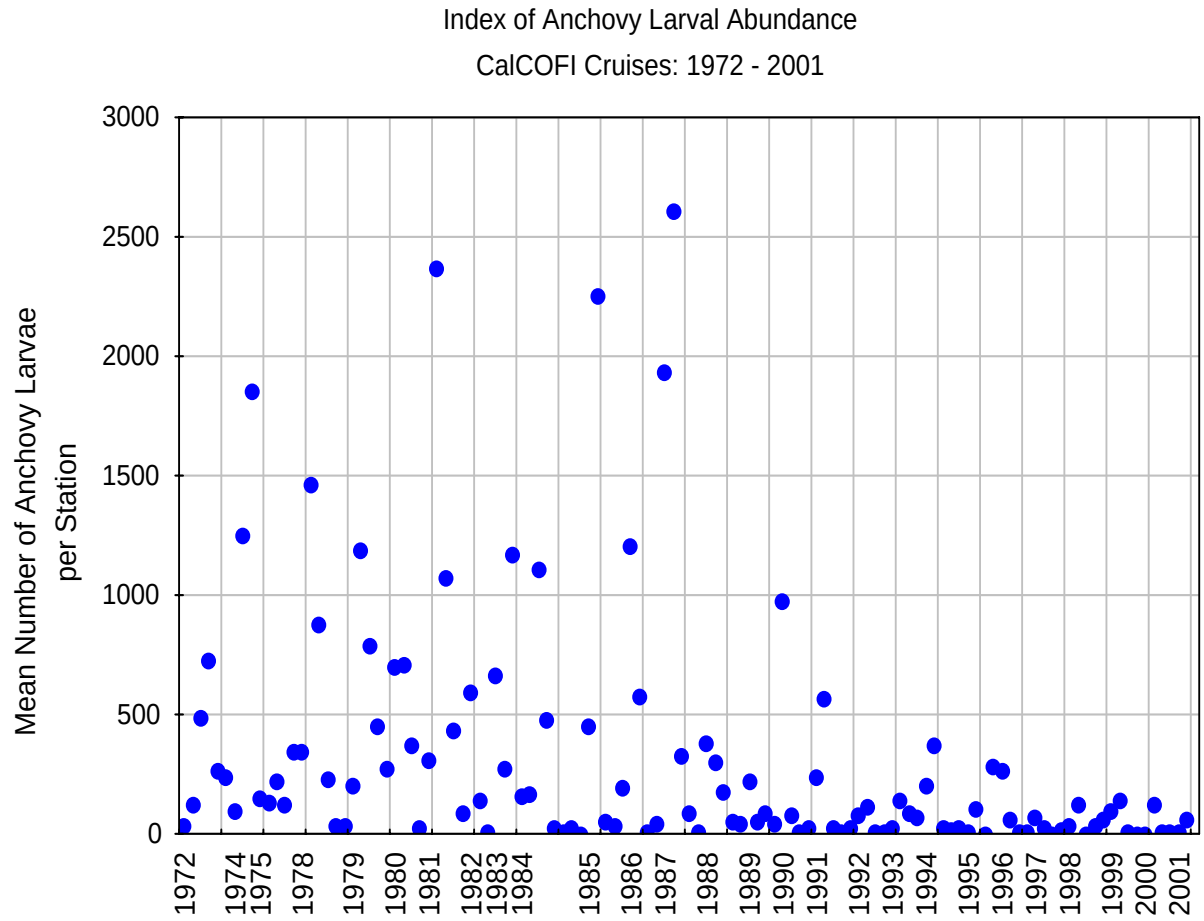

Figure 24. Index of larval Anchovy abundance in southern California, 1972-2001 (data derived from CalCOFI cruises, and obtained from Paul E. Smith, NOAA, National Marine Fisheries Service, La Jolla, California).