

STATUS AND CONSERVATION OF THE BREEDING SEABIRDS ON OFFSHORE PACIFIC ISLANDS OF BAJA CALIFORNIA AND THE GULF OF CALIFORNIA

WILLIAM T. EVERETT¹ & DANIEL W. ANDERSON²

1 Department of Birds and Mammals, San Diego Natural History Museum
P.O. Box 1390, San Diego, California 92112, U.S.A.

2 Department of Wildlife and Fisheries Biology
University of California, Davis, California 95616, U.S.A.

ABSTRACT

Up to 34 species of seabirds breed, or have bred, at locations within the region. Most colonies are located on islands. Many species achieve their southern or northern range limits in this transition zone between seabird biogeographical elements, and several species are endemic. This paper reviews the status of breeding seabird populations and indicates areas in need of further investigation. Introduced predators and human disturbance constitute the most serious current conservation problems in the region. Immediate action is recommended to protect vulnerable colonies of Townsend's Shearwater *Puffinus auricularis*. Additional conservation measures are suggested.

RESUMEN

La región descrita en este reporte comprende las áreas litorales del oeste de Norteamérica, aproximadamente entre los 23°00' y los 33°00' del latitud norte (sur de Sinaloa, México hasta la frontera México/Estados Unidos), también se incluyen islas fuera de la costa de Baja California, y hacia el sur hasta los 18°00'N. Una gran parte de esta región (principalmente la parte norte) representa una zona de transición entre dos zonas biogeográficas de aves marinas. Se estima que unas 34 especies de dichas aves se han reproducido o reproducen en various lugares de la región, y muchas especies llegan a sus límites norte o sur de distribución en esta área. Varias de las especies presentes son endémicas. En el trabajo presente hacemos una revisión del status de las poblaciones reproductoras de aves marinas en various lugares, también indicamos las áreas que requieren de investigaciones posteriores. Los depredadores y competidores introducidos, la competencia e interacción con las pesquerías comerciales, así como la perturbación de colonias reproductoras por el hombre, son algunos de los problemas más serios de conservación en la región, variando relativamente en intensidad de una isla a otra. Se sugieren varias medidas de conservación para la mayoría de las especies aquí descritas, haciendo énfasis en la urgencia de tomar las acciones debidas para proteger las colonias del Pufino de Townsend *Puffinus auricularis*, quizás el ave marina que está en más peligro en la región.

INTRODUCTION

The total area covered by this report (Figures 1, 2 and 3) encompasses a wide range of habitats used by breeding seabirds, including coastal and offshore waters and islands, bays and lagoons, and the highly biologically productive Gulf of California (Tafall 1944; Hutchinson 1950; Moser *et al.* 1974; Briggs 1974). Most of the region lies within a geographic transition zone between the temperate climatic and oceanic zone to the north, and the tropical zone to the south (Hubbs 1960; Hubbs & Roden 1964; Anderson 1983). The northern boundary of our area is the United States/Mexico border; however, many of the species we discuss also breed or occur in the Southern California Bight (SCB) to the north of the border. This region has previously been discussed by Hunt *et al.* (1980) and SOWLS *et al.* (1980), and is covered by Ainley & Hunt (this volume). Significant seabird colonies also occur to the south, at Isla Isabela, Las Tres Marietas, Islas Tres Marias, and numerous other localities along the coast of mainland Mexico (Friedman *et al.* 1950; American Ornithologists' Union (AOU) 1983; Anderson 1983). The primarily tropical seabird fauna of this southern region is outside the scope of our account.

We aim to provide detailed breeding seabird accounts for the southern segment of the area which was only partially treated previously by Jehl (1984). Despite the relative paucity of knowledge and incomplete exploration of the area, we hope that our summary will provide a base on which to add further data on the status, distribution, and conservation of seabirds of the region.

Many species of seabirds have their southern or northern range limits within this region, but only Craveri's Murrelet *Endomychura craveri* and the Yellow-footed Gull *Larus livens* are virtually restricted to it throughout the year. In addition, species whose breeding range is essentially limited to this area include: Townsend's Shearwater, Black-vented Shearwater *Puffinus opisthomelas*, Black Storm Petrel *Oceanodroma melania*, Least Storm Petrel *Halocryptena microsoma*, Heermann's Gull *Larus heermanni*, and Elegant Tern *Sterna elegans*. The Guadalupe Storm Petrel *O. macrodactyla* is considered extinct (AOU 1983; Jehl & Everett 1985).

Despite 100 years of scientific interest and investigation, most published accounts of seabirds of the region are anecdotal, and scant detailed data are available. Sixty years ago, Grinnell (1928) summarised historic information for the birds of the region (excluding Las Islas Revillagigedo), and since that time only a few papers (e.g. Brattstrom & Howell 1956; Jehl & Parkes 1982; Anderson 1983, 1988; Jehl & Everett 1985; Pitman 1985; Everett 1988a) have provided more recent information for selected areas.

This paper reviews and summarises recent data for those species of marine birds which breed, or have bred, at islands and other locations along the coasts of the peninsula of Baja California, within the Gulf of California, at Isla Guadalupe, Las Islas Revillagigedo, and Rocas Alijos (Figures 1, 2 and 3). This area is vast, and several sectors are isolated and often inhospitable. Many smaller rocks and remote parts of larger islands have never been investigated. It is unlikely, however, that any large seabird colonies have been overlooked. Every effort has been made to provide and use proper Spanish names for locations mentioned in the text. Exceptions are made only in instances where significant previously published references would be obscured by changing names.

For this paper, marine birds are defined as all species within the avian orders *Procellariiformes*, *Pelecaniformes*, and selected families within the order *Charadriiformes* (see Croxall *et al.* 1984). The terns *Sterna* spp. have been included somewhat arbitrarily, but the intent is to include all breeding marine bird species that primarily inhabit coastal and pelagic waters.

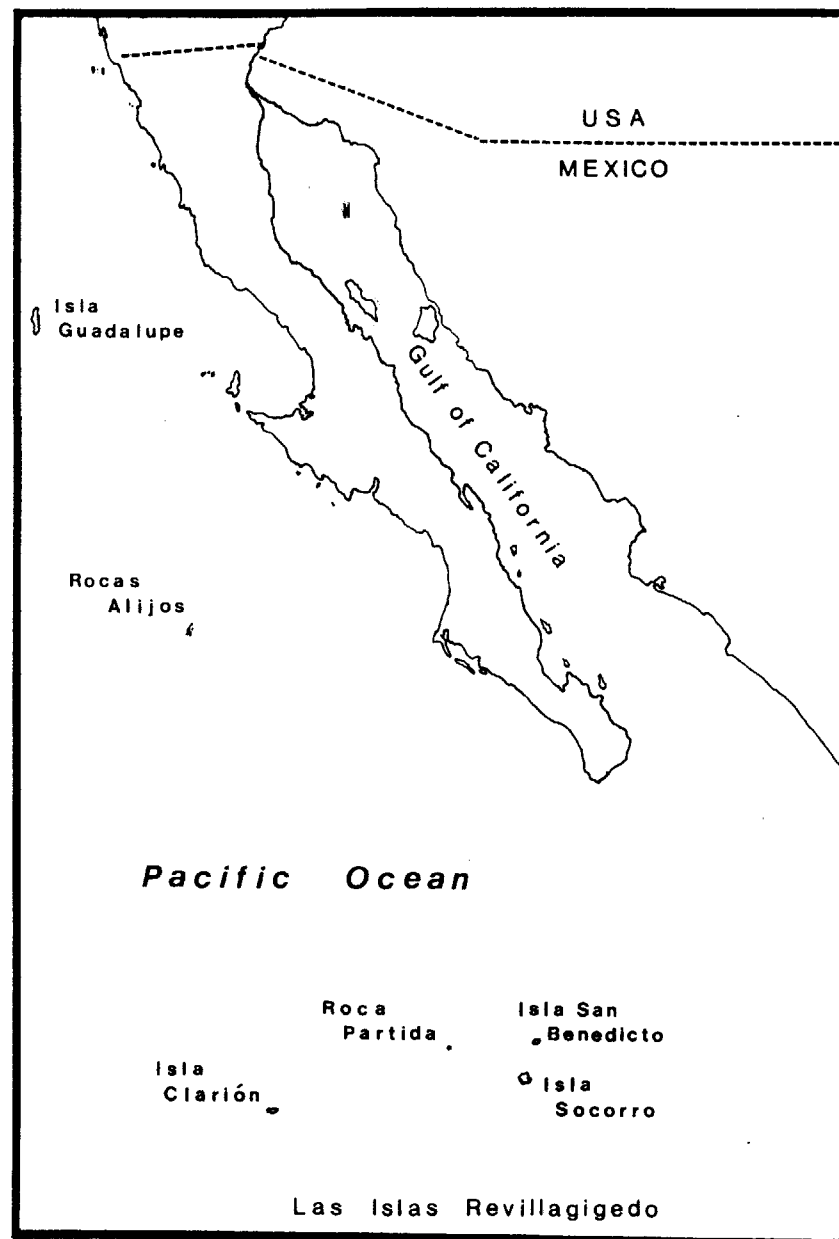


Figure 1: Region discussed in this paper, with offshore Pacific islands.

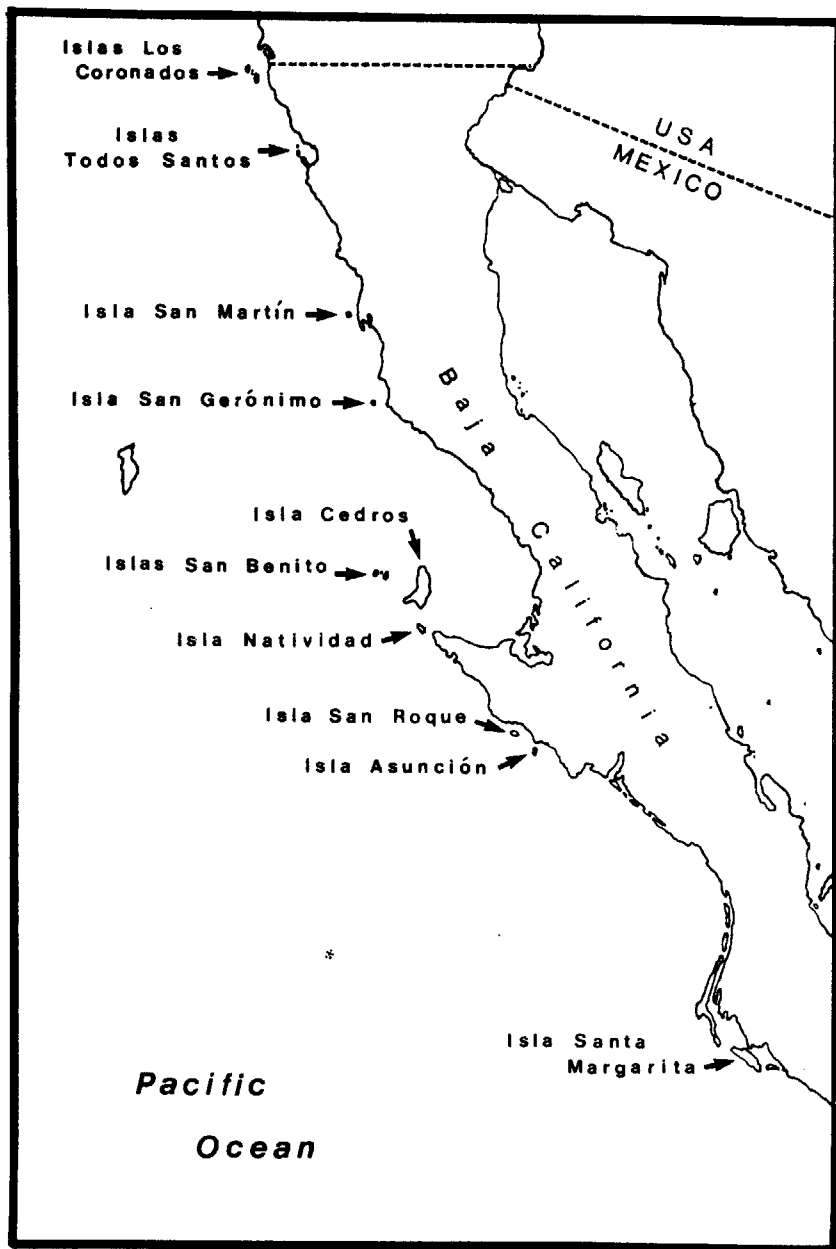


Figure 2: Near-shore Pacific islands discussed in text.

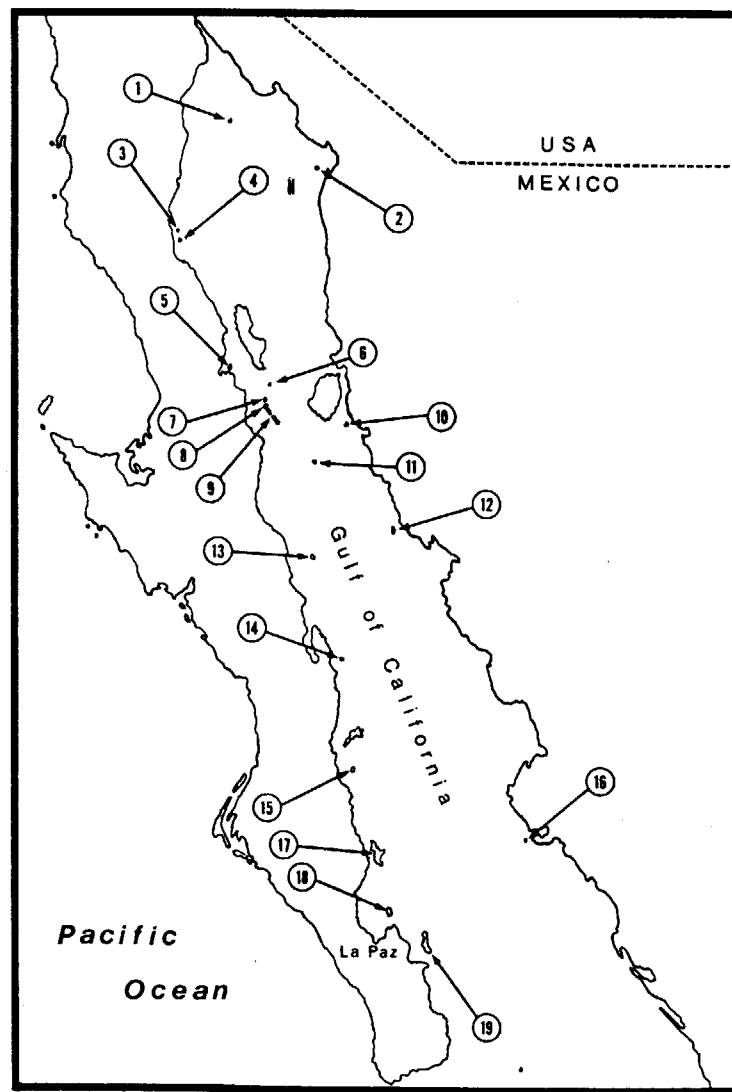


Figure 3: Major seabird breeding islands within the Gulf of California. For locations of sites not indicated here, see Grinnell (1928), van Rossem (1945), Anderson *et al.* (1976), Anderson (1983), and Velarde *et al.* (1985). 1 Roca Consag; 2 George's Island; 3 Isla Cholluda; 4 Isla San Luis; 5 Isla Gemelos; 6 Islas Cardinosa and Little Cardinosa [= Isla Partida]; 7 Isla Raza; 8 Isla Salsipuedes; 9 Islas San Lorenzo Norte and San Lorenzo Sur; 10 Isla Alcatraz; 11 Isla San Pedro Mártir; 12 Isla San Pedro Nolasco; 13 Isla Tortuga; 14 Isla San Ildefonso; 15 Isla Monserrate; 16 Farallón de San Ignacio; 17 Isla San José; 18 Isla Espíritu Santo; 19 Isla Cerralvo.

Information in this paper is derived primarily from literature published after that included in Grinnell (1928), unpublished reports, collections and field notes at the Western Foundation of Vertebrate Zoology (WFVZ) in Los Angeles and the San Diego Natural History Museum (SDNHM), personal communications with knowledgeable observers, and from observations of the authors spanning 20 years at numerous locations in Baja California waters. Seabird ecologists from Mexico and other countries are now active in many parts of the region and the next decade will yield additional data as studies are completed and results published.

SPECIES ACCOUNTS

Laysan Albatross *Diomedea immutabilis*

In May 1986 a small breeding colony of Laysan Albatrosses, consisting of six downy young and attending adults, was discovered at the south end of Isla Guadalupe (Dunlap 1988). The colony is situated atop the cliffs overlooking Melpomene Cove, several hundred meters east of the weather station. The colony was visited again in March 1988, at which time there were five pairs with large downy chicks and a single egg (Oberbauer *et al.* 1989). Six adults, apparently on eggs, were again noted at this colony in November 1989 (E. Palacios pers. comm.). Thirty Laysan Albatrosses were seen on Isla Clarión in February 1988, including two birds on eggs (Howell & Webb 1989). Pitman (1988) reported three birds vigorously displaying on Isla San Benedicto in May 1987. During 9 to 11 February 1988, Howell and Webb (1990) observed 11 to 14 birds, including three displaying pairs, also on San Benedicto. Pitman (1985) also suspected breeding at Rocas Alijos to be forthcoming. These colonies represent a significant expansion of breeding range for the species and the newest addition to the breeding seabird fauna of the region. It appears likely that they will persist and expand in the coming years, assuming these breeding colonies remain adequately protected from disturbance.

Townsend's Shearwater *Puffinus auricularis*

This species breeds only on Las Islas Revillagigedo. They breed on Isla San Benedicto at least until the massive volcanic eruption there in 1952 (Jehl 1982; specimens WFVZ). They currently are known to breed only on Isla Socorro and Isla Clarión. Jehl (1982) estimated the population at Socorro to be approximately 1,000 pairs, but there are no estimates for Isla Clarión. This is clearly the most endangered seabird of the region (see discussion below).

Wedge-tailed Shearwater *Puffinus pacificus*

The only known colony of Wedge-tailed Shearwaters in the region is on Isla San Benedicto in Las Islas Revillagigedo. The colony has never been studied in detail, but in 1978 the number of burrows was estimated to be up to 1,000 (Jehl & Parkes 1982). It is possible that this species will warrant special concern for the region, but more data are needed.

Black-vented Shearwater *Puffinus opisthomelas*

These shearwaters are known to breed only at Isla Guadalupe (Jehl & Everett 1985), Islas San Benito (Boswall 1978), and Isla Natividad (Lamb 1927). They have been reported breeding at several other islands, but these records lack substantiation (Everett 1988b). However, it is possible that small undiscovered colonies persist at other locations, perhaps even in the Gulf of California (Anderson 1983). None of

these outlying colonies, if they exist, likely contains large numbers of birds. There are no historic population estimates, but currently there could be as many as 2,500 pairs at Isla Guadalupe, based on observations (W. T. Everett) of birds staging near the island during the breeding season, 250 to 500 pairs at Islas San Benito, and as many as 5,000 to 10,000 pairs, possibly more, on Isla Natividad (Everett 1988b).

Least Storm Petrel *Halocysterna microsoma*

Off the Pacific coast of Baja California, Least Storm Petrels are currently known to breed only on Islas San Benito. There are two recent estimates of population size for this island group. Crossin (1974) gives a figure of 15,000 total individuals for the three islands, based on surveys in 1968. Boswall (1978) guessed that there were "hundreds, probably thousands" of birds present. This is undoubtedly the most abundant seabird species in the Gulf of California, concentrated most heavily at Cardinosa and Little Cardinosa islands. They probably nest, or have nested, on nearly every small islet (those free of terrestrial predators) from the area of Isla San Luis south to La Paz. There are certainly hundreds of thousands of birds, perhaps millions, but at present we cannot provide a better estimate of the total population size.

Leach's Storm Petrel *Oceanodroma leucorhoa*

A regular breeding species at Islas Los Coronados (Jehl 1977), Islas San Benito (Boswall 1978), and on offshore rocks adjacent to Isla Guadalupe (Jehl & Everett 1985), Leach's Storm Petrel has its southernmost Pacific colonies within our region. A few pairs probably nest at Rocas Alijos (Pitman 1985). The population at Islas Los Coronados was most recently (in 1968) estimated at less than 100 pairs (Crossin 1974). On Islas San Benito, Boswall (1978) considered them to be abundant with "hundreds of thousands, possibly even millions" of breeding birds. A more conservative estimate of 50,000 birds for the island group was made during the Pacific Ocean Biological Survey Program (POBSB) in 1968 (Crossin 1974). At Isla Guadalupe the breeding populations on offshore rocks may exceed 10,000 individuals (DeLong & Crossin MS). Some colonies on the main island may have been destroyed by feral Cats *Felis catus*, but others may persist in inaccessible areas. At Isla Guadalupe there appear to be distinct summer and winter breeding populations of this species, but further detailed study is needed. There has been much debate over the subspecific forms (those at Guadalupe and elsewhere in Baja California) of this polytypic species (Crossin 1974; Ainley 1980; Bourne & Jehl 1982; Ainley 1983; Jehl & Everett 1985; Power & Ainley 1986), based primarily on breeding locale and phenology, morphometrics, voice and variation in coloration. Despite detailed analysis of available collections, the fact remains that for specimens taken at sea, the local races or breeding grounds cannot always be ascertained with complete certainty. This species has been occasionally seen in the Gulf of California (D. W. Anderson pers. obs.), but its status there is unclear. Thorough searches are needed in storm petrel colonies, known or suspected, to determine if the species breeds in the Gulf of California.

Black Storm Petrel *Oceanodroma melania*

Along the Pacific coast of Baja California, Black Storm Petrels are known to breed only on Islas Los Coronados and Islas San Benito. On Los Coronados it is thought to be the most numerous breeding storm petrel, with a population of 200 to 300 birds (Sowls *et al.* 1980; DeLong & Crossin MS). Since 1980, sightings of this species at sea near Los Coronados have steadily declined (W. T. Everett pers. obs.). At Islas San Benito there are two widely divergent recent population estimates.

Crossin (1974) gave a figure of 10,000+ breeding birds for the island group in 1968. Based on observations made in 1975, Boswall (1978) reported that "at a guess the Black Storm Petrel was present on the islands in hundreds of thousands". Although Boswall spent three weeks on the islands, neither he nor Crossin (whose stay was much briefer) provides details on survey effort that would allow critical assessment of their estimates. In the Gulf of California this is probably the second most abundant seabird species, with much the same breeding distribution as the Least Storm Petrel. Again, present knowledge does not allow a precise estimate of population size, but shipboard observations suggest the species is about one-third to one-fifth as abundant as the Least Storm Petrel. For example, from 26 April to 7 May 1982, the overall ratio of Least to Black Storm Petrels observed in transects from La Paz to Isla Salsipuedes was 3.14/1.00, $n = 3,173$ sightings (D. W. Anderson pers. obs.).

Ashy Storm Petrel *Oceanodroma homochroa*

F. Stephens took a specimen of this species (found in a burrow with an egg) from Islas Los Coronados on 20 April 1916 (Huey 1925). There are four specimens in the collection of the San Diego Natural History Museum, taken in a mist net by J. R. Jehl, Jr. at Los Coronados in 1968. According to Jehl (1977), it is a "very rare summer resident" of the islands. Studies currently in progress indicate this species may be more abundant than the 2 to 3 pairs (Crossin 1974; Jehl & Everett 1985) previously suspected. This is apparently the southernmost breeding site of a species that is much more common to the north (AOU 1983).

Guadalupe Storm Petrel *Oceanodroma macrodactyla*

Now considered extinct (AOU 1983), this species' destruction was brought about by feral cats. The last sighting was in August 1912, at the breeding grounds among the pine trees on the high ridge at the north end of Isla Guadalupe. Because no intensive search has been made at the proper season, there is still a very remote possibility that the species persists. For a detailed history see Jehl & Everett (1985).

Red-billed Tropicbird *Phaethon aethereus*

Historical accounts indicate Red-billed Tropicbirds have always been fairly common in Las Islas Revillagigedo (Anthony 1898; Brattstrom & Howell 1956), although documented instances of breeding are few. Jehl & Parkes (1982) reported the probable breeding of up to four pairs in 1981 at Roca Oneal, near Isla Socorro, and the discovery of a nest with a nearly-fledged chick on Isla San Benedicto in 1978. Palmer (1962) reported an egg taken at Isla Clarión on 17 November (year not specified). Up to 20 individuals were investigating cliffs at Isla Clarión in January 1986 (W. T. Everett pers. obs.). After a visit to Las Islas Revillagigedo during February 1988, Howell & Webb (1990) reported 50 to 70 pairs at San Benedicto, 5 to 6 pairs courting and prospecting cliffs at Cabo Pearce on Isla Socorro, two pairs at Roca Oneal, and 40 to 50 pairs at Isla Clarión. The total population at the island group is probably about 100 pairs. Pitman (1985) estimated seven pairs breeding at Rocas Alijos. The population in the Gulf of California consists of 500 to 1,000 pairs. Isla San Pedro Mártir, during some years, hosts up to 250 pairs. At Roca Vela 10 to 15 pairs breed in some years. Grinnell (1928) lists other breeding locations in the Gulf, including Roca Consag, Isla San Luis, Isla Monserrate, and Isla Espíritu Santo. The AOU Check-list (1983) also gives George's Island as a breeding locale. A single egg of this species was collected by E. E.

Sechrist from Isla San Roque, along the west coast of Baja California, on 17 April 1917 (WFVZ).

Red-tailed Tropicbird *Phaethon rubricauda*

Although this species has not been documented as breeding in the region, the observation of 1 to 2 courting pairs at Isla San Benedicto in February 1988 (Howell & Webb 1990) suggests it may soon do so.

Brown Pelican *Pelecanus occidentalis*

In the last few decades, the local race (*P. o. californicus*) of this species has probably received more attention and study than any other breeding seabird of the region. Much of this activity resulted from concern over severe breeding population declines brought about by eggshell thinning caused by organochlorine (DDE) ingestion (Jehl 1973; Anderson *et al.* 1975; Anderson & Gress 1981). Ainley & Hunt (this volume) also speculate that the overharvesting of Sardines *Sardinops caerulea* may have helped contribute to this decline. We doubt that the cause/effect relationship between the Brown Pelican decline and sardine overfishing is as significant as is suggested by those authors (see Anderson & Anderson 1976).

The California Brown Pelican is the most cosmopolitan species of seabird in the region, breeding both to the north and to the south of the area under consideration here, but definitely reaching its maximum abundance and most dense distribution within this region. The U.S. Fish and Wildlife Service (1983) defined four distinguishable populations of breeding California Brown Pelicans: (1) Southern California Bight population, (2) South-west Baja California population, (3) Gulf of California population and (4) the Mexican Mainland population. During the breeding season, the centre of abundance for this species is clearly in the Gulf of California, where an average of about 35,000 pairs nest in typical years (U.S. Fish & Wildlife Service 1983). Colonies are widely distributed, with most occurring on 15 to 20 islands in the north and central portions of the Gulf. Of these islands, significant large colonies are on Isla San Luis and Isla Cholluda, islands in the Puerto Refugio area, the Isla Salsipuedes/Isla San Lorenzo Norte/Isla San Lorenzo Sur island complex, Isla San Pedro Mártir, Isla Tortuga, Isla Cerralvo, an island complex in Bahía del Pabellón, and several offshore islands near Mazatlán. On the Pacific Ocean side of Baja California, large breeding colonies are currently located at Isla Santa Margarita, Islas San Benitos, and Islas Los Coronados. Another significant colony is on Anacapa Island, California (outside our area of coverage). Smaller (less than 1,000 to 2,000 pairs), but no less important, colonies occur throughout the region. At one time or another, California Brown Pelicans probably have bred on all the coastal islands along the Pacific Coast of Baja California; and the same is probably true for Gulf of California populations on islands that were free from human predation (see Anderson & Keith 1980).

A comprehensive California Brown Pelican breeding colony catalogue is now in preparation (Anderson), therefore details are not repeated here. However, since the man-influenced history of California Brown Pelicans has mostly, until now, involved detriment to the pelican colonies of the west coast of Baja California, that portion of the range is of enough immediate interest to warrant a review of the individual statuses of various colonies, for they are apparently much reduced in present numbers compared to historical levels.

Grinnell (1928) characterised Brown Pelicans as an "abundant resident", and Jehl (1973) provided a detailed review of the history and status of most Pacific coast colonies through 1971. Anderson & Gress (1983) provided additional data on the colony at Islas Los Coronados through 1980. The following accounts primarily

contain information not presented in these previous reviews, and they document continuing and acute conservation problems at several breeding sites.

Islas Los Coronados

From 1980 to 1985, the number of active nests on Coronado Norte fluctuated between 220 and 760, with average fledging rates between 1.20 and 1.39 young per active nest (Anderson 1988). In 1986 the colony on Coronado Norte was abandoned, largely due to human disturbance (Anderson 1988), and a new colony was established on Coronado Medio. On 19 April 1986 Everett counted about 250 active nests on Coronado Medio. There are no data on the success of the colony that year, but at the same location on 7 June 1987, Everett counted about 200 nests, half of which were unoccupied. At least 35 downy white juvenile pelicans were seen, along with eight to ten carcasses. Because this visit was late in the season, the actual total number of fledglings is unknown. On 23 April 1988, Everett counted 37 occupied pelican nests on Coronado Norte, all of which were abandoned by the time the colony was visited on 19 June. On Coronado Medio that year, the colony consisted of about 285 active nests on 23 April, with the visit on 19 June revealing about 175 to 250 large young. Signs of significant recovery (see Anderson 1988), therefore, apparently began in 1988.

Islas Todos Santos

We know of no evidence suggesting recent breeding on these islands by Brown Pelicans, although the island is known to have been used in the past. Local fishermen often stay at the camp on the south island, and harvesting of Western Gull *Larus occidentalis* eggs is apparently common (W. T. Everett pers. obs.). Occupied buildings were seen on both islands during an aerial survey on 24 March 1977 (D. W. Anderson), and the only species seen nesting was the Western Gull (about 2,500 nests). Human activities probably prevent reestablishment of a pelican colony, although the island remains a potential site for future colonies, given proper management and protection.

Isla San Martín

Since 1972 few, if any, young have fledged from this historically important Brown Pelican nesting site. Until the late 1960s, this rugged volcanic island supported a large and viable colony. Although disturbance by tourists has been suggested as a major factor in the demise of the colony (Kenyon 1973; Jehl 1973, 1984; Anderson & Keith 1980), equally significant factors also include disruptive activities by egg harvesters, fishermen, and their pet dogs, and feral cats (W. T. Everett pers. obs.). The high degree and variability of man-induced disruptions now make this island a poor prospect for future California Brown Pelican nesting efforts. Although feral cats are not believed to be important predators of nesting Brown Pelicans (Anderson *et al.* 1989), cats on the island probably preclude the establishment of most other smaller species of seabirds.

Islas San Benito

In 1968, DeLong & Crossin (MS) counted 50 old nest platforms on Benito Este, which were unoccupied on 26 June. Jehl (1973) reported on surveys on the islands during the late 1960s and early 1970s, with a maximum of 270 nests counted on 25 May 1971. In addition, Jehl (pers. comm.) estimated 933 (\pm ten per cent) present on Benito Este on 5 April 1974.

Isla Cedros

Jehl (1973) guessed that a colony found in May 1971, high in an arroyo at the north end of the island, consisted of 50 to 100 pairs. During an aerial survey in March 1977 Anderson recorded 150 nests at the same location.

Isla Natividad

In April 1930 D. DeGroot (field notes, WFVZ) observed several hundred pairs of pelicans nesting on this island. On 16 May 1946 Karl Kenyon (pers. comm.) observed a "large pelican colony on peaks one-fifth of the distance from the north-west end of the island". On 7 July 1987 Everett found a small nesting colony near the same area. Up to 40 large downy young were counted, and at least ten adults were still on nests. These observations of nesting on the island in 1987 were based on a limited survey; the actual number of breeding birds present could have been higher. Pelicans have apparently bred at Natividad for many years.

Laguna San Ignacio

In the spring of 1988 a colony consisting of 250 to 300 nests was discovered on Islas Ballena at the upper end of the lagoon (R. Carmona pers. comm.). Breeding was also observed at the same site in 1989 (G. Danemann pers. comm.).

Isla San Roque and Isla Asunción

Pelicans certainly bred on these islands in the past (Anthony 1925; Huey 1927; D. DeGroot field notes WFVZ 1930), but the status of the colonies in recent years is unclear (Jehl 1973). The only recent information is of 250 nests on Isla San Roque, observed by Anderson during an aerial survey in March 1977.

Isla Santa Margarita

During an aerial survey in 1977 Anderson observed 400 nests on the island. On 25 March 1984, 250 pairs were noted at a colony on the north-west coast of the island (Amador 1985). Over 3,000 pairs nested on the island in 1986 and 1987, but none were present in 1988 (J. Guzmán pers. comm.).

In summary, the Pacific coast of the peninsula probably averages around 5,000 breeding pairs during normal years. It is likely that Brown Pelicans regularly shift their colony locations along the Pacific coast and elsewhere, perhaps in response to disturbance (Anderson 1988), ectoparasite infestation (King *et al.* 1977), or changes in abundance or distribution of prey (Anderson & Anderson 1976; Anderson *et al.* 1982; Anderson & Gress 1982). These factors can affect relative annual attendance at regular breeding sites, and can result in highly variable colony attendance patterns from year to year. Yet, overall California Brown Pelican breeding populations in the Gulf of California were essentially the same from 1970 (when long-term studies began) to 1988 (the most recent survey information, D. W. Anderson unpubl. data). On the Pacific Coast of California (in the Southern California Bight [SCB]), breeding populations in adequately protected areas have recovered enough to warrant consideration for reclassification (see *Pacific Seabird Group Bulletin* 14(1), 4). Complete recent data from the SCB area (outside the area of this report, but very relevant to the comprehensive picture) are as yet unpublished, but breeding colonies have shown significant increases in the last decade (Gress & Lewis 1988). The U.S. Fish and Wildlife Service (D. Harlow, Sacramento Endangered Species Office, California, pers. comm.) is currently (1990) proposing to reclassify the California Brown Pelican and upgrade its status from 'endangered' to 'threatened'. A decision is expected by 1991. The California Brown Pelican represents a 'success story' of

endangered species recovery among seabirds in the eastern Pacific that, we hope, will soon be repeated elsewhere for other endangered seabirds.

Blue-footed Booby *Sula nebouxii*

Nelson (1978) characterised the Gulf of California as "far and away the most important area in the world for this species". He reported major breeding islands (based partly on observations of D. W. Anderson) as Isla San Pedro Mártir, George's Island, Isla San Ildefonso, Isla Tortuga, and Farallón de San Ignacio. The species also breeds on Isla Cholluda, Isla San Luis, Roca Vela, Roca Consag, Isla San Pedro Nolasco, and undoubtedly at a number of other sites. Although precise estimates are unavailable, the population in the region is probably in the high tens to low hundreds of thousands (Anderson 1983).

Jehl & Parkes (1982) properly questioned the supposition by Brattstrom & Howell (1956) and Nelson (1978) that this species breeds in Las Islas Revillagigedo. The San Benedicto record specifically referred to by Nelson came from a clutch reportedly collected there in 1939 (WVZ), the identity and date of which were erroneous (E. Harrison pers. comm.).

Masked Booby *Sula dactylatra*

This species is a common breeder on Islas San Benedicto and Clarión. The San Benedicto population has consisted of up to 2,000 pairs (Jehl & Parkes 1982). In February 1988, 585 to 600 pairs were reported at San Benedicto and 380 to 470 pairs at Isla Clarión (Everett 1988a). About 50 pairs nest on Rocas Alijos (Pitman 1985).

Red-footed Booby *Sula sula*

A few small colonies occur on Isla San Benedicto (Jehl & Parkes 1982; Howell & Webb 1990). On Isla Clarión at least 800 occupied nests were counted in January 1986 (Everett 1988a), and 3,010 to 3,210 pairs were present on the island in February 1988 (Howell & Webb 1990). All but a few of these birds were white-phase individuals.

Brown Booby *Sula leucogaster*

Islands along the east side of the Gulf of California are the principal breeding stronghold in the region for this species. Large colonies occur as far north as George's Island, where in some years up to 5,000 pairs breed. Other sizeable colonies have been reported from Isla San Pedro Mártir, Isla San Ildefonso, Farallón de San Ignacio (Nelson 1978), and Isla San Pedro Nolasco (Mailliard 1923). Small colonies are scattered throughout the region. The current total population may be in the tens to hundreds of thousands (Anderson 1983). Although historical data are scant, there is some evidence that the population has declined over the last 75 years (van Rossem 1945). Up to 100 pairs have bred in recent years at Isla San Benedicto and Roca Partida in Las Islas Revillagigedo (Brattstrom & Howell 1956; Jehl & Parkes 1982; Howell & Webb 1990). The population there was apparently much larger (Anthony 1898; E. N. Harrison field notes, WVZ) prior to the massive volcanic eruption of the island in 1952. They have also been reported breeding at nearby Roca Partida (Brattstrom & Howell 1956). There is no published evidence to support the contentions (Nelson 1978; Howell & Webb 1990) that this species breeds or has ever bred at Isla Clarión, although it is not entirely unlikely.

Double-crested Cormorant *Phalacrocorax auritus*

As with Brown Pelicans, colonies of this species at Islas Los Coronados experienced decreases in breeding success due to eggshell thinning during the late 1960s and early 1970s (Gress *et al.* 1973). Not more than 30 pairs have nested there in the last few years (W. T. Everett pers. obs.). At Islas Todos Santos, Everett has seen up to 50 nests with eggs during several visits in the late 1970s and early 1980s. The formerly immense colony at Isla San Martín, reportedly consisting of up to 1,800,000 birds (Wright 1913) is now nearly if not totally abandoned. In both 1987 and 1988, Everett noted up to a dozen recently completed but unoccupied nests on the west side of the island. It appears likely that feral cats, rats, domestic dogs, and possibly also human disturbance, are responsible for the desertions (see above discussion on Brown Pelicans). Kaeding (1905) noted the presence of this species at Isla San Gerónimo in mid-March. His comments suggest nesting was taking place. Karl Kenyon (pers. comm.) recorded 25 nests near the crest of Isla San Gerónimo on 12 April 1946. It is likely they continue to breed there, but in insignificant numbers compared to Brandt's Cormorants. On Isla Cedros, DeLong & Crossin (MS) noted five nests on the cliffs of the eastern shoreline on 23 April 1968, and possible additional nesting in the vicinity of the pelican colony at the north end of the island. E. N. Harrison (field notes, WVZ) recorded a "very large colony" of Double-crested Cormorants on Isla San Benito Este in late May 1932. We are aware of no evidence supporting the unlikely occurrence of this coastal species on Las Islas Revillagigedo. Although this matter was discussed and presumably resolved by Brattstrom & Howell (1956), the species was still reported as breeding by the most recent AOU Check-list (1983). There is also no basis for breeding reports at Isla Guadalupe (see Jehl & Everett 1985), contrary to Palmer (1962).

On Isla Natividad, Double-crested Cormorants have bred for many years; specific references include Lamb (1927) and DeLong & Crossin (MS), the latter estimating 1,000 nests in April 1968, but they saw only 100 nests there in June 1968. During a stay on the island in early July 1987, Everett found several active colonies at the north end, and counted at least 130 nests with eggs. Small colonies have been reported in Laguna Ojo de Liebre (Scammon's Lagoon) (Bancroft 1927). Double-crested Cormorants have also been reported breeding on Isla San Roque, where Townsend (1923) observed "nearly 1,000" on 15 March 1911, and Huey (1927) noted 300 pairs on 27 April 1927. Isla Asunción is also apparently a breeding site (Hanna & Anthony 1923). In the spring of 1988, R. Carmona (pers. comm.) found a colony of 100 to 150 nests on Islas Ballena, in the upper reaches of Laguna San Ignacio. Amador (1985) reported a breeding colony of this species at Isla Santa Margarita, which in February 1986 consisted of 200 active nests. This colony has apparently been active for many years, as D. DeGroot and J. Tyler collected eggs (WVZ) and noted an "immense colony ... thousands of pairs" in late March 1930.

The Gulf of California population of this species is probably in the low tens of thousands (Anderson 1983). Large colonies occur on islands and also in mangrove complexes along the Sonora and Sinaloa coast. Known breeding islands include San Ildefonso, San Luis, Alcatraz, San Pedro Nolasco, Gemelos, San José, and George's Island. This species is easily disturbed at nesting colonies.

Olivaceous Cormorant *Phalacrocorax olivaceus*

This species is assumed to be a resident breeder along the coast of Sonora and Sinaloa, mainland Mexico, but published accounts (van Rossem 1945; Friedmann *et al.* 1950; AOU 1983) provide almost no specific information. Wilbur (1987) reports a single sighting of about 250 birds at Bahía Magdalena in 1982, and Anderson

(unpubl. data) photographed a single bird there in 1977. We know of no other records from Baja California. The status of this species in the region needs investigation.

Brandt's Cormorant *Phalacrocorax penicillatus*

This is the most abundant cormorant in the region, with the vast majority occurring along the Pacific coast of the peninsula. Its status has probably changed little since Grinnell's time, except that there is no longer a large breeding population on Isla San Martín, and the colony at Islas Los Coronados is currently very small, with fewer than 20 pairs (W. T. Everett pers. obs.). A small but apparently stable population breeds at Isla Guadalupe (Jehl & Everett 1985). There are no confirmed reports of breeding on Islas San Benito. Willett (1913) inferred breeding on Isla Cedros, which, although likely, is unsupported by documentation. This species probably breeds on many offshore rocks along the Pacific coast (e.g. Gull Rock in San Cristobal Bay, Friedmann *et al.* 1950) and on mainland cliffs such as those at Cabo Colnett. The southernmost known colony is at the north end of Isla Santa Margarita, where approximately 80 to 100 pairs nested in 1986 and 1987 (J. Guzmán pers. comm.). The major colonies of this species along the Pacific coast of Baja California are still located at Isla San Gerónimo (Jehl 1973), Isla Natividad (W. T. Everett pers. obs.), and Isla Asunción (Wilbur 1987). The Pacific coast population is certainly in the tens of thousands.

Few Brandt's Cormorants breed within the Gulf of California. Although Grinnell (1928) reported only one record of occurrence within the Gulf, this was undoubtedly an oversight. Small colonies are widely scattered, rarely exceeding 250 pairs. The total population for the Gulf is probably no more than 500 to 1,000 pairs. Known breeding sites include: Roca Vela, Isla Salsipuedes, Isla Calaveras (perhaps the largest colony in the Gulf of California in "cold-water" years), Isla San Estaban, Roca Cardinosa, and Isla Smith (D. W. Anderson pers. obs.). As is the case with the Double-crested Cormorant, this species is easily disturbed at breeding colonies. Disturbance occurs regularly in the Gulf; perhaps as a result overall numbers have remained low.

Pelagic Cormorant *Phalacrocorax pelagicus*

A few pairs occasionally breed at Islas Los Coronados (Jehl 1977), and may have bred in the past at Isla San Martín (Wilbur 1987; K. Kenyon pers. comm.). They have been observed much farther south (Grinnell 1928), but no breeding sites other than Islas Los Coronados have been documented. This region represents the extreme southern range limit of the species.

Magnificent Frigatebird *Fregata magnificens*

The only productive colony of Magnificent Frigatebirds along the coast of Baja California is at Isla Santa Margarita, where there is a breeding colony of up to 20,000 pairs (Moreno & Carmona 1988). This colony has long been known (Grinnell 1928). E. N. Harrison collected eggs of this species (WFVZ) from a "large colony" on Isla San Benedicto in 1938 and 1940 (see next account). Howell & Webb (1990) reported two birds on nests at Isla San Benedicto in February 1988. There may be a small breeding population at Isla Socorro, but this has not been confirmed (Jehl & Parkes 1982). We know of no basis for the report by Palmer (1962) of "nesting" at Rocas Alijos. There are several islands in the Gulf of California where breeding activities (but not documented breeding success) have been noted (San Luis, Alcatraz, Cholluda; D. W. Anderson pers. obs.). Large mangrove complexes along the coast of Sinaloa support at least two (and probably

more) colonies, one at Bahía del Pabellón consisting of 10,000 to 20,000 pairs (D. W. Anderson pers. obs.), the other at Bahía Santa María consisting of about 18,000 pairs (R. Carmona pers. comm.). The colony at Pabellón (also containing Brown Pelicans, cormorants, and several species of herons) has been subjected to severe disturbance since a boat canal was dredged near a series of islands in the bay. This colony may be declining as a result, but data confirming this are not available.

Greater Frigatebird *Fregata minor*

The most recent report (Howell & Webb 1990) indicates about 100 pairs currently breed on Isla San Benedicto. Jehl & Parkes (1982) reported about 50 pairs nesting there in 1981. Brattstrom & Howell (1956) estimated a population of over 100 pairs on the island in 1953. Jehl & Parkes (1982) also suggested that this species nests on Roca Partida. The AOU Check-list (1983) gives Isla Clarión as a breeding site, but we know of no published details documenting this. The presence of two species of frigatebirds at Las Islas Revillagigedo was first noted in 1938 by E. N. Harrison (field notes, WFVZ). Since earlier investigators did not distinguish the two species, the relative historical status of Greater and Magnificent Frigatebirds at the islands is problematic. It is noteworthy, however, that all eight frigatebird specimens from the islands in the collection of the California Academy of Sciences (two from Clarión in November 1898, two also from Clarión in April 1925, and two from San Benedicto in May 1925) are all referable to *F. minor* (S. Bailey pers. comm.).

Heermann's Gull *Larus heermanni*

The vast majority of these gulls breed on islands in the Gulf of California (Anderson 1983). The largest colonies are on Isla Raza and nearby Little Cardinosa Island. Another historically important colony is on Isla San Ildefonso (Thayer 1911a). Boswall & Barrett (1978) provided the most recent detailed published data on the Isla Raza colony. They summarised historic accounts of breeding populations (which vary from year to year) ranging from 12,000 to 800,000 pairs. In recent years the colony appears to be stabilised at around 150,000 to 200,000 pairs (E. Velarde pers. comm.). Additional smaller colonies (200 to 300 pairs) currently exist at several other locations throughout the entire length of the Gulf. There are insufficient data to estimate the population as a whole, but it is certainly in the mid-to-high hundreds of thousands. Two small colonies have been reported from the Pacific coast of Baja California; Isla San Roque, where Huey (1927) found 35 pairs in 1927, and Islas San Benito, where Jehl (1976) found a small number of breeding birds in 1971 and 1974. Boswall (1978) found the San Benito colony still active in 1975. The report of breeding at Las Islas Revillagigedo (Friedmann *et al.* 1950) is clearly erroneous (see Brattstrom & Howell 1956).

Yellow-footed Gull *Larus livens*

This species breeds throughout the Gulf of California at many locations, but known colonies of more than 100 pairs are few. A rough estimate (Anderson 1983) suggests the total population consists of somewhere between 10,000 to 20,000 pairs. McCaskie (1983) has provided the most recent published review of extralimital occurrences, and Spear & Anderson (1989) provide and review additional information on breeding biology and predation. The report of occurrence on Las Islas Revillagigedo, given under this taxon by Friedman *et al.* (1950), is unsubstantiated.

Western Gull *Larus occidentalis*

Along the Pacific coast of Baja California this is the most ubiquitous marine bird, breeding on virtually every coastal island, just as the Yellow-footed Gull is "typical" of the Gulf of California. They have bred on islands in Laguna Ojo de Liebre (Bancroft 1927) and Laguna San Ignacio (R. Carmona pers. comm.), and probably breed in small groups at many additional locations along the coast. A small and possibly distinct population breeds on Isla Guadalupe (Hubbs 1960; Jehl & Everett 1985). They are abundant on Islas Los Coronados, Islas Todos Santos, Isla San Martín, and Isla Natividad (W. T. Everett pers. obs.). Boswall (1978) reported hundreds, possibly thousands, of pairs nesting at Islas San Benito in 1975. They have been reported as abundant at Isla San Roque (Huey 1927), and are probably equally common on Isla Asunción (Bancroft 1932). There is a colony of at least 200 pairs at Isla Santa Margarita (Amador 1985), probably the southernmost major breeding site of this species. The breeding population of Western Gulls in Baja California is probably at least 30,000 to 40,000 pairs.

Gull-billed Tern *Gelochelidon nilotica*

There is one "possible" record of this species breeding on Isla Montague, at the mouth of the Colorado River (Friedmann *et al.* 1950), and there are suspicions that it breeds elsewhere in the region (van Rossem 1945; AOU 1983). It is unlikely that the population of this species is locally very large, if extant, but investigation is needed.

Caspian Tern *Sterna caspia*

The only known breeding colony in the region is at Laguna Ojo de Liebre. First reported by Bancroft (1927), the colony of about 20 pairs is apparently stable, because it was still active in 1975 (M. Evans pers. comm.).

Sooty Tern *Sterna fuscata*

A "large colony" was reported on Roca Oneal, off the north-west coast of Isla Socorro, in 1897 by Anthony (1898) and in 1905 by Slevin (1931). There are no additional breeding data from there, but birds have been observed in the vicinity in recent years (Jehl & Parkes 1982). Howell & Webb (1990) recorded 40 to 50 adults at Roca Partida, including two to three "probably" on eggs and several displaying, on 18 February 1988. On this basis, and the report by McLellan (1926) that Partida was "evidently a breeding ground" (because a specimen in juvenile plumage was collected there), Howell & Webb (1990) assume breeding at this site, but this must still remain conjectural. Actual breeding at Roca Partida is still unconfirmed. About 250 pairs breed at Rocas Alijos (Pitman 1985).

Least Tern *Sterna antillarum*

The California race *S. a. browni* has been reported breeding at the Estero de Punta Banda in Bahía de Todos Santos (Escofet *et al.* 1988), Bahía San Quintín, Laguna Manuela, Laguna Ojo de Liebre, and San José del Cabo (Massey 1977; Wilbur 1987). Other colonies were recently discovered at Isla Santa Margarita (Palacios 1988), the Bay of La Paz (E. Palacios pers. comm.) and Laguna Percebé (Carvacho *et al.* 1989). A few hundred pairs are known to breed in Baja California, but many potential breeding sites have not been investigated, and the population could be much larger.

Royal Tern *Sterna maxima*

Within the Gulf of California, Isla Raza has the largest colony of this species. Boswall & Barrett (1978) estimated the population in 1975 at up to 5,200 pairs. As

with many seabirds in the Gulf, numbers of breeding pairs vary from year to year. An average breeding population on Isla Raza may be between 8,000 to 10,000 pairs. Elsewhere in the Gulf, they have nested on George's Island (van Rossem 1945), and may nest at several other locations. No estimates are available on the size of the population in the region as a whole. These terns are commonly seen off the Pacific coast of the peninsula, but have been confirmed breeding only at Laguna Ojo de Liebre (Bancroft 1927; Kenyon 1947), Isla San Roque (Bancroft 1927), and on Islas Ballena in Laguna San Ignacio (R. Carmona pers. comm.).

Elegant Tern *Sterna elegans*

The vast majority (perhaps at times 90 to 95 per cent of the world's population) of these nearly endemic terns nest on Isla Raza in the Gulf of California. Boswall & Barrett (1978) estimated between 4,700 and 7,800 breeding pairs during their investigations in 1975. They also reviewed the historical reports for the island and quoted figures between 6,000 and 200,000 pairs. The current population is probably about 80,000 pairs (Anderson 1983). Elegant Terns have also nested at a few other locales within the Gulf, including George's Island (van Rossem 1945) and Isla Cerralvo (Thayer 1911b). On the Pacific side of the peninsula, they have nested in small colonies at Laguna Ojo de Liebre and Isla San Roque. Anthony (1925) alluded to nesting on Isla Asunción. For these sites, we know of no data more recent than those summarised by Grinnell (1928).

Brown Noddy *Anous stolidus*

Anthony (1989) reported "a large colony" at Roca Oneal. The species is usually present at Roca Partida (R. Pitman pers. comm.), but breeding (as reported by Brattstrom & Howell 1956) has apparently not been confirmed.

Xanthus's Murrelet *Endomychura hypoleuca*

These alcids breed on most of the offshore islands of the Pacific coast of Baja California, with centres of abundance in the region at Isla Guadalupe and possibly Islas San Benito. Up to 2,400 pairs breed at Isla Guadalupe (Jehl & Everett 1985). There are no additional population estimates for Baja California. The distribution and taxonomy of Xanthus's Murrelet was most recently summarised by Jehl & Bond (1975).

Craveri's Murrelet *Endomychura craveri*

Craveri's Murrelets breed on numerous islands throughout the Gulf of California (DeWeese & Anderson 1976). The nesting locations are so scattered, and the birds so secretive, that it is extremely difficult to determine the population size. Our best estimate is that there may be as many as 5,000 pairs in the Gulf. A few birds have been seen during the breeding season on the Pacific coast of the peninsula at Bahía Magdalena and near islands from there north to Islas San Benito (Jehl & Bond 1975; DeWeese & Anderson 1976). Jehl observed a pair with half-grown chicks in Bahía de Ballenas on 19 May 1976 (Wilbur 1987), which is the strongest evidence to date of breeding along the Pacific coast. The possibility of this species breeding sympatrically at Islas San Benito with both races of Xanthus's Murrelet (Jehl & Bond 1975) certainly deserves study.

Cassin's Auklet *Ptychoramphus aleuticus*

These auklets are abundant at the following locations: Isla San Gerónimo, Islas San Benito, Isla San Roque, and Isla Asunción. Grinnell (1928) also reported additional smaller breeding localities. Recent data indicate the population at Isla Guadalupe

consists of up to 200 pairs (Jehl & Everett 1985). The current overall breeding status of the species at Islas Los Coronados is unclear, but recent observations of adults and eggs in burrows, and one large downy young (W. T. Everett pers. obs. 1989) suggest the reestablishment of a colony considered by Jehl (1977) to be abandoned. There are two sets of eggs of this species in the WFVZ collection from Isla San Martín. Presumably these provide the basis for breeding reports given by Kaeding (1905) and Friedman *et al.* (1950). There are also two specimens in the San Diego Natural History Museum with the island given as the locality of collection, but there are no field notes or additional data indicating whether the birds were actually collected on the island or nearby at sea. Regardless of its former status, the species has most likely been extirpated from Isla San Martín. Although Kaeding (1905) reported breeding on Isla Cedros, a single egg collected (WFVZ) on a small offshore islet by G. Willett in 1912 is the only supporting evidence we found for breeding there. There are also apparently few data substantiating Kaeding's report that they are (or were) "abundant" on Isla Natividad. This extremely widespread species has its southernmost limit of breeding and distribution within the region.

POPULATION TRENDS

Because most of the historic accounts are incomplete and anecdotal, and some smaller breeding colonies were quite likely overlooked, it is usually difficult to say with certainty what changes in marine bird populations have taken place in recent times. The extinction of the Guadalupe Storm Petrel and establishment of Laysan Albatross are obvious. Natural cycles of breeding success and failure are common in most seabirds (Ainley *et al.* 1989), and for some species shifting of colony location also occurs with regularity (Myres 1979). However, the abandonment of Isla San Martín as a major colony site for Brown Pelicans and Double-crested Cormorants probably represents a significant change from historic times. It is also well-documented that pesticide-related eggshell-thinning led to the decline of breeding colonies of Brown Pelicans and Double-crested Cormorants along the northwest coast of Baja California in the 1960s and 1970s (Gress *et al.* 1975). Fortunately, this specific problem has been reduced to the point where some formerly devastated pelican colonies have now made a strong recovery towards former levels of abundance.

THREATS TO SEABIRDS OF THE REGION

Direct exploitation

Along the Pacific coast of Baja California, collecting of eggs for commercial purposes has been documented at Islas Todos Santos, Islas Los Coronados (Western Gull, W. T. Everett pers. obs.) and Isla Santa Margarita (Brown Pelican, J. Guzmán pers. comm.), and probably occurs at other locales. Within the Gulf of California eggging also takes place, primarily at colonies of terns, pelicans, and gulls (Bahre 1983). Historically, it was the major reason for population declines of several species and the reason one local sanctuary (Isla Raza) was established (Anderson *et al.* 1976; Anderson & Keith 1980; Velarde *et al.* 1985). Intrusion into larger colonies still occurs and can result in destruction far greater than the impact of the removal of a small number of eggs. There should be stringent penalties for any eggging in the region.

Incidental take

Within the last five years a coastal gill-net fishery has been developed and expanded on both sides of the peninsula. No data are available on related seabird mortality, but breeding species that could be affected include the Black-vented Shearwater, Brandt's and Double-crested Cormorants, and possibly Cassin's Auklets, Craveri's and Xanthus's Murrelets. Similar species have suffered from comparable fishing operations conducted elsewhere (Atkins & Heneman 1987). In addition, migratory species (shearwaters, loons, grebes, diving ducks, etc.) could also be killed in gill-net fisheries.

Competition with commercial fisheries

Although there is no direct evidence for declining bird populations in the region as a result of overfishing, there may be cause for concern in the Gulf of California. Extensive purse-seine operations for sardines *Sardinops* ssp. and Japanese long-line fishing are taking unprecedented amounts of fish, exploiting different trophic levels simultaneously (Anderson *et al.* 1976). A formerly large shark fishery has virtually collapsed, and many local fishermen have turned to gill-net fishing for rays in its place. Unfortunately, there are few baseline data upon which to predict the impacts of current levels of exploitation, or even data documenting the current levels of fishery harvest.

Pollution and poisoning

Reduced seabird breeding success resulting from pesticide pollution, primarily affecting the northwest segment of the region under consideration here, has been discussed above in the account of the California Brown Pelican. Additional information can be found in Anderson *et al.* (1976). To summarise, at present there are no known serious threats to seabird populations in the region as a result of pollution or poisoning. Increasing shipping traffic in the Gulf of California enhances the risk of oil spills, which could cause significant damage in some areas. Agricultural runoff from farm lands along the coast of Sinaloa could be a source of pesticides in the lower Gulf, but the absence of sampling data precludes any current assessment of this potential problem.

Disturbance and habitat destruction

Human disturbance has often been cited as a reason for reproductive failures at several important colonies within the region (Kenyon 1973; Jehl 1973, 1984; Anderson & Keith 1980; Anderson 1988). The most susceptible species are the Brown Pelican, Double-crested Cormorant, and Brandt's Cormorant, whose eggs or small chicks are often consumed by gulls when parents are flushed from nests. Even Yellow-footed Gulls have experienced negative impacts resulting from intrusions of eggers, tourists, and researchers (Hand 1980). Transient fishermen also occasionally cause disturbance by their presence at breeding colonies (D. W. Anderson pers. obs.). Development of housing and recreational facilities at tidal estuaries currently poses a threat to Least Tern colonies near Ensenada (Escofet *et al.* 1988) and San Quintín. Disruption by off-road vehicles has adversely affected Least Tern colonies at San Quintín (D. W. Anderson pers. obs.), in the Bay of La Paz (J. Guzmán pers. comm.), and at Laguna Percebú (Carvacho *et al.* 1989).

Predators

As noted by Jehl (1984), feral cats pose potential and real threats to many seabirds of the region. They are the apparent cause of the disappearance of the Guadalupe Storm Petrel, and are well established and preying on seabirds on many other

islands. They could extirpate Townsend's Shearwater from Isla Socorro. Feral cats occur at all the major breeding islands of the Black-vented Shearwater (Everett 1988b). Fortunately, cats apparently do not usually represent a serious threat to Brown Pelicans (Anderson *et al.* 1989). Introduced Black and Brown Rats *Rattus rattus* and *R. norvegicus* are present on many of the islands noted in this paper. Although their destructive potential is well-known from other regions (Moors & Atkinson 1984), we know of no reports of serious predation from the area covered in this paper. Sometime shortly after 1979, domestic pigs *Sus scrofa* were introduced to Isla Clarión (Everett 1988a). This unfortunate event, coupled with the impact of cat predation on Isla Socorro, poses a serious threat to the survival of Townsend's Shearwater in the not distant future. Pigs have been known to dig seabirds from their burrows (Harris 1970; Rudge 1976; Moors & Atkinson 1984), and have apparently done so on Isla Clarión (Howell & Webb 1990).

CONSERVATION ACTION AND REQUIREMENTS

Existing programmes

In 1964 Isla Raza was declared a National Reserve and Refuge of Migratory Birds by the Mexican government (Anderson *et al.* 1976). This important step prohibited commercial eggging and eventually led to the stationing of personnel to protect the island's breeding colonies. Enforcement is intermittent due to funding inconsistencies, and disturbance from tourists and curiosity-seekers remains a threat. Detailed histories of conservation efforts on Raza have been presented by Anderson *et al.* (1976), Villa-Ramírez (1976), Anderson & Keith (1980), and Velarde *et al.* (1985). Due in large part to the results of an international conference on the Gulf of California held in 1976 (see series of papers in *Natural Resources Journal* vol. 16, 1976), Mexican President López Portillo in 1978 declared 47 islands in the Gulf as wildlife refuges. This has set the stage for management of the islands and enforcement of protective measures, which still need to be implemented on a broad scale in all offshore waters of Baja California and Western Mexico.

Present and future requirements

SURVEY. Many areas in the region need to be carefully surveyed and censused. Annual counts at major seabird colonies are desirable, and would provide much-needed baseline data. A seabird colony catalogue would be an excellent and much-needed step towards assembling these data. In lieu of this, the most important immediate needs are for an accurate census of breeding Townsend's Shearwaters, mapping and census of tern colonies along both sides of the peninsula, a census of Black-vented Shearwaters and storm petrels on Islas San Benito, and a census of the Black-vented Shearwater colony at Isla Natividad. Continued monitoring of Brown Pelican colonies (in progress at Islas Los Coronados and selected colonies in the Gulf of California) is also highly desirable.

RESEARCH. Applied research is needed to assess the impact of introduced predators on seabird breeding success and to determine management requirements, especially on Las Islas Revillagigedo and Isla Natividad. Long-term studies of primary productivity and fisheries in the Gulf of California are badly needed, and may indirectly shed light on seabird population fluctuations in the region. Studies of seabird feeding habits and preferred foraging areas are essential for effective management. Gill-netting operations should be monitored by an observer

programme to determine the level of incidental seabird mortality. A long-term pollutant-monitoring programme should also be initiated in the Gulf of California.

DIRECT ACTION. A most critically needed conservation action for the region is the eradication of pigs on Isla Clarión. With the cooperation of the Mexican government this could be accomplished with relative ease and minimal expense. Clarión is small (c.8 km²), and the terrain and vegetation are not too difficult to accommodate a shooting operation. In 1986 the pigs were estimated to number up to 1,000 (Everett 1988a). Unless the situation has changed dramatically, a shooting operation of 10 to 14 days in duration would be sufficient to eradicate most if not all the pigs. This programme should be initiated as soon as possible.

Within the Gulf of California, enforcement of existing regulations and active management of all marine resources are long overdue. Monitoring and regulating fisheries are an integral part of any conservation plan for the region. Numerous specific ideas for education of tourists, locals, and fishermen have been proposed (Pacific Seabird Group 1974; Anderson *et al.* 1976; Anderson & Keith 1980) and only await funding and implementation. For the most valuable and vulnerable islands, access needs to be strictly limited and enforced. A seasonal warden on patrol, with the power to issue fines, seems to be the most effective means to accomplish these goals. A system of regulation similar to that employed in the Galápagos Islands could work well here. A modest licence fee for tourist vessels and passengers could help defray the costs of such a programme. Licensing, and the threat of suspension for violations, also provides additional incentive for tourist vessels to adhere to regulations.

Along the Pacific coast of the peninsula, most islands should be declared as wildlife sanctuaries. This could be compatible with tourist and fishery operations, provided development is limited and effective education and restrictive measures are taken. The value of tourism to the Mexican economy increases yearly, so preservation of natural resources will ultimately provide great and lasting direct benefits.

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