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Seabird Colonies of the Small Islands of Bahía Santa María-La Reforma, Sinaloa, México

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Abstract.—During the 2010-2011 and 2011-2012 breeding seasons (November to June), there were 21 colonies of 13 species, with at least 40,000 to 50,000 pairs of seabirds on six islands of Bahía Santa María-La Reforma in Mexico. Bahía Santa María maintains the largest breeding congregation of the west coast of Mexico for Laughing Gull (*Leucophaeus atricilla*; 22,000 pairs), Royal Tern (*Thalasseus maximus*; 11,000 pairs) and Black Skimmer (*Rynchops niger*; 1,500 pairs). In the past decade, most of the species that breed on El Rancho Island (coastal dune habitat) have increased their population size, apparently related to a combination of factors such as colonies recently established (and hence still expanding) and increased habitat availability. On the other hand, species breeding on islands with mangroves seem to be decreasing (in particular the Brown Pelican (*Pelecanus occidentalis*) population), but with no obvious reason to explain these low numbers of some species. Despite the small size of the islands used by breeding seabirds, this coastal system supports important seabird populations and its conservation should be a priority. *Received 12 May 2014, accepted 9 July 2014.*

Key words.—colony size, Gulf of California, monitoring, population trend, seabirds.

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The populations of seabirds have deteriorated rapidly in recent decades; almost 50% of them are known or suspected to have suffered population declines, and 28% are listed in a risk category (Croxall *et al.* 2012). The monitoring of seabird populations is a conservation priority (Croxall *et al.* 2012) because information is needed to prioritize and manage the risks arising from marine ecosystem degradation, which is a critical component in the management of marine protected areas (Šúr *et al.* 2013).

At least 35 seabird species breed in the Gulf of California (Everett and Anderson 1991; Velarde *et al.* 2005). However, information about their population status and trends is scarce. There have been efforts to assess the population size of some species throughout their range in Mexico (e.g., Brown Pelicans (*Pelecanus occidentalis*); Anderson *et al.* 2013). However, there are no long-term monitoring programs. In particular, in the Bahía Santa María-La Reforma (BSM), there have been population estimates for some seabird colonies since the late 1970s, but without a long-term monitoring effort (Knoder *et al.* 1980; Carmona and Danemann 1994; Anderson *et al.* 2013).

The objectives of this work were to compile an updated list of seabird species and the number of their breeding pairs (colony size) in BSM. Moreover, in compiling the data and information available, we were able to identify initial population trends for some of the breeding seabird species in BSM.

Methods

Study Area

The BSM (24° 70′ to 25° 30′ N, 107° 90′ to 108° 40′ W) is the largest coastal wetland in Sinaloa (583 km^2; Fig. 1), with 107 islands and islets on which three types of vegetation cover predominate: coastal dunes, mangrove forest, and thorny scrub. Seabird colonies were found on two islands with coastal dune vegetation (El Rancho and Melendres) and four with mangrove forest (El Mero, Pájaros, Tunitas, and El Salero; Fig. 1).

Survey Methods

We searched for seabird colonies between December and May of the 2010-2011 and 2011-2012 breeding seasons throughout the BSM (two times per month). Once seabird colonies had been detected,

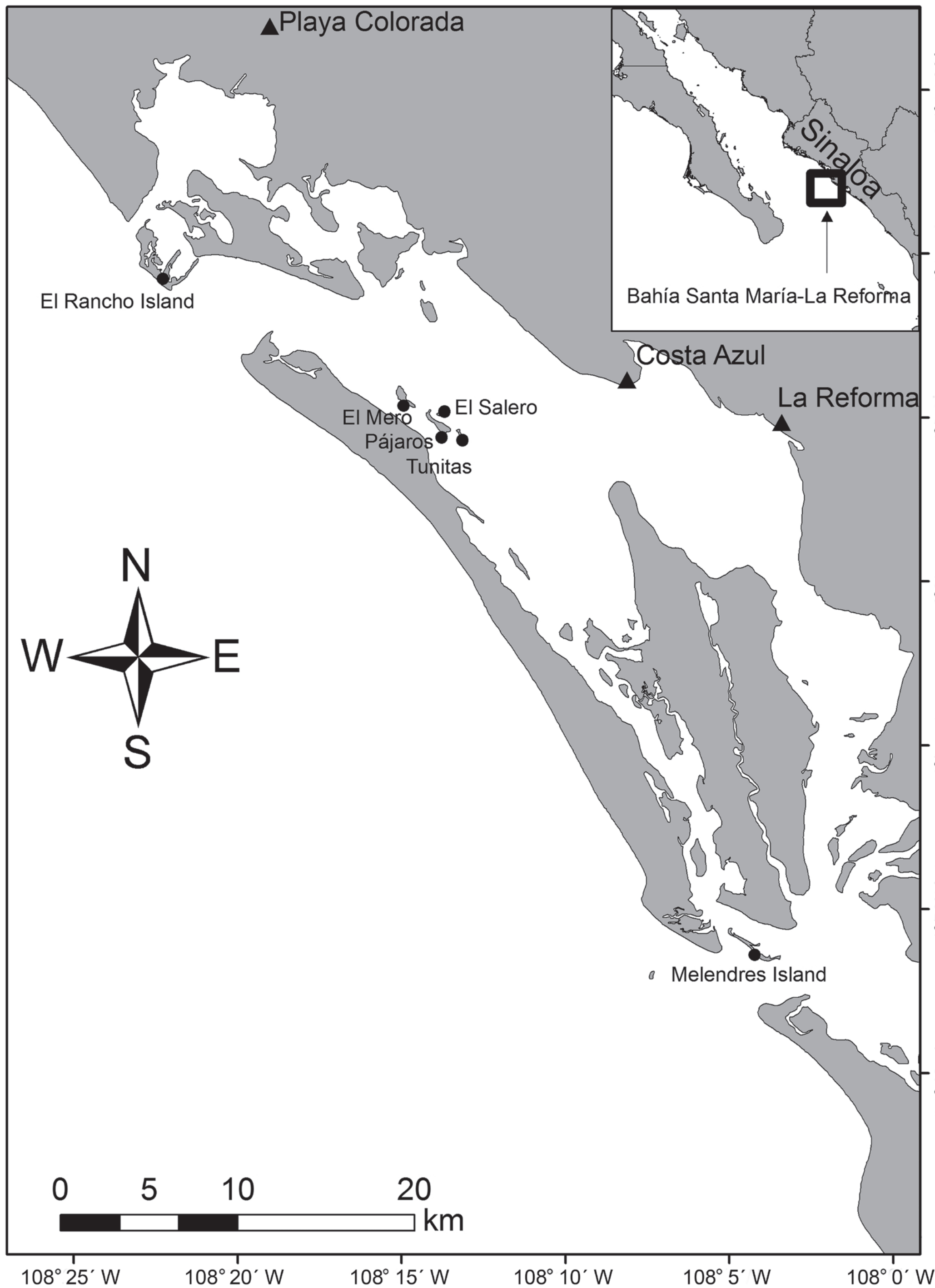

Figure 1. Bahía de Santa María-La Reforma, Sinaloa, Mexico. Islands monitored for seabird colonies during the breeding seasons of 2010-2011 and 2011-2012 are indicated.

we recorded the species composition, location and size (number of nests) for each species between January and June. The surveys in the seabird colonies were conducted at the beginning of the breeding season, after the individuals were settled on the nest to incubate eggs.

We used different nest survey techniques depending on the seabird species. The total number of nests for each species was used as an estimate of the minimum number of breeding pairs for that season. For Royal (*Thalasseus maximus*) and Elegant (*T. elegans*) tern colonies, we calculated the number of nests by averaging the nest estimates made by four different observers on two visits during the incubation period; observations were made at a distance of approximately 30 m. The colony of Magnificent Frigatebird (*Fregata magnificens*) was settled into a dense mangrove area. Because limited visibility complicated estimation of colony size, we used the average nest density at random points (22 points in total). At each point, we considered a radius of 5 m (78.5 m^2) and all nests within that area were counted. The area of the colony was defined in terms of the extreme outer nests, and with the average nest density we estimated the total number of nests in the colony. For the rest of the seabird species, we directly counted the total number of nests. For ground-nesting species, we used binoculars or spotting scopes from a high vantage point that allowed the entire colony to be viewed. Large colonies were divided into "sections" using natural landmarks.

Population Trends

We used field notes and previously published information about breeding seabirds within BSM. Field notes included data collected since 2003 on Isla El Rancho following the same method and with similar effort in all years. Published information, including reports, thesis, and papers with heterogeneous sampling dates and methods, comprised data from several islands of BSM since the late 1970s (see Tables 2 and 3). Population trends were estimated only for the seabird species that breed on El Rancho Island. We evaluated trends for the past decade using the number of nests counted or estimated for each species against years and using a linear or quadratic regression line. Slopes that were significantly different than zero (F-tests) were considered a trend. Slope value indicates the rate of annual increase or decrease of each species. Analyses were carried out with Statistica (StatSoft 2005).

Results

During the breeding seasons of 2010-2011 and 2011-2012, we detected 21 seabird colonies (20 colonies in 2010-2011 and 21 in 2011-2012) with 12 and 13 species, respectively (Table 1). The most important islands for seabird colonies were El Rancho, El Mero, Pájaros, and Melendres. The colonies started settling in winter (November-December) and remained until May. We estimated 40,000 and 50,000 breeding pairs in BSM in the respective seasons (Table 1). El Rancho

Table 1. Colony sizes (average number of nests ± SE) of seabirds breeding in Bahía Santa María-La Reforma, Sinaloa, Mexico, from January to June 2011 and 2012. In parenthesis: number of surveys. Categories in Mexican Endangered Species Act (NOM) also indicated. NOM categories: Pr = Special Protection; A = Threatened; IUCN (International Union for Conservation of Nature) category: NT = Near Threatened.

Species	Colony	Nests 2011	Nests 2012	Month of Egg Laying	NOM/IUCN
Magnificent Frigatebird	Pájaros	8,294 ± 3,066[1] (22)	Presence[2]	Dec-Mar	
Blue-footed Booby	El Rancho	2,976 ± 493 (6)	3,490 ± 440 (4)	Dec-Jan	Pr
Double-crested Cormorant	El Mero	683 ± 44 (2)	1,094 (1)	Dec-Jan	
Double-crested Cormorant	Pájaros	1,626 (1)	2,389 (1)	Dec-Jan	
Brown Pelican	El Mero	289 ± 159 (3)	1,895 ± 159 (3)	Jan	A
Brown Pelican	Pájaros	88 ± 12 (2)	120 ± 12 (2)	Jan	A
Laughing Gull	El Rancho	10,360 (1)	20,293 (1)	May	
Laughing Gull	Melendres	1,650 (1)	2,430 (1)	May	
Heermann's Gull	El Rancho	9 ± 0 (4)	17 ± 0 (4)	Apr	Pr/NT
Western Gull	El Rancho	5 (1)	7 (1)	Apr	
Least Tern	Melendres	48 (1)	7 ± 0 (3)	May	Pr
Least Tern	El Rancho	0	28 ± 0 (2)	May	Pr
Gull-billed Tern	El Rancho	18 ± 0 (5)	55 ± 0 (3)	Apr-May	
Caspian Tern	El Rancho	0	2 ± 0 (3)	May	
Royal Tern	El Rancho	9,059 ± 1,966 (8)	7,920 ± 180 (2)	Mar-Apr	
Royal Tern	Melendres	2,250 (1)	1,016 ± 12 (3)	Mar-Apr	
Elegant Tern	El Rancho	1,000-2,000 (1)	800-1,200 (1)	Mar-Apr	Pr/NT
Black Skimmer	El Rancho	26 ± 0 (2)	250 (1)	May	
Black Skimmer	Melendres	1,200-1,500 (1)	220 (1)	May	

[1]Estimate based on average nest density of random point counts.
[2]No survey, but presence was reported.

Island was the most important breeding site, with ~23,000 pairs of eight species in 2011, and ~36,000 pairs of 10 species in 2012. The colonies formed on the same island and location consistently, except for the Least Tern (*Sternula antillarum*) and Caspian Tern (*Hydroprogne caspia*), which both had few nests (28 and 2, respectively) and only in 2012.

Population Trends

In the absence of historical records, long-term population trends are unknown, but with the information available we estimated trends for the past decade for some species at El Rancho Island (Table 2). The number of species breeding on this island increased from five to 10 species between 2000 and 2012 (Table 2). Of these species, seven had increased their breeding population on the island and two species showed no change (Table 2). The highest annual population growth rate on the island was shown by Laughing Gull (*Leucophaeus atricilla*), Royal Tern, Blue-footed Booby (*Sula nebouxii*) and Elegant Tern (Table 2). For Melendres Island, information was limited. In 2000, there were nests of Laughing Gull ($n = 100$), Royal Tern ($n = 50$), and Black Skimmer (*Rynchops niger*, $n = 75$) (Del Viejo *et al.* 2004). In the 2011 and 2012 breeding seasons, the numbers of nests for these species were considerably higher (Table 1).

There was less information available for the islands with mangrove forest. The first survey was conducted about 40 years ago and, although the species recorded then have been the same in subsequent counts (late 1980s and between 2004 and 2012), the estimated number of nests has changed markedly (Table 3). Differences in survey methods and dates hinder interpretation of the data in the long term. However, for the Brown Pelican, population size in 2011 was estimated at a record low and the magnitude of the difference may indicate a severe downward trend (Table 3).

DISCUSSION

Seabird colonies were located on only six of the 107 islands and islets in BSM. Our

Table 2. Number of nests estimated at the seabird colonies on El Rancho Island, Bahía Santa María-La Reforma, Sinaloa, Mexico, from the 2000 to 2012 breeding seasons. Pres = presence, without population estimate. Population trend indicated as: I = increasing, NT = no trend. Regression values under species name are slope and r^2.

		Year										
Species		2000	2001	2002	2003	2004	2005	2006	2007	2010	2011	2012
Blue-footed Booby	(I) slope = 276, $r^2 = 0.92$	150[1]	450[1]	370[1]	400[6]	500[6]	Pres[6]	1,000[6]	1,500[6]	Pres[6]	2,976	3,490
Laughing Gull	(I) slope = 274, $r^2 = 0.82$	6,300[1]	9,000[1]	4,500[1]	3,000[6]	Pres[6]	—	4,000[6]	6,000[4]	Pres[6]	10,360	20,293
Heermann's Gull	(I) slope = 1.74, $r^2 = 0.88$	—	—	—	0[6]	0[6]	—	2[6]	4[6]	Pres[6]	9	17
Western Gull	(I) slope = 0.29, $r^2 = 0.65$	—	4[3]	3[3]	2[3]	4[6]	—	5[6]	Pres[6]	Pres[6]	5	7
Least Tern	(NT) slope = -1.5, $r^2 = 0.04$	—	—	85[1]	0[6]	0[6]	—	0[6]	0[6]	25[6]	0	35
Gull-billed Tern	(I) slope = 2.3, $r^2 = 0.43$	5[2]	23[2]	5[2]	15[2]	5[2]	2[2]	20[6]	Pres[6]	23[6]	18	55
Caspian Tern		—	—	—	0[6]	0[6]	—	0[6]	0[6]	1[6]	0	2
Royal Tern	(I) slope = 670, $r^2 = 0.84$	527[1]	1,286[1]	2,009[1]	883[1]	~2,500[6]	—	~3,000[6]	2,300[5,6]	Pres[6]	9,059	7,920
Elegant Tern	(I) slope = 194, $r^2 = 0.89$	—	—	—	0[6]	5[6]	—	50[6]	250[6]	Pres[6]	~1,000-2,000	~800-1,200
Black Skimmer	(NT) slope = 14, $r^2 = 0.07$	73[1]	150[1]	90[1]	50[1]	12[1]	—	300[6]	Pres[6]	Pres[6]	26	250
No. of species		5	6	7	6	7	—	8	8	10	8	10

Sources: [1]Vega 2008; [2]Molina *et al.* 2010; [3]González-Bernal *et al.* 2003; [4]González-Medina *et al.* 2009, [5]Angulo-Gastélum *et al.* 2011; [6]J. A. Castillo-Guerrero, unpubl. data.

Table 3. Estimated number of nests in colonies of seabirds that nest in mangrove in Bahía Santa María-La Reforma, Sinaloa, Mexico, between 1971 and 2012. Pres = presence, without population count.

	Year						
Species	1971	1972	1988	2004	2006	2011	2012
Magnificent Frigatebird	1,500[1]	1,000[1]	15,000[2]	~6,000[4]		8,294 ± 3,066	Pres
Double-crested Cormorant	4,000[1]	4,300[1]	1,000-1,500[2]	~5,000[4]		2,309	3,483
Brown Pelican		1,500[1]	1,000-1,500[2]	~5,500[4]	9,140[3]	377	2,015 ± 171

Sources: [1]Knoder *et al.* 1980; [2]Carmona and Danemann 1994; [3]Anderson *et al.* 2013; [4]J. A. Castillo-Guerrero, unpubl. data.

findings show that BSM supports the largest breeding populations of Royal Tern, Laughing Gull, and Black Skimmer along the west coast of Mexico. Furthermore, species that breed on the two islands with coastal dune habitats have increased their breeding populations, whereas those that breed in mangrove habitats appear to have decreased, as seen for the Brown Pelican.

Seabird colonies were located on the same site every year and the common feature of these islands is the absence of land predators (Coulson 2002). There are other islands in BSM with similar coastal dune and mangrove habitats. However, on the larger islands (Altamura, Tachichilte, and Saliaca) there are coyotes (*Canis latrans*) and raccoons (*Procyon lotor*). Furthermore, cattle (*Bos primigenius*) grazing may have negative effects on potential seabird colonies (Conservation International 2003).

There were increasing population trends on the two islands with coastal dune habitats but not on those with mangrove habitats. The increase in population size in coastal dune habitats could be related to several factors. First, there has been an increase in the coastal dune habitat, in particular on El Rancho Island where there was an 81% increase in area between 2003 and 2012 (from 172 ha to 312 ha). Second, the presence of park rangers at the Natural Protected Area "Islas del Golfo de California" (Gulf of California Islands) has increased through time, which could influence the use of the islands by local fishermen. Finally, species such as the Elegant Tern, Heermann's Gull (*L. heermanni*), and Caspian Tern have established colonies on the island recently, namely in 2004, 2006, and 2010, respectively. Thus, the population increase of these species might be due to the dynamics of a recently established colony that is not yet limited by density-dependent processes such as competition for food and space (Coulson 2002).

In contrast, it is not clear why seabird species nesting in mangrove habitat have decreased. The coverage and quality of mangroves has not changed significantly in the past 40 years in BSM (Ruiz-Luna *et al.* 2010). It is possible that human disturbance is adversely affecting these species. There has been an increase in the number of fishing boats in all coastal wetlands of Sinaloa (4,331 boats in 1980 vs. 11,828 boats in 2009; Departamento de Pesca 1981; Comisión Nacional de Acuacultura y Pesca 2011), and there are tours to visit some of the seabird colonies in BSM. This increase in activity could have an adverse effect on species such as the Brown Pelican that are very sensitive to human disturbance during the breeding season.

For Laughing Gull (~22,000 pairs), Royal Tern (~9,059 pairs) and Black Skimmer (1,200-1,500 pairs), the population estimates at BSM are the largest for the west coast of Mexico. Laughing Gull colonies ranged from two pairs in Cerro Prieto, Baja California (Molina and Garret 2001), to 2,500-3,000 pairs in the Marietas Islands, Nayarit (Rebón 1997). At Laguna Cuyutlán, 10,000 pairs of Laughing Gulls were recorded in 1978 (Knoder *et al.* 1980), but in 2003 the same colony had only "a few hundreds of pairs" (E. Mellink and E. Palacios, unpubl. data). For the Royal Tern, colony size on El Rancho Island was slightly larger than that reported for Rasa Island, at ~8,500 pairs (Velarde *et al.* 2005; Mellink *et al.* 2007). The current population estimates for BSM and Rasa Island together account for over 90% of breeding pairs for this species on the west coast of

Mexico (*sensu* Mellink *et al.* 2007). For the Black Skimmer, there are records of small breeding colonies (fewer than 200 nests) at 14 sites on the west coast of Mexico, with a population estimate of about 1,000 pairs between 1998 and 2005 (Mellink *et al.* 2007). The population estimate in BSM surpasses the previous regional estimate, making it the most important Black Skimmer colony on the west coast of Mexico. However, the reasons for the wide interannual variations (see Table 2) in the breeding population size are not clear.

BSM has been described as the largest breeding site for the "Mexican Mainland, Estuarine" subpopulation of Brown Pelicans (Anderson *et al.* 2007). The breeding population of Pájaros Island in 2006 included 86% of this subpopulation and was believed to be a dispersion center for the species (Anderson *et al.* 2007). In this regard, the decline of BSM Brown Pelican colonies raises uncertainty for the viability of the subpopulation. This subpopulation typically shifts among the numerous bays and islands with some frequency (Anderson *et al.* 2013).

Considering that seabirds are declining globally at an accelerating rate (Croxall *et al.* 2012), it is encouraging to have a significant population increase for some species. It is critical to maintain a long-term monitoring effort to determine population changes and conservation issues for each seabird species. This will allow early changes and risks to be detected, so that mitigating actions can be implemented, and seabird populations and their resources can be managed. Finally, BSM supports important seabird populations, and we recommend that its conservation should be a priority for conservation institutions in Mexico.

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