Recovery and current status of seabirds on the Baja California Pacific Islands, Mexico, following restoration actions

Y. Bedolla-Guzmán, F. Méndez-Sánchez, A. Aguirre-Muñoz, M. Félix-Lizárraga, A. Fabila-Blanco, E. Bravo-Hernández, A. Hernández-Ríos, M. Corrales-Sauceda, A. Aguilar-Vargas, A. Aztorga-Ornelas, F. Solís-Carlos, F. Torres-García, L. Luna-Mendoza, A. Ortiz-Alcaraz, J. Hernández-Montoya, M. Latofski-Robles, E. Rojas-Mayoral and A. Cárdenas-Tapia

Grupo de Ecología y Conservación de Islas, A.C., Moctezuma 836, Zona Centro, 22800, Ensenada, Baja California, Mexico. <yuliana.bedolla@islas.org.mx>.

Abstract The Baja California Pacific Islands, Mexico, are globally important breeding sites for 22 seabird species and subspecies. In the past, several populations were extirpated or reduced due to invasive mammals, human disturbance, and contaminants. Over the past two decades, we have removed invasive predators and, for the last decade, we have been implementing a Seabird Restoration Programme on eight groups of islands: Coronado, Todos Santos, San Martín, San Jerónimo, San Benito, Natividad, San Roque, and Asunción. This programme includes monitoring; social attraction techniques; removal of invasive vegetation; reducing human disturbance; and an environmental learning and biosecurity programme. Here, we summarise historical extirpations and recolonisations during the last two decades of restoration actions, and we update the status of breeding species after more than a decade. To date, from 27 historically extirpated populations, 80% have returned since the first eradication in 1995. Social attraction techniques were key in recolonisations of Cassin's auklet (*Ptychoramphus aleuticus*), royal tern (*Thalasseus maximus*), and elegant tern (*T. elegans*). A total of 19 species breed on these islands, four more species than a decade ago, including 12 new records. The most abundant seabirds, black-vented shearwater (*Puffinus opisthomelas*), Cassin's auklet, western gull (*Larus occidentalis*), and Brandt's cormorant (*Phalacrocorax penicillatus*), have shown a remarkable population increase. Current threats include the potential reintroduction of invasive mammals, guano mining, recreational activities, pollution, and commercial fisheries. To maintain these conservation gains in the long-term it is necessary to continue implementing restoration actions and reinforcing protection on these important natural protected areas.

Keywords: conservation, invasive mammal eradications, population status, seabird recovery, social attraction techniques, threats

INTRODUCTION

Mexican islands and their surrounding waters are key breeding and foraging sites for one-third of all seabird species worldwide, placing Mexico as the third most diverse country and the second in terms of endemism (Croxall, et al*.,* 2012). In particular, the Baja California Pacific Islands (Fig. 1), influenced by the productive waters of the California Current System, support more than a million breeding pairs of 22 seabird species and subspecies (Wolf, et al*.,* 2006). Unfortunately, on these islands at least 18 seabird populations were extirpated, several more diminished from their former abundances, and the Guadalupe storm-petrel (*Oceanodroma macrodactyla*) is presumed extinct due to the presence of invasive mammals, human disturbance, and contaminants that affected their breeding grounds during the last two centuries (Everett & Anderson, 1991; McChesney & Tershy, 1998; Wolf, et al*.,* 2006).

Over the past two decades, we have removed 60 populations of invasive mammals from 39 islands in Mexico, in collaboration with government agencies, academic institutions, fishing cooperatives and a donor network (Aguirre-Muñoz, et al*.,* 2011, 2016, 2018). In the Baja California Pacific, 12 islands smaller than 1,000 ha are now free of invasive predators; 24 populations of cats (*Felis catus*), goats (*Capra hircus*), rabbits (*Oryctolagus cuniculus*), donkeys (*Equus asinus*), dogs (*Canis lupus familiaris*), ship rats (*Rattus rattus*), and deer mice (*Peromyscus eremicus cedrosensis*) were eradicated between 1995–2004 and 2013 (Aguirre-Muñoz, et al*.*, 2011, 2016). Only a small population of house mice (*Mus musculus*) remains on Coronado Sur Island, and white-tailed antelope squirrels (*Ammospermophilus leucurus*) on Natividad Island (Aguirre-Muñoz, et al*.,* 2016).

Seabird surveys, carried out on some of these islands a few years after the eradications, recorded a low number of natural recolonisations (Palacios pers. comm., 2003, Wolf, et al., 2006, Whitworth pers. comm., 2007). In order to attract birds back and improve recolonisation rates, we initiated, in 2008, a Seabird Restoration Programme that includes monitoring, implementing social attraction techniques used successfully elsewhere (Jones & Kress 2012), removal of introduced vegetation for habitat enhancement, and an environmental learning and biosecurity programme with local communities (Aguirre-Muñoz, et al*.,* 2011, 2016). Over the last decade, we have recorded several positive

Fig. 1 The Baja California Pacific islands where seabird restoration actions have been done.

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outcomes after the implementation of these restoration actions that have not been documented yet. Moreover, the last comprehensive compilation of the status of seabird breeding populations on these islands was made more than 10 years ago and needs to be updated (Wolf, et al., 2006).

Here, we summarise historical seabird extirpations for each island and subsequent recolonisations after the implementation of restoration actions during the last two decades and update the status of all breeding species on eight islands groups: Coronado, Todos Santos, San Martín, San Jerónimo, San Benito, Natividad, San Roque, and Asunción.

METHODS

We used historical records of breeding seabirds from published and grey literature to determine the number of extirpated populations and compare the status of seabird populations after the implementation of restoration actions (invasive mammal eradication, social attraction techniques). Current information derives from our own seabird censuses and estimations conducted in 2008–2017 on San Roque and Asunción islands, in 2013–2017 on Coronado, Todos Santos, San Martín, San Jerónimo, and Natividad, and in 2016–2017 on San Benito islands. For surface-nesting species, we surveyed active nests from land-based vantage points, complemented with boat counts and searches around the islands, every 15 days during the whole breeding season. All colonies were mapped and divided into sub-colony sites to increase count accuracy. For burrow-nesting species, we conducted a continuous exhaustive and intensive search of active nests in all potential breeding sites. On islands with accessible nesting sites, we conducted a census all around and across the whole island and checked nest content using a hand-lamp or a borescope. For those species with high nest density such as western gull (*Larus occidentalis*) on Todos Santos Islands, Cassin's auklet (*Ptychoramphus aleuticus*) on San Jerónimo Island, and black-vented shearwater (*Puffinus opisthomelas*) on Natividad Island, we estimated nest densities during peak incubation, counting nests within circular and square plots randomly distributed and georeferenced. Burrow occupancy was determined by recording apparently occupied burrows, i.e. with signs of activity such as guano, feathers, clear entrances, and footprints (Walsh, et al., 1995). Population size was calculated through Bayesian statistics using the total number of nests and occupied burrows (McCarthy, 2007). We included in our counts pairs nesting within artificial colonies installed on all the islands (Table 1).

We analysed the number of recolonisations of extirpated colonies by island and seabird group (surface-nesting species and burrow-nesting species). A recolonisation rate was not possible to estimate as post-eradication surveys were not systematic on many islands until we started our monitoring in 2008. We also present a brief account for each currently breeding species, where we include the maximum number of breeding pairs estimated during our own survey period on each island, except for storm-petrels on San Benito Islands.

Table 1 Social attraction techniques implemented on seabird populations on the Baja California islands, Mexico, from 2008 to 2017. Y = Yes, N = No. *Mirrors were used from 2008–2011.

Species	Island	Year	Social attraction techniques	Successful
Heermann's gull	San Roque	2008–2017	Decoys, acoustic playbacks	Y
Elegant tern	San Roque	2008–2017	Decoys, acoustic playbacks, mirrors*	Y
	Asunción	2008–2017	Decoys, acoustic playbacks, mirrors*	N
Brandt's cormorant	Coronado Norte	2014–2017	Decoys, acoustic playbacks	N
	Coronado Sur	2014–2017	Decoys, acoustic playbacks	N
	Todos Santos Sur	2014–2017	Decoys, acoustic playbacks	Y
Double-crested cormorant	Coronado Norte	2014–2017	Decoys, acoustic playbacks	N
	Coronado Sur	2014–2017	Decoys, acoustic playbacks	N
	Todos Santos Sur	2014–2017	Decoys, acoustic playbacks	Y
Pelagic cormorant	Todos Santos Sur	2016–2017	Decoys	N
Cassin's auklet	Coronado Norte	2015–2017	Artificial burrows, acoustic playbacks	N
	Coronado Sur	2014–2017	Artificial burrows, acoustic playbacks	Y
	Todos Santos Sur	2014–2017	Artificial burrows, acoustic playbacks	Y
	Todos Santos Norte	2016–2017	Artificial burrows, acoustic playbacks	Y
	San Martín	2014–2017	Artificial burrows, acoustic playbacks	N
	San Jerónimo	2014–2017	Artificial burrows, acoustic playbacks	Y
	Natividad	2014–2017	Artificial burrows, acoustic playbacks	Y
	San Roque	2014–2017	Artificial burrows, acoustic playbacks	Y
	Asunción	2014–2017	Artificial burrows, acoustic playbacks	Y
Scripps´s murrelet	Todos Santos	2016–2017	Artificial burrows, acoustic playbacks	Y
Black storm-petrel	Coronado Norte	2015–2017	Artificial burrows, acoustic playbacks	N
	Coronado Sur	2015–2017	Artificial burrows, acoustic playbacks	N
Ashy storm-petrel	Coronado Norte	2017–2017	Artificial burrows, acoustic playbacks	N
	Coronado Sur	2015–2017	Acoustic playbacks	N
	Todos Santos Sur	2016–2017	Artificial burrows, acoustic playbacks	N

Study area

The eight island groups are located on the continental shelf off the west coast of the Baja California Peninsula, Mexico within 66 km of the coast (Fig. 1). Their climate is Mediterranean to desert-like. The northern islands are characterised by subarctic waters throughout the year while a tropical-subtropical domain persists during summer and autumn in the southern islands (Durazo & Baumgartner, 2002; Durazo 2009, 2015). Natividad (736 ha), San Roque (35 ha), and Asunción (41 ha) islands were designated as part of the El Vizcaíno Biosphere Reserve in 1988 (CONANP, 2000) while Coronado (173 ha), Todos Santos (118 ha), San Martín (265 ha), San Jerónimo (48 ha) and San Benito (541 ha) were recently included in the Islas del Pacífico de la Península de Baja California Biosphere Reserve in 2016 (DOF, 2016).

RESULTS AND DISSCUSION

Recovery and status

In total, according to historical records, 27 seabird populations were extirpated from the 12 coastal Baja California Pacific islands where restoration actions were conducted; Todos Santos, San Martín, and San Roque islands were the most affected islands, with between five to six taxa extirpated on each island. In contrast, San Benito Islands have no historical record of any extirpation (Table 2, Fig. 2). Extirpated species included five burrow-nesting species: Leach's storm-petrel (*Oceanodroma leucorhoa*), black storm-petrel (*O. melania*), Scripps's murrelet (*Synthliboramphus scrippsi*), Craveri's murrelet (S. craveri) and Cassin's auklet; and five surface-nesting species: brown pelican (*Pelecanus occidentalis*), double-crested cormorant (*Phalacrocorax auritus*), Brandt's cormorant (*Phalacrocorax penicillatus*), royal tern (*Thalasseus maximus*), and elegant tern (*T. elegans*) (Table 2). Burrow-nesting species lost 15 breeding populations of which 9 colonies corresponded to Cassin's auklet and Scripps's murrelet that were extirpated from almost all their historical breeding sites in Mexico (Table 2, Fig. 3). Similarly, 12 colonies of surface-nesting species were extirpated, with brown pelican and double-crested cormorant being the most impacted species (Fig. 3).

After two decades of restoration actions, in total, 22 colonies of extirpated seabirds have returned to breed to these islands, which represent 80% of all extirpated colonies. San Martín and San Roque islands are the islands that have benefited the most as currently all extirpated species are breeding again on these islands. Likewise, the species with more colonies extirpated are now breeding on almost all their historic sites (Table 2, Fig. 3). Social attraction techniques were key in recolonisations of Cassin's auklet on Natividad Island; and royal tern and elegant tern on San Roque Island (Table 1).

Moreover, we have recorded 12 new colonisations during the last decade that have never been recorded before, five of them on San Jerónimo Island (Table 2). These new records together with recolonisations have increased considerably the number of breeding taxa on many islands in comparison with the last comprehensive compilation (Wolf, et al., 2006). For instance, San Jerónimo Island with only four species recorded last decade now supports 12 breeding species (Fig. 4). Currently, breeding seabirds on these 12 islands comprise 19 species, four more species than the last record (Wolf, et al., 2006).

The most abundant seabird is the black-vented shearwater, which has a total population an order of magnitude higher than all other species, but is restricted to three breeding sites (Natividad, San Benito and Guadalupe islands). Cassin's auklet, western gull, Brandt's cormorant, and double-crested cormorant are relatively abundant and have a wide distribution. In contrast, elegant tern and blue-footed booby (*Sula nebouxii*) only have one pair nesting in one site (Table 2).

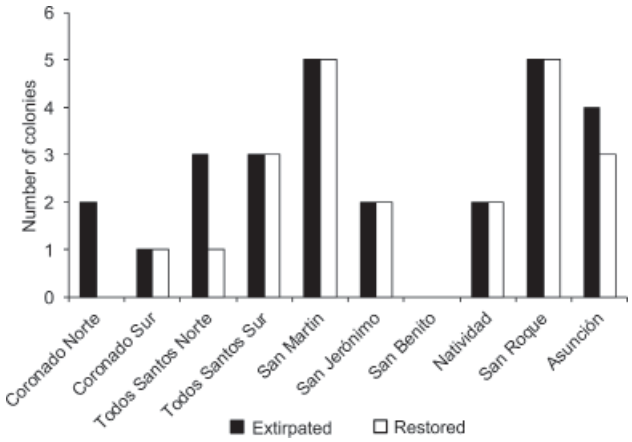

Fig. 2 Number of seabird colonies historically extirpated and restored after two decades of restoration actions on the Baja California Pacific islands, Mexico.

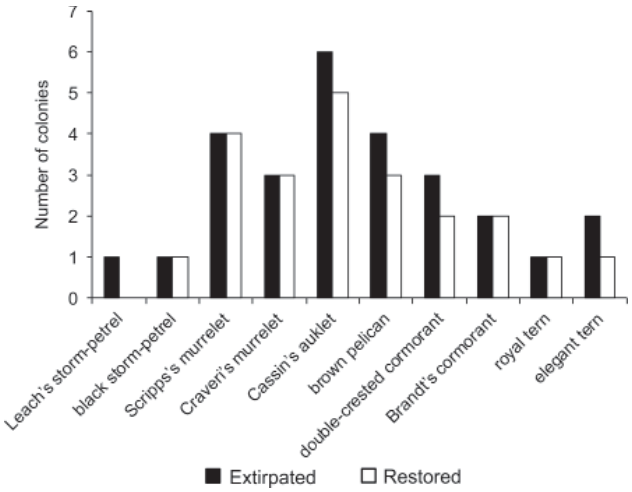

Fig. 3 Number of colonies historically extirpated and restored after two decades of restoration actions of each seabird species on the Baja California Pacific islands, Mexico.

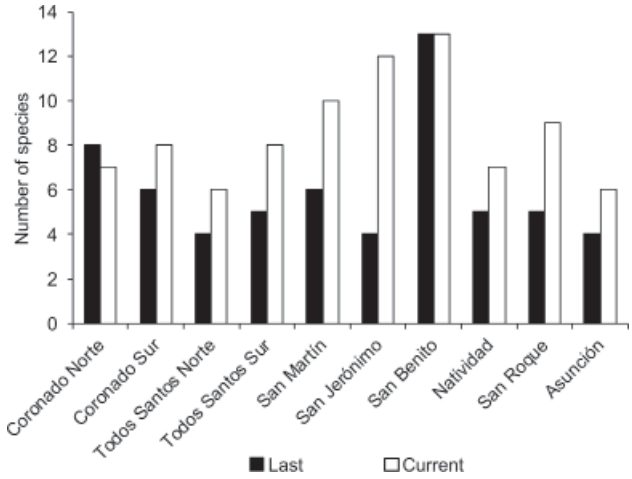

Fig. 4 Number of seabird species recorded a decade ago in the last comprehensive compilation (Wolf, et al., 2006) and during our monitoring on the Baja California Pacific islands, Mexico.

Table 2 Last and current status of the seabird breeding populations on the Baja California Pacific Islands, Mexico. CN: Coronado Norte, CS: Coronado Sur, TSN: Todos Santos Norte, TSS: Todos Santos Sur, SM: San Martín, SJ: San Jerónimo, SB: San Benito, NA: Natividad, SR: San Roque, AS: Asunción. L = mostly estimates from Wolf, et al., 2006; C = our own surveys: maximum numbers recorded during the monitoring period on each island. Estimates are number of breeding pairs. Historical extirpations are indicated. B: Breeder, PB: Probable breeder, E: Extirpated, PE: Possibly extirpated, U: Unknown. *New record, #Intensive nest search on the island, $Estimation for the whole archipelago with spotlight survey, %Adults with fully developed brood patch were captured with mist-nest, &Scripps's and Guadalupe murrelets were considered together, a) Van Rossem, 1915; b) Carter, et al., pers. comm. 1996; c) Ainley & Everett, 2001; d) Whitworth, et al., pers. comm.,2007; e) Palacios, et al., pers. comm. 2003; f) Wolf, et al., 2006; g) Jehl, 1977; h) Van Denburgh, 1924; i) Jehl & Bond, 1975; j) Everett, 1989; k) Anderson & Keitt, 1980; l) Everett & Anderson, 1991; m) Whitworth et al. 2018. n) Keitt, et al., 2003; o) McChesney & Tershy, 1998.

Species	CN		CS		TSN		TSS		SM		SJ		SB		NA		SR		AS	
	L	C	L	C	L	C	L	C	L	C	L	C	L	C	L	C	L	C	L	C
Black-vented shearwater													125–600[f]	124[#]	76,570[n]	110,000-120,000				
Leach's storm-petrel	E[a]	PE										PB*	510,000[f]	B						
Ashy storm-petrel	PB[b]	PB				55*		20*		PB*[%]										
Black storm-petrel	B[c]	78	E[c]	1						PB*[%]			260,000[f]	B						
Least storm-petrel													135,000[f]	B						
Brown pelican	1,818[d]	203	33[d]	328	E[e]	E	E[e]	1,200	204[Eek]	376		299*	197[f]	101	37–75[f]	366	<10[f]	99	E[f]	270
Blue-footed booby												1*								
Double-crested cormorant	168[d]	30	230[d]	187	E[e]	E	93[e]	238	520[Eel]	791	20[f]	150	63[f]	40	57[f]	434	E[f]	113	10[f]	131
Brandt's cormorant	100[d]	32	150[d]	164	0[Beh]	53	336[e]	732	E[e]	335	E[f]	833	79[f]	18	750[f]	3,504	<100[f]	5,802	25–50[f]	5,200
Pelagic cormorant	7[d]		2[d]	3	20[e]	15		13				1*								
Heermann's gull													100[f]	109			34[f]	42		
Western gull	225[e]	133	135[e]	364	150[e]	2,248–3,691	1500[e]	5,846–9,598	300[e]	1382	250[f]	2,442	575[f]	1,010	2,500–5,000[f]	2,746	B[f]	1,749	B[f]	1,373
Caspian tern										186*		49*								
Royal tern												80*					E[l]	870		
Elegant tern																	E[l]	1	E[l]	E
Scripps's murrelet	750-1,250[$f]	15[#]	B[e]	22	B[PEfi]	19	25-125[$PEfi]	90[#]	25–125[PEfi]	PB	50–250[PEfi]	9[#]	125-50[0f&]	174[&]						
Guadalupe murrelet												PB								
Craveri's murrelet									1[m]	PB			PB[f]	B	PE[m]	1*	B[PEm]	4	B[PEm]	1
Cassin's auklet	E[g]	E		14*	B[f]	12	B[PEfj]	20	500–2,500[Efl]	136[#]	30,000[f]	50,000-110,000	37,667[f]	B	E[o]	10	E[o]	1,659	E[o]	2,128
Total breeding taxa	8	7	6	8	4	6	5	8	6	10	4	12	13	13	5	7	5	9	4	6
Total extirpated taxa	2	2	1	0	2	2	1	0	1	0	1	0	0	0	2	0	4	0	3	1

Black-vented shearwater (*Puffinus opisthomelas*)

In the past, the breeding population of black-vented shearwater declined on Natividad Island, its main breeding colony worldwide due to predation by feral cats and habitat destruction (Keitt, et al*.,* 2002, 2003). At present, we estimate a population of 110,000–120,000 breeding pairs, which indicates almost a twofold increase in relation to the last estimation two decades ago (Keitt, et al*.,* 2003). The small population on San Benito Islands of around 100 pairs remains almost unchanged since its last record (Wolf, et al., 2006, Table 1).

Leach's storm-petrel (*Oceanodroma leucorhoa*)

Leach's storm-petrel, considered the most abundant species in the region, currently breeds only on Islote Medio in Coronado Islands and on San Benito Islands (Wolf, et al., 2006), however, its population estimate has not been updated yet. In the last century, it was extirpated from Coronado Norte Island by feral cats (Grinnell & Daggett, 1903, van Rossem, 1915), our surveys indicate that the species is possibly extirpated. In 2016, we captured adults with brood patches using mist nets on San Jerónimo Island, thus, we consider this species as a probable breeder but we have not found active nests.

Ashy storm-petrel (*Oceanodroma homochroa*)

The Coronado Islands are considered the southernmost breeding range of the ashy storm-petrel and the only breeding site in Mexico (Ainley, 1995). This species was considered as a probable breeder on Coronado Norte Island (Jehl, 1977) and at present, our surveys indicate the same, although we have not found an active nest. In the last decade, Islote Medio, an islet historically pest-free, was the only confirmed site with a small breeding population (Wolf et al., 2006, Carter, pers. comm. 2006). However, we recently confirmed this species breeding on Todos Santos Islands. In 2014, we found the first active nest on Todos Santos Sur Island, and we corroborated species identification by measuring adults captured using mist-nets at night; broadcasting responses in the nest; and carrying out genetic analyses (GECI unpubl. data). We captured five adults with brood patches on San Martín Island, which indicates that the breeding range of the ashy storm-petrel is probably expanding or is wider that was recorded before (Table 2).

Black storm-petrel (*Oceanodroma melania*)

In the Mexican Pacific, black storm-petrels nest exclusively on Coronado and San Benito islands (Ainley & Everett, 2001). On Coronado Islands, this species is recorded as breeding on Coronado Norte, Coronado Medio, and Islote Medio, and as extirpated on Coronado Sur, with a total estimated population of 100–150 breeding pairs (Grinnell & Daggett, 1903; Osburn, 1909; Sowls, et al*.,* 1980; Ainley & Everett, 2001; Carter, pers. comm. 2006). In 2016, we found 120 breeding pairs breeding on Coronado Norte and Islote Medio, and one nest on Coronado Sur, which indicates this species recolonisation of this island (Table 2). On San Martín Island, we captured adults with fully developed brood patches in 2017, thus, we consider this species as a probable breeder, but we have not found an active nest yet. Its breeding population size on San Benito Islands has not been updated yet since the last estimate in 1999 (Wolf, et al., 2006).

Brown pelican (*Pelecanus occidentalis)*

Currently, the brown pelican breeds on all its historical breeding sites on these islands, except on Todos Santos Norte Island, and 40% of its breeding population is concentrated on Todos Santos Sur Island (Table 2). San Jerónimo Island, previously not recorded as a breeding site (Wolf et al., 2006), recently supports a population of around 300 pairs (Table 2). This species was one of the most affected by organochlorines and human disturbance; colonies of thousands or hundreds of pairs recorded in the last century were dramatically reduced on Coronado (ca. 5,000 pairs; Jehl, 1973, Gress, 1995), and San Benito islands (~1,000 pairs, Everett & Anderson, 1991; Wolf, et al., 2006), and was extirpated on Todos Santos (Everett & Anderson, 1991; Palacios & Mellink, 2000; Palacios, pers. comm. 2003), San Martín (ca. 1000 pairs; Jehl, 1973; Anderson & Keith 1980), and Asunción islands (Anthony, 1925; Wolf, et al*.,* 2006). All colonies, except on Todos Santos Islands, recovered considerably after these threats were mitigated (Palacios & Mellink, 2000; Wolf, et al., 2006; Whitworth, pers. comm. 2007). At present, no declined colony has reached its historical numbers as the species' population size remains in the hundreds of pairs, except on Todos Santos Sur Island that supports a population of more than 1,000 pairs (Table 2).

Blue-footed booby (*Sula nebouxii*)

We recorded one nest of blue-footed booby with two chicks on San Jerónimo Island in September 2016. This record represents the first on the Baja California Pacific islands and the northernmost breeding range for this species that was previously considered on Midriff Islands, in the Gulf of California (Hernández Díaz & Salazar Gómez, 2011).

Double-crested cormorant (*Phalacrocorax auritus*)

During the last century, the double-crested cormorant was extirpated from Todos Santos Norte (Van Denburgh, 1924; Palacios pers. comm. 2002), San Martín (Everett & Anderson, 1991), and San Roque islands (Wolf, et al., 2006). Currently, this species breeds on all 12 islands, except on Todos Santos Norte Island where it remains extirpated (Table 2). In the past, San Martín Island supported the largest colony in North America with hundreds of thousands of pairs (Wright, 1913; Gress, et al., 1973; Carter, et al., 1995); after the main threats were removed, the colony increased from zero to around 600 pairs (Palacios & Mellink, 2000, Palacios, pers. comm. 2003) and, at present, this island sustains the biggest population in the region with about 800 pairs (Table 2).

The breeding colony on the Coronado Islands declined from thousands to hundreds of pairs (Howell, 1917; Gress, et al., 1973, Carter, et al., 1995), and on San Roque Island from thousands to zero pairs (Townsend, 1923; Huey, 1927; Wolf, et al., 2006). We recorded double-crested cormorant recolonisation on San Roque in 2008. These colonies have remained in the hundreds of pairs during the last two decades (Carter, pers. comm. 1996; Palacios, pers. comm. 2003; Whitworth, comm. pers. 2007; Table 2).

The small colony recorded on Natividad in 2000 of around 60 nests (Wolf, et al., 2006), at present, has a sevenfold increment in population size (Table 2). On Todos Santos Sur Island the colony doubled its size and social attraction techniques were successful with a record of eight nests within an artificial colony.

Brandt's cormorant (*Phalacrocorax penicillatus*)

Brandt's cormorant returned to nest at all its historical breeding sites on the Baja California Pacific Islands (Table 2). In the past, it was extirpated from San Martín Island, the main breeding site with several thousand nests (Wright, 1913; Everett & Anderson, 1991; Palacios & Mellink, 2000; Palacios, pers. comm. 2003), and from San Jerónimo

Island (Wolf, 2002). At present, both islands maintain colonies of hundreds of pairs, and the largest colonies with > 3,000 pairs are located on the southernmost islands, Natividad, San Roque, and Asunción that before had low numbers of pairs (Table 2; Wolf, et al. 2006). In total, the breeding population of Brandt's cormorant has increased nine times more than the last decade from around >1,000 pairs to > 10,000 pairs (Table 2; Wolf, et al. 2006).

Pelagic cormorant (*Phalacrocorax pelagicus*)

Coronado and Todos Santos islands are considered the southernmost breeding range for the pelagic cormorant (Hobson, 2013). On these islands, small breeding populations have been previously reported on all four Coronado Islands and Todos Santos Norte Island (Palacios, pers. comm. 2003; Carter, pers. comm. 2006, Whitworth, pers. comm. 2007). During our monitoring in 2013–2017, we have recorded nests on Coronado Sur, Coronado Medio, both Todos Santos islands, and, for the first time, one nest on San Jerónimo Island in 2017, which represents an expansion of its breeding range to the south (Table 2).

Heermann's gull (*Larus heermanni*)

Heermann's gull breeds in small colonies (ca. 50–100 pairs) on San Benito Medio and San Roque islands (Table 2). On San Benito, the colony has increased from nine nests (Jehl, 1976) to more than 100 pairs that has not changed during the last decade (Wolf, et al., 2006, Table 2). On San Roque, previous surveys showed a population of 35–42 pairs (Huey, 1927; Mellink, 2001). In 2008, when we started implementing social attraction techniques, we recorded 23 nests within the artificial colony and also during all subsequent years. The colony has reached its maximum number in 2017 with 42 nests (Table 2).

Western gull (*Larus occidentalis*)

The western gull is a species widely distributed on the Baja California Pacific islands. There are no historical records of extirpated colonies. It breeds on all 12 islands and is one of the most abundant species, with a total population estimate of approximately 20,000 breeding pairs (Table 2). The Todos Santos Islands concentrate around 50% of the current population. Estimates 10 years ago, showed a total population three times smaller than today. This increase has been very remarkable mainly on Todos Santos Sur, but also on Todos Santos Norte, San Martín, and San Jerónimo where colony sizes range from about 1,000 to 8,000 pairs (Table 2).

Caspian tern (*Hydroprogne caspia*)

In 2013, we recorded 15 nests of Caspian tern on San Jerónimo Island, the first record on the Baja California Pacific islands. In 2014, the population increased to 49 pairs and we also recorded nests on San Martín Island (89 pairs). The colony on San Jerónimo decreased to 11 pairs the last year because it was established on a California sea lion (*Zalophus californianus*) resting area. In contrast, the colony on San Martín found suitable habitat on the island and has increased to almost 200 pairs. (Table 2).

Royal tern (*Thalasseus maximus*)

This species was extirpated from San Roque Island and its last breeding record was 90 years ago (Bancroft, 1927; Everett & Anderson, 1991). In 2017, after eight years of the implementation of social attraction techniques, 870 breeding pairs were recorded nesting within the artificial colony installed for elegant tern (Table 2). For the first time, we found 80 nests of royal tern on San Jerónimo Island in 2013 but their numbers decreased rapidly to seven in 2017 (Table 2).

Elegant tern (*Thalasseus elegans*)

In the past, the elegant tern bred on San Roque and Asunción islands (Anthony, 1925) but was extirpated from both islands (Everett & Anderson, 1991). Currently, in 2017, we found one pair nesting on San Roque Island within the colony of royal tern associated with the artificial colony. On Asunción Island, this species remains extirpated.

Scripps's murrelet (*Synthliboramphus scrippsi*)

Scripps's murrelet was presumably extirpated from all historical breeding sites, except Coronado and San Benito islands (Table 2; Jehl & Bond, 1975; Everett & Anderson, 1991; Drost & Lewis, 1995; Wolf et al., 2006). At present, it has returned to breed on all the islands where was extirpated (Table 2). Our nest census on the islands shows lower population sizes from Coronado to San Benito in comparison to nocturnal surveys at-sea conducted a decade ago (Wolf, et al., 2006; Carter, pers. comm. 2015). We considered the last monitoring overestimated the population size. We found four breeding pairs nesting in artificial burrows on Todos Santos Sur Island (Table 1).

Guadalupe murrelet (*Synthliboramphus hypoleucus*)

Guadalupe murrelet breeds on the San Benito islands in a low proportion in comparison with Scripps's murrelet, but we do not have a precise number as identification in the nest is complicated. Colonies extirpated from Natividad, San Roque and Asunción islands mentioned by Wolf, et al. (2006) may have been a misidentification of *Synthliboramphus craveri* (Keitt, 2005, Carter pers. comm. 2015; Whiworth, et al., 2018). We recorded a pair (one individual was Guadalupe and the other Scripps's murrelet) on a trap-camera on San Jerónimo Island but the species' breeding status is not confirmed yet.

Craveri's murrelet (*Synthliboramphus craveri*)

Craveri's murrelet is currently breeding in low numbers on San Benito, Natividad, San Roque, and Asunción islands (Table 2). Whitworth, et al. (2018) previously found breeding evidence on San Martín, San Roque, and Asunción islands in 2007.

Cassin's auklet (*Ptychoramphus aleuticus*)

Cassin's auklet was also extirpated from almost all of its historical breeding sites, except from San Jerónimo and San Benito islands (Table 2). Currently, it is breeding again on all islands but Coronado Norte, an island that supported a population of thousands of breeding pairs (Osborn, 1909) extirpated by cat predation (Jehl, 1977). Extirpated colonies from San Roque and Asunción islands have been growing from about 100 pairs in 2008, when we recorded their recolonisation, to around 2,000 pairs in 2017 (Table 2).

Social attraction systems were key for the colonisation on Coronado Sur and recolonisation on Natividad Island. In 2017, we recorded 20 breeding pairs nesting in artificial burrows on Coronado Sur Island, which represents the first record for this island, and for the archipelago, as the last record was on Islote Medio, a pest-free islet, three decades ago (Everett & Anderson, 1991). After more than a century since the last breeding record (Kaeding, 1905), in 2016, we found five breeding pairs on Natividad Island, including one pair inside an artificial burrow close to a sound system (Table 1). We recorded one nest on Todos Santos Sur in 2014, and currently, more than 40 pairs are nesting on the archipelago, 17 of them in artificial burrows (Tables 1 and 2).

THREATS

Major historic threats to seabird colonies included predation by invasive mammals, habitat modification, and direct disturbance (Everett & Anderson, 1991; Wolf, et al., 2006). Current threats are similar to a decade ago but less extensive: 1) potential reintroduction of invasive mammals; 2) invasive plants that reduce nesting habitat, 3) habitat modification by guano mining, 4) exploitation of eggs, 5) disturbance by human activities including recreation and inadequate waste management; 6) fisheries impacts, and 7) pollution.

All these islands are now free of invasive predators (Aguirre-Muñoz, et al., 2016), however, potential reintroduction is high on all islands due to constant movement from the continent, as temporal and permanent fishermen's camps are established on all of them, except on the Coronado Islands. Natividad Island, inhabited by a fishing community of about 300 people, is the most susceptible to this threat: the reintroduction of a few pets has been recently recorded (CONANP, comm. pers.). The impacts of house mice that remain on Coronado Sur Island and white-tailed antelope squirrels on Natividad Island need to be evaluated.

Invasive plants such as ice-plant (*Mesembryanthemum crystallinum*) are widely distributed on many islands (Rebman et al., 2016), and are displacing native flora and affecting their associated fauna. Brandt's cormorants that nest on clean areas along the coast line, and Cassin's auklets and black-vented shearwaters that breed in subterranean burrows might be the most affected species.

Guano mining caused severe damage on San Jerónimo, San Roque, and Asunción islands during the last century (Everett & Anderson, 1991; Wolf, et al., 2006). At present, this activity continues on San Jerónimo Island at least since 2015 and is causing disturbance and destruction of the Cassin's auklet colony (GECI unplub. data). Human exploitation of western gull eggs persists on San Benito and Natividad islands. However, the impact on these populations is unknown. In 2016, the harvesting of Heermann's gull eggs on the small colony of San Benito Medio Island caused low productivity (GECI unpubl. data).

Recreation activities (surfing, kayaking, and fishing) are a threat on Todos Santos, San Benito Oeste, and Natividad islands. We have recorded tourists and residents walking close to breeding colonies which could cause temporal abandonment of nests and increase gull predation, and also damage to the burrows of nocturnal species. On Natividad Island, a metal fence around the town landfill built in front of the breeding colony in 2014, severely impacted the population. In 2016, the structure was removed by the fishing cooperative, however, inadequate waste management is a serious problem for the black-vented shearwater.

Commercial fishing is one of the most important economic activities along the Mexican Pacific coast (CONAPESCA, 2014). Although no fisheries bycatch impacts have yet been evaluated, information from the Gulf of California, shows that 17 species of seabirds and aquatic birds, mainly brown pelicans and blue-footed boobies, are incidentally caught in nets during fishing operations (Comunidad y Biodiversidad, A.C. pers. comm.). The most abundant seabird species in the region forage on small pelagic fish, thus, probable competition for food with commercial fisheries represents a potential threat that should be studied.

Light pollution in fishermen's camps created an important impact on nocturnal species decades ago (Wolf, et al., 2006) – currently this threat has been mitigated (GECI unpub. data) but still it is necessary to evaluate it on fishing boats around the islands. Current information about pollution-related threats is scarce. Oil spill hazards are a potential threat due to the region being an important transportation route and having fuel reception facilities. However, there is no action plan or personnel trained to manage oiled seabirds, and fauna in general.

Plastic consumption for variety of seabird species is increasing worldwide (Wilcox, et al., 2015). We have found evidence of plastic consumption in black-vented shearwater breeding on Guadalupe Island (GECI unpubl. data), thus, the impact of microplastics on seabirds in the region requires evaluation.

CONSERVATION

Although 65% of all seabirds recorded breeding on the islands are listed in the IUCN Red List of threatened species and are protected in Mexico in the Norma Oficial Mexicana NOM-059-SEMARNAT-2010, it is essential to update the status of several species. The majority of protected natural areas fully protect breeding and foraging areas for coastal species, however, foraging sites of pelagic seabirds are not included as most are located hundreds of kilometres from colonies. To address this issue, we are developing a Marine Important Bird Areas (Marine IBAs) proposal in collaboration with government agencies, national and international NGOs and seabird experts. We are also in the process of publishing an action plan for endemic seabirds that delineates the next actions to improve their conservation status. In the short-term this plan will incorporate all breeding seabirds in Mexico.

Regulations and surveillance enforcement to prevent introduction of invasive species, mitigate disturbance to colonies and impacts of fisheries are primordial. An important step is the National Island Biosecurity Programme, recently initiated on several islands including San Benito Islands, which aims to involve all key stakeholders in the protection of island environments from invasive alien species (Latofski-Robles et al., 2019). Moreover, it is necessary to continue working together with local communities to raise awareness about the threats seabirds are facing.

We consider research priorities to improve management decisions are: 1) to continue monitoring of populations and obtain data on productivity; 2) to obtain accurate population estimates for nocturnal seabirds, especially for storm-petrels; 3) to evaluate the impact of threats such as fisheries interactions and microplastics.

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