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Effects of the 1997-1998 El Niño and 1998-1999 La Niña events on breeding waterbirds and sea lions in the Upper Gulf of California, México

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RESUMEN

En 1998 y 1999 revisé las colonias de aves acuáticas que anidan en Isla San Jorge, La Purinera e Isla Montague, en el norte del Golfo de California, al igual que la de lobos marinos de la Isla San Jorge. Encontré que El Niño coincidió con que los bobos cafés de San Jorge dejaran de anidar y se ausentaran de la isla, al tiempo que llegaban varios miles de bobos de patas azules. Las condiciones de El Niño coincidieron con un incremento en el número de individuos anidantes de gallitos menor, elegante y máximo y de rayadores, en Montague. Ni los patos buzo orejones en San Jorge, ni los gallitos menores en La Purinera, ni las garzas níveas, perros de agua, gaviotas risueñas, ni gallitos picogruoso, en Montague, parecen haber sido afectados. Los lobos marinos en San Jorge duplicaron aproximadamente su población, sin que esto repercutiera sobre la producción de crías. La Niña coincidió con un regreso de las poblaciones de las especies anteriores a las condiciones previas a El Niño. Además, durante 1999 en San Jorge anidaron gaviotas plomas y patos buzo de Brandt. Esa gaviota había dejado de anidar hacía mucho tiempo en San Jorge, y el pato buzo nunca se había registrado anidando ahí. Es prematuro concluir si estos registros fueron resultado de La Niña o de fenómenos en otra escala.

PALABRAS CLAVE: Aves marinas, lobo marino, El Niño, La Niña, Alto Golfo de California.

ABSTRACT

During 1998 and 1999 I monitored waterbirds nesting on Isla San Jorge, at La Purinera and on Isla Montague, in the northern Gulf of California, as well as sea lions on Isla San Jorge. During El Niño the brown boobies on San Jorge ceased breeding and left the island, coinciding with an influx of several thousand blue-footed boobies. El Niño conditions coincided with an increase in the numbers of nesting least, elegant, and royal terns and black skimmers on Montague. Double-crested cormorants on San Jorge, least terns on La Purinera, and snowy egrets, black-crowned night-herons, laughing gulls, and gull-billed terns on Montague did not seem affected by this event. Sea lions at San Jorge about doubled their number, but the number of pups did not increase. La Niña conditions coincided with a return to population levels before El Niño in all these species. During 1999 Heermann's gulls and Brandt's cormorants nested on San Jorge. Heermann's gulls had stopped breeding there long ago, and Brandt's cormorants had never been known to nest there.

KEY WORDS: Seabirds, sea lions, El Niño, La Niña, Upper Gulf of California.

INTRODUCTION

The homeotherms of the Upper Gulf of California, a vast and shallow body of water, have received little attention. Some form breeding congregations that are biologically or biogeographically relevant. This region harbors the largest known population of least terns (*Sterna antillarum*) and one of the two largest sea lion (*Zalophus californianus*) rookeries in Mexico, one of the important breeding colonies of brown boobies (*Sula leucogaster*), and a number of breeding waterbirds with a disjunct breeding distribution (Everett and Anderson, 1991; Aurióles-Gamboa and Zavala 1994; Mellink and Palacios, 1993; Palacios and Mellink 1992, 1993; Peresbarbosa-Rojas and Mellink 1994, 2001; Zuria and Mellink, 2002). These colonies are on Isla San

Jorge and at La Purinera, in the northeastern corner of the Gulf, and on Isla Montague, in the delta of the Río Colorado.

These colonies have experienced both short- and long-term changes in their composition or number of individuals (see for example Mailliard 1923 vs. Mellink and Palacios, 1993; also, Peresbarbosa-Rojas and Mellink, 2001, Mellink 2000b, and Palacios and Mellink, 1996). For Isla San Jorge, we suggested that this could be the result of changes in the oceanographic characteristics of the area (Mellink and Palacios, 1993). It has been argued, however, that certain oceanographic events like El Niño, which often affect marine homeotherms greatly, do not impact pinnipeds in this region (Aurióles and Le Boeuf, 1991).

El Niño of 1997-1998 offered an opportunity to study its effects on the sea lions and waterbirds breeding in the area. This opportunity was further enhanced by La Niña conditions during 1999-2000. Here I report on some results of monitoring of the breeding colonies of these homeotherms during 1998 and 1999 and contrast them with previous data—some unpublished—on those same colonies.

STUDY SITES AND METHODS

During this project I studied three sites: Isla San Jorge, La Purinera, and Isla Montague (Figure 1). Isla San Jorge lies about 13 km west of the mouth of Bahía de San Jorge. It consists of one major and a few smaller islands, their total length being about 1100 m; its highest point is 63 m above mean sea level. The island is devoid of vegetation. The breeding birds are brown boobies (*Sula leucogaster*), which nest over most of the island except on the steepest cliffs on the western side, double-crested cormorants (*Phalacrocorax auritus*), which nest along the upper ridges (Mellink and Palacios, 1993), and red-billed tropicbirds (*Phaethon aethereus*). Elegant and royal terns (*Sterna elegans* and *S. maxima*) and Heermann's gulls (*Larus heermanni*) nested here early in the 20th century but had ceased doing so by 1991, for unknown reasons (Mellink and Palacios, 1993).

La Purinera is at the end of the 10-km long barrier beach that limits Bahía de San Jorge on the south. Its tip has large flat sand expanses covered by broken shells. This is the nesting substrate for a large colony of least terns (*Sterna antillarum*). Wilson's plovers (*Charadrius wilsonia*) and American oystercatchers (*Haematopus palliatus*) nest in sandy areas on the seaward edge of the flats of broken shells (Mellink and Palacios, 1993).

Isla Montague (22 x 7 km), at the mouth of the Río Colorado, is formed by alluvial sediments. Its only vegetation is saltgrass (*Distichlis palmeri*) along tidal channels. This vegetation along one major tidal channel on the southern end of the island, "Estero del Chayo," and several subsidiary channels conform one of the two waterbird breeding areas of the island. The other is formed by a number of shell mounds on the southwestern end, near the lighthouse. Eleven species of waterbirds and one of landbird have been recorded nesting here. The great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), black-crowned night-heron (*Nycticorax nycticorax*), and laughing gull (*Larus atricilla*) nest solely or mostly in the Estero del Chayo area. The elegant tern, royal tern, caspian tern (*S. caspia*), least tern, and american oystercatcher nest only on the shell mounds. Gull-billed terns (*S. nilotica*) and black skimmers (*Rynchops niger*) nest in both areas, while the terrestrial large-billed sparrow (*Ammodramus sandwichensis rostratus*) nests in

saltgrass patches throughout the island. The island is under the influence of large spring tides that flood it fortnightly (Mellink 2000b, Mellink, *et al.*, submitted; Peresbarbosa-Rojas and Mellink, 2001).

With my assistants and students I made 30 field visits from January 1998 to November 1999: 14 to Isla San Jorge, 10 to La Purinera, 3 to Isla Montague, and 3 to other relevant sites. On Isla San Jorge we monitored the populations, their breeding activities, and collected samples for diet analysis of brown boobies and sea lions; we recorded other species of nesting waterbirds. At La Purinera we monitored the population of nesting least terns. In 1998 we also sampled with a 1 x 10-m beach seine (3/16 mesh) the small fish along the beaches where the terns fed. On Isla Montague we counted nests of all species. Because of rising tides we could not count the nests at Estero del Chayo in 1999.

RESULTS

Isla San Jorge

The population of brown boobies on Isla San Jorge changed from average (5000-6000 individuals) in the fall of 1997 to severely reduced (641) in the summer of 1998, returned to previous levels in the fall of 1998, and continued there through 1999 (Figure 2, Appendix). Coinciding with the 1998 summer low in brown booby numbers, in April of that year some blue-footed boobies (*Sula nebouxii*) began to appear in the area, a rather unusual event. In June blue-footed boobies were scarce, but by the end of July there were 4546 on the island and about 500 on the beach at La Purinera.

During the summer of 1998, when brown boobies had left Isla San Jorge, they were abundant in the delta of the Río Colorado. On 19 August 1998 there were about 2000 individuals on Cerro del Crestón, San Felipe, but I have no data from this site from other years for comparison. Six days later, Miguel Lavín (pers. comm.) noted large numbers of brown boobies between Roca Consag and Isla Montague, which contrasted with their rarity on all other cruises he has made to that area (see also Patten *et al.*, 2001).

In April 1998, brown boobies exhibited not only a reduction in their numbers on the island, but their breeding was severely depressed, when it should have been at its maximum (Mellink, 2000a). The breeding season had begun normally the previous fall, and normal breeding resumed in the fall of 1998.

The double-crested cormorant (*Phalacrocorax auritus*) has increased from about 200 individuals in 1991 (Mellink

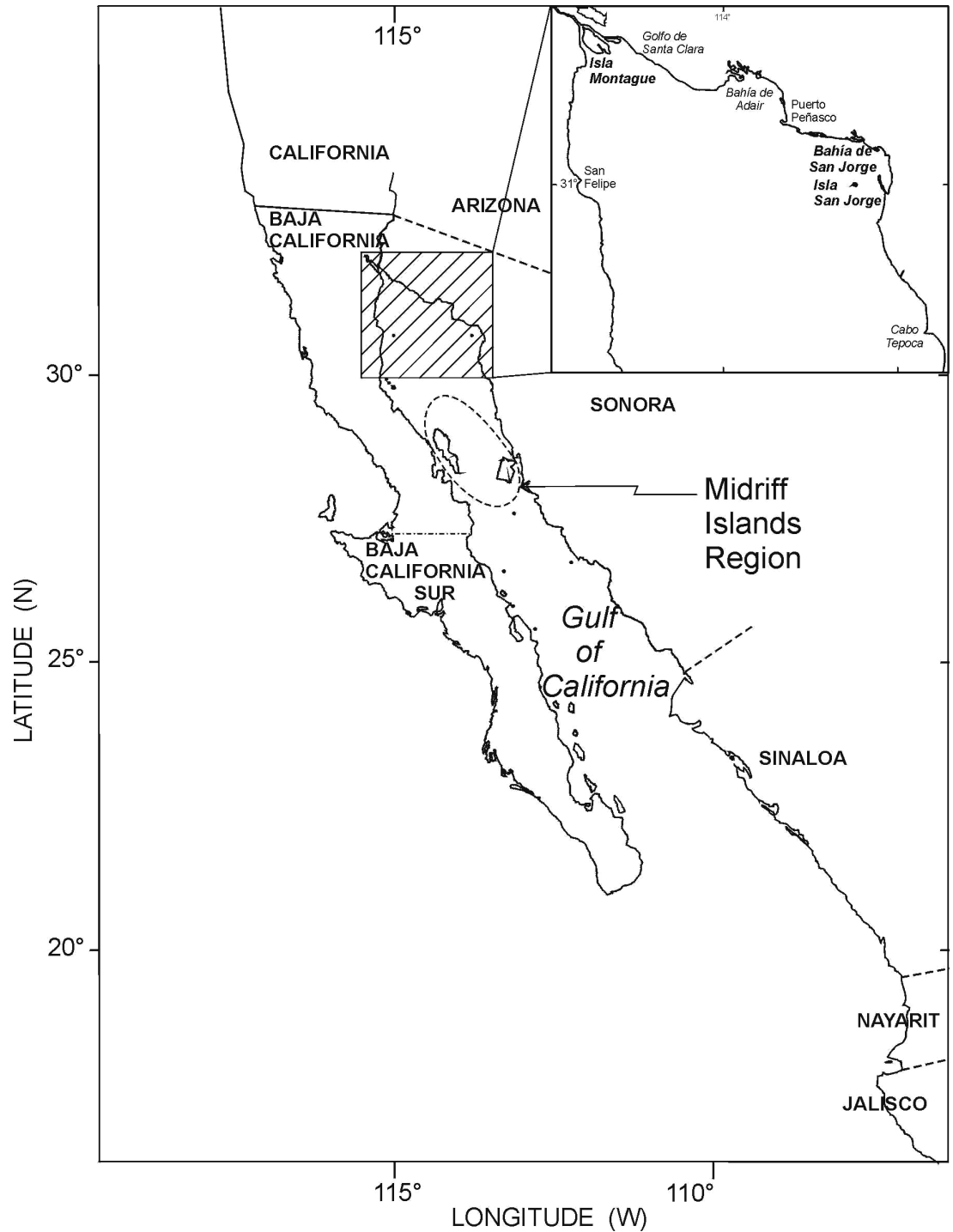


Fig. 1. The northern Gulf of California showing Isla San Jorge, Bahía de San Jorge and Isla Montague.

and Palacios, 1993) to 1145 on 9 November 1999 (J. Cervantes-Sánchez, unpublished data). On all our visits from autumn to spring we have found this species nesting. During this project they were nesting on 9 October 1997, 10 Febru-

ary, 6 April, 11 October, 22 November, and 1 December 1998, and 19 January, 23 March, 28 October, and 9 November 1999. This species suspends its breeding during the summer, and this was not different during 1998 and 1999. On 4 Septem-

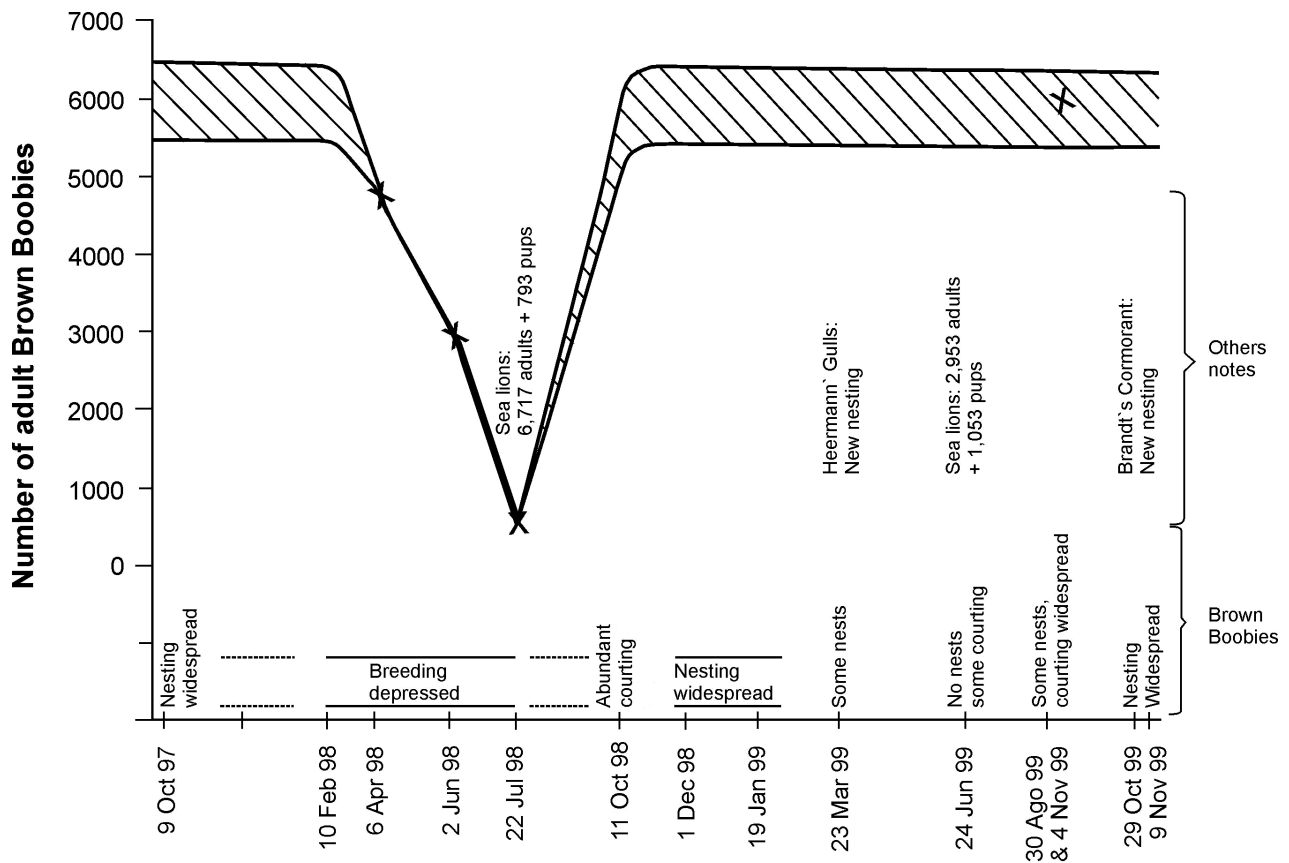


Fig. 2. Numbers of brown boobies on Isla San Jorge between the autumn of 1997 and the autumn of 1999, and other observations. The shaded area represents the range within which the population of brown boobies was supposed to be (i.e. "normal" population), the X represent actual counts.

ber 1999, after their summer breeding suspension, there were already adults in alternate plumage (J. Cervantes-Sánchez, unpublished data).

Heerman's gulls (*Larus heermanni*) were recorded nesting on Isla San Jorge on all visits reported between 1921 and 1944 (de Witt, 1939; Mailliard, 1923; Osorio Taffal, 1945), but by 1991 they had ceased doing so (Mellink and Palacios, 1993). On 23 March 1999, we found 2 nests, containing 1 and 3 eggs, on the northern flat, the site they had traditionally used for nesting. During the fall of this same year, Brandt's cormorant (*Phalacrocorax penicillatus*), a species not previously known to nest on San Jorge, established at least 19 active nests on the island (Cervantes-Sánchez and Mellink, 2001). Five nests were still active in January 2000. The nearest known colony of this species is in the midriff region of the Gulf of California, over 200 km to the south.

From 1991 to 1995, there were between 2183 and 4536 sea lions on San Jorge during the breeding season (Zavala and Mellink, 1997). During the summer of 1998 the number

of sea lions increased, remarkably, to 6717. The number of young born, however, did not reflect this increase in population. In 1999 there were 2953 adults, a value within the pre-1998 counts, but the number of pups counted was slightly higher than in other years. The number of sea lions entangled in fishing nets during the two years of study (12, and 18) was similar to that in previous years (Zavala and Mellink, 1997).

La Purinera

During 1998 the least terns arrived during early spring, their normal arriving time, and on 6 April at least 2 dozen were fishing near the colony site. In early May (4-5) there were 141 nests, the highest tally for that year. Some years ago coyotes, attracted to La Purinera by fishing refuse, learned to associate our nest markers with ready food. Therefore during this study we did not mark the nests, but rather two or three observers, 10 m one from the other, swept the entire area on foot, counting the nests. Some double-checking suggested that by using this method we might have undercounted

the number of nests by 10-20%. This would put the number of nests to between 155 and 169. A large proportion of the nests (35%) had one egg, none had three, and some pairs were courting and copulating. This suggests that this nesting attempt had recently started, likely after the spring tides of 25-28 April, as spring tides have caused failure of many or most nests in the past (Zuria and Mellink, 2002).

On 2 June there were 137 nests, the majority of which (62%) had one egg. This suggests again that spring tides of 24-27 May flooded and destroyed a large part of the colony. However, we found also 7 chicks. On 1 July there were 53 nests, most of them with chicks, 11 chicks running for cover and 7 juveniles at a feeding zone on the beach.

During 1999 the nesting colony of least terns at La Purinera was diminished. Our maximum tally, on 25 June, was 62 nests. At this time we also counted 6 chicks. On 27 August we saw adult least terns carrying fish to feed young. According to resident fishermen a large colony of least terns established itself this year on a large non-flooding flat between San Francisquito and El Jagüey, about 20 km to the south of La Purinera. This could be an alternate breeding site for San Jorge (see Palacios and Mellink, 1996).

The number of fish captured in the beach seine at La Purinera varied greatly throughout the study, but their abundance in 1998 was similar to that during 1995 (Zuria and Mellink, 2002). More importantly, silversides and anchovies, previously identified as prey of least terns at La Purinera were abundant during the summer of 1998.

Isla Montague

The analysis of the waterbirds nesting on Montague includes the snowy egret, black-crowned night-heron, laughing gull, gull-billed, least, elegant, and royal terns, and black skimmer. Great blue herons are too weary for their nests to be located effectively in short time; American oystercatchers had only 2 nests in 1998, and 1 in 1999. Search effort on Montague has been variable from year to year, as it is affected by tidal level, number of days on the island, number and enthusiasm of observers, etc. Therefore, only very large changes from year to year can be safely taken as indicators of variation. This does not mean that other, minor differences are nonexistent, but I cannot exclude them as artifacts of variations in effort. All things considered, during this decade the numbers of nests of different waterbirds have been approximately stable for some species, but highly variable for others (Table 1). Clearly, three terns (least, elegant, and royal) and black skimmers increased during 1998. Moreover, elegant and royal terns nested in similarly large numbers in 1992, another El Niño year. During 1999 numbers of all species were concordant with those recorded in non-El Niño years.

DISCUSSION

The El Niño event of 1997-1998 affected the numbers of several breeding homeotherms. However, only brown boobies were locally diminished, albeit severely so. The other important breeding species on San Jorge, the double crested cormorant, exhibited no impact. Neither did sea lions breeding on the same island in spite of their almost doubled adult population.

Very often, a nesting failure of sea birds results from food shortages. But, although photosynthetic pigments were reduced during the 1997-1998 El Niño throughout the Gulf of California, they were less so in the northern Gulf (Lluch-Cota *et al.*, 1999). The reproductive success and increased populations of sea lions, the uninterrupted breeding of double-crested cormorants, the arrival of a sizable group of blue-footed boobies, and the fish samples obtained with the beach-seine all suggest that there was abundant food in the area. The brown booby's reproductive failure must have had its origin in a factor other than fish abundance. Indeed, in June 1998 68% (relative frequency) of sea lions faeces consisted of fish species consumed at other times by brown boobies (Mellink *et al.*, 2001, Romero and Mellink, unpublished data). At this time, the diet of brown boobies consisted mostly of Pacific anchoveta (*Cetengraulis mysticetus*), a species consumed in large quantities when breeding is widespread (Mellink *et al.*, 2001). In July, 40% of components of sea lion diet fell in this category, but 30% of this was of species consumed but not preferred by the boobies. At this time, we were unsuccessful in obtaining regurgitates from brown boobies.

During the spring and summer of 1998 sea water was unusually warm (see Lavín *et al.*, this volume). This could cause the fish to swim deeper, making them more difficult for the brown booby, a plunger, to reach. The double-crested cormorant, being a pursuit diver, did not find this a severe problem, and neither did the sea lions, which can forage very deep. Similarly, blue-footed boobies forage deeper than brown boobies (Robert L. Pitman, pers. comm.)

On Isla Montague (Table 1), the increased breeding populations of some nesting species during El Niño appear to reflect poor environmental conditions, unsuitable for breeding at traditional grounds elsewhere in the Gulf, rather than of especially attractive conditions there. The closest breeding colony of elegant and royal terns to the south, from where they probably would have come to breed, is over 200 km away, on Isla Rasa, in the midriff region. It is unreasonable to expect them to reach Montague were it not for poor conditions on Rasa or on other, as yet unknown, breeding grounds. The similar increase during the 1992 breeding season, also under the influence of El Niño conditions, reinforces this. We lack knowledge of the breeding

distribution of black skimmers and on the success of most colonies of least terns during 1998, and I can therefore not elaborate further on the source of their increased populations on Montague.

The La Niña conditions of 1999 brought back normality to the colonies of brown boobies and sea lions on San Jorge, while maintaining those of double-crested cormorants, and to the nesting birds on Isla Montague. More notably, two unexpected species bred on San Jorge: Heermann's gull, which had not nested there for a long time, and Brandt's cormorant, which had not been reported to nest here before. Whether this appearance was a consequence of La Niña conditions or represents population movements at another scale will remain unknown until further data is obtained.

For the sea lions, 1999 meant more pups than in other years, although the number of adults was back to normal. This increased pup production might have been an effect of La Niña conditions. On the other hand, when determined, the number of pups has been reasonably uniform from year to year, despite changes in the number of adults on the island. This suggests that the population of breeding females on the island is, from the viewpoint of breeding habitat, at about carrying capacity.

During 1999 the least tern colony at La Purinera was drastically reduced. It is unlikely that this was the result of La Niña conditions, as the colony apparently moved only 20 km to the south, presumably under the same oceanographic conditions as La Purinera. Rather, the birds must have moved in response to some other stimuli. La Purinera is subject to frequent flooding during spring tides (Zuria and Mellink, 2002), and 1998 and 1999 were no exception. It is also used by fishermen en route to a fishing camp, and fishing appeared to have increased during 1999. Disturbance during the initial establishment of a breeding colony can cause the birds to settle on an alternative site (see Palacios and Mellink, 1996). Increased vehicular traffic, either by itself or in addition to flooding might have driven the birds away. In any case, in 1999, as in 1998, the colony was successful in raising juveniles.

CONCLUSIONS

Clearly, there was no uniform response of the homeotherms breeding in the Upper Gulf of California to the 1997-1998 El Niño, or to the 1998-1999 La Niña. Responses varied from species to species and, in the case of least terns, site to site. Some species increased their local populations at the expense of animals that failed to breed elsewhere. In the case of the sea lions, however, augmented population did not mean increased breeding. La Niña, in addition to reestablishing "normality" to the local breeding colonies of homeotherms, might have brought two previously absent species to breed in the area.

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APPENDIX

Data on brown boobies on Isla San Jorge between the autumn of 1997 and the autumn of 1999.

- 9 October 1997.- As abundant as usual (between 5000 and 6000). Breeding widespread: from nest construction to nests with eggs. Two thirds of nests examined had 1 egg.
- 10 February 1998.- Normal numbers. Southern half of the island inspected: no nests, and only 12 juveniles, 1 half-grown chick, and 16 "fresh-dead" chicks.
- 6 April 1998.- Notoriously fewer adults than normal, and only 26 nests in the entire island. A few adults courting.
- 2 June 1998.- 3031 adults and no evidence of nesting.
- 22 July 1998.- 641 adults and no sign of nesting. Unlike previous and latter visits we were unable to make any birds regurgitate.
- 11 October 1998.- Normal numbers. Breeding abundant: from courting and nest building to incubation.
- 1 December 1998.- Normal numbers. Almost all birds were sitting on young or incubating eggs; the few that weren't, were courting. One quart of the nests had chicks < 1/4 growth, and the other, mostly 2 eggs.
- 19 January 1999.- Normal numbers. From courtship and nests with eggs to large chicks.
- 23 March 1999.- Normal numbers. Still some nests with eggs, but also chicks molting their down plumage, and juveniles.
- 24 June 1999.- Normal numbers. No nests, but some adults were carrying nest building materials; others were courting. Some large chicks.
- 30 August 1999.- 6,120 adults. Most birds were courting, and a few had nests. One nest contained two chicks at least 1 month old.
- 4 September 1999.- Normal numbers. A quick visit to the lighthouse section produced 10 nests with 1 egg, and one with 2.
- 29 October 1999.- Normal numbers. 61 nests in the northern flat, one of the last areas to be used for nesting.
- 9 November 1999.- Normal numbers. 76 nests in the northern flat.

Table 1

Maximum numbers of nests recorded for waterbirds nesting on Isla Montague, delta del Río Colorado, 1991-1999

	1991 ¹	1992 ^{2,3}	1993 ^{4,5}	1994 ⁵	1998 ⁶	1999 ⁶
Snowy egret	> 100	many	87	23	129	≅ 1998
Black-crowned night-heron	several?	2?	0	10	0	5
Laughing gull	> 60	many	170	127	102	≅ 1998
Gull-billed tern	-	± 150-200	92	94	77	≅ 1998
Least tern	few	20	> 1	27	± 110	8
Elegant tern	?	± 275	0	0	160	2
Roya tern	-	± 275	0	0	135	16
Black skimmer	-	?	14	21	± 178	20

¹Palacios and Mellink, 1992; ²Palacios and Mellink, 1993; ³Mellink unpublished data; ⁴Peresbarbosa and Mellink, 1994; ⁵Peresbarbosa-Rojas and Mellink, 2001; ⁶current work.

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E. Mellink

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