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## Survival and Recruitment of Rehabilitated Caspian Terns in Southern California

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Every year thousands of birds are brought into care centers for rehabilitation in hopes that they can be treated and returned to the wild (McRuer et al. 2017). Many are victims of oil spills and other anthropogenic activities (Duerr et al. 2016; Henkel and Ziccardi 2018). In southern California, International Bird Rescue, Los Angeles (hereafter “IBR”) rehabilitates and releases 300 to 500 aquatic birds annually. Caspian Terns (*Hydroprogne caspia*) are among the many species of birds treated at IBR. Caspian Terns currently breed at three colony sites in southern California (Cuthbert and Wires 1999; Suryan et al. 2004; Collins 2006). Two of these sites—Pier 400 in the Port of Los Angeles, Los Angeles County (“Pier 400”), and Bolsa Chica State Ecological Reserve in northern Orange County (“Bolsa Chica”)—are approximately 18 km apart. The third is 180 km south on salt evaporation pond levees in the South San Diego Bay Unit of the San Diego Bay National Wildlife Refuge (“Salt-Works”) (Collins 2006). Since 2001, when IBR opened its Los Angeles facility, 69 Caspian Terns have been rehabilitated. Forty-four (63%) of these terns came from two separate incidents on barges anchored in Long Beach Harbor; nine others (13%) had injuries related to fish hooks and entanglement in fishing line. These barges presented an island-like habitat for nesting in an area that historically had islands available. Caspian Terns are known to have a prolonged post-fledging period during which young terns accompany their parents on foraging trips and migration (Cuthbert and Wires 1999), and thus it was not certain whether chicks rescued from these events and raised in captivity would survive and subsequently recruit into the breeding population.

The first barge incident took place in 2006 when an estimated 360 pairs of Elegant Terns (*Sterna elegans*) and 586 pairs of Caspian Terns nested on two barges anchored in the outer Long Beach Harbor (California Department of Fish and Wildlife, 2007 unpublished data). The barges’ owners directed their employees to wash the nests and small chicks overboard prior to moving the barges out of the area. This was an illegal activity, since these species are protected under the Migratory Bird Treaty Act of 1918 (the owners were successfully prosecuted and damages were assessed). Most of the chicks died; 413 dead chicks were recovered (California Department of Fish and Wildlife, 2007 unpublished data). Twenty-six chicks were rescued and taken to IBR for rehabilitation and release. One Caspian Tern chick was euthanized after 44 d in care because of an elbow infection; one Elegant Tern chick was euthanized on arrival because of a wing fracture. On average the chicks were in care at IBR for 46 d (range was 43–52 d). Nine Elegant Tern and 15 Caspian Tern chicks survived and were deemed strong enough to be safely released to the wild (Table 1). Since

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Table 1. Age, admission weight, and final disposition of Caspian and Elegant Tern chicks admitted for rehabilitation after 2006 and 2007 barge incidents.

Year, age	Admission weight (g)		Days in care		Disposition		N
	Mean*	Range	Mean	Range	Euthanized	Released	
Caspian Terns							
2006							
Downy	263.0	190-336	50.8	50-52		4	4
Pre-fledge	460.5	344-566	50.5	44-52	1	10	11
2007							
Downy	294.0		61			1	1
Pre-fledge	517.0	397-684	8.3**	1-32	2	25	27
Elegant Terns							
2006	178.4	74-216	41.5	1-57	1	9	10

\* Adult body mass Caspian Tern: 538-782g (Cuthbert and Wires 1999).

\*\* Mean shown includes birds kept longer due to injury.

adult Elegant Terns were still foraging in Los Angeles Harbor, the Elegant Tern chicks were released locally to join them prior to leaving on migration. Since most of the adult Caspian Terns had already departed, the Caspian Tern chicks were released at Salton Sea National Wildlife Refuge. The Salton Sea is an important migratory stop-over and foraging location for Pacific Coast Caspian Terns (Craig and Larson 2017).

The second barge incident took place in 2007 when a group of Caspian Terns nested on the flat deck of the Arctic Challenger, a large sea-going barge anchored in Long Beach Harbor (Ross 2008). The colony was estimated to be fewer than 100 pairs (Ross 2008), but it was not possible to get a definite count given that human disturbance can cause colony desertion (Cuthbert and Wires 1999). In late July 2007, several larger, nearly fledged chicks were found swimming near the barge. These had likely fallen off the flat edge of the deck, but numerous potential human disturbances that had taken place in the harbor near the barge during the nesting period may have contributed to these chicks falling into the water (Ross, 2008). Additionally, some chicks, having made a first flight off the barge, may have lacked the strength to return to the elevated deck and instead landed in the water nearby. Twenty-eight chicks were rescued and taken to IBR for rehabilitation. Chicks were deemed to be in releasable condition if in good body condition with blood values within normal limits and normal waterproof plumage, and if they were free from injuries or signs of disease. One chick with respiratory problems was euthanized. Most chicks were held at IBR for 2–5 d (Table 1), the intent being to reunite them with their colony at the barge and ideally with their parents. Four chicks were held longer at IBR because of age or injury, and were released at the Salton Sea in the same manner used in the 2006 release described above.

Twenty-three chicks were returned via boat to the vicinity of the barge over the course of several days while adults were still in the vicinity. All chicks being released were removed from transport kennels and held in hand to encourage vocalization in order to draw the attention of the adult terns on and near the barge. Once several adult terns were vocalizing and flying overhead, the chicks were allowed to fly away at will, and appeared to join the adults. It is unknown, but possible, that individual chicks were reunited with their parents or were adopted by other adults, a phenomenon reported for two other tern species

Table 2. Sightings of rehabilitated Caspian Terns at nesting colonies at Bolsa Chica and Pier 400. Identification of individual terns made by reading U.S. Fish and Wildlife Service numbered aluminum bands with a 20x-60x zoom spotting scope. Search effort varied by year.

Band number	2009	2010	2011-4	2015	2016	2017	2018	2019
925-76171	-	BC	-	-	-	-	-	-
925-76178	BC/P400	BC	-	-	-	-	-	-
1035-45297	-	-	-	-	-	P400	P400	P400
1035-45303	-	-	-	-	-	P400	-	-
1035-45312	-	-	-	P400	-	-	-	-
1035-45318	-	-	-	-	-	-	P400	-

BC = Bolsa Chica.

P400 = Pier 400.

(Saino et al. 1994). One of these chicks was discovered several days later with an injured carpal joint. An adult remained attentive by vocalizing and flying overhead until IBR staff removed the chick from the area. That injured chick was later euthanized. The ability of young Caspian Terns to dive and catch fish takes at least 60 d to develop (Cuthbert and Wires 1999). Juveniles tend to stay with, and be fed by, parents for several months (Cuthbert and Wires 1999). Accordingly, releasing young birds in the company of adults was thought to be important to their learning to forage for themselves and to follow on the subsequent migration to wintering areas. The 2007 juveniles that were released locally may have joined adults from the barge-nesting colony, and possibly their parents, before leaving on migration.

Although IBR bands most birds at release and has banded more than 24,000 rehabilitated birds since 2002, band recoveries are not common. An important question is how many rehabilitated birds survive and ultimately rejoin the breeding population. Several Caspian Tern chicks rehabilitated in 2006 and 2007 not only survived and rejoined a local breeding population, but also demonstrated subsequent nest-site fidelity (Table 2). Of the 15 chicks rehabilitated and released at the Salton Sea in 2006, two were seen breeding in 2009 and 2010 in the colony at Bolsa Chica (Table 2). One of these two was then observed at Bolsa Chica on 16 May 2009 and identified at Pier 400 on 25 June 2009. Such inter-colony movement of breeding adults between Bolsa Chica and Pier 400 was noted previously (Collins 2006). Of the 23 terns released in Long Beach Harbor in 2007, four have been sighted as adults breeding in the Pier 400 colony (Table 2).

Caspian Terns typically start breeding when three years old (Cuthbert and Wires 1999), but none of the 2007 chicks were observed until they were eight to ten years old. No searches for banded Caspian Terns have been made at Salt-Works since 2007. One additional encounter with a banded tern was discovered in an examination of North American encounter data for Caspian Terns provided by the USGS Bird Banding Laboratory. In this encounter (1035-45301), the bird was recovered on 23 May 2011 near Laguna Beach in southern Orange County after becoming entangled in fishing line. Unfortunately, the band was removed before the bird's release, so any affinity to one of the breeding colonies could not be determined. Annual survival of adult Caspian Terns is high, with some individuals reaching an age of >26 yr (Ludwig 1965). An adult originally banded as a chick at Bolsa Chica was observed at Pier 400 in 2017 at 23 years of age. However, the period of greatest mortality for Caspian Terns is the first six months of life (Ludwig 1942; Ludwig 1965), and only 57% of fledglings reach adulthood on the Pacific Coast (Gill and Mewaldt 1983).

We do not know which colonies were used by the unbanded barge-nesting adult terns in the years subsequent to 2006 and 2007. The fidelity of first-time breeding Caspian Terns to their natal colony is low (10%) (Cuthbert and Wires 1999). However, older adult Caspian Terns show substantial colony-site fidelity, with 69% being recorded at the same colony two years in a row, particularly if they bred successfully in the first year (Cuthbert 1988; Cuthbert and Wires 1999), and 29% breeding at nearby colonies. One of the 2006 chicks in this study bred in two successive years at Bolsa Chica, and one of the 2007 chicks bred in three successive years at Pier 400 (Table 2). The future survival and degree of colony-site fidelity of other 2007 individuals remain to be determined.

The observations reported here provide information on the survival of some of the Caspian Terns rehabilitated in southern California and their subsequent recruitment into a local breeding population. These observations also support high nest-site fidelity in this species. The rehabilitative efforts described were aided by several factors: the chicks entered care in sizable groups rather than as single chicks, many of the chicks were pre-fledglings so had spent several weeks with their parents, and the release locations and circumstances were very carefully chosen. Barges are not thought to be preferable to natural locations as nesting sites for Caspian terns, except possibly as a temporary option when new natural sites are being developed. The limited success in rearing young tern chicks in captivity, as documented here, does not suggest this is a viable alternative for augmenting populations of critically endangered species such as the Chinese crested tern (*Sterna bernsteini*). However, our results do suggest that, when properly conducted, ex situ conservation methods may prove successful in salvaging individuals that might otherwise perish because of an acute calamity at a critically endangered breeding colony. It remains possible that Caspian Terns may be more behaviorally flexible than previously thought with regard to acquiring adult life skills, but this may or may not be the case for other tern species.

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