

## ROYAL TERN NESTING ATTEMPTS IN CALIFORNIA: ISOLATED OR SIGNIFICANT INCIDENTS?

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Only four nesting attempts are known for the Royal Tern (*Sterna maxima*) in California, all at the San Diego Bay salt evaporating ponds. This paper describes the two most recent nesting attempts in detail and discusses all four attempts in terms of coincidental events in California fish stocks of the close inshore area.

### PREVIOUS NESTING RECORDS

The first known nesting attempts in California by both the Royal Tern and Elegant Tern (*S. elegans*) occurred in 1959 on the dikes separating the salt evaporating ponds at the south end of San Diego Bay, San Diego County, California (Gallup and Bailey 1960). The attempt, by a single pair of Royal Terns, failed. The egg was collected by Gallup and is on deposit at the Western Foundation of Vertebrate Zoology, Los Angeles (WFVZ 114, 199-1). It measures 62.8 x 44.9 mm.

In 1960 a second nesting attempt was reported without details (Small 1960) to have involved at least 30 nests and produced many young, but no nests of this species were found in 1961 (Small 1961).

### RECENT NESTING ATTEMPTS

In spring of 1980 a single pair of Royal Terns attempted to nest on the saltworks dike separating ponds 35 and 33 (circled "a," Figure 1) in the colony of Elegant Terns, which numbered 607 breeding pairs in 1980, 861 in 1981 and 800 in 1982. The nest scrape with its single egg was located on the periphery of a group of 32 Elegant Tern scrapes. Amongst this group also were three Caspian Tern (*S. caspia*) nests—two containing two eggs and one containing three eggs. (The number of Caspian Tern breeding pairs at the saltworks was roughly 400 in 1980 and 1981 and roughly 350 in 1982.)

I discovered the Royal Tern egg on 9 May and at that time one Royal Tern could be seen nearby. Later that afternoon, from a vantage point off the breeding dike, I saw two Royal Terns together at the nest and observed them for about 2 hours, until darkness set in. On 11 May I did not see the Royal Terns at the nest site and I found the egg with a number of puncture holes, cracked and lying in a pool of its own former contents. This was apparently the work of Ruddy Turnstones (*Arenaria interpres*), which I had previously observed destroying Elegant Tern eggs in a similar fashion, much like the Ruddy Turnstone predation on Sooty Tern (*S. fuscata*) eggs on Eniwetok Island (Crossin and Huber 1970). Within a few days the Royal Terns were no longer seen in the area.

I collected the damaged egg and deposited it at the Western Foundation of Vertebrate Zoology (WFVZ 125, 645). It measures 68.0 x 40.8 mm, which compares favorably with other eggs in the WFVZ collection, as well as with

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the measurements of 63 x 45 mm suggested by Harrison (1978) as average for Royal Tern eggs.

The most recent breeding by Royal Terns occurred at the San Diego saltworks during 1982. On 8 May I discovered two Royal Tern nest scrapes, each with a single egg, in a group of about 230 Elegant Tern nest scrapes atop the north to south running arm of dike 33/5 (circled "b," Figure 1). The first nest was with a group of three Elegant Tern nests, placed about 1 m from the south edge of the large Elegant Tern nesting group. The second nest was about 10 m north of the first nest, towards the middle of the large Elegant Tern nesting group and on its western periphery.

The egg of the first nest measured 62.4 x 42.3 mm and had an off-white ground color with an approximately random pattern of medium-to-large dark brown spots, and was similar in appearance to the 1980 egg. The egg of the second nest had a pale beige or buff ground color and was completely covered with a rather uniform pattern of small-to-medium dark brown spots. It measured 62.9 x 42.8 mm.

On 10 June the first nest contained a chick which may have hatched up to 2 days previously. The chick had bright orange legs and bill. Its down was a pale yellow color, lightly overlaid with small brown spots.

On 18 June the second nest contained a chick which was approximately 3 days old. This chick also had bright orange legs and bill but its down was a medium yellow-beige color, heavily overlaid with medium-to-large dark brown spots.

On this visit I banded both chicks (USFWS bands 664-81701 and 664-81702), each on the left leg. I also examined the nest scrapes and in the first nest I found two Northern Anchovies (*Engraulis mordax*) measuring 6.0 and 7.2 cm, standard lengths. I also recovered a regurgitation consisting of a small 6.2 cm (standard length) Northern Anchovy from the older chick. The regurgitations of the smaller Elegant Tern chicks consisted of larger specimens of *E. mordax*, ranging from 8.0 to 13.2 cm (standard length) and averaging 10.0 to 11.0 cm (standard length).

After the banding and above-mentioned collections were completed, the older chick became ambulatory while the younger chick remained quiet in its nest. On 23 June both Royal Tern chicks had entered the creche (nursery flock) of Elegant Tern chicks. On this visit and again on 1 July I recovered both chicks from the creche and collected their regurgitations. The regurgitations consisted primarily of partially digested tail pieces. These appeared to be fragments of fairly large (15 to 20 cm) atherinids, probably the very common Topsmelt (*Atherinops affinis*). Some fragments were probably surfperch (Embiotocidae). I also recovered a 5.5 cm (standard length) specimen of an anchovy, *Anchoa*.

Interestingly, on all visits up to 23 June each Royal Tern chick was attended by both parents, unlike the Elegant Tern chicks which were usually attended by only one parent or left unattended in the creche. On 1 July I found the younger chick attended by both parents and the older chick attended by a single parent.

During the last week of May 1982 the Elegant Tern colony was invaded by a pair of stray dogs. They destroyed a section of the colony on the northeast to southwest running arm of the dike 33/5 and on dike 36/37 (Figure 1) which

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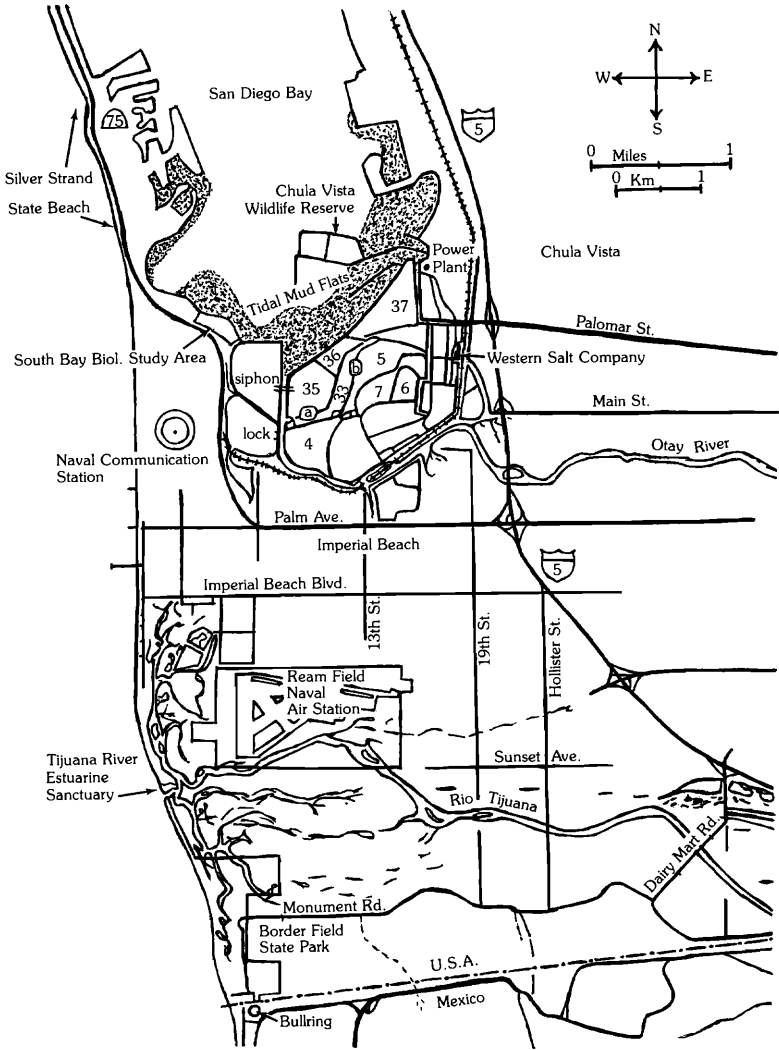


Figure 1. The south San Diego Bay area including the salt evaporating ponds and the Tijuana River sloughs (Tijuana River Estuarine Sanctuary): a = the location of the unsuccessful 1980 Royal Tern nesting attempt; b = the location of the 1982 successful nesting by two pairs of Royal Terns.

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had few nests of aggressive Caspian Terns associated with it, leaving this area almost completely unprotected. I found over 100 dead Elegant Tern chicks, all badly mauled. Many more chicks were missing. Fortunately, however, the section of the colony in which the Royal Tern chicks were located had many associated Caspian Tern nests. The dogs never penetrated this area and both Royal Tern chicks were seen in the creche again on 19 June, capable of short hop-and-glide flights.

By this time the Royal Tern chicks were visited only intermittently by one or both parents and, by 1 August, either chick could be seen flying, following one or both of its parents over the saltworks or over the Tijuana River sloughs (Tijuana River Estuarine Sanctuary, Figure 1), where the Royal Terns frequently foraged. On such occasions the parent that was followed usually carried a large fish. I was seldom able to identify positively the fish being carried, but in very few instances did the fish show the familiar silver and black appearance of *E. mordax*, which constitutes the great bulk of the Elegant Tern diet (Schaffner 1982). I tentatively identified most of these fish as Atherinidae, again, probably Topsmelt.

## DISCUSSION

Although there may have been other intermittent but unreported Royal Tern nesting attempts at the San Diego saltworks during the past 25 years, the possibility seems unlikely, given the many very competent observers visiting the saltworks over the years.

The nearest Royal Tern breeding colony is on Isla Raza, Mexico, roughly 600 km south of San Diego in the Gulf of California, Mexico, where they breed in mixed groups with Elegant Terns and Heermann's Gulls (*Larus heermanni*; Walker 1965, Lindsay 1966). A portion of the populations of all three species migrates north into California at the close of each breeding season and this site is almost certainly the point of origin of the Royal Terns which nested at San Diego, as well as the San Diego Elegant Tern breeding population itself, as Isla Raza appears to be the closest and largest regularly active colony.

Schaffner (1982) discussed the dependence of California Elegant Terns (both breeding and visiting) on *E. mordax*, noting that the establishment of the San Diego Elegant Tern breeding population coincided with the expansion of *Engraulis* stocks in southern California waters and that current seasonal movements of California Elegant Terns and *Engraulis* are roughly similar.

Royal Terns, however, have not followed the same trends as Elegant Terns in California. Although Royal and Elegant terns typically occur together in San Diego Bay immediately before and after the nesting season, visiting Royal Terns occur in California relatively more often in winter and less often in fall and spring, in contrast to Elegant Terns, which are more commonly seen in the fall and the spring than in winter. What is especially interesting is that the occurrence of the Royal Tern in California has, except perhaps for these recent years, decreased markedly since 1950 (Cogswell 1977). Thus, the historical occurrence of the Royal Tern in California is unlikely to have been related to Northern Anchovy abundance and distribution but is likely to be related to the abundance and distribution of the Pacific Sardine (*Sardinops sagax*), which experienced a tremendous population crash in the 1940s resulting in near extinction by 1950 (MacCall 1979, 1984). Ainley and Lewis

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(1974) and Baldrige (1973) presented very good evidence regarding the severe impact of the disappearance of Pacific Sardines on cormorants, puffins and especially on Brown Pelicans (*Pelecanus occidentalis*) in California waters farther north (Farallon Islands and Monterey).

Although the commercial sardine fishery was primarily centered around Monterey, the Pacific Sardine was very widely distributed throughout California waters, extending from far offshore to shallow inshore areas (Murphy 1966, 1968). According to many old-time fishermen in the San Diego area, during their peak population years such as 1936, sardines could be found in great abundance inshore within the breakers and just a few meters from the beach. With the possible exception of *E. mordax* during its period of peak abundance in the 1960s (Smith 1972, Smith and Eppley 1982), there has thus far been no significant replacement of the Pacific Sardine by any species in close inshore areas.

The close inshore components of the sardine and other fish populations are of particular interest because the Royal Tern tends to be a warm-water littoral species and is primarily an inshore coastal forager (Murphy 1936, Buckley and Buckley 1972, Blake 1977), in contrast to the small-bodied "crested terns" (*Thalasseus* subgenus; AOU 1976) such as the Elegant Tern, which tends to forage farther offshore (Schaffner 1982). Furthermore, the other large-bodied crested tern, the Swift or (Greater) Crested Tern (*S. bergii*), is also an inshore forager (Ashmole 1968, Hue and Etchecopar 1970, Henry 1971, Feare 1975, Etchecopar and Hue 1978); in Australia *S. bergii* is recognized as an indicator of shoals (schools) of Pilchard, a *Sardinops* sardine (Serventy et al. 1971).

Sardine abundance in California remained extremely low during the 1950s, but during a warm-water period from 1957 to 1960, Pacific Sardine (and *Engraulis*) stocks briefly improved (MacCall 1979, 1984). Royal Terns nested in San Diego in 1959 and 1960 (Gallup and Bailey 1960; Small 1960, 1961), and many other marine organisms also extended their ranges northward during 1957 to 1960 (Radovich 1960, 1961).

Like most of the other crested terns, the Royal Tern tends to be non-aggressive towards most potential predators and may require the presence of other, more aggressive larids at its breeding colonies for protection, in addition to topographical requirements such as relatively isolated locations with good visibility of surroundings. In European Sandwich Tern (*S. sanduicensis*) colonies this protection is provided by the Common Black-headed Gull (*Larus ridibundus*; Veen 1977), and in southeastern U.S. Royal Tern colonies, protection may be provided by the Laughing Gull (*L. atricilla*; Buckley and Buckley 1972). In coastal California an important aggressive predator-mobbing larid is the Caspian Tern, which provides the San Diego Elegant Tern colony with predator protection in a fashion similar to that of the medium-sized gulls mentioned above (Schaffner 1982). Thus, the prior establishment ca. 1940 of the Caspian Tern breeding colony (Emblen 1954, Schaffner 1982, Gill and Mewaldt 1983) was probably a prerequisite for Elegant and Royal tern breeding at the San Diego saltworks.

Considering the above, it is unlikely that any adequate breeding site for Royal Terns existed within easy reach of the food supply during the period of peak *Sardinops* abundance. Significant Caspian Tern breeding colonies did

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Figure 2. Royal Tern (foreground) and Elegant Tern at San Diego, May 1982.



Figure 3. Nesting Royal Tern (center foreground) with nesting Elegant and Caspian terns at San Diego, May 1982.

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Figure 4. Royal Tern egg (of first nest of 1982 at San Diego), center, compared to Elegant Tern egg (left) and Caspian Tern egg (right).



Figure 5. Chick of first Royal Tern nest of 1982 at San Diego, in its nest scrape.

*Photos by Fred C. Schaffner*

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not exist in coastal California at that time; the establishment of the San Diego and other coastal California breeding colonies was apparently the result of extensive alteration of inland nesting habitat between 1910 and 1940 which forced Caspian Terns to seek other nesting areas. The major California Caspian Tern colonies now occur along the coast and, like the San Diego colony, tend to be associated with human-created habitats (Gill and Mewaldt 1983). The recent successful nesting of two pairs of Royal Terns is in part also due to the presence of the Elegant Terns, with whom they share the important social characteristics of extremely dense and gregarious nesting groups and creche formation.

The recent California Royal Tern breeding probably indicates some degree of change in the local coastal marine environment and its fish fauna. Southern California coastal waters have been experiencing a slight warming trend over the past few years (Alec MacCall pers. comm. 1982) and there has been a slight increase in Pacific Sardine abundance as well, though this change should in no way be taken as the beginning of a recovery (Klingbeil 1981). The important factors relevant to Royal Tern breeding in California, however, are the abundance and availability of close inshore schooling fishes in general, and not *Sardinops per se*.

The fishes of greatest interest are the atherinids and engraulids which inhabit the several river mouths and adjacent estuaries of northern San Diego County, the shallow water areas of the Coronado Islands and especially the Tijuana River sloughs, a principal foraging area for the Royal Terns which bred at San Diego. Atherinids of various age classes are common and abundant and may be increasing in the Tijuana River sloughs and adjacent areas; and, although detailed information is as yet unavailable, some circumstantial evidence suggests an increase in the abundance of larval and juvenile stages of the engraulid, *E. mordax*. Larval and juvenile *Engraulis* of up to about 6.0 cm standard length have become increasingly apparent over the past two breeding seasons (1981 and 1982) at the nest sites of the 1000 or so Forster's Terns (*S. forsteri*) which breed at the San Diego saltworks. *Engraulis* specimens of up to 1 year of age (roughly 10.0 cm standard length; Huppert et al. 1980) were first observed at Caspian Tern nest sites in 1981 and were quite apparent in 1982. Specimens of 1- to 2-year-old *Engraulis* measuring 11.0 to 15.0 cm were commonly found at Caspian Tern nests in 1981, somewhat less commonly in 1982, but not at all in 1980. Yet, *Engraulis* is a minor component of the local Caspian Tern diet, the major component being the large 15.0 to 25.0 cm Topsmelt from the Tijuana River sloughs and other nearby coastal saltwater and brackish water areas.

Additional circumstantial evidence of an increase in the abundance of close inshore fishes comes from Black Skimmers (*Rynchops niger*), which first began breeding at the San Diego saltworks in small numbers during the mid-1970s (Gerald Collier, Michael Evans pers. comm.). The Black Skimmer population increased to some 60 pairs in 1982. Fishes collected at their nest sites include 2.0 to 6.0 cm Longjaw Mudsuckers (*Gillichthys mirabilis*), 4.0 to 6.0 cm California Halibut (*Paralichthys californicus*) and an abundance of larval and juvenile atherinids and engraulids measuring up to about 7.0 cm. During 1982, engraulids measuring 4.0 to 6.0 cm and *Paralichthys* of similar lengths were especially apparent.



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### SUMMARY

Royal Terns visiting California prior to 1950 probably relied heavily on Pacific Sardines as a food source. At present Royal Terns appear to feed on atherinids and engraulids. The establishment of the Caspian Tern breeding colony at San Diego was probably a prerequisite for the utilization of that site by both Royal and Elegant terns. The recent (1980, 1982) Royal Tern nesting attempts in California may not be mere isolated incidents, but may indicate at least local changes in the coastal marine environment and its fish fauna, particularly increases in some close inshore fish stocks. Future increases or decreases in the abundance and frequency of occurrence of both visiting and nesting Royal Terns are likely to reflect similar changes in the abundance and availability of their food supply.

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