

BREEDING STATUS AND DIET TRENDS OF TWO CALIFORNIA LEAST TERN COLONIES IN THE SAN FRANCISCO BAY

ABSTRACT

The two largest colonies of the California least tern (*Sterna antillarum browni*) in the San Francisco Bay area, Alameda Point and Hayward, are located 10 miles apart. The Alameda Point colony, on the former Naval Air Station, Alameda, has grown at an average rate of 9.2% per year since its inception in 1976. Long-term breeding success at Alameda has averaged 0.86 fledglings per breeding pair. Breeding success increased through the 1980s, declined through the 1990s and the early 2000s, and increased again in the last five years. The Hayward colony, located on an island created from dredge materials in 2001 has been enhanced with additional substrate materials, vegetation management, social attraction devices, and predator management. Least terns began appearing at this island in 2003, and successful breeding attempts have been observed since 2006. This colony has grown at an average rate of 51.5% per year. Long-term breeding success has averaged 0.87 fledglings per breeding pair, despite lower success rates in 2008 and 2009. Dropped fish have been collected from both colonies, and silversides (family Atherinopsidae) are the dominant dropped prey at both sites. Hayward terns forage mainly on nearshore species in the shallow marsh waters near their breeding site; Alameda terns forage on a greater variety of species found in both shallow and deeper waters of the Central and South Bay. While Atherinopsids remain the dominant dropped prey, northern anchovy (*Engraulis mordax*) and surfperches have declined since the 1990s.

STUDY AREA

The Alameda Point colony is situated on the runway complex of the former Naval Air Station, Alameda, California (Figure 1). The air station closed in 1997; is now known as Alameda Point and is owned by the United States Navy. The tern breeding site is 9.7 ac. The Hayward Shoreline colony is located within the Hayward Regional Shoreline marsh complex, Hayward, California (Figure 1) and is operated by the East Bay Regional Park District. The least tern island is 0.6 ac in size.



Figure 1. The locations of the Alameda Point and Hayward Shoreline Least tern colonies. They are the two largest colonies north of San Luis Obispo County and are 23 km apart.

METHODS

Data collection to determine nest distribution, chronology of nesting, and reproductive success has primarily been accomplished using the Type 1 method (active monitoring inside colony by permitted biologists) and Type 2 methods (passive monitoring outside colony by staff or volunteers). These types of monitoring allows for quantitative comparisons to be made among sites and years.

Prior to 2000, dropped fish were collected opportunistically during the breeding season and identified to the lowest taxonomic category possible. From 2000-2010, dropped fish were collected during each in-site nest survey. Each specimen was identified to the lowest taxonomic level possible.

Similarities	
<ul style="list-style-type: none"> • Successful breeding colonies • Substrate • Predator and site management • Use of Volunteers 	
Differences	
Alameda Point	Hayward Shoreline
More urban surroundings	More secluded
Declining population – Emigrating to other northern CA colonies?	Increasing population – Predator management? Alameda terns?
Increasing productivity – More predator deterrents? More anchovy in diet?	Stable productivity – Carrying capacity?
More diverse diet – Foraging in Bay	Less diverse diet – Foraging in ponds/ marshes
Three other nesting species	Nine other nesting species

Table 1. Similarities and differences for the Alameda Point and Hayward Shoreline California least tern colonies.

RESULTS

Since the colony's inception, the Alameda Point population has increased yearly in the number of least tern pairs and nests. However, the colonies productivity has varied. It increased through the 1970s, 1980s and then declined through the 1990s and early 2000s. 2005 was the peak year with 424 breeding pairs. Depredation events by burrowing owls are attributed to the decrease in 2006. The average annual growth rate for this colony is 9.2% per year (Figure 2). Despite the population decline in recent years, the breeding success and productivity of the colony is improving. The nesting density for this colony ranges from 1-153 nests per ha (0.5-62 per ac) (Figure 6).

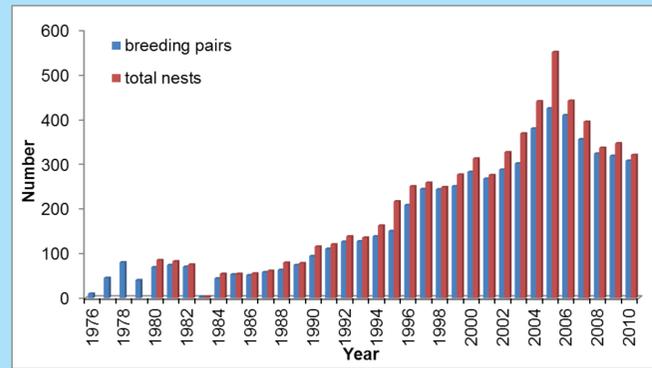


Figure 2. The average annual growth rate of 9.2% for the Alameda Point California least tern colony.

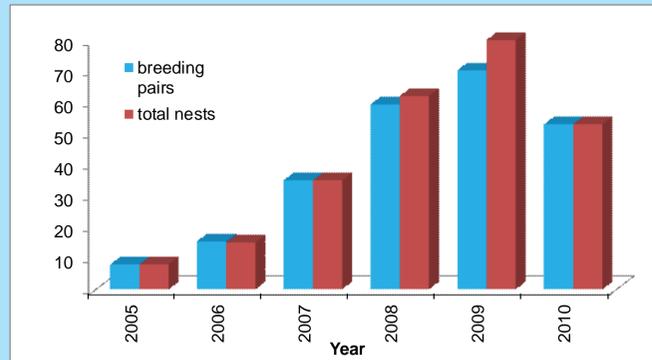


Figure 3. The average annual growth rate of 51.5% for the Hayward Shoreline California least tern colony.

California Gull depredation at the Hayward site resulted in complete colony failure in 2005 and near colony failure in 2006. Starting in the 2007 nesting season a predator/gull management effort started and the colony increased dramatically. 2009 was the peak year with 70 breeding pairs and 80 nests. This colony has a 51.5% average annual growth rate (Figure 3). The nesting density for this colony ranges from 33-333 nests per ha (13-133 per ac) (Figure 6).

Based on twenty-five years of dropped fish data for the Alameda colony 19 different families have been collected of which three have been the most common. Atherinopsidae are the most abundant family followed by Engraulidae (northern anchovy) and Clupeidae (pacific herring) (Figure 4). The northern anchovy was frequently collected during most of the 1980s and 1990s, has declined in the 2000s, with the exception of 2009. The opposite appears true for pacific herring which became more abundant in the 2000s, especially in 2008. Based on five years of dropped fish data for the Hayward colony, 6 different families have been collected of which Atherinopsidae are the most abundant fish (Figure 5). Freshwater fishes, like killifishes (Fundulidae) are common at this site due to the brackish water marsh, as compared to the open Bay environment available to the Alameda terns.



A recently hatched California least tern chick.



California least tern with a silverside (family Atherinopsidae).

DISCUSSION

These two successful least tern colonies located in San Francisco Bay estuary, the northern end of the range for this species have several similarities and differences (see Table 1). For example the Alameda site is in a more urban setting, while Hayward is secluded along the shoreline. The Alameda population has declined in recent years, while the Hayward colony has increased. This could be explained by terns moving from Alameda to other sites. Alameda productivity is on the rise, possibly due to fewer predators and more energy-rich fish in the diet. Hayward productivity is stabilizing, suggesting that this could be due to the island reaching its carrying capacity or the spread of a noxious weed [mayweed chamomile (*Anthemis cotula* L.)] which limits tern nesting space by confining them to just a few open areas. Alameda terns have a more diverse diet than Hayward, which can be explained by the different foraging habitats they utilize. Herring and anchovy are both rich in lipids and could be considered a favorable fish to terns and may help explain the increased breeding success at the Alameda colony. More years of data will help us see if this trend continues.

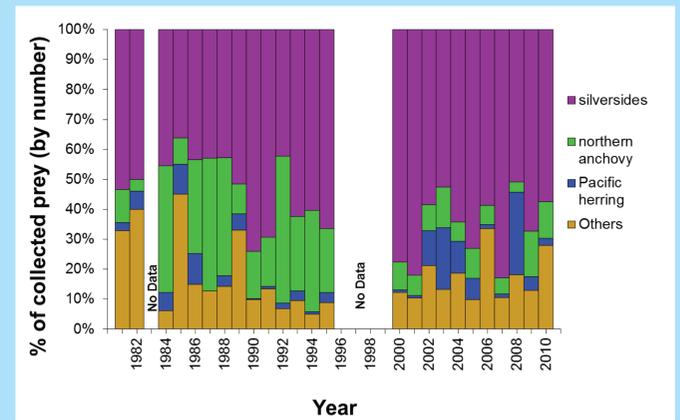


Figure 4. Twenty-five years of dropped fish data for the Alameda Point California least tern colony representing 19 different families with the Atherinopsidae being the most abundant followed by Engraulidae and Clupeidae.

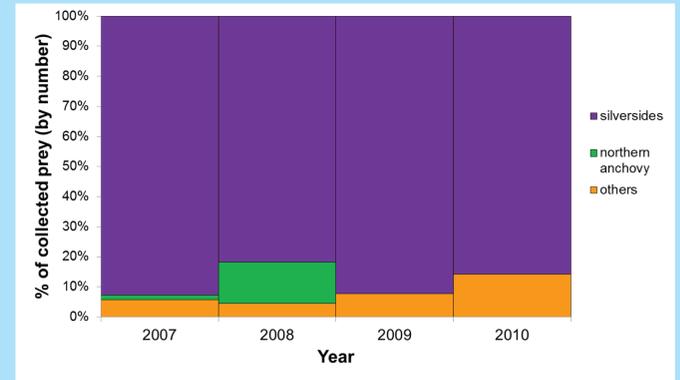


Figure 5. Five years of dropped fish data for the Hayward Shoreline California least tern colony representing 6 different families with the Atherinopsidae being the most abundant followed by Fundulidae.

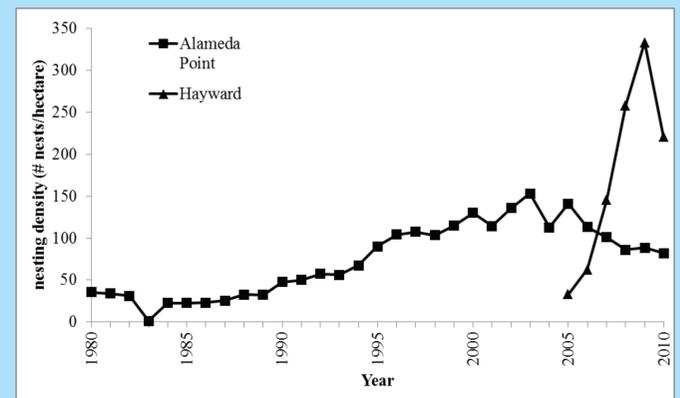


Figure 6. Nesting density for the Alameda Point and Hayward Shoreline California least tern colonies.

AUTHORS