ID# 63507

Poster Number P2-152

STATUS OF THE ENDANGERED CALIFORNIA LEAST TERN: POPULATION TRENDS AND INDICATORS FOR THE FUTURE

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ABSTRACT

The California Least Tern (CLT) is a small seabird that nests in several protected nesting sites on the coast of California, USA, as well as parts of coastal Mexico. Following listing as an endangered species, the California population[1] increased from 664 in 1976 to approximately 7,000 in 2009. The majority of the increase occurred during the 1990's, following the initiation of focused predator management. Despite ongoing protection efforts, egg and chick predation by several avian and mammalian species at many sites, as well as fluctuations in prey abundance and chronology, have resulted in low reported levels of productivity[2] in recent years. Thus, although annual estimates of breeding pairs suggest a continued slow increase, many CLT researchers predict a sudden population decline. However, estimates of breeding pairs and fledglings are not systematically and consistently calculated. Thus, we analyzed several other breeding variables derived from field data. Results suggest large annual variations, but, aside from a statistically-significant decline in clutch size, no significant change over time in egg abandonment, egg predation, chick/fledgling mortality or chick/fledgling predation.

[1] *estimated number of breeding pairs*
[2] *estimated number of fledglings*

INTRODUCTION

The California Least Tern (*Sternula antillarum browni*), a small (9-inch, 20-inch wingspan) is one of three Least Tern subspecies breeding in North America. In California, nesting sites extend along the coast from San Francisco Bay to the U.S./Mexico border. California Least Terns (CLT) presumably winter in Central or South America, although the location and extent of their wintering range remains unknown. CLT forage in ocean, bays, estuaries and freshwater lakes.

CLTs historically nested in small, loosely aggregated colonies on sandy beaches and estuarine salt flats. A progressive loss of habitat in the late 1800 resulted in severe reductions in nesting sites and nesting pairs (Chambers 1908). By the 1940's, CLT were gone from most Southern California beaches (Grinnell and Miller 1944).

Following federal listing as an endangered species and subsequent development and implementation of a Recovery Plan, the number of protected CLT nesting areas increased from 23 sites in 1976 to over 40 in 2009 (Marschalek 2009; Figure 1). Population estimates also escalated exponentially from 664 nesting pairs in 1976 to over 7,000 in 2009 (Marschalek 2009; Figure 2). Fencing at most sites has limited human disturbance. However, most are located near suburban, military or industrial areas, which support a variety and abundance of both native and non-native animals documented as predators on CLT eggs and young. Management of predators not considered protected species (Figure 3) is conducted at most nesting sites; nevertheless, high predation levels and resulting low fledgling estimates are still reported at some sites during some years. In addition, CLT prey (Figure 4) availability and chronology appears to have changed recently due to factors such as ENSO events. Thus, although the estimated number of nesting pairs continues to increase at a slow rate, fledgling estimates have declined (Figure 2).

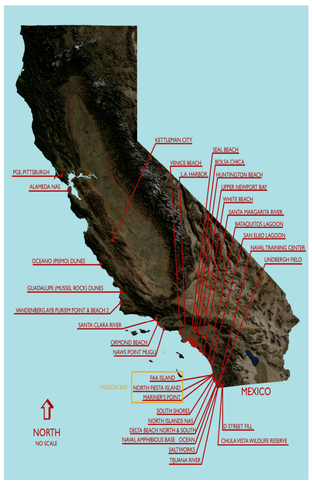


Figure 1. Locations of California Least Tern Nesting Sites in California, 2009

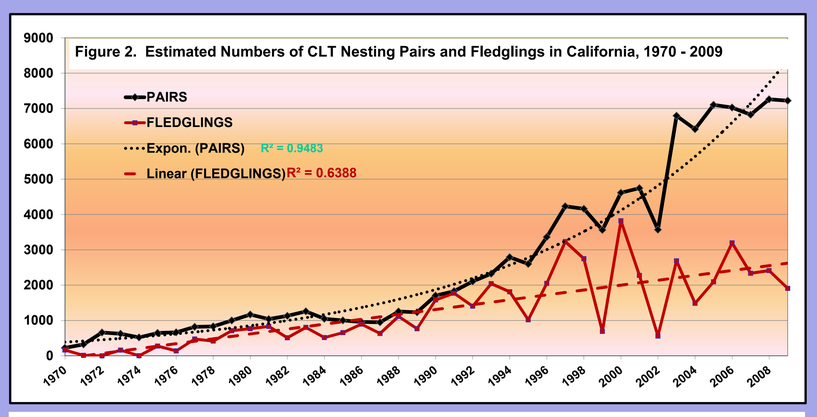


Figure 3.Peregrine Falcon, one of over 40 potential CLT predators

Figure 4. CLT adult feeding a chick; one of approximately 50 documented prey species collected at nesting sites and/or observed as chick prey items

METHODS

Since the 1970's, when CLT protection efforts were initiated, population status & reproductive success have been evaluated using two variables, respectively: annual estimates of nesting pairs and of fledgling numbers. The first is derived by one of three methods, all of which require a best guess at the number of pairs re-nesting, which are subtracted from total nests to arrive at total pairs for each site. Four methods are approved for estimating fledglings (e.g, Figure 5). Some CLT researchers use a combination of methods, but most rely at least in part on fledgling censuses, although census methods are inconsistent and CLT nesting is rarely synchronous. Thus, an attempt at a CLT population viability analysis concluded:

Figure 5. Reading the band number of a CLT near-fledgling as part of the band-recapture method of estimating chick survival to fledging. This method is likely the most reliable for estimating fledglings but is

"Although there are substantial data on the demography of California least tern populations, there is also considerable uncertainty, because data on survival (based on capture-recapture) and on fecundity (from counts of fledglings) are inconsistent with the observed growth of the population." (Akcakaya et al 2003) (e.g, Figure 6).

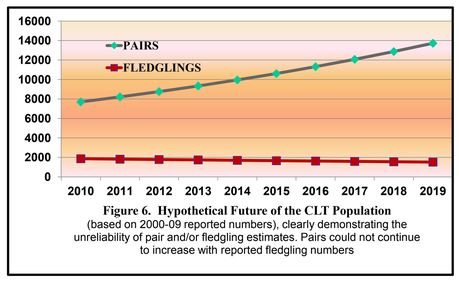
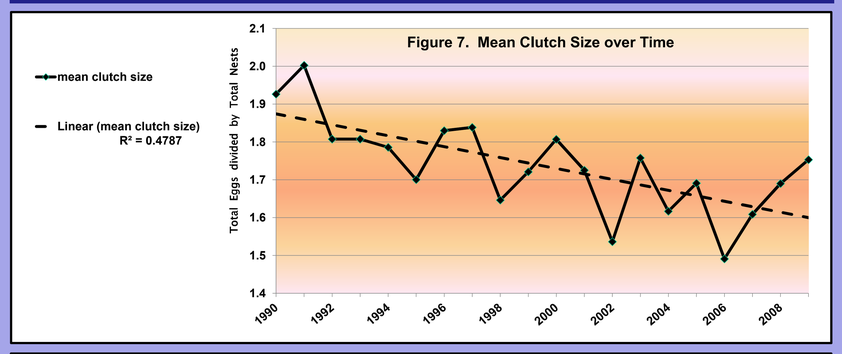


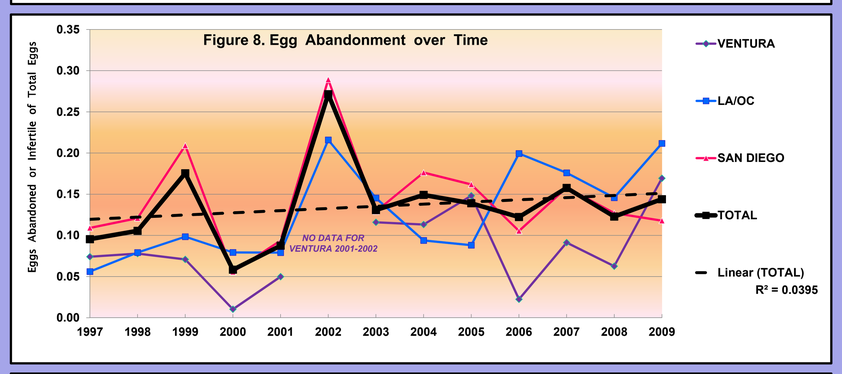
Figure 6. Hypothetical Future of the CLT Population (based on 2000-09 reported numbers), clearly demonstrating the unreliability of pair and/or fledgling estimates. Pairs could not continue to increase with reported fledgling numbers

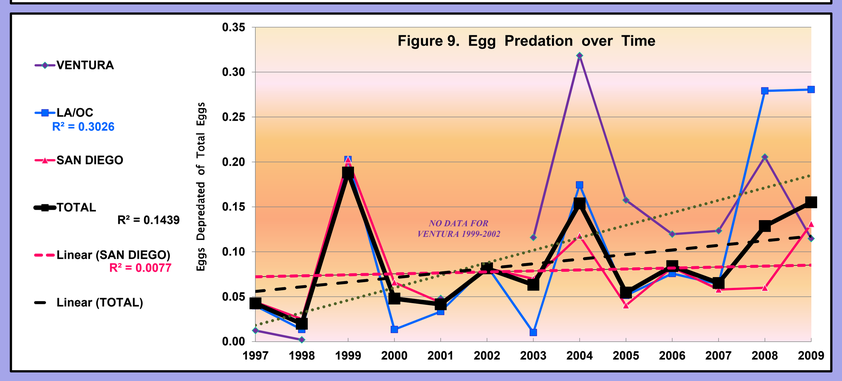
This finding, and response to concerns, based on several years of low fledgling estimates, that the CLT population is headed for a crash, prompted us to examine several breeding variables to determine whether a trend was evident. Data from 28 to 35 Southern California (90-95% of the population) nesting sites per year were combined for a total as well as separated by region, for a regression analysis on each variable (see below). In addition to R^2, we calculated the *t*-statistic to test the significance of the slope (ß) of the regression line (H_0; ß = 0, [the slope is NOT significantly different from zero], H_A; ß ≠ 0 [the slope IS significantly different from zero], $\alpha = 0.05$). *Post-hoc* power analysis was also conducted to ensure that sample size was sufficient.

Our null hypotheses are: No statistically significant changes over time are evident in:
- **> Mean Clutch size**
- **> Egg Abandonment**
- **> Egg Predation**
- **> Chick/Fledgling (non-predator) Mortality**
- **> Chick/Fledgling Predation**

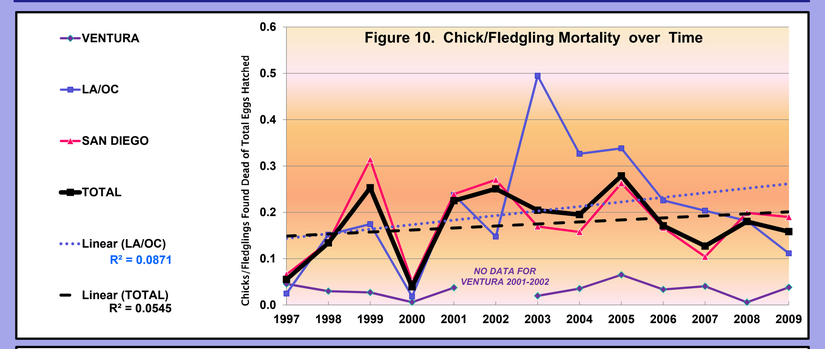
RESULTS

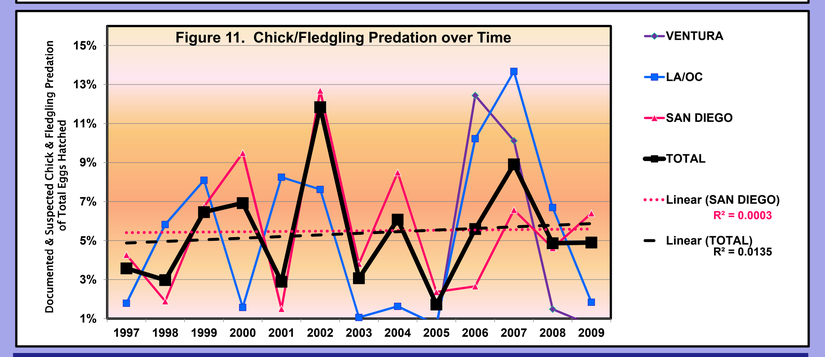






RESULTS (continued)





CONCLUSIONS

Mean Clutch Size (Figure 7)

We reject the null hypothesis that the clutch size for all sites combined (**TOTAL**) exhibits no change over time; a statistically significant (P=0.001) decline is evident. The regression line (**RL**) explains nearly 43% of the data variation.

Egg Abandonment (Figure 8)

We accept the null hypothesis that total egg abandonment shows no significant change over time (p = 0.45). The RL explains less than 4% of the data variation.

Egg Predation (Figure 9)

➢ We accept the null hypothesis that total egg predation shows no significant change over time (p=0.195). The RL explains less than 15% of the data variation.

➢ An increase (but not significant; p=0.052) over time was evident for LA/OC with 30% of the data variation explained by the RL.

➢ Despite alleged increases in egg predation in San Diego, documented/suspected egg predation there appears to have been nearly stable over time, with less than 1% of the data variation explained by the RL (p=0.89).

Chick & Fledgling Mortality (Figure 10)

➢ We accept the null hypothesis that total chick mortality shows no significant change over time (p=0.35). The RL explains less than 6% of the data variation.

➢ LA/OC shows a slightly steeper regression line, with nearly 9% of the data variation explained by the RL, but the trend is not significant (p=0.33).

Chick & Fledgling Predation (Figure 11)

➢ We accept the null hypothesis that total chick predation shows no significant change over time (p=0.89). 13% of the data variation is explained by the RL.

➢ The RL slope for San Diego is flatter than for the total (R^2 = 0.000, p=0.73). These results do not support assertions of recent catastrophic increases in chick/fledgling predation in the San Diego region. Documented/suspected chick/fledgling predation in San Diego appears to have remained nearly stable for the past 13 years.

DISCUSSION

Aside from clutch size, the data for egg predation, egg abandonment, chick predation and chick mortality show substantial variation over time but no statistically significant changes. It is possible, since predation data are minimum values, and little information exists on fledgling survival following nesting site departure, that the CLT population is actually experiencing reduced recruitment. Steep population declines are evident at some nesting sites (e.g., LA Harbor, -72%, 2005–2010). However, since adults can breed until at least age 21, an overall population decline may not be evident for several years. Trapping of banded adults in San Diego in 2008 and 2009 to estimate the population age profile found that ages ranged from 2 to 21 years, with a mean of 8 to 9 years (Allen et al. 2010), suggesting the population still consists of a majority of pairs able to breed for another 10-15 years.

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ACKNOWLEDGMENTS

Dan Marschalek, California Dept of Fish and Game, for providing data for 2001 – 2009.

Dr. Charles Collins, for mentorship, guidance and CLT expertise since 1983.

Dr. Peter Dillingham, Dr. Casey Lott and Dr. Michael Fuller, for review of statistical analyses.

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