

Annotated atlas and regional monitoring of heron and egret nesting colonies in the San Francisco Bay area

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INTRODUCTION

The slender, poised profiles of foraging herons and egrets are distinctive features of wetland and shoreline ecosystems. To many observers, these conspicuous birds signify the presence of potentially diverse and healthy wetlands worthy of protection. Consequently, herons and egrets are frequently used as symbols of wetland conservation. Such recognition is well substantiated by the ecologically important roles they play. As important predators, herons and egrets are sensitive to subtle changes in ecosystem productivity, hydrology, and vegetation, and they are recognized widely as indicators of processes that sustain or threaten wetland ecosystems.

The atlas of heronries summarizes continuing efforts by Audubon Canyon Ranch and the San Francisco Bay Bird Observatory to monitor colonially nesting herons and egrets in the central coastal region of California surrounding the San Francisco Estuary. It presents detailed accounts of all known heronries in the San Francisco Bay area from 1991-2005. I also provides a regional analysis of nesting distributions, nest survivorship, productivity, nesting habitat, intraseasonal timing, human disturbance, nest predation, property ownership, and management concerns. The results are based on field observations conducted from 1991-2005 and additional data available for previous years as far back as 1967 (38 years).



Distribution of heron and egret nesting colony sites in the San Francisco Bay area, 1991-2005. The bold, dashed line indicates the study area boundary; thin, dashed lines within the study area separate heronries associated with the labeled wetland subregions.

A PROTOCOL FOR REGIONAL MONITORING

We observed all colonies from the ground or from boats using binoculars and telescopes. We were assisted at many sites by trained volunteer field observers. Observers visited most colony sites at least four times each breeding season (annual average = 6.8 ± 0.31 , SE); 15 \pm 0.6% of sites were visited at least ten times. Longer periods of observation were required at larger colonies (hours per visit = 1.25 ± 0.004 x peak annual nest abundance; $F_{1,201} = 54.9$, $P < 0.001$).

We examined differences in intraseasonal timing among colonies and subregions during each of five, 3-day regional observation periods, by estimating differences in the average proportion of nests in (1) the egg-laying and incubation period, (2) the parental guardian period, and (3) the post-guardian period.

We used focal nest samples observed through the entire nesting season to measure nest survivorship. We measured the productivity of successful nests based on the size of completely visible broods when nestlings were too young to hop away from their nests and old enough (larger species) to have survived the period when most brood reduction occurs. Estimates of the number of young in successful nests included focal nests followed through the nesting cycle as well as nests that were not followed but contained young known to have reached the appropriate age prior to fledging. Overall reproductive success was estimated as the product (and its variance) of focal nest survivorship and pre-fledging brood size.

We recorded evidence of nest predation and disturbance during each site visit and summarized rates of colony site disturbance, abandonment, colonization, and recolonization.

Additional information on methods for regional monitoring of heron and egret nesting colonies is provided in the Annotated Atlas.



STATUS, TRENDS, AND IMPLICATIONS FOR CONSERVATION

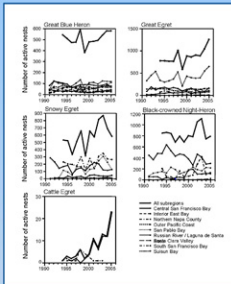
Regional nest abundances were stable or increasing (see figure). Great Blue Heron nest numbers increased significantly by 25 ± 2.8 nests yr^{-1} from 1999-2005 ($F_{1,4} = 82.4$, $P < 0.001$). Great Egret nest numbers increased significantly 32 ± 11.2 nests yr^{-1} from 1994-2005 ($F_{1,10} = 8.2$, $P = 0.02$), reflecting primarily sharp increases in 2004 and 2005. A marginally significant linear increase in the number of Snowy Egret nests was evident from 1994-2005 ($F_{1,10} = 4.5$, $P = 0.057$). Strong increases in Cattle Egrets resulted from a small number of nests in the Laguna de Santa Rosa.

On average, 73 ± 2.1 (SE) colony sites were active each year, supporting 62 ± 1.7 Great Blue Heron colonies, 25 ± 1.5 Great Egret colonies, 13 ± 0.7 Black-crowned Night-Heron colonies, and 12 ± 1.0 Snowy Egret colonies. Cattle Egret and Little Blue Heron nested at a few sites.

Great Blue Heron colonies tended to be small and widely distributed ($44 \pm 1.9\%$ of colonies had < 6 nests yr^{-1} and $65 \pm 1.4\%$ of those colonies occurred without other nesting species of herons or egrets). Great Egret nesting abundance was concentrated at several colony sites in Suisun Bay, with other important colony sites in Central and South San Francisco Bay and along the Outer Pacific Coast.

Annual changes in nest abundance within colony sites and subregions were consistent with shifts in colony site preference as wetland suitability and disturbance patterns fluctuate across years and over space.

New colonies were often initiated with a few nests and grew, either gradually or abruptly, into larger colonies in subsequent years. However, colonies tended to become inactive within 5 years unless nest abundance reached a threshold of increasing persistence. Colony site persistence was substantially greater at sites with at least 20 active nests.



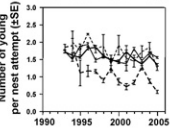
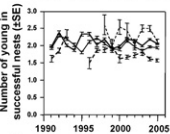
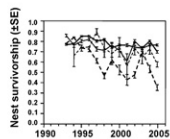
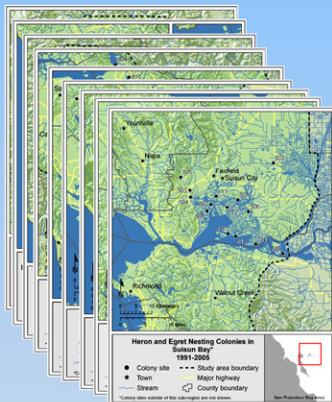
Regional abundances of colonially nesting herons and egrets were stable or increasing from 1994-2005

Wetland subregions exhibited slight but significant differences in nest survivorship, productivity, and overall reproductive success.

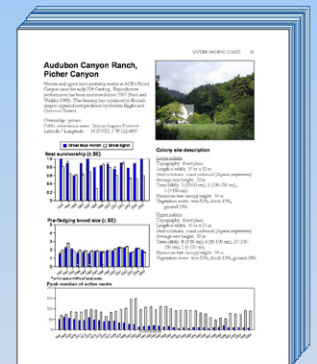
Patterns of seasonal weather and annual reproductive performance suggested that declines in nest abundances may have resulted from increased juvenile mortality in winter.

Significant linear declines in regional reproductive success of Great Blue Herons, Black-crowned Night-Herons, and Snowy Egrets resulted primarily from declining nest survivorship, which coincided with regional increases in abundances of Common Ravens.

The *Annotated Atlas and implications for the Conservation of Heron and Egret Nesting Colonies in the San Francisco Bay Area* can be viewed or downloaded free at www.egret.org/atlas. GIS shape files are available from Audubon Canyon Ranch and have been provided to county planning departments and other interested groups throughout the region.



Annual mean \pm SE nest survivorship, number of young in successful nests, and number of young per nest attempt by Great Blue Herons (bold, solid lines), Great Egrets (thin, solid lines), Black-crowned Night-Herons (bold, dashed lines), and Snowy Egrets (thin, dashed lines) in the northern San Francisco Bay area.



The atlas includes detailed accounts of all known heronries in the San Francisco Bay area from 1991-2005.

Local and subregional productivity of successful Great Blue Heron and Great Egret nests fluctuated within larger-scale variation across the region. In contrast, changes in nest survivorship were associated with processes that operated at local or subregional scales, such as nest predation, colony disturbance, and extreme weather events.

Increases in the number of herons and egrets nesting in San Pablo Bay since the late 1990s coincided with increases in the extent of restored tidal marshes, suggesting that heron and egret nesting distributions may be useful in monitoring the landscape-scale effects of restoration projects in tidal landscapes. Such distributional shifts may occur gradually with incremental habitat restoration or enhancement.