Frontispiece. Great Egrets (*Ardea alba*) nesting in a grove of coastal redwoods (*Sequoia sempervirens*) near Bolinas Lagoon, Marin County, California, USA. Photo by Larry Goodwin.
Nesting Dynamics of Four Ardeid Species at Subregional Scales: Recovery Rates after Sudden Major Declines in Nest Abundance

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Abstract.—The functional roles of nesting heron species (Ardeidae) as top predators in regional wetland landscapes may be sensitive to variation in nesting abundances at subregional scales corresponding to available habitat for nesting and foraging within individual wetland subsystems. This study investigates the dynamics of annual nesting abundances of four ardeid species within 10 major wetland subsystems of the San Francisco Bay Area, California, USA, during 1991-2010. Interrupted time series analysis was used to measure impact and recovery rates related to sudden major declines in nesting abundance below selected thresholds of annual change. Year-to-year persistence of initial impacts was above 78% for Great Blue Herons (Ardea herodias) and Great Egrets (A. alba). Snowy Egrets (Egretta thula) recovered more quickly, with 63-66% annual carryover of initial impacts. The time required for 95% recovery averaged 18.8 years for Great Blue Heron, 13.0 years for Great Egret, 7.2 years for Snowy Egret, and 14.5 years for Black-crowned Night-Heron (Nycticorax nycticorax). Most of the major subregional declines in nest abundance were associated with impacts at a single colony site. The results highlight the significant effects of sudden major declines in nesting abundance on the status of ardeids within individual wetland systems across a larger regional wetland landscape. Received 5 February 2018, accepted 26 May 2018.

Key words.—Ardeidae, colonial, disturbance, foraging range, landscape, management scale, nesting distribution, recovery, subregion, time series.

Understanding ecological relationships requires investigation at appropriate spatial and temporal scales relative to the questions addressed and the “ecological neighborhood” of the associated organisms (Addicott et al. 1987; Wiens 1989). Although predicted recovery rates after major disturbance are a key aspect of environmental planning, models are lacking to predict the recovery of heron species’ (Ardeidae) nest abundances at spatial scales corresponding to the availability of resources for both nesting and foraging. The effective conservation of ardeids and their functional influence as top predators in extensive wetland complexes suggests the importance of understanding the impacts of disturbance and the associated recovery of nesting and foraging densities at subregional scales, which are likely to reflect differences in wetland condition, access to foraging areas, and the corresponding use of colony sites (Pratt 1983; Kelly et al. 2007; Kelly and Nur 2015). The status of nesting ardeids at subregional scales may not be reflected by their status or dynamics in the surrounding region because processes operating at larger spatial scales can mask the changes occurring at smaller spatial scales (Wiens 1989; Schneider 1994). Similarly, the dynamics of individual nesting colonies can be averaged out over larger spatial scales and often fail to reflect annual changes within a subregion.

Nesting ardeids respond to environmental changes beyond the immediate vicinity of their colony sites. Patterns of colony-site selection and reproductive success in ardeids reflect adaptive responses to surrounding landscape conditions within their foraging range (Fasola et al. 2002; Custer et al. 2004; Kelly et al. 2008; Baker et al. 2015). Colony-site occupancy can vary substantially in response to changes in extent and/or quality of their wetland feeding areas (Bancroft et al. 1994; Tourenq et al. 2000; Kelly et al. 2008; Carrasco et al. 2015), disturbance by