Local shifts, indefinite cycles, and the future of herons and egrets in Bolinas Lagoon

Ripples in the Pool

by John P. Kelly

In the spring of 2014, a conspicuous "silence" spread over the redwood canopy of Picher Canyon. For the first time since Audubon Canyon Ranch was founded in 1962—when a campaign to protect the iconic heronry near Bolinas Lagoon launched ACR's legendary work to protect important natural areas in Marin and Sonoma counties—herons and egrets chose not to reoccupy the nest trees (Griffin 1998, Millus et al. 2013a).

The steep redwood canyon at the Martin Griffin Preserve (MGP) was first colonized sometime before 1941. An account of seven Great Egrets seen "at Bolinas" at the height of the nesting season, on 7 May 1929, suggests that they may have nested there since the late 1920s (Stoner 1934). Back then, these elegant birds were extremely rare, just beginning to recover from near extinction by late-19th-century plume hunters. Now, in 2014, the value of Picher Canyon to these birds has again attracted ACR's close attention. This time, we are interested in how the "ripple effects" of their departure might affect their continuing presence in Bolinas Lagoon and the possible return of Great Egrets to Picher Canyon (Figure 1).

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Figure 1. A Great Egret carrying nest material indicates that it has established a pair bond with another adult and initiated a new nest attempt.

The disappearance of the Great Egrets surprised many people who have known and loved these birds for decades. Ecologically, however, their sudden absence is not so surprising. The impressive loyalty of herons and egrets to traditional colony sites is actually offset by the movements of many nesting adults to alternative sites between years, augmented by fluctuating incursions of itinerant, first-time breeders (maturing juveniles). Such movements fuel dynamic annual changes in the sizes of heron and egret colonies (Figure 2). However, these changes are generally unrelated to regional population trends in the San Francisco Bay area (Figure 3; Kelly et al. 2007). Dramatic changes in colony size are typically stimulated by local disturbances involving nest predatory species, such as raccoons or ravens, or by changes in extent, variability, or intensity of human activity (Kelly et al. 2005, 2007). Occasionally, colony sites are completely abandoned. Still, few people expected this to occur in Picher Canyon.

The abandonment at Picher Canyon was probably caused by Bald Eagle disturbance, although other unknown factors may have

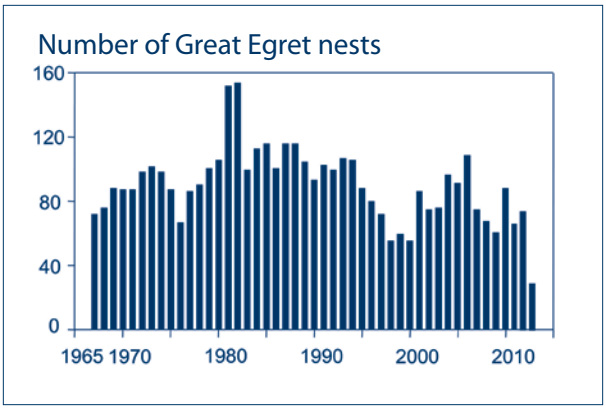

Figure 2. Annual abundance of Great Egret nests in Picher Canyon, at ACR's Martin Griffin Preserve, near Bolinas Lagoon. 1967–2014.

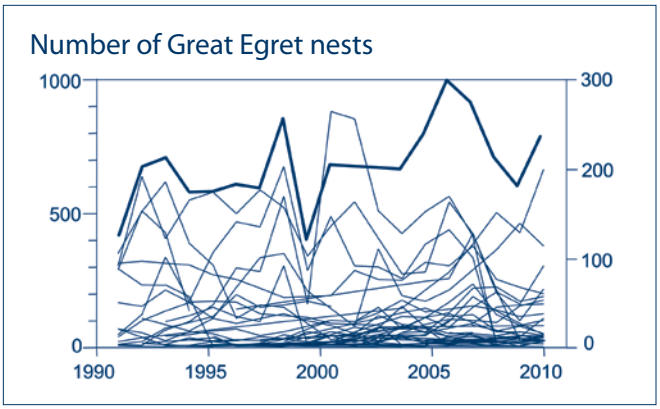

Figure 3. Annual changes in the number of Great Egret nests in the San Francisco Bay area (bold line, scale on left) are generally unrelated to changes in nest abundance at individual colony sites (thin lines, scale on right), 1967–2010.

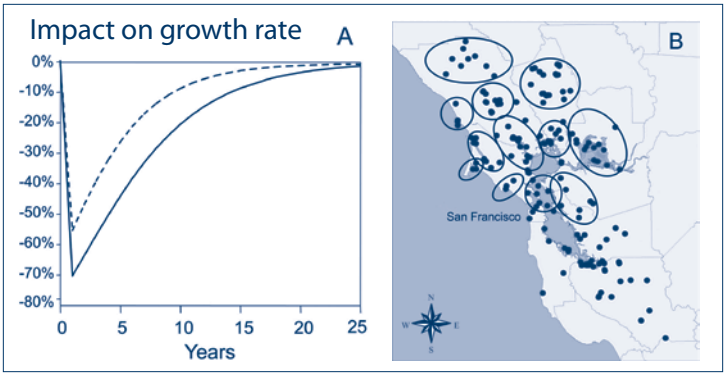

Figure 4. (A) Recovery from impacts on annual growth rates of Great Egret (solid line) and Great Blue Heron (dashed line) nest-abundance after major colony site disturbance leading to nest loss exceeding 95% of annual fluctuations (year 1), within (B) subregional wetland landscapes (circled) in the northern San Francisco Bay area, 1991–2010 (filled circles indicate colony sites).

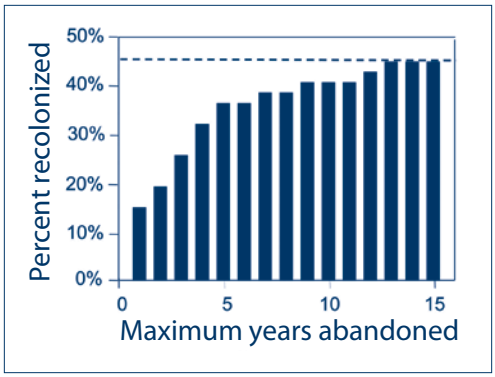

Figure 5. The percent of abandoned colony sites that were recolonized by Great Egrets in the northern San Francisco Bay area, 1991–2011, (47 ± 7.4%, dashed line) includes sites abandoned for at least 13 years, based on 21 recolonizations among 45 abandoned sites that remained available.

been involved (Millus et al. 2013a). The mere presence of a Bald Eagle in or near a heronry is sufficient to disturb the nesting activities of herons and egrets—without any actual predation (which is also possible). The likelihood that herons or egrets will abandon their nests increases with the frequency or intensity of disturbance (see "A Safe Place to Nest," Ardeid 2002).

Local values

After a major disturbance, nesting egrets often move to neighboring trees or establish nearby "satellite colonies." Such localized responses reflect the persistent value of nesting within a kilometer or so of profitable foraging sites (Kelly et al. 2008). Occasionally, egrets recolonize sites that were previously abandoned. Although the pull of familiar and productive wetlands presents a strong incentive for their annual return to nesting areas, some individuals relocate to distant wetlands, tens of kilometers away, or farther. The forces that drive such large-scale movements are a mystery but, like localized shifts in nesting distribution, they seem to involve responses to local disturbance (Kelly et al. 2007).

Nesting herons and egrets may move to other wetland areas in the region even when local feeding areas are productive and suitable for foraging. The availability of prey to herons and egrets in Bolinas Lagoon has remained high in recent years, allowing nesting pairs to provision more young than expected elsewhere in the San Francisco Bay area (see lead article in this issue). Despite the consistent availability of prey, however, the number of nesting and foraging egrets in Bolinas Lagoon declined dramatically in 2014 after the failed nesting attempts at Picher Canyon in 2013. What happens to an estuary when there is a local collapse in the number of top predators? The potential consequences are complex, but an intuitive ecological principle seems relevant: "everything in nature is connected."

Lagoon-wide consequences

The sustainability and resilience of ecosystems is reflected in natural cycles of disturbance and recovery. When disturbances become unusually frequent or extreme, systems tend to become less resilient, with persistent reductions in productivity or diversity. To what extent is the disturbance of a single Great Egret colony likely to alter the surrounding wetland system, such as Bolinas Lagoon?

Some insight into this question is revealed by ACR's long-term studies of herons and egrets. Although Great Egret numbers in the San Francisco Bay area have been relatively stable since 1990 (Kelly and Robinson-Nilson 2011), the loss of nesting herons or egrets at a single colony site can reduce their overall presence in the associated wetland landscape—for a long period of time (Figure 4; Millus et al. 2013b). The number of Great Egret nests in the Bolinas Lagoon area declined from 80 in 2012 (75 in Picher Canyon) to 47 in 2013 (32 in Picher Canyon) to 32 in 2014 (zero in Picher Canyon). Because nesting herons and egrets typically forage within a few-to-several km of their nests, the disturbance-induced movement of birds to other nesting areas not only reduces local nesting activity, but also results in fewer foraging individuals in the surrounding wetland area.

One example of how a local disturbance can have continuing system-wide effects can be seen in Tomales Bay, an estuary north of Bolinas Lagoon that is approximately 20 km long by 1.5 km wide. From 1991 through 1997, an average of 53 ± 2.6 (SE) pairs of Great Egrets nested in Tomales Bay. Over the next five years, a newly arrived, resident pair of Common Ravens repeatedly disturbed the main Great Egret colony at the north end of the bay, which finally led to its abandonment. Increases in nest abundance at other colony sites in the bay seemed to reflect localized responses by some of the disturbed birds, but the baywide number of Great Egrets dropped to less than half of the pre-1998 levels, averaging only 22 ± 1.4 pairs from 2003 to 2013.

Recolonization?

The extent to which Great Egrets use previously abandoned colony sites depends on sites that remain suitable for recolonization for at least 13 years after abandonment (Figure 5). Great Egrets recolonized 21 of 45 abandoned colony sites in the northern San Francisco Bay area over a 21-year period, suggesting a 47 ± 7.4% chance of recolonization. However, because the suitability for recolonization depends on the complex, adaptive preferences of the birds, recolonization is more likely at some sites than at others.

No substantial changes in habitat quality have been observed in Picher Canyon, although future conditions could include additional disturbance by potential nest predators or humans. Therefore, given the historic value of Picher Canyon to nesting herons and egrets, their occasional recolonization of abandoned sites, and the tendency of Great Egrets to nest in locations away from human activity (Watts and Bradshaw 1994), stewardship concerns include protecting the potential for recolonization.

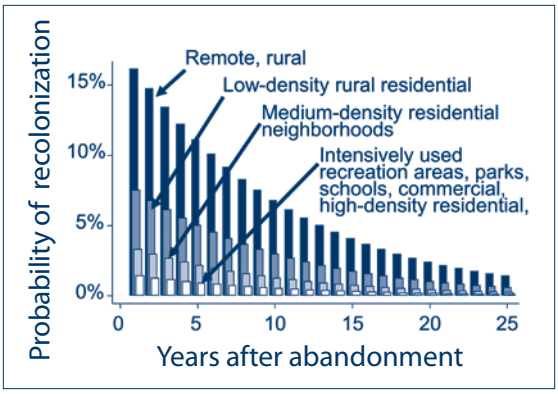

Figure 6. Predicted annual probability of recolonization at Picher Canyon by Great Egrets, based on observed recolonization events among 280 abandoned-site years in the northern San Francisco Bay area, 1991–2011. Bars represent predictions associated with varying levels of human activity.

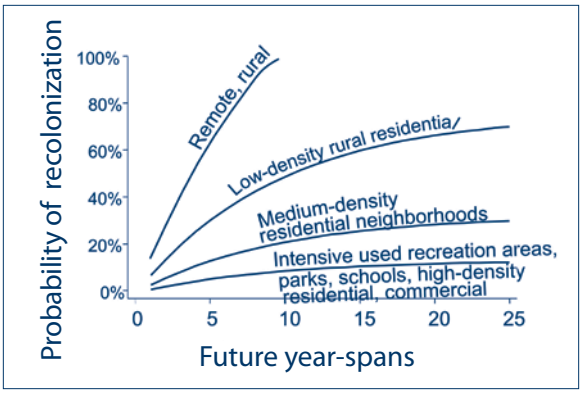

Figure 7. Predicted probability of recolonization at Picher Canyon by Great Egrets over longer periods of time, based on conditions at Picher Canyon and observed recolonization events among 280 abandoned-site years in the northern San Francisco Bay area, 1991–2011. Lines represent predictions associated with varying levels of human activity.

Recolonization depends on colony-site choices made by first-time breeders and by adult birds that have decided not to return to the sites where they nested in the previous year. Individuals that choose to nest in abandoned sites must base their selection of sites on criteria unrelated to the presence or reproductive performance of other nesting birds. Thus, recolonization may depend on conditions completely unrelated to those that led to the previous abandonment. For example, individuals that choose to recolonize an abandoned site may be more interested in the quality of nesting substrates, the daily level of human activity, or nearby foraging conditions, than in the hidden possibility of rare or intermittent nesting interference by an eagle.

To estimate the probability of recolonization at particular sites, I developed a (logistic regression) model predicting the use or non-use of abandoned colony sites in the northern San Francisco Bay area (Kelly 2014). The analysis was based on 21 recolonization events across 280 abandoned-site-years, 1991–2011. Several potential predictors were considered: (1) number of years Great Egrets nested at the site prior to abandonment; (2) presence of other nesting heron or egret species; (3) maximum known colony size; (4) average colony size across five years immediately prior to abandonment; (5) number of Great Egret nests immediately prior to abandonment; (6) number of years abandoned; and (2) level of human activity within 300 m.

To account for differences in human activity, each abandoned colony site in the region was classified into one of the following categories: (1) remote or very low-density rural; (2) low-density rural residential; (3) medium-density residential neighborhoods; and (4) intensively used public parks, schools, or high-density residential or commercial development. After the predictive model was developed, the estimated chance of recolonization at Picher Canyon was calculated by plugging values for its particular history and nesting conditions into the model. The resulting predictions are consistent with observed patterns of egret behavior across the northern San Francisco Bay region.

In general, the results provide evidence that reducing human activity will increase the possibility that nesting egrets will return to the site, with declining chances of recolonization in subsequent years (Figure 6). However, annual chances of recolonization are additive across future year spans, so the eventual chance of recolonization is greater over longer periods over time (Figure 7). Indeed, some colony sites are recolonized many years after abandonment (Figure 5).

Future outcomes

The management of natural areas can rarely, if ever, guarantee particular outcomes. Cautious interpretation of predicted outcomes is always important, especially when estimating the chance of an infrequent event. The estimated chance of recolonization is best understood as probabilistic: although "heads" is accurately predicted, on average, within two flips of a coin, other outcomes often occur. Regional population growth, changes in the quality of other feeding or nesting areas, or the effects of other ecological influences that drive nesting behaviors, could lead herons or egrets to recolonize Picher Canyon at any time. Because the behaviors of these birds are often mysterious and unpredictable, exactly when or if they will recolonize Picher Canyon remains unknown.

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