Conservation Science and
Habitat Protection at
Audubon Canyon Ranch

THE ARDEID

Martin Griffin Preserve

heronry changes

ripples

effects on the estuary

Bolinas Lagoon

science and place

Central Mayacamas

long-term monitoring

2014

In this issue

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Ardeid masthead: *Great Blue Heron ink wash painting by Claudia Chapline.*

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Recent events at the Martin Griffin Preserve heronry

Where Have All the Egrets Gone?

by Sarah Millus

LARRY GOODWIN / CREATIVE COMMONS

Figure 1. Great Egrets nesting in the redwood canopy of Picher Canyon.

Great Egrets *(Ardea alba)* have nested in Martin Griffin Preserve's (MGP) Picher Canyon for many decades (Figure 1). Anecdotal reports suggest that this colony site was occupied as far back as 1941 (Pratt 1983). In 1962, ACR established permanent protection for the canyon and surrounding lands, and nature lovers from all over the world began to visit each year, to marvel at the courtship displays and nesting activities that have been continuing here for so many years. In 2014, no herons or egrets nested in Picher Canyon. This major change for the colony was a sequel to developments that we closely observed one year prior.

The 2013 nesting season

In contrast to its long history as a productive site for nesting herons and egrets, the nesting cycle in Picher Canyon was very different last season. Only 32 Great Egret nests were established at the heronry in 2013, the smallest peak nest abundance recorded to date (peak nest numbers, 1967–2012: 88 ± 21.8 [SD, standard deviation]; Figure 2). Moreover, the 2013 season was the first known year that no chicks fledged from the colony (average number of fledglings per year, 1967–2012: 115 ± 47.5).

The 2013 nesting season appeared to begin normally, with the first nests initiated on 8 April. Nest abundance continued to increase at a normal rate relative to past years, reaching a peak on 2 May. Most of the egrets began incubating by mid-April and, given an average incubation time of 28 days, chicks should have started hatching around mid-May. Instead, most adults were still incubating at that time, and a steady decline in nest abundance had begun (Figure 3).

The rate of nest failure was relatively consistent throughout the season, and no single event of major nest loss occurred (Figure 2). By mid-to-late June, most of the nests had failed and were unoccupied. Around this time, approximately 20% of the nests appeared to have chicks, based on the behavior of adults. No chicks were directly observed, but it is normally difficult to see chicks during the first week after they hatch, as they are still small, depend on brooding parents for warmth, and spend most of their time low in the nest. The chicks that were presumed to hatch died shortly after hatching, for unknown reasons.

Only one pair of Great Blue Herons attempted to nest in 2013. The nest was initiated on 2 May, which is much later than average. At least one chick hatched around 11 June, and it appeared to be healthy and developing normally. On the morning of 6 July, the depredated remains of a Great Blue Heron chick were found below a telephone pole in Picher Canyon. The thick, somewhat gritty guano at the base of the pole near the remains suggested that the guano may have been from an owl.

Great Egret nest success at Picher Canyon fell steeply over the three years preceding the 2013 nesting failure, providing the first instance of consecutive declines in below-average reproductive success at this colony since the late 1960s (Figure 4). Although the previous period of decline was associated with the widespread effects of DDT compounds, which resulted in egg-shell thinning (Faber et al. 1972), the recent decline was localized, limited to only Picher Canyon, and we found no evidence of egg-shell thinning or other symptoms of chemical toxicity (Millus et al. 2013). However, the declining nest success rate since 2011 suggests that the underlying cause(s) of colony failure may not have been limited to the 2013 season.

Nearest neighbors

The colony site at Picher Canyon is part of a system of heronries that extends throughout the San Francisco Bay area and beyond. The closest colony to MGP lies across Bolinas Lagoon, near the town of Bolinas, at the foot of the Francisco Mesa. A Great Blue Heron colony was established in nearby trees in 1990 and persisted until the nesting trees were cut down in 1999. Great Blue Herons recolonized the site in 2007 and, in 2008, established a "satellite colony" on nearby Kent Island.

Great Egrets first nested at the Bolinas colony in 2011, when four egret pairs initiated nesting late in the season, but none of the four attempts was successful. In 2012, Great Egrets returned to establish three nests at this colony, and one was successful, fledging two chicks.

In 2013—when all of the nest attempts failed in Picher Canyon—the Bolinas colony grew substantially: Great Egrets established 15 nests, 40% of which were successful. At least 13 chicks were fledged from the colony, at an above-average rate of 2.4 ± 0.24 (SE, standard error) young per successful nest. On 17 June that year, six additional pairs of Great Egrets initiated new nests. This jump in nest initiations coincided with four nest failures and the sighting of an adult Bald Eagle in Picher Canyon (Table 1), suggesting that the new nesting pairs at the Bolinas site may have been fleeing from disturbance by the eagle in Picher Canyon. Bald Eagles are a well-known source of nesting disturbance in heronries throughout the United States (Norman et al. 1989, Vennesland and Butler 2004, Kenyon et al. 2007). They prey directly on both heron and egret chicks and adults, and they flush adults off nests, which can facilitate predation on eggs and chicks by opportunistic ravens, crows, and gulls. Bald Eagles have successfully nested every year since 2008 at Kent Lake, approximately four miles north of the Picher Canyon heronry.

Likely causes

Using available information on egret nesting biology, twice-weekly observations of the nesting colony (Table 1), careful reconnaissance of Picher Canyon, and information gained from interviews with people that have particular knowledge of egrets or Bolinas Lagoon, we considered a number of possible explanations for the decrease in nest numbers and poor reproductive performance of egrets (Table 2; Millus et al. 2013). However, we found no evidence to conclusively determine the cause(s) of nest failure or colony-site abandonment at Martin Griffin Preserve.

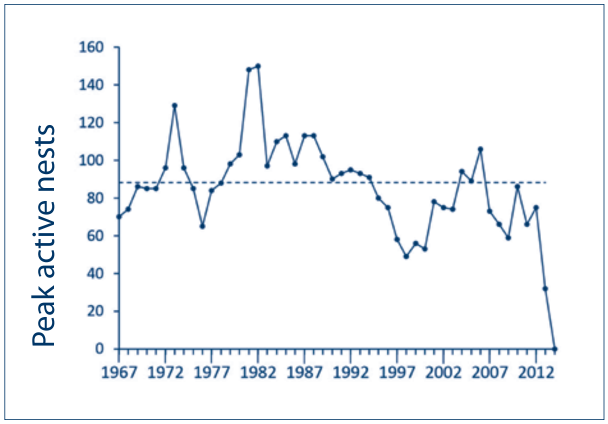

Figure 2. Peak number of active Great Egret nests at Picher Canyon 1967–2014. Dashed line represents the 46 year average of 88 ± 26.1 (SD) nests, 1967–2012.

We reasoned that local disturbance related to predation and/or harassment by avian nest predator(s), especially Bald Eagle, is the most compelling scenario leading to the 2013 failure in Picher Canyon. Although inconclusive, this explanation is supported by the presence of a Bald Eagle in the heronry, the flushing of egrets from their nests, the predation of at least one adult egret, continuing weekly nest failures leading to the failure of all nest attempts, normal survival rates among nests in the nearby Bolinas colony, and an intensive analysis suggesting that most other potential causes were unlikely (Table 2, Millus et al. 2013).

However, multiple influences may have affected the egrets' sensitivity to colony-site disturbance. Our analysis concluded that human disturbance, the absence of nesting Great Blue Herons, and infertile eggs could not be excluded as potential contributing factors. However, because evidence to support these potential causes was lacking, they were rejected as the most likely reasons for colony decline or abandonment.

Nearby successes

Although many people remained hopeful that the egrets would return to Picher Canyon, no herons or egrets nested there in 2014. Two Great Blue Herons flew low over the colony on 29 January, but no other herons or egrets were seen in the canyon. However, the Bolinas colony saw a dramatic increase in the number of nesting Great Egrets in 2014, with a peak of 34 nests—more than double the number of nests in the preceding year. In addition, nesting performance in Bolinas was strong: 68% of the Great Egret nests were successful and fledged an average of 2.8 ± 0.19 (SE) chicks per nest. Nine Great Blue Heron nests were also established, 89% of which were successful and fledged an average of 2.8 ± 0.31 (SE) chicks per nest.

Table 1. Unusual observations of the Picher Canyon heronry during the 2013 nesting season.

19 April	Broken egg shell fragments observed above a previously occupied egret nest.
7 June	Large group of adult egret feathers found in the MGP courtyard.
11 June	Adult egret flight feathers and nuptial plumes observed on an empty nest that had been occupied the previous monitoring visit.
16 June	Unidentified large bird with a yellow beak observed in Picher Canyon.
18 June	Adult Bald Eagle flushed the colony. Most nests were still unoccupied about an hour after the egrets were flushed.
6 July	Depredated remains of a Great Blue Heron chick found near the Volunteer Center.

Table 2. Likelihood of potential causes leading to nest failure and colony decline (Millus et al. 2013).

Potential cause	Unlikely	Possible contributing influence	Most likely
Disease and parasites	●		
Chemical toxicity	●		
Food availability	●		
Weather	●		
Vegetation changes	●		
Predation/Disturbance - mammals	●		
Eggs infertile or inviable		●	
Absence of Great Blue Heron		●	
Disturbance from humans		●	
Predation/Disturbance - avian			●

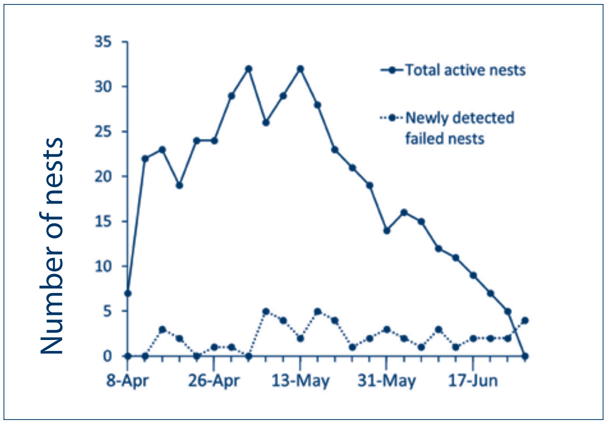

Figure 3. Number of Great Egret nests observed at Picher Canyon in 2013. Dashed line represents the number of newly failed Great Egret nests observed on each monitoring visit.

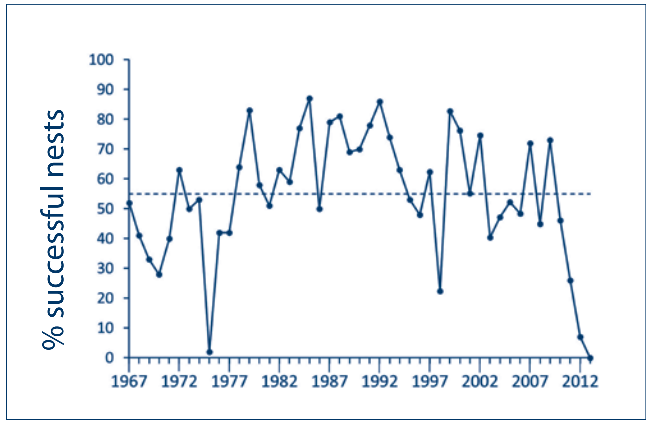

Figure 4. Proportional success of Great Egret nest attempts at Picher Canyon 1967–2013. Dashed line represents the 47 year average percent nest success of 55 ± 20% (SD), 1967–2013.

Bald Eagles were observed at both the Picher Canyon and Bolinas colony sites during the 2014 nesting season. On 19 March, a Bald Eagle was seen flying over Picher Canyon. A juvenile Bald Eagle landed in the Bolinas colony early in the season, after the Great Blue Herons had arrived but before the Great Egrets arrived. Landing in the colony trees, it flushed all the herons, but it was not observed chasing or attacking them. Bald Eagles were also seen regularly on Bolinas Lagoon throughout the nesting season.

For Great Blue Heron, both nest survivorship and the number of chicks fledged per nest was higher at the Bolinas colony in 2014 than the average for the San Francisco Bay region. For Great Egret, brood size was higher than average and nest success was slightly below the regional average, but higher than the historical average for Picher Canyon. The high number of young produced per successful nest suggests that food was not limiting for herons and egrets nesting on Bolinas Lagoon. The processes leading to the abandonment of Picher Canyon appear to be specific to that site and did not apparently have any adverse effects on the nesting colony at Bolinas.

Shifting but stable

The birds that nest at any colony site are members of a much larger breeding population and will readily move to different sites between years. Therefore, local colony dynamics such as the abandonment of Picher Canyon do not generally reflect the status of these birds in the surrounding region. Since the inception of ACR's regional Heron and Egret Project in 1991 (see Ardeid 2005), Great Egrets in the northern San Francisco Bay area have abandoned nesting colonies 49 times. Despite these local perturbations, the number of nesting Great Egrets has remained relatively stable, and nearly half of the abandoned sites have been recolonized (see the following article in this issue). We are hopeful that egrets will recolonize Picher Canyon and, in the meantime, we continue to watch their nesting activities throughout our region.

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Remembering Helen Pratt

Helen Pratt, who passed away peacefully in her home on July 27, 2014, brought a gentle and thoughtful presence to Audubon Canyon Ranch. It was from this quiet presence that Helen's legendary influence on ACR grew. She was one of the first to notice the unusual opportunity at Martin Griffin Preserve to view nesting herons and egrets from above. This motivated Helen, in the spring of 1967, to begin an intensive, volunteer effort to understand the lives of these beautiful birds. Picher Canyon and the Henderson Overlook became her second home, where she closely followed the nesting performance and behaviors of every heron and egret, every year, for more than 30 years. Helen became an outstanding naturalist who showed ACR how connecting with nature can be the key to lifelong learning. She placed the natural history of Great Egrets and Great Blue Herons within reach of everyone who visits ACR, and her scientific research established much of what is currently known about the nesting behaviors of these birds (See Ardeid 2000). Helen's humble, evidence-based way of thinking provided a powerful model that inspired ACR to promote a careful and respectful interpretation of nature—grounded in what we actually know.—*John Kelly*

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).

TOM GREY

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

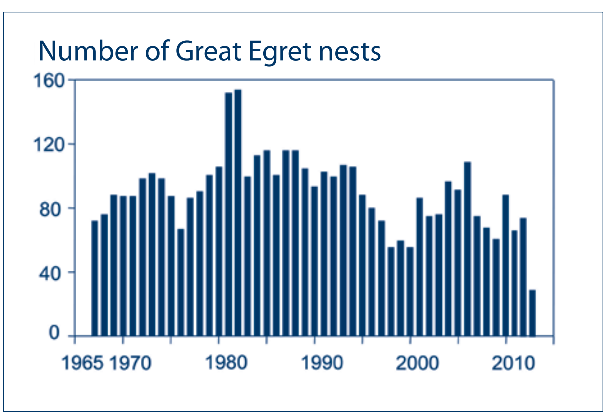

Figure 2. Annual abundance of Great Egret nests in Picher Canyon, at ACR's Martin Griffin Preserve, near Bolinas Lagoon. 1967–2014.

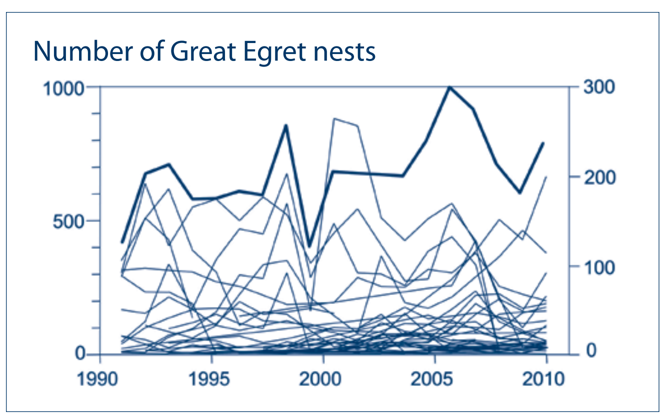

Figure 3. Annual changes in the number of Great Egret nests in the San Francisco Bay area (bold line, scale on left) are generally unrelated to changes in nest abundance at individual colony sites (thin lines, scale on right), 1967–2010.

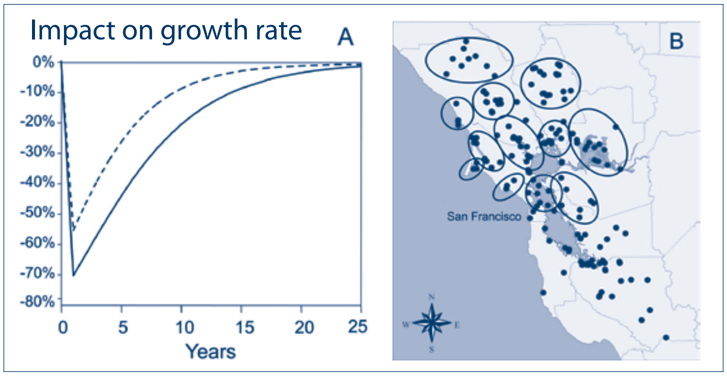

Figure 4. (A) Recovery from impacts on annual growth rates of Great Egret (solid line) and Great Blue Heron (dashed line) nest-abundance after major colony site disturbance leading to nest loss exceeding 95% of annual fluctuations (year 1), within (B) subregional wetland landscapes (circled) in the northern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

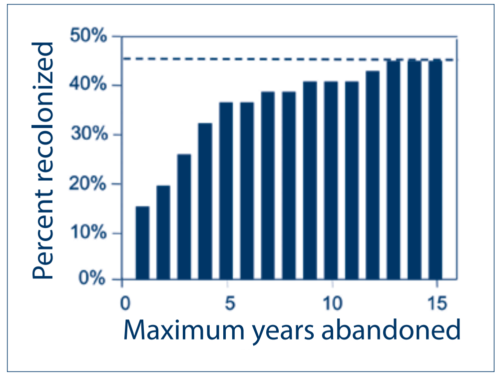

Figure 5. The percent of abandoned colony sites that were recolonized by Great Egrets in the northern San Francisco Bay area, 1991–2011, (47 ± 7.4%, dashed line) includes sites abandoned for at least 13 years, based on 21 recolonizations among 45 abandoned sites that remained available.

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.

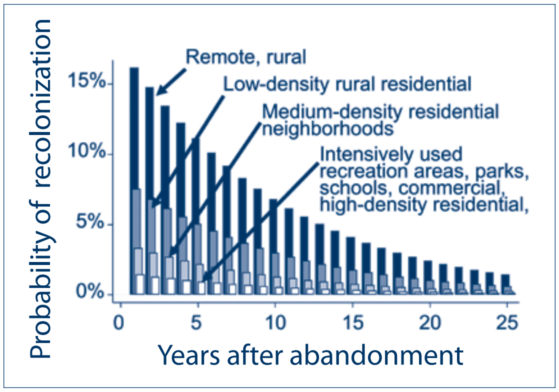

Figure 6. Predicted annual probability of recolonization at Picher Canyon by Great Egrets, based on observed recolonization events among 280 abandoned-site years in the northern San Francisco Bay area, 1991–2011. Bars represent predictions associated with varying levels of human activity.

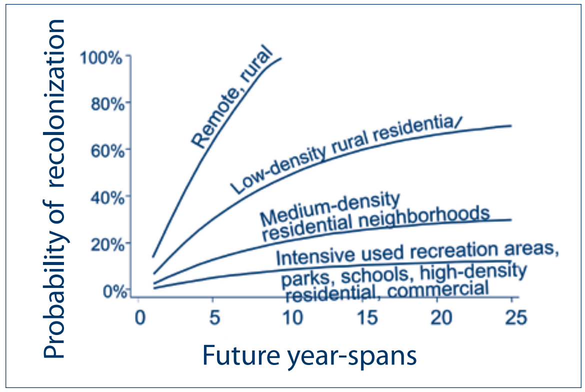

Figure 7. Predicted probability of recolonization at Picher Canyon by Great Egrets over longer periods of time, based on conditions at Picher Canyon and observed recolonization events among 280 abandoned-site years in the northern San Francisco Bay area, 1991–2011. Lines represent predictions associated 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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Incorporating science and sense of place in a changing world

Bolinas Lagoon

by Gwen Heistand

"At Bolinas Lagoon, Marin County, California, local folklore about rapid aging of the estuary became a powerful institutional myth that influenced resource policy-making. Initially this myth grew out of a strong sense of place and history and was certified by government scientists who subscribed to a classical view of uniform and directional change" (Rowntree 1975).

Anyone who has ever fallen in love with the smell of salt air and incoming tide, Marbled Godwits and Long-billed Curlews spread out on sun-warmed mudflats employing their precisely adapted beaks to mine ghost shrimp and polychaete worms (Figure 1), sinuous tidal channels weaving through pickleweed and salt grass, and the expansive feeling on the verge of continent and ocean, knows the precious and glorious place that is Bolinas Lagoon.

A tidal estuary of approximately 1,100 acres with a watershed of 16.7 square miles located on the San Andreas Fault 15 miles northwest of San Francisco, Bolinas Lagoon is a Ramsar Wetland of International Importance (see Ardeid 2006), an important wintering area for many thousands of birds, an important component of the Pacific Flyway, a breeding area for hundreds of resident and migratory birds, and a

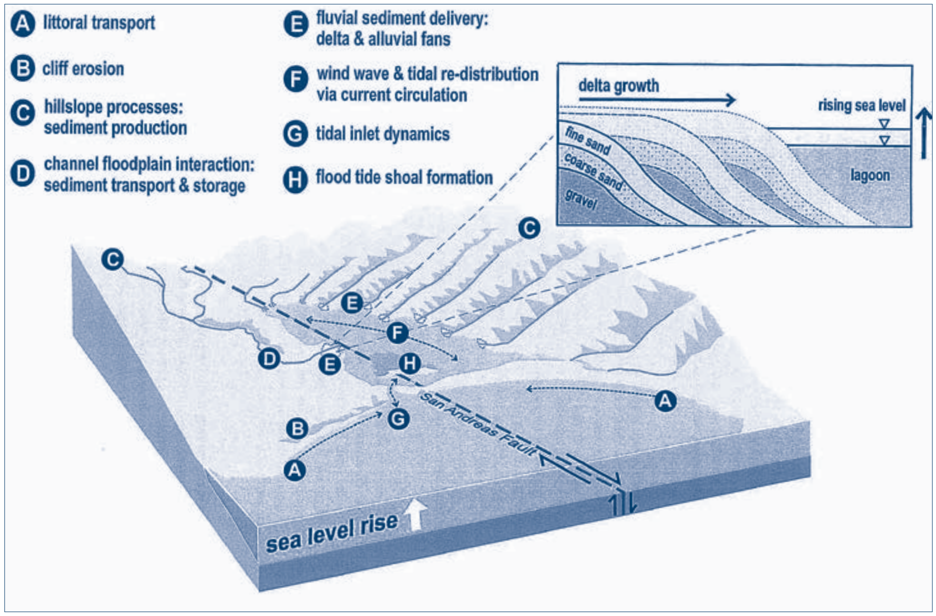

Figure 2. Physical processes affecting Bolinas Lagoon (Marin County Open Space District 2006).

Figure 1. Shorebird species, such as the Marbled Godwit, depend on the availability intertidal mudflats in Bolinas Lagoon.

year-round haul-out site and pupping grounds for harbor seals. Bolinas Lagoon and its watershed are also home to local fisherman, organic farmers, year-round residents, second-homers, day-trippers, elementary schools, public land managers, vacationers, outdoor recreationists, artists, local businesses, and Audubon Canyon Ranch. Added to this mix are many jurisdictional organizations: Gulf of the Farallones Marine Sanctuary, National Park Service, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Army Corps of Engineers, U.S. Coast Guard, California Department of Fish and Game, California Coastal Commission, State and Regional Water Resources Control Boards, Department of Transportation (Caltrans), Marin County Parks and Recreation, and Marin County Public Works. Understanding how the many facets of Bolinas Lagoon interact is an amazing challenge.

As with any piece of this earth that is deeply cherished by many and undergoing change, land management decisions necessarily incorporate a wide array of opinions and needs. The questions are complicated, and answers deal in probabilities, not certainties. Denizens of the Lagoon environs have seen the Lagoon fill in, mouth dynamics change, tidal channels shift. Over the course of Bolinas Lagoon's 7,700-year life span, what was the context and significance of these recent changes? Is it possible to balance multiple human uses and responsibly represent widgeons and ghost shrimp, salt marsh bird's beak and Marbled Godwits, gaper clams and Great Blue Herons? Has human activity been the driving force behind what the estuary looks like today? Is this vital estuary healthy?

As we have learned more about processes affecting Bolinas Lagoon (Figure 2), our answers to these questions and how we frame the questions themselves have changed. In the header quote above, Rowntree identifies myth as a model for human behavior that provides a reference for value and meaning and narrates a sacred history of change (Rowntree 1975). The

Saving Kent Island

Humans have envisioned distinctly different futures for Bolinas Lagoon. Jurisdictional responsibility for Bolinas Lagoon changed from the State of California to the Bolinas Harbor District in 1956. The Harbor District presented a plan for extensive development of the lagoon, with massive construction and dredging on Kent Island that included a hotel, restaurant, parking lots, and a marina for 1600 boats.

In 1967—in a strategic move that changed the course of local conservation— hours before the Harbor District's planned condemnation of Kent Island—Audubon Canyon Ranch and the Nature Conservancy conveyed the lands on the island to Marin County under the condition they be kept as a nature preserve.

The saving of Kent Island led, in 1969, to the transfer of the Bolinas Lagoon tidelands to Marin County by the State, with a requirement to develop a plan for their protection. The Bolinas Lagoon Technical Advisory Committee (BLTAC) was established in 1974 by the Marin County Board of Supervisors as a forum for stakeholders, community members, agencies, and scientists to review lagoon-related information and advise the Board. Audubon Canyon Ranch has been an active member of BLTAC since its inception.

management history of Bolinas Lagoon is a story of how a community's sense of place has expanded as people have learned to use science to inform the process (see sidebar: Saving Kent Island).

First applications of conservation science

The **Bolinas Lagoon Resource Management Plan** developed in 1981 and updated in 1996 states, "If present physical and ecological trends continue there will be a continued loss of estuarine habitat and the diversity and abundance of Lagoon life as subtidal and intertidal habitats are converted to emergent marsh and uplands." It was posited that changes in land use in the mid- to late 1800s, specifically logging and agriculture, were causes of rapid sedimentation (Wetland Research Associates, et al. 1996).

Fueled by this concern, **The Bolinas Lagoon Restoration Project** was initiated in 1998 by the US Army Corps of Engineers (USACE), in cooperation with Marin County Open Space District (MCOSD). USACE contracted with Tetra Tech, Inc. to prepare a watershed sediment budget. Their assessment was surprising to some people: it concluded that current erosion rates appear close to pre-1850 levels, that several alterations in the watershed could be contributing to increased sediment deposition or decreased sediment export, and that there was "no clear evidence that Bolinas Lagoon was ever a deep-water embayment, thus dredging may not actually 'restore' Bolinas Lagoon to any historical natural condition" (Tetra Tech 2001).

A **Draft Environmental Impact Statement/Report and Draft Feasibility Report** was released for public review by USACE and MCOSD in June 2002. Two alternatives were presented, both reflecting the view that dredging of approximately 1.5 million cubic yards of material was necessary to "restore" the lagoon. The project estimated that 290–300 days of round-the-clock dredging would be needed, but due to sensitive species activity, this would take place over 9 years, converting 100 acres of jurisdictional wetlands to lower intertidal or subtidal habitat. The project would have required wet slurry to be pumped from dredges in the lagoon through a flexible pipeline over the end of the Stinson sandspit into transport barges anchored in Bolinas Bay and subsequently towed by tugboat to a disposal site 55 miles away. Bulldozers, loaders, and cranes would have been used to remove upland material which would be trucked to Redwood Landfill in Novato (U.S. Army Corps 2002).

Scientific community review of the EIR/S found that project justification hinged upon poorly assessed consequences of the No Action Alternative. There was inadequate consideration of littoral sediment delivery, marginal attention was paid to sea-level rise, assessment of tectonic activity in maintenance of lagoon health was confusing, biological and ecological impacts of dredging alternatives were inadequately assessed, and an adaptive management plan was not delineated. (Schwartz 2002)

Evolving insights, changing conditions

Marin County contracted with Philip Williams & Associates to assess the No Action Alternative. The resulting **2006 Bolinas Lagoon Ecosystem Restoration Feasibility Project** concluded that Bolinas Lagoon has persisted as a tidally dominated estuarine landform for approximately 8,000 years (see sidebar: Large-scale Forces). While recognizing the long-term, dynamic stability of the lagoon, GFNMS and MCOSD spearheaded a working group comprised of scientists, local stakeholders, state and federal agency representatives, and environmental groups that was tasked with developing a Locally Preferred Plan (LPP) to ameliorate recent adverse human impacts and promote natural processes.

In developing the LPP, the working group considered a new set of questions: Can the lagoon be protected by management actions that are likely to be sustained by natural processes? Is existing information about natural vs. human-caused changes sufficient to determine whether active management is needed to protect the lagoon? Anthropogenic disturbances that were evaluated included the armoring of Stinson Spit, construction of Bolinas Groin, channelization of creeks on both the east and west side of the lagoon, construction in the floodplains, growth of Pine Gulch Creek delta, amassing of non-native vegetation on Kent Island, hardening of the perimeter by roadways, placement of fill required for roadways, installation and maintenance of culverts, and construction of Seadrift Lagoon (Working Group 2008).

Based on the resulting **Recommendations for Restoration and Management**, Marin County and GFNMS initiated projects that included the installation of a tide gauge, a multi-year effort to remove non-native invasive species from Kent Island, completion of a comprehensive bathymetric study by USGS, Caltrans replacement of some of Highway One's culverts, and development of an oil-spill recovery plan. A community lecture series was established, and the first State of the Lagoon conference was held.

Sea-level rise redirects management

In April of 2013 the **San Francisco Bay Joint Venture** (SFBJV) sponsored a design review group (DRG) comprised of coastal ecologists, geomorphologists, and hydrologists to review the LPP and provide guidance for larger projects. The DRG agreed

Large-scale Forces

The 2006 Bolinas Lagoon Ecosystem Restoration Feasibility Project, with a key report on Projecting the Future of Bolinas Lagoon, by Philip Williams & Associates (PWA), concluded that the primary forces affecting Bolinas Lagoon morphology are large-scale earthquakes; sediment transport by wind, wave, and tidal energy; severe winter storms; and sea-level rise (Marin County Open Space District 2006). Sediment core analyses (Byrne et al. 2006) of the north basin revealed that:

- Large earthquakes along the San Andreas Fault punctuate Bolinas Lagoon's evolutionary trajectory every few hundred years, dropping the floor of the lagoon, after which delivery of littoral sediment is increased, reducing tidal prism (volume of tidal exchange from the ocean), until a quasi-equilibrium is reached;
- Ocean-derived beach sand accounts for 80% of sediment deposited in the lagoon; and
- Logging and agriculture increased watershed sediment delivery to the lagoon in the latter half of the nineteenth century. However, the 1906 earthquake, which averaged 45 cm in the deeper part of basin, significantly increased the tidal prism and effectively counterbalanced increased deposition.

The modeling and analysis by PWA were based on an estimated sea-level rise of only 0.12m (0.4 ft.), which is far below current estimates. Despite this underestimation, the project team concluded that the answer to the popular concern—"Is the lagoon 'filling-in' at a rate that would lead to the loss of tidal circulation in the next 50 years?"—was "almost certainly, no." (Current predictions of sea level rise disprove any realistic possibility that the mouth of the lagoon will close.) The analysis further indicated that, although a shift in the proportion of habitats is expected, species abundance and diversity and ecological function are unlikely to change.

that with conservative 2100 sea-level rise estimates now ranging between 1.2 and 1.4 meters, sea-level rise and large storm events replace the risk of excessive sedimentation as an ecosystem concern. Further, the focus of conservation management should be to provide for migration of upper intertidal marshes and transition zones into the lowlands of stream and fault valleys. Bolinas Lagoon's barrier spit (Stinson Beach and Seadrift) and tidal inlet are essential components of its ability to evolve in response to sea-level rise and climate change. Conceptual models of Bolinas Lagoon's evolution should be developed based on best available interdisciplinary science without reference to jurisdiction or ownership. Finally, planning for the ecological health of Bolinas Lagoon needs to be based on a range of possible, contingent, but foreseeable circumstances rather than project planning (Baye 2014).

CLAIRE PEASLEE

Figure 3. Shoreline Highway was recently armored with a rock surface to reduce tidal erosion and flooding on the east side of Bolinas Lagoon.

The Design Review Group recommended a focus on Pine Gulch Creek delta and the head of the Lagoon (at "the Bolinas Y") as important accommodation zones during accelerated sea-level rise. The DRG also recommended that, when increased flooding on the east-shore road forces redesign (Figure 3), culverts should be replaced with causeways to allow stream valleys to reconnect with the rising lagoon (Baye 2014). Marin County is developing a plan to address these concerns and recommendations. Philip Williams has been contracted to reevaluate the 50-year projection using current science.

Conservation science and future management

In the last almost 200 years of human history, Bolinas Lagoon and its watershed have transitioned from a primarily natural system, to a place for extraction and transport of resources, to the proposed site of a large-scale marina and four-lane roads, to a wetland of international significance. Anyone who works or lives around Bolinas Lagoon knows that it looks different than it did 10 years ago, 50 years ago, 100 years ago. However, the classical myth of uniform and directional change—that sedimentation from the watershed is turning the lagoon into a meadow—is no longer accepted.

Although human activity has altered some processes that shape the estuary, we know that Bolinas Lagoon's location in a fault zone is a primary, long-term driver of its morphology. Sea-level-rise predictions are an order of magnitude larger than when the PWA analysis was completed in 2006. More frequent and larger storm events are projected to impact coastal communities. Some people in the community are concerned that nothing has been done. However, the strongly focused attention of the scientific community, which generates increased understanding of the complex and interrelated system that is the Bolinas Lagoon, *is* doing something. Learning as a community is doing something. The challenge is to weave what we understand and what we continue to learn into responsible management of the lagoon and its watershed—balancing near-term needs with long-term projections.

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ACR launches a new long-term monitoring survey on Pine Flat Road

Branching Out

by Emiko Condeso

Sonoma County is a place of beautiful contrasts. In the Mayacamas Mountains, which extend south from Mendocino County to the Napa Valley (highest elevation at Mt. St. Helena), one can encounter a myriad of habitat conditions—and thus a diverse suite of wildlife—in a very short span of time and space. As one climbs the sometimes dramatic slopes, oak woodland may give way to rolling open grasslands, fire-scarred knobcone pine forest, and dense stretches of chaparral. One perfect place to experience this habitat mosaic, and all the interesting plant and wildlife that comes with it, is Pine Flat Road—a winding route better suited to 19th-century wagons than to cars. This road also happens to be an excellent place to build an understanding of the bird habitat values that extend across the central Mayacamas.

Located just northeast of the city of Healdsburg, Pine Flat Road rises out of the Alexander Valley and climbs until it reaches a high ridge near the Geysers, a naturally-occurring steam field that was once a mecca for tourists and has since become the largest provider of geothermal power in the United States. It is a public thoroughfare, but it winds its way through several private ranches and landholdings, including the Modini Mayacamas Preserves of Audubon Canyon Ranch. This 3,300-acre sanctuary was formed by the merger of the Modini Ingalls Ecological Preserve, bequeathed to ACR by conservationists Jim and Shirley Modini, and the Mayacamas Mountains Sanctuary. The road is not only a lovely place for nature-watching and cycling, but it is also an important link connecting a growing network of protected lands that include public properties and private holdings with conservation easements, including the Modini Mayacamas Preserves. This network offers benefits to wildlife beyond what can be achieved by protecting individual parcels, by providing habitat connectivity that allows for wildlife movement at larger scales.

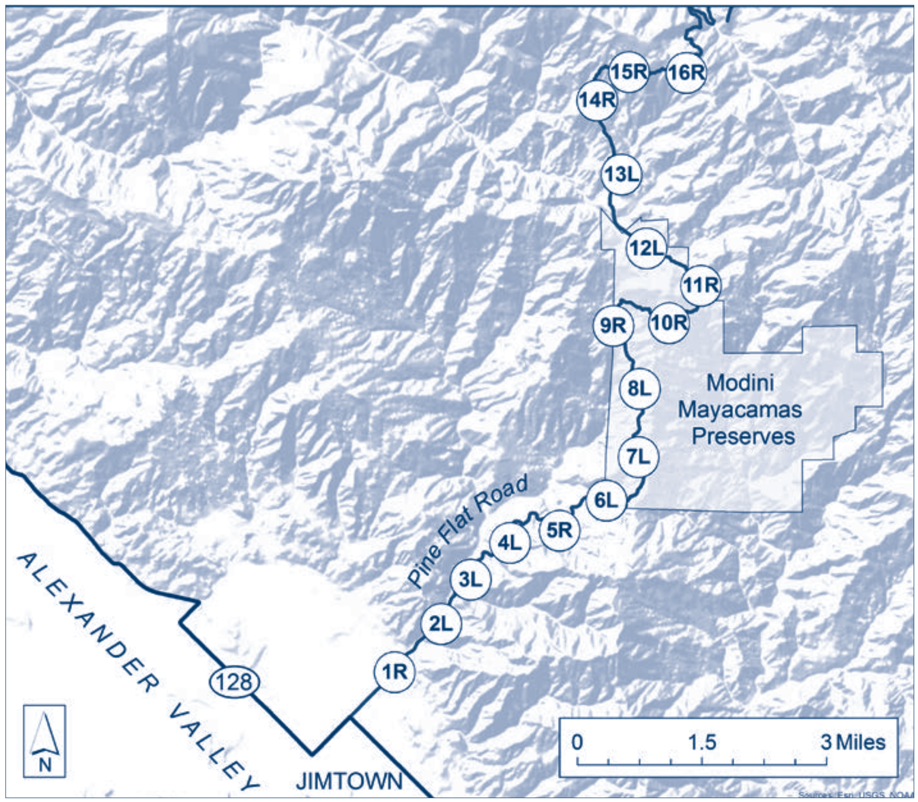

Figure 1. Location of the 16 point count stations that make up the Mayacamas Mountains Breeding Bird Survey route along the approximately 20 mile stretch of Pine Flat Road, near Healdsburg, Sonoma County, CA.

Bird use in the central Mayacamas

As an important part of this network of protected areas, ACR has launched an effort to establish a baseline understanding of the ecological status of the Modini Mayacamas Preserves. The results will not only inform our stewardship practices, but will also create an understanding of how our preserves fit in to the greater regional conservation picture. In 2009, ACR Biologist and Preserve Manager Sherry Adams began this work at the Modini Ingalls Ecological Preserve, with a broad set of goals. In 2010, John Kelly and I joined the effort, with a focus on measuring breeding bird use. In 2013, we began a program to monitor bird use beyond the preserve borders, to include all of Pine Flat Road, as a basis for building models that can estimate breeding bird habitat values throughout the central Mayacamas Mountains (see below). By putting the central Mayacamas "on the map" with regard to bird use, we hope to expand upon previous works by ACR, the Madrone Audubon Society and others to create a robust baseline data set from which to identify species and habitats of special conservation interest.

As with our other long-term monitoring programs, highly skilled volunteers are the driving force behind this project. Volunteer observers use a simple web portal to sign up to conduct a survey. Following a protocol we adapted from Ralph et al. (1995, USFS Tech Rept. PW-GTR-149), observers record the presence of birds along a survey route

COURTESY LARRY JORDAN

Figure 2. A Purple Martin (male at left) nest in a cavity abandoned by woodpeckers.

comprised of 16 stopping points. These "point count stations" are distributed at approximately one-kilometer intervals, from the starting point just outside of Jimtown, to the Geysers gate (Figure 1). At each station, observers conduct a five-minute count of every bird seen or heard, noting whether each bird was within or beyond 50 m of the station center (to a maximum distance of 400 m). The number of birds detected within 50 m of each count station is used to estimate bird densities, and birds detected beyond 50 m provide a more general measure of abundance (Table 1).

Laser rangefinders are used to help observers gauge distances to birds, which can be almost as challenging as identification! Birds are known to obscure their position by changing the volume of their voice and by turning their heads while vocalizing. In addition, one must take into account that sound travels differently in different habitats (for example, open grassland versus dense forest). Perhaps the greatest challenge is that about 90% of detections during these counts are auditory. Although some of the most interesting detections are visual and quite obvious (Figure 2), most detections are

Table 1. Preliminary results for the Mayacamas Mountains Breeding Bird Survey (April-June counts only), 2013 and 2014 (n = 15 survey days). Average bird abundance (individuals detected within 400 m) and density (birds/km^2), with associated standard errors (SE), are based on five-minute point counts across 16 survey stations along Pine Flat Road (n = 240 station-counts).

Species Name	Average abundance (SE) (number of birds)		Average density (SE) (birds/km^2)		Species Name	Average abundance (SE) (number of birds)		Average density (SE) (birds/km^2)	
Acorn Woodpecker	1.94	(0.15)	49.89	(7.91)	Red-tailed Hawk	0.10	(0.02)	3.72	(1.75)
Orange-crowned Warbler	0.68	(0.05)	35.03	(4.81)	Western Tanager	0.10	(0.02)	3.18	(1.29)
Spotted Towhee	0.60	(0.06)	38.75	(5.18)	White-breasted Nuthatch	0.10	(0.02)	7.43	(2.45)
Wrentit	0.58	(0.06)	18.58	(3.76)	Wild Turkey	0.10	(0.03)	1.06	(0.75)
California Quail	0.52	(0.06)	12.21	(3.48)	California Thrasher	0.09	(0.02)	3.72	(1.39)
Western Scrub-Jay	0.49	(0.06)	20.17	(4.45)	Black Phoebe	0.08	(0.02)	6.90	(1.87)
Lesser Goldfinch	0.44	(0.09)	40.34	(10.64)	Pileated Woodpecker	0.08	(0.02)	1.06	(0.75)
Steller's Jay	0.42	(0.05)	17.52	(3.78)	American Kestrel	0.06	(0.02)	2.65	(1.40)
European Starling	0.39	(0.13)	19.64	(6.88)	Blue-gray Gnatcatcher	0.06	(0.02)	5.84	(2.16)
Black-headed Grosbeak	0.38	(0.05)	15.92	(3.62)	Chestnut-backed Chickadee	0.06	(0.02)	6.90	(2.62)
Turkey Vulture	0.38	(0.06)	7.96	(3.19)	Red-shouldered Hawk	0.05	(0.01)	0.53	(0.53)
House Wren	0.37	(0.04)	22.82	(4.10)	Wilson's Warbler	0.05	(0.02)	4.78	(1.74)
Dark-eyed Junco	0.32	(0.05)	20.70	(3.71)	Brewer's Blackbird	0.04	(0.02)	4.25	(2.24)
California Towhee	0.29	(0.04)	24.95	(3.68)	Eurasian Collared-Dove	0.04	(0.02)	1.59	(0.92)
Violet-green Swallow	0.29	(0.06)	16.99	(5.42)	Golden-crowned Sparrow	0.03	(0.01)	3.18	(1.29)
Mourning Dove	0.27	(0.03)	3.72	(1.39)	Bell's Sparrow	0.02	(0.01)	0.53	(0.53)
American Crow	0.26	(0.07)	6.37	(2.09)	Hairy Woodpecker	0.02	(0.01)	1.59	(0.92)
Common Raven	0.26	(0.04)	7.43	(2.45)	Red-winged Blackbird	0.02	(0.01)	0.53	(0.53)
Bewick's Wren	0.25	(0.04)	15.92	(3.11)	Western Meadowlark	0.02	(0.01)	-	-
Cassin's Vireo	0.25	(0.04)	17.52	(3.47)	White-crowned Sparrow	0.02	(0.02)	2.65	(2.65)
Pacific-slope Flycatcher	0.24	(0.04)	17.52	(3.30)	Yellow-rumped Warbler	0.02	(0.01)	2.12	(1.50)
Northern Flicker	0.23	(0.03)	5.84	(2.03)	American Goldfinch	0.01	(0.01)	-	-
Purple Martin	0.21	(0.06)	4.25	(1.82)	Black-throated Gray Warbler	0.01	(0.01)	0.53	(0.53)
Anna's Hummingbird	0.20	(0.03)	22.82	(3.58)	Brown Creeper	0.01	(0.01)	0.53	(0.53)
Warbling Vireo	0.20	(0.03)	14.86	(3.22)	Brown-headed Cowbird	0.01	(0.01)	1.59	(0.92)
Band-tailed Pigeon	0.19	(0.12)	11.15	(10.63)	Bullock's Oriole	0.01	(0.01)	-	-
Oak Titmouse	0.18	(0.04)	13.27	(3.38)	Downy Woodpecker	0.01	(0.01)	1.06	(0.75)
Song Sparrow	0.18	(0.03)	13.80	(3.15)	Grasshopper Sparrow	0.01	(0.01)	1.59	(0.92)
Mountain Quail	0.17	(0.03)	0.53	(0.53)	Northern Mockingbird	0.01	(0.01)	0.53	(0.53)
Western Bluebird	0.17	(0.04)	15.92	(4.26)	Northern Pygmy-Owl	0.01	(0.01)	-	-
American Robin	0.16	(0.03)	7.43	(2.20)	Olive-sided Flycatcher	0.01	(0.01)	1.06	(0.75)
Rufous-crowned Sparrow	0.16	(0.03)	12.21	(3.05)	Tree Swallow	0.01	(0.01)	-	-
Ash-throated Flycatcher	0.15	(0.03)	7.43	(2.20)	Bald Eagle	<0.005	(<0.005)	-	-
Purple Finch	0.15	(0.03)	8.49	(2.55)	Belted Kingfisher	<0.005	(<0.005)	-	-
Hutton's Vireo	0.14	(0.03)	8.49	(2.43)	Chipping Sparrow	<0.005	(<0.005)	-	-
House Finch	0.11	(0.04)	9.55	(3.22)	Cliff Swallow	<0.005	(<0.005)	0.53	(0.53)
Lazuli Bunting	0.11	(0.02)	4.78	(1.89)	Hooded Oriole	<0.005	(<0.005)	-	-
Western Wood-Pewee	0.11	(0.02)	3.18	(1.29)	Sharp-shinned Hawk	<0.005	(<0.005)	-	-
Bushtit	0.10	(0.03)	12.21	(3.86)	Yellow Warbler	<0.005	(<0.005)	-	-
Nuttall's Woodpecker	0.10	(0.02)	7.43	(2.07)					

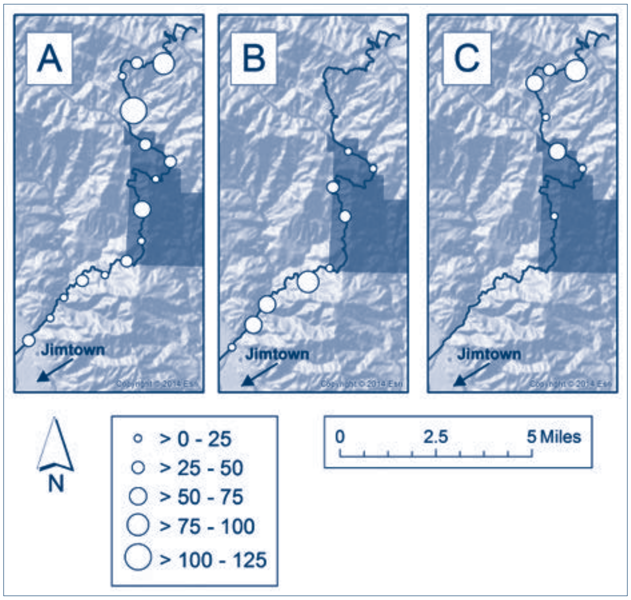

Figure 3. Average density (birds/km^2 detected within 5 minutes; open symbols) of (A) Spotted Towhee, (B) Dark-eyed Junco, and (C) Wrentit within the 50 m radius boundary at each point count station along Pine Flat Road (dark line). Data shown were collected April–June, 2013 and 2014 (n = 15 survey days). Dark shaded area represents the boundary of ACR's Modini Mayacamas Preserves.

subtle, requiring observers to identify the expected (and unexpected!) bird species by sound alone. Such skill can take a years to develop—but fortunately, Audubon Canyon Ranch continues to be aided by many proficient birders in the area.

Exceptional birding

This new survey has acquired a small but loyal group of observers who already have strong ties to the area around Pine Flat Road. New observers continue to join the effort, as the word is getting around that doing one of these surveys makes a wonderful half-day of birding—the perfect combination of easy-paced fieldwork, intellectual challenge, and a strong likelihood of finding "good birds." So far, 79 species have been documented on our spring surveys (Table 1). On Pine Flat Road, one frequently encounters less-commonly-seen species such as Rufous-crowned Sparrows, Purple Martins, and California Thrashers. Occasionally, lucky observers are treated to the magical song of the Bell's Sparrow, or to a long joyous look at a territorial Grasshopper Sparrow.

A preliminary analysis of the spatial distribution of the birds has revealed some expected, yet interesting, patterns (e.g., Figure 3). Some species, such as Spotted Towhees, are often present at nearly every station, apparently able to utilize many different vegetation assemblages. Dark-eyed Juncos appear to favor the lower reaches of the survey route, which is characterized by evergreen oak woodland. In contrast, the Wrentit is more common in the top third of the route, where elevations are higher, habitats are significantly drier, and vegetation leans toward chaparral.

Modeling habitat values

These preliminary results will come as no surprise to seasoned birders. As more data are acquired, we will build a more nuanced and detailed understanding of each breeding species' habitat preferences. To achieve this, we are conducting a detailed analysis of vegetation and structural habitat features, such as creeks, snags, and rocky outcrops, at each of the point count stations along Pine Flat Road, which we will later link with the bird survey results. In the next few years, we will incorporate results from a high-resolution vegetation map of Sonoma County, which is currently being developed by the Sonoma County Agricultural Preservation and Open Space District (SCAPOSD) and the Sonoma County Water Agency (www.sonomavegmap.org). This highly detailed map, in conjunction with habitat relationships revealed by our point count data, will be a key component of our effort to model habitat values throughout the northern Sonoma County reaches of the Mayacamas Mountains.

If you are interested in applying your birding experience to our scientific work in one of Sonoma County's most beautiful locations, please contact me at emiko@egret.org and see our project webpage (https://sites.google.com/site/acrmms-breedingbirdsurvey/). Your efforts will contribute to a better understanding of avian species–habitat relationships that will inform conservation efforts at ACR's Modini Mayacamas Preserves and beyond.

Emiko Condeso is the Ecologist/GIS Specialist at ACR's Cypress Grove Research Center.

Visiting investigators

Audubon Canyon Ranch hosts graduate students and visiting scientists who rely on the undisturbed, natural conditions of our sanctuaries to conduct investigations in conservation science.

Long-term monitoring of the Giacomini wetland. Lorraine Parsons, Point Reyes National Seashore.

Analysis of sedimentation in natural and restored marshes. Lorraine Parsons, Point Reyes National Seashore.

Dispersal vectors and risk assessment of noxious weed spread: medusahead invasion in California rangelands. Emily Farrer, University of California, Berkeley.

Effects of non-motorized recreation on medium- and large-sized mammals in the San Francisco Bay Ecoregion. Michelle Reilly, Northern Arizona University.

Spatial and temporal variability in eelgrass genetic structure. Laura K. Reynolds, University of California, Davis.

Interactions between marsh plants along a longitudinal gradient: the effect of environmental conditions and local adaptation. Akana Noto, University of California, San Diego.

In Progress: project updates

Current projects by Audubon Canyon Ranch focus on the stewardship of sanctuaries, ecological restoration, and issues in conservation science.

Picher Canyon Heron and Egret Project ◗ To evaluate effects of the 2014 abandonment of the heronry at ACR's Martin Griffin Preserve, we are closely monitoring changes in heron and egret nesting abundance and distribution in Bolinas Lagoon (see lead article in this issue of the Ardeid).

Tomales Bay Shorebird Census. ◗ Since 1989, we have conducted annual shorebird censuses on Tomales Bay. Each census involves six baywide winter counts and one baywide count each in August and April migration periods. The data are used to investigate winter population patterns, local habitat values, and implications for shorebird conservation. We are currently measuring benefits of the Giacomini Wetlands Restoration Project to shorebirds using Tomales Bay.

Tomales Bay Waterbird Census. ◗ Since the winter of 1989–90, teams of observers have conducted winter waterbird censuses from survey boats on Tomales Bay. The results provide information on habitat values and conservation needs of more than 50 species.

North Bay Counties Heron and Egret Project. ◗ John Kelly and Emiko Condeso recently published a scientific paper on the effects of climate change on heron and egret nesting abundances (**www.egret.org/kelly-and-condeso-2014-Wetlands**). Annual monitoring of all known heron and egret nesting colonies in the northern San Francisco Bay area began in 1990. ACR's atlas of heronries in the San Francisco Bay area is available online (**www.egret.org/atlas**) along with an Google-Earth program showing the locations and status of individual colony sites (**www.egret.org/googleearthheronries**).

Four Canyons Project. ◗ We are restoring native vegetation in the lower reaches of four canyons at ACR's Martin Griffin Preserve, controlling invasive plant species and using locally collected and propagated plant materials to repair disturbed sites.

Monitoring and Control of Non-Native Crayfish. ◗ Together with the Bouverie Stewards and Junipers, Bouverie staff is studying the distribution of non-native signal crayfish *(Pacifastucus leniusculus)* in Stuart Creek and investigating control methods to reduce the impacts of crayfish on native amphibians and other species.

Plant Species Inventory. ◗ Resident biologists maintain inventories of plant species known to occur on ACR lands, including ACR's Tomales Bay properties, Bouverie Preserve, Martin Griffin Preserve, Mayacamas Mountains Sanctuary, and Modini Ingalls Ecological Preserve.

Annual Surveys and Removal of Non-Native *Spartina* and Hybrids. ◗ ACR is collaborating with the San Francisco Estuary Invasive Spartina Project to coordinate and conduct field surveys and removal of invasive, non-native *Spartina* in Tomales Bay.

Monitoring and Eradication of Perennial Pepperweed in Tomales Bay. ◗ We are removing isolated infestations of invasive, non-native pepperweed *(Lepidium latifolium)*, known to quickly cover floodplains and estuarine wetlands, compete with native species, and alter habitat values.

Saltmarsh Ice Plant Removal. ◗ After eradicating non-native ice plant from ACR's Toms Point on Tomales Bay, we are continuing to remove resprouts and new patches.

Removal of *Ammophila arenaria* in Coastal Dunes. ◗ Removal of invasive dune grass *(Ammophila arenaria)* at ACR's Toms Point is helping to restore and protect native species that depend on mobile dune ecosystems.

Vernal Pool Restoration. ◗ In the vernal pools at Bouverie Preserve, we are monitoring the federally listed Sonoma sunshine *(Blennosperma bakeri)*, the California species of conservation concern, dwarf downingia *(Downingia pusilla)*, and native plant populations. We continue to remove invasive plants that encroach upon vernal pools, using manual removal and rotational cattle grazing.

Yellow Starthistle at Modini Ingalls Ecological Preserve. ◗ Sherry Adams conducted an inventory of yellow starthistle *(Centaurea solstitialis)*, established a monitoring program, and developed guidelines to reduce the spread of this invasive plant.

Serpentine and Rare Plant Survey at Modini Ingalls Ecological Preserve. ◗ Sherry Adams and volunteers are identifying and mapping unique plant assemblages associated with serpentine outcrops to help understand their status in the central Mayacamas Mountains.

Breeding Bird Assessment at Modini Ingalls Ecological Preserve. ◗ Using breeding-bird atlas and point-count methods, we are assessing the breeding status, abundance, and distribution of bird species at MIEP. This work will contribute to an understanding of regional bird use in the central Mayacamas Mountains.

Roadside Breeding Bird Survey in Northern Sonoma County. ◗ We are measuring the densities and abundances of breeding birds along a roadside route in the central Mayacamas Mountains of northern Sonoma County. The survey route includes 16 point-count stations, extends from the bottom to the top of Pine Flat Road, and includes ACR's Mayacamas Mountains Sanctuary. Interested birders who can identify local breeding bird species by ear are encouraged to contact the Cypress Grove Research Center or visit **https://sites.google.com/site/acrmmsbreedingbirdsurvey/home**.

Oak Woodland Restoration. ◗ With the successful completion of Project GROW (Gathering to Restore Oak Woodlands) in 2014, ACR is now partnering with the Hanna Boys Center and volunteer groups to expand its oak woodland restoration sites by planting additional native tree species such as Madrone, as well as native perennial grasses at its restoration sites.

Wildlife Movement Research. ◗ ACR has partnered with the Felidae Conservation Fund's Bay Area Puma Project to record mountain lion activity at Bouverie Preserve with remote wildlife cameras since 2011. Bouverie staff are currently expanding these efforts as part of the Wildlife Observers Network Bay Area (WONBA) in partnership with other local conservation and land preservation organizations in the Sonoma Valley.

Control of Invasive Pest Plants at Bouverie Preserve. ◗ To protect and restore vernal pool, grassland, and upland habitats at Bouverie Preserve, we are mapping and removing infestations of more than 12 invasive non-native plant species.

Trail Improvements at Bouverie Preserve. ◗ With support from a volunteer trail task group and the North Bay Conservation Corps, efforts are underway to decommission a portion of the Canyon Trail that suffers from ongoing erosion and stability problems and replace it with a new trail to the Waterfall Overlook at Bouverie Preserve.

Wildlife Photo Index in the Central Mayacamas Mountains. ◗ ACR is collaborating with colleagues at Pepperwood Preserve and Susan Townsend on a system of camera traps at ACR's Modini Ingalls Ecological Preserve and Mayacamas Mountains Preserve northeast of Healdsburg, and at Pepperwood Preserve ten miles to the south. The motion-activated cameras, installed at 1-km intervals across a 20-km^2 grid, provide information on wildlife use that may reveal conservation needs for protecting wildlife habitat connectivity in the central Mayacamas.

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Conservation Science
and Habitat Protection
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Madrone Audubon Society group identifies birds near Pine Flat Road, in ACR's new Mayacamas Mountains bird monitoring area.

DAVID SELF / ACR

Branching Out see page 10

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