



Conservation Science and
Habitat Protection at
Audubon Canyon Ranch

THE ARDEID



► herons and egrets

climate change

► Modini Ingalls

Ecological Preserve

stewardship

► manzanita discovery

loss and redemption

► Giacomini Wetlands

return of the tide

2010



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Cover: Western toad, one of the amphibian species at Modini Ingalls Ecological Preserve. Photo by Leah Grunzke / Flickr Creative Commons. *Ardeid masthead:* Great Blue Heron ink wash painting by Claudia Chapline.

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How will heron and egret populations respond to regional climate change?

Hérons in the Mist

by John P. Kelly

As the earth spins and the edges of daylight and darkness sweep across its surface, sunrise and sunset colors manifest brilliantly over some areas, yet are muted or obliterated in others. Latitude plays a role in this expression of refracted light, influencing the angle at which solar rays strike the atmosphere, and driving the dynamics of warm and cold air masses that determine zones of arid, semi-arid, rainy, or tropical climate—but local weather within any climate zone can enhance or interfere with an elaborate sunrise. Ultimately, a sunrise or sunset is a global process that appears according to the vagaries of local weather, influenced by complex processes involving topography, seasonal timing, and geographic position relative to continents, oceans, lakes, and rivers. Just as the colors of a sunset are the uniquely local consequence of the earth's rotation, the spectrum of life in any one place will be uniquely affected by global climate change.

Climate change may have numerous consequences affecting wetlands (Table 1), but it can be difficult to determine how they will affect the structure and dynamics of wetland life in a particular region. Specifically, little is known about how climate change might affect the roles of top wetland predators such as herons and egrets. Emiko Condeso and I are currently investigating this question: what are the likely effects of climate change on the number of herons and egrets nesting in the San Francisco Bay area?

Change in seasonal rainfall is one aspect of

climate change that might strongly affect breeding and wintering populations of herons and egrets. The potential influence of rainfall change is reflected by the sensitivity of nesting and foraging herons and egrets to differences in water depth and vegetation structure, and to hydrologic processes that affect runoff, circulation, drainage, and water quality. Changes in the timing or extent of seasonal rainfall can enhance or depress foraging opportunities and the availability of prey for herons and egrets. As a result, changes in seasonal rainfall may lead to changes in local or regional nesting abundance. In addition, because herons and egrets are top predators in wetland systems, their numbers may help sustain the complex fabric of wetland life. In ancient Egypt, the hieroglyphic symbol for “flood,” used to describe the annual flooding of the Nile and the associated idea of “rebirth” or appearance of new life, was a heron.

Wetland quality

Feeding opportunities for herons and egrets are enhanced if conditions associated with seasonal rainfall or runoff confine potential prey to receding ponds or create confluences, eddies, flooded fields, or isolated ponds. In Florida, Great Egrets shift their nesting colonies away from areas undergoing drought conditions immediately prior to nesting. In California, winter rainfall is needed for the annual development of extensive seasonal wetlands. With substantial amounts of winter rainfall, ground and surface waters can sustain vast wetland feeding areas through the nesting season. Alternatively, increased rainfall can reduce foraging efficiency if flooding or turbidity reduces the supply or availability of prey. So, depending on the extent and timing, increased rainfall might enhance or degrade foraging conditions, nesting provisioning rates, and reproductive success.

Table 1. Effects of climate change on regional wetlands

| Climate effects | Wetland consequences |
|---|---|
| Rising sea level | Inundation and loss of tidal marshes, unless adjacent landscapes allow for the landward migration of marshes into undeveloped lowlands |
| Changes in the extent or timing of seasonal rainfall, snowpack, groundwater, surface runoff, or evaporation | Expansion or loss of permanent and seasonal wetlands |
| Geographic redistribution of hydrologic conditions that generate wetland systems | Reduction or loss of wetlands in some areas; development of new wetlands in other areas unless prevented by barriers, such as roads and buildings, or other elements of human-altered landscapes |
| Changes in the flow of water through wetlands, including drainage pattern, volume, speed, seasonal timing, and associated effects on scouring or deposition of sediment | Changes in the functional shape of wetlands and associated habitat conditions for plants and animals |
| Changes in average or extreme temperature, precipitation, or other environmental conditions | Benefits or constraints on the survival or reproduction of wetland organisms, potentially leading to the growth, decline, or extirpation of wetland populations, and to changes in the structure of wetland communities |

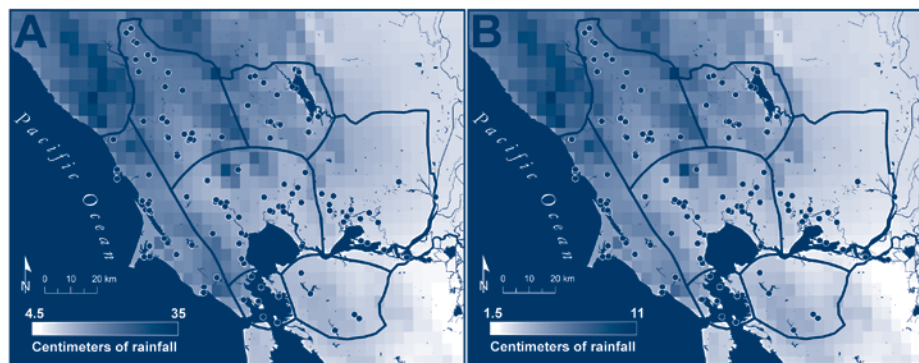


Figure 1. Average monthly rainfall during (A) winter (November–February) and (B) spring (March–June) in the northern San Francisco Bay area, 1990–2008. Filled circles indicate the locations of heron and egret colony sites. Bold lines separate major wetland subregions. The geographic distribution of rainfall is similar between seasons, although rainfall values differ (as shown in the two rainfall gradients). Figure created by Emiko Condeso.

This could stimulate departures or incursions of nesting birds and lead, respectively, to decreases or increases regional nesting abundance.

Production and recruitment

If changes in seasonal rainfall increase or reduce either the production or survival of juveniles, subsequent effects on the recruitment of first-time breeders are likely to enhance or reduce growth of the nesting population. The per capita production of juveniles depends strongly on the annual extent of “brood reduction,” which results from asynchronous incubation and hatching that leads to a hierarchy of competitiveness and survivorship among nestlings (Kushlan and Hancock 2005). One benefit of brood reduction is that it enables nesting herons and egrets to match the number of young produced in successful nests to unpredictable changes in the availability of food needed to provision nestlings. Therefore, changes in rainfall that affect the extent or quality of surrounding feeding areas are likely to influence the number of young produced (Kelly et al. 2008).

Changes in seasonal rainfall might lead to behavioral changes among predators, increasing or decreasing the risk of nest predation. Herons and egrets respond to changes in predation risk by altering patterns of nest attendance (see *Ardeid* 2009). However, nest attendance patterns are also subject to climate-related changes in wetland quality and associated changes in the amount of time needed to provision nestlings with food. If changes in nest attendance, attributable to climate-induced changes in predation

risk or foraging effort, lead to increases or decreases in reproductive success, the number of young birds available to sustain regional nesting abundances may also increase or decrease.

Modeling population change

The goal of this study was to determine the annual effects of seasonal rainfall on heron and egret nesting abundance. We based the analysis on observations gathered by numerous volunteer field observers on ACR’s Heron and Egret Project, who have collectively monitored heron and egret nesting performance at all known colonies in the northern San Francisco Bay area since 1991 (Figure 1; Kelly et al. 2006, 2007). The preliminary analyses presented here, based on 18 years of observations, will lead to a more formal analysis of rainfall effects on nesting abundance over 20 years.

We tested the extent to which potentially influential periods of seasonal

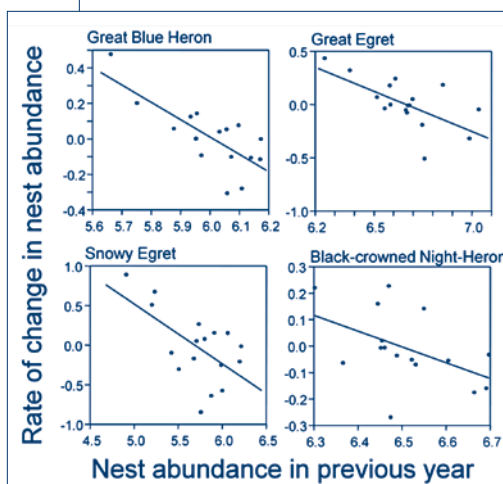


Figure 2. Dependence of the annual rate of change in heron and egret nest abundance on the number of nests in the previous year (values on vertical and horizontal axes are in natural-log scales).

rainfall, alone and in various combinations (across several statistical models), are linked to changes in nest abundance (Table 2). The heron and egret species under study generally do not breed until the second spring after their hatching year, when they approach two years of age. Therefore, to account for the potential influences of rainfall on the production and recruitment of new breeders, we considered seasonal rainfall effects on reproduction and winter survival at time lags of up to two years.

We estimated seasonal rainfall patterns for each colony site, using spatially detailed estimates of average monthly rainfall, calculated in relation to local geography by the PRISM Climate Group, Oregon State University. This approach allowed us to predict changes in nest abundance in relation to rainfall patterns at each heronry (Figure 1).

To distinguish the effects of rainfall, our models also had to account for “density-dependent” population change. This is because annual nest abundances increase less, or even decline, when regional populations grow larger (Figure 2). Such apparent regulation of regional abundance is interesting in itself, because it suggests that herons and egrets may be operating near the carrying capacity of San Francisco Bay area wetlands. This dependence also accounts for other (unknown) processes unrelated to rainfall, such as foraging competition, that might influence population size. Like black holes in space, these regulatory forces are known only indirectly, by their effects on what we can see—in this case, annual changes in nest abundance.

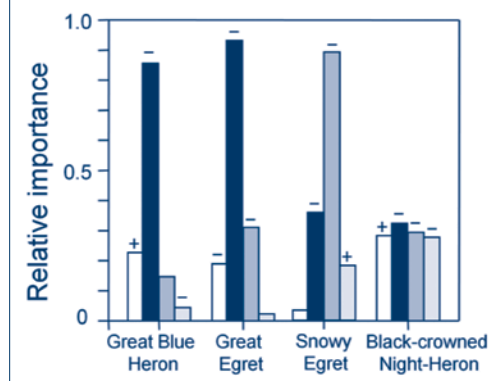


Figure 3. Relative importance of rainfall periods predicting changes in heron and egret nesting abundance (sum of AIC weights across associated models). White bars = winter before the current nesting season; black bars = winter before the previous nesting season; gray bars = spring two years before the current nesting season; light-gray bars = winter before nesting two years earlier. Negative (–) or positive (+) influences on nest abundance are indicated above the bars.

Table 2. Hypothetical effects of increased winter (November–February) and spring (March–June) rainfall on the regional abundance of nesting herons and egrets. (Hypothetical effects of reduced rainfall are implied by the opposite of each effect listed here.)

| Rainfall period | Negative effect | Positive effect |
|--|--|--|
| Winter, immediately prior to nesting | Harsh winters might reduce foraging success and winter survival, or stimulate regional departures, prior to nesting. | Increased winter rainfall might enhance the quantity or quality of wetland feeding areas and winter survival, or stimulate immigration, prior to nesting |
| Winter, prior to the previous nesting season | Harsh winters might reduce the availability and recruitment of first-time breeders by reducing juvenile foraging success and survival, or stimulating regional departures, during their first winter. | Increased winter rainfall might increase the availability and recruitment of first-time breeders by enhancing the quantity or quality of wetland feeding areas and juvenile survival, or stimulating immigration, during their first winter. |
| Spring, two years before nesting | Heavy spring rainfall might reduce the availability and recruitment of first-time breeders by reducing foraging success, nest success, or productivity in their hatching year. | Increased spring rainfall might increase the availability and recruitment of first-time breeders by enhancing foraging conditions and productivity in their hatching year |
| Winter, prior to nesting two years earlier | Harsh winters might reduce the availability and recruitment of first-time breeders by reducing the number of nesting pairs during their hatching year, if conditions reduce foraging success and winter survival, or stimulate regional departures of wintering birds. | Increased winter rainfall might increase the availability and recruitment of first-time breeders by increasing the number or productivity of nests during their hatching year, if conditions enhance the suitability of feeding areas, increase winter survival, or stimulate immigration prior to the nesting season. |

Delayed impacts of winter rainfall

Our results revealed that changes in Great Blue Heron and Great Egret nest abundance were influenced more strongly by rainfall during winter than during the nesting season. The strongest effects of winter rainfall were lagged one year, such that heavy winter rainfall was likely to reduce nest abundance or population growth in the second subsequent spring (Figure 3). This delayed effect suggests that increases in winter rainfall may reduce the survival (or stimulate regional departures) of juveniles during their first winter and, consequently, lead to a decline in the regional recruitment of first-time breeders into the nesting population.

The results for Snowy Egret and Black-crowned Night-Heron were more complex and less definitive. However, similar to other species, the best models consistently revealed delayed, negative effects of rainfall. Heavy winter or spring rainfall seemed to limit the production of fledglings or reduce the first-winter survival of juveniles (or stimulate their regional departure) and, consequently, reduce the subsequent recruitment of nesting Snowy Egrets and Black-crowned Night-Herons.

Shifting distributions

Our results for major wetland subregions were generally consistent with regional results, but they were complex and worthy of more intensive investigation. For example, in contrast to regional patterns, results from the diked marshes of Suisun Bay and the drier wetland landscape of northern Napa County suggested that increased winter rainfall in seasonally dynamic, non-tidal landscapes may lead to increased (rather than reduced) nest abundance, possibly through enhanced juvenile survival or immigration. Such differential effects of rainfall among subregions might explain the geographic shifts in nesting distribution that occur annually among San Francisco Bay area heronries (Kelly et al. 2007).

The future

Regional climate models predict future increases in precipitation in northwestern California, but decreases in spring (April–August) rainfall (Kueppers et al. 2005), implying increased precipitation during the winter months. Based on our results, long-term increases in winter rainfall may reduce rates of population growth, depress annual resilience, or lead to declines in the

number of herons and egrets nesting in the San Francisco Bay region. In addition, predicted increases in flood frequency, storminess, and loss of tidal marsh feeding areas associated with sea level rise all highlight the sensitivity of herons and egrets to rainfall patterns during their first winter. We are currently furthering this investigation by using the results to forecast long-term heron and egret population trends in relation to predicted climate-change scenarios. Although climate predictions clearly suggest substantial changes to the ecological character of our region, there is much to learn about particular outcomes.

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Natural resource management planning for the Modini Ingalls Ecological Preserve

Preparing for Stewardship

by Sherry Adams

Through the work of countless individuals, non-profits, and government agencies, most of the central Mayacamas Mountains are still wild. Salmon can be found in the creeks, bear signs are common, and outcrops of our state rock, serpentine, are home to a host of specialist plants, including rare county endemics. The highest ridge of the Mayacamas Range is the spine that separates Mendocino and Sonoma counties, to the west, from Lake and Napa counties to the east. Mount St. Helena is perhaps the most well known feature of the range which also includes Cobb and Hood Mountains. In the heart of this remote area lies the beautiful Modini Ranch (Figure 1).

The central Mayacamas Mountains include over 12,000 acres of contiguous protected land. These protected lands include a 1,735-acre natural area owned by Jim and Shirley Modini. The land has been in their family for generations, and the Modinis have been careful and tireless stewards of the land. The property extends across a steep and rugged landscape that includes grassland, oak and coniferous woodlands, chaparral, riparian corridors, and natural springs. It has a Forever Wild conservation easement held by the Sonoma County Agricultural Preservation and Open Space District, and it is almost entirely surrounded by other protected lands. It ranges in elevation from about 500 to about 2700 feet. Through a planned giving agreement with Audubon Canyon Ranch, the Modinis have decided that this stunning property will someday become ACR's fourth major wildlife sanctuary, to be known as the Modini Ingalls Ecological Preserve (MIEP). However, ACR is already becoming familiar with the preserve.

ACR biologists are using the intervening time to get to know the place by gathering information from the Modinis and from the land itself. Since June of 2009, I have been spending considerable time on the ground, learning about the history and management of the ranch from Jim and Shirley and



Figure 1. Looking south from the center of the Modini Ranch.

beginning to compile biological assessments that will inform our Modini Ingalls Ecological Preserve Natural Resources Management Plan.

The Natural Resources Management Plan (RMP) is needed to guide stewardship activities at the Modini Ingalls Ecological Preserve once ACR assumes management responsibility for the property. We have identified a number of key tasks, based on a thorough evaluation of biological values, cultural history, and resource management needs, that are necessary to complete an effective RMP.

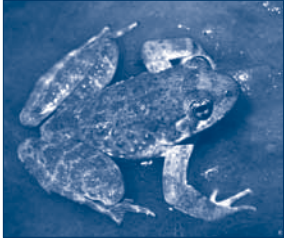
We began by outlining the approximate timing and key objectives for preparing the RMP, in consultation with the Modinis and their advisors. The proposed actions focus on conducting field surveys needed to guide us in developing appropriate RMP

objectives. The completed objectives and procedures will target the management, protection, and to the extent needed for practical stewardship, continued assessment and monitoring of local resources at MIEP. To account for large-scale processes that influence the central Mayacamas Mountains area, the completed plan will reflect both local and regional perspectives on conservation. Therefore, when developing field protocols and project goals, we are considering their potential for future application or expansion to facilitate regional conservation in the central Mayacamas Range.

We are focusing on six important areas of work at the Modini Ranch:

► **Compiling and integrating existing data from multiple partners:** A significant amount of biological and geographic data

A preliminary survey of amphibians at Modini Ingalls Ecological Preserve, February–March 2010.



Foothill yellow-legged frog.

Foothill yellow-legged frog (*Rana boylii*). A potentially robust concentration was found at the confluence of the two major creeks of the ranch and in the surrounding area, suggesting the possibility of strong numbers in other riparian areas of the preserve. The foothill yellow-legged frog is listed as a

California and federal Species of Special Concern, now gone from approximately half of its historic range. Two predatory invasive species, signal crayfish and bullfrog, were also observed during the survey, and may pose threats to yellow-legged frogs.

Sierran tree frog (*Pseudacris sierra*). This species is common at MIEP and across its range from the northern Rockies to most of California.

(California) western toad (*Bufo boreas halophilus*). Both adults and eggs were encountered. The Modinis report that this species is far less common than in the past. The International Union for the Conservation of Nature includes this species on their Red List as “Near Threatened” due to declining population, including drastic declines in parts of its range.

Bullfrog (*Rana catesbeiana*). This species was found only at the created pond near the Modini residence. Bullfrogs are native to the U.S. east of the Rockies and are documented to have a negative impact on native amphibians in disturbed habitats in the introduced range. Reports from the Modinis indicate that this species is not new to MIEP. We have observed it at other locations near MIEP.

Coast range newt (*Taricha torosa*). This is a California Species of Special Concern that is endemic to California. It was found at one location on MIEP. Its favored habitat, in still waters, is uncommon on the preserve.

California giant salamander (*Dicamptodon ensatus*). California giants were found in one location on the preserve. This species of limited range has just two isolated populations: one in Sonoma and Marin counties and portions of neighboring

counties, the other extending from San Mateo County to Santa Cruz County.

Oregon salamander (*Ensatina eschscholtzii oregonensis*). This species is common in woodland areas of MIEP.

California slender salamander (*Batrachoseps attenuatus*). These salamanders are very common in the leaf-litter layer of forested areas throughout MIEP. This species occurs in a diverse range of habitats, including areas that have been disturbed and modified.

Black salamander (*Aneides flavipunctatus flavipunctatus*). Black salamanders are common in woodland areas of MIEP. MIEP is near the southern end of the range of this subspecies. The International Union for the Conservation of Nature includes this salamander on their Red List as “Near Threatened.”

Red-bellied newt (*Taricha rivularis*). Red-bellied newts are very common at MIEP, in or near riparian habitats. This species is limited to the North Coast Range in California from Sonoma County to Humboldt County

The preliminary amphibian survey in 2010 was of limited duration; the following additional species might be present at MIEP:

Arboreal salamander (*Aneides lugubris lugubris*). This species is likely to be present at MIEP. Survey methods used can easily miss this species, which uses tree cavities.

Rough-skinned newt (*Taricha granulosa*). While MIEP is within the published range of this species and it may be present, its favored breeding habitat, in still waters, is uncommon at MIEP. A possible sighting of this species during the survey could not be confirmed.

Yellow-eyed salamander (*Ensatina eschscholtzii xanthoptica*). This species occurs just south of MIEP and may be present on the Modini property. MIEP is located at the approximate boundary between this subspecies and the closely related Oregon salamander, which was found during this survey. However, records show that the two subspecies overlap in range.

Thanks to Diana Ruiz for field work assistance and to Gary Nafis for identification assistance on the amphibian inventory.

already exist for the region that includes the Modini Ranch. Geographic information includes soil maps and detailed aerial photography, which helps us to identify vegetation types and locations of serpentine outcrops. Mapping by the U.S. Forest Service provided a basis for the vegetation map. Local experts have put together plant species lists and bird lists for a neighboring property which, along with state databases, have helped us to identify which species are likely to be found. Several organizations in the region have done preliminary work to identify conservation goals and threats.

Mapping, assessment, and inventory: Using the powerful tools of Geographic Information Systems (GIS) along with the significant amount of landscape-scale data already available, we have been creating a series of data-filled maps, each focused on different aspects of the ranch. The GIS mapping is combined analytically with previous biological assessments and the results of field work, allowing us to identify the current status of the biological resources of the ranch.

So far, we have completed these elements of the RMP:

- A map of the vegetation types of the ranch, which facilitates future biological work (Figure 2).
- A map of yellow star thistle present on the ranch along with management recommendations.
- A map of the infrastructure of the ranch; this includes roads, fences, gates, developed springs, place names and notable natural features. Current and future work involves these additional elements:
- Inventory of amphibians which identified a species of concern, taxa at the edge of

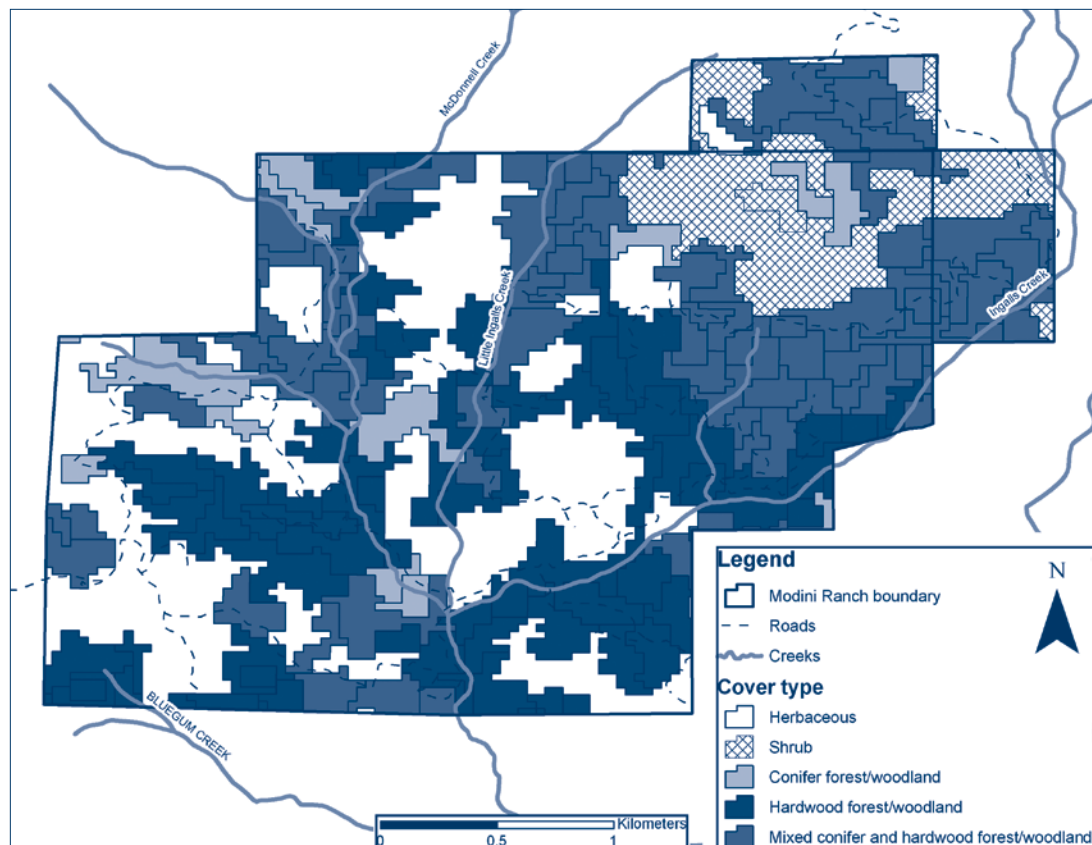


Figure 2: A map of the vegetation types of the Modini ranch (created by Sherry Adams).

their range and suggested management actions to reduce threats (see box, page 5).

- A map of the serpentine outcrops on the ranch—known to be potential hotspots for rare and endemic plants in the region—along with field work to survey each outcrop for rare plants.
- Multiple-year survey of breeding birds on the ranch.
- Development of a plant species list for the ranch; we have documented about 300 plant species so far.
- A creek assessment to determine potential sources of erosion and other threats, as well as management plans to address those threats.
- An investigation of the threat posed by sudden oak death for this parcel, and a future strategy for minimizing the threat.

►**Spending time with the Modinis:** Jim and Shirley Modini have spent over 60 years on the ranch and know every inch of the place. We are using this time to learn the oral history of the land and understand how they have managed the land during the many years they've lived there. This includes reviewing historic documents and spending time on the ranch with Jim and Shirley.

►**Planning and drafting the RMP:** All of this knowledge we are amassing is not just stacking up in file cabinets, collecting dust. We are using it to craft the management plan, which will be an evolving document that directs how ACR will manage the Modini Ingalls Ecological Preserve. For example, where we've identified rare or vulnerable species we also identify threats to these species and appropriate monitoring protocol. As we've identified invasive species we also draw on existing research to identify methods to minimize the threat of these species. As we continue to find evidence which suggests that sudden oak death is not present on the ranch, we rely on existing research to determine the best strategy for management of the property in the face of the presence of this pathogen in other parts of the county.

►**Getting to know the neighborhood:** Many factors help explain why the Modini Ranch is such a gem. The Modinis have consistently put a very high value on conservation throughout their tenure on the land. Another factor is the "neighborhood." If the wild, natural landscape of the Modini Ranch were an island surrounded by intensive agriculture, it would probably not

support animals like bears and mountain lions that require much larger tracts of land. Many threats, such as sudden oak death or a common amphibian fungus, travel through creeks. So we know that what goes on in neighboring parcels in the watershed could dramatically influence the ecological health of the area. We're new to this neighborhood, so we're taking the time to learn how to collaborate with others in the area to make sure the central Mayacamas stay wild.

►**Beginning to get involved with land management:** The Modinis still live at the ranch and are actively involved in management. However, as needed, Audubon Canyon Ranch is beginning to help them with management and stewardship tasks, and they have welcomed us to share their connections to this beautiful place as part of the Modini family.

Audubon Canyon Ranch continues to listen to and learn from the Modinis and from the land as we craft a management plan to ensure this beautiful property will always be a place of wildness.

Lessons from the rediscovery of the Franciscan manzanita

Loss and Redemption

by Dan Gluesenkamp

Many of California's plant species are the product of multiple episodes of climate change. When climate has cooled, species have colonized from the north. When climate has warmed, species have colonized from the south. With each episode of change, evolving conditions have selected for new traits and generated new biological diversity. Much of California's unique biological richness is the product of rapid radiation events that generated great diversity in very short periods of time.

Manzanitas (*Arctostaphylos*) in California are an example of climate-induced adaptive radiation. California now supports 96 taxa of *Arctostaphylos*, products of a rapid radiation event approximately 1.5 million years ago. Most of these species and subspecies are restricted to California. Many species are restricted to very limited geographic areas, as demonstrated by their names: Vine Hill manzanita (*A. densiflora*), Mt San Bruno manzanita (*A. imbricata*), The Cedars manzanita (*A. bakeri* ssp. *sublaevis*), Tamalpais manzanita (*A. montana*), Mount Diablo manzanita (*A. auriculata*), San Gabriel manzanita (*A. gabriniensis*), San Francisco manzanita (*A. franciscana*), and dozens of others. It seems that every coastal mountain once had its own particular species of manzanita, a plant uniquely adapted to local soil and climatic conditions. Now many of these local taxa are rare, endangered, or extinct.

The Franciscan manzanita (*A. franciscana*) was driven extinct in the 1940s, as some of San Francisco's century-old open spaces—cemeteries—were developed for houses, shops, and tennis courts. The species was part of the diverse and miraculous Franciscan floristic region, the smallest floristic region in California and one largely replaced by its namesake city. Fortunately, portions of this floristic region are preserved in the Marin headlands, at Mount San Bruno, and in key natural areas in San Francisco.

Sixty years ago, well-developed Franciscan plant communities still occurred on the peninsula, many associated with the Gold Rush era cemeteries on Lone Mountain and Laurel Hill. As the forces of progress began developing San Francisco's remaining wild places, the legendary botanists of yesteryear fought to preserve some floristic remnants. In 1906, Alice Eastwood rescued the type specimens of *A. franciscana* by throwing them out the windows of the burning California Academy of Sciences. Decades later, Alice begged San Francisco to save part of the old Laurel Hill Cemetery for a city botanical reserve—to no avail. Before he was diverted into the war effort, James Roof salvaged *A. franciscana* plants from bulldozers clearing land for homes and tennis courts. Along with other plants, these rescued shrubs were moved to the Regional Parks Botanical Garden in Tilden. For the rest of his life, however, Roof grieved at not rescuing more flora of the Franciscan region before it was ultimately lost. By the end of the 1940s, the old 49'er bones had been moved to new cemeteries in the city of Colma, and the Franciscan manzanita was believed extinct in the wild. Until last year.

Discovering a survivor

On October 16, 2009, I noticed a beautiful manzanita growing on a traffic island just south of the Golden Gate Bridge. Thinking the plant might be a Raven's manzanita (*A. hookeri* ssp. *Ravenii*), a nearly extinct manzanita native to San Francisco, I called Lew Stringer, a biologist with the Presidio Trust. Lew worked with biologists Mark Frey, also with the Presidio Trust, and Michael Chasse from the National Park Service to identify the plant as an unexpected Franciscan manzanita. Tom Parker and Mike Vasey, manzanita experts from San Francisco State University, applied morphological and molecular analyses to confirm our fortunate rediscovery of the Franciscan manzanita.



Three months after transplantation (see photo story, page 8), the Franciscan manzanita festooned with an exuberant collection of cream-colored flowers. Since this photo was taken, the flowers shown have matured into plump little "apples." While it remains unknown whether these fruit will germinate to produce a new generation of manzanita plants, efforts are underway to ensure the return of other individuals to the site.

Rediscovery of an extinct species is cause for great excitement, but there is an added sense of urgency when that plant grows in the middle of a \$1.1 billion highway realignment project. While it is certain that some effort would have been made to protect and save this species, its proximity to the Doyle Drive highway project provided the imperative for quick action and expedited the funding of restoration efforts. Within days, representatives from Caltrans, the Golden Gate National Recreation Area, National Park Service, Presidio Trust, and U.S. Fish and Wildlife Service began developing a conservation plan for the plant and the species.

Saving the Franciscan manzanita



ASHA SETTY

Daniel Gluesenkamp poses with the Franciscan manzanita mother plant, shortly after its discovery. The plant occupied a small outcrop of serpentine soil, wedged between the busy Golden Gate Bridge and a 20-foot deep retaining wall. The manzanita was discovered only weeks before construction crews completed clearing the site; cut stumps visible on the hillside are all that remain of the other shrubs and trees removed during preparation of the construction site.



DANIEL GLUESENKAMP

On a Saturday morning in January, working in a torrential pre-dawn rain storm, biologists and construction personnel worked to transport the 10-ton serpentine soil monolith to a new location. In this photo, a Caltrans project manager dances a little jig to celebrate successful “lift off” of the mother plant. Visible behind the plant is the road sign for downtown San Francisco and, in the background, the lights of Coit Tower and the Transamerica Building.



DANIEL GLUESENKAMP

Four hours after “lift off” the Franciscan manzanita arrived at its new home. Tree contractors and National Park Service biologists worked carefully to place the mother plant. The recipient hole was prepared in advance, in soil remarkably similar to that of the source location and in a location carefully chosen to resemble the source site. The plant has been watered and inspected regularly by dedicated biologists, and the surrounding area was seeded with local native wildflowers.



ASHA SETTY

Daniel Gluesenkamp exchanges a “high five” with Presidio Trust biologist Lewis Stringer. Stringer was the first person contacted following discovery of the plant. He and his colleague Mark Frey positively identified the plant as the presumed-extinct *Arctostaphylos franciscana*.

Hundreds of cuttings were collected so that the rare manzanita could be propagated at conservation nurseries. Seeds and seed-containing soil were collected and are undergoing experimental treatments to encourage germination. Finally, plans were made to translocate the mother plant to a new location elsewhere in the national park. The plant was excavated, and the monolith of serpentine soil was carefully wrapped in burlap and wire to protect the fragile root system. Early one Saturday morning the 10-ton mother plant was lifted by crane, driven through sleepy San Francisco streets, and replanted in a new location where it is being carefully tended. As cuttings and seeds are nurtured to produce additional plants, plans are underway to recover a viable population of Franciscan manzanita, by bringing all these plants together in a restored serpentine prairie.

Lessons learned

The success of the Franciscan manzanita conservation action has much to teach about the promise and limitation of translocation as an effective tool in modern biodiversity conservation. We expect that this will be a successful translocation and we hope to ultimately restore a population of this species. With hard work and luck we may establish a place where San Francisco manzanita plants exchange pollen, bear seed, and produce new manzanita plants to continue the lineage. To some people the cost is prohibitive (e.g. more than \$200,000 to save the Franciscan manzanita), but when compared with the cost of highway work (Doyle Drive is 5500 times more expensive) it seems to be a reasonable investment in saving species from extinction.

However, this success story is also an exception that proves the rule: translocation is a very difficult conservation strategy. "Translocation" is the term that conservation biologists use to describe attempts to establish a population in a new location. Translocation is increasingly discussed as one potential method of reducing the impact of climate change on natural systems; academics and conservation professionals have also used terms such as assisted migration, managed relocation, and assisted colonization. As climatic conditions change in the future, and the climatic zones that species occupy shift, many species must either shift their geographic range accordingly or decline or go extinct.

We are able to successfully translocate this plant because of many fortuitous circum-

stances: it grew on federal land and so was covered by the federal Endangered Species Act; translocation costs were miniscule when compared to the \$1.1 billion overall project cost; it was found in the Golden Gate National Recreation Area, which trains and employs perhaps the state's greatest concentration of native plant restoration experts; and, in a miracle of serendipity, Mark Frey had already begun his master's thesis—a restoration plan for San Francisco's endangered manzanitas. Even given these miraculous circumstances, it is possible that the mother plant may not survive, and successful recovery of the species might become a distant dream. Even if a population of this species is successfully established, we will never be able to fully restore the diversity of other species needed to sustain the biological community it once shared.

Efforts to save the Franciscan manzanita provide an important lesson in an era of climate change, when experts are discussing exciting, ambitious, often unproven technical solutions for protecting California biodiversity in the face of inevitable and unavoidable change. There is no doubt that translocation will remain an important tool for saving species from extinction when all other strategies have failed, but the story of the Franciscan manzanita has taught us that translocation should be an action of last resort. Protecting habitat and preventing population declines remain the most effective conservation actions.

To protect populations and ecosystems from climate change we must identify those that are most likely to suffer. While climate modeling or additional research may assist with this task, research should be secondary to actions we can undertake immediately. The easiest and most efficient action is to identify and preserve populations of species that are already rare. Once identified, these populations should be protected against non-climate stressors such as biological invasion, habitat loss, and inappropriate fire regimes. We must also support the natural ability of ecosystems to tolerate or adapt to climate change. This includes restoring riparian forests and other habitat to promote connectivity needed for the natural distribution shifts of plants and animals.

In addition to maintaining connectivity, we must also identify biological refugia that have survived previous episodes of climate change. For example, in the hot, dry chaparral of Audubon Canyon Ranch's Bouverie Preserve one can stand within a small and isolated redwood forest (*Sequoia semper-*

virens). These trees are the last remnants of the more widespread redwood forests of wetter millennia, and Bouverie Preserve's redwood oasis maintains a cool, moist forest understory that supports at least two rare plant species: redwood lily (*Lilium rubescens*) and false indigo (*Amorpha californica* var. *napensis*). Persistence of these moisture-loving relictual species may be an indicator of distinctive microclimates or environmental conditions and may provide refuge for species in this coming era of change.

Climate change has shaped California. We are surrounded by evidence of this fact. At Toms Point there stands a small grove of wind-dwarfed Garry oaks (*Quercus garryana*), a tree more commonly encountered far inland. Fifteen thousand years ago, when the Farallones were part of the mainland, this grove may have stood at the inland edge of a coastal grassland that extended to the cedar-cloaked coastal Farallon mountains. In the few short millennia since, North America's continental glaciers melted and California's coastline was inundated by rising seas. Expansive redwood forests grew thin and then were lost altogether but for a thin band along the coast and a few scattered pockets as far east as the Napa-Sonoma county border. Manzanitas migrated to new suitable climatic zones, and then were blocked from further migration when they reached the tip of San Francisco's peninsula. At times the pace of climate change was comparable to that predicted for our near future, and yet species survived and ecosystems adapted; as some evolutionary threads were clipped, new lineages were initiated, and consequently we have inherited a rich and wonderful tapestry of life.

It is important to remember that the places we love are often the product of rapid environmental change. We must also remember that while our past actions have guaranteed that some amount of change will occur, it is our future actions that will determine how much we lose. If we remain vigilant for species in need of rescue, then we can act to save them. If we preserve migration corridors and preserve wild places and refugia, then species can migrate, mingle in new combinations, and form new ecosystems. If we plan carefully and act thoughtfully, then much of the nature that we cherish may survive. Millennia hence, manzanitas may recolonize land newly exposed as the earth cools and oceans inevitably, once again, recede.

Shorebird use in the evolving Giacomini Wetlands

Return of the Tide

by Emiko Condeso

Early in the morning, low clouds hover over Tomales Bay. The water is so still that every bird swims or stands atop a perfect reflection. At the far southern end of the bay, in a marsh that just two short years ago was blanketed in pasture, a handful of people, early risers, begin trekking out to watch shorebirds. The sticky mud clings to their rubber boots as they make their way through the upland vegetation and down onto the mudflat. This is not yet the deep chocolate mud of a tidal wetland, so smooth that it is difficult to wipe from your fingers, but instead has the texture of wet pasture. The decaying roots of European grasses support the birders' feet beneath the mud. These volunteers are walking on a very young wetland—or rather, a very old wetland, turned dairy farm and now in the process of evolving toward its former state.

Before the settlement of West Marin by its current human residents, the headwaters of Tomales Bay were a vast tidal marsh complex that extended southward to Bear Valley and northward to Inverness. During the World War II era, Waldo Giacomini diked the southern end of Tomales Bay to increase the extent of available pastureland for his dairy. This and many other alterations to the landscape since the mid-1800s have had dramatic consequences. The construction of roads and railways, logging, and the loss of tidal circulation have substantially altered Tomales Bay. Open water areas were converted to upland grassland and vegetated marsh. Mudflats formed by creek deltas were transformed into isolated pocket marshes. Water quality in Tomales Bay and the associated creeks was degraded by sediments carrying pollutants.

In the 1970s, the local community began calling for change, and in 2000, with the cooperation of Caltrans, the California Coastal Commission, and the Gulf of the Farallones National Marine Sanctuary, the National Park Service purchased the Giacomini dairy lands and began the long process of ecological restoration. Because

the environment had changed so dramatically, replication of the historic estuary was not possible. However, restoration to a dynamic estuary by bringing back the dominant ecological process—tidal circulation—was an exciting and achievable goal. In October of 2008, after years of planning and hard work, the last levee was removed and high tide reclaimed the headwaters of Tomales Bay.

The dramatic changes associated with this restoration include the area's wildlife community. Tomales Bay waterbird and shorebird numbers are expected to increase in response to the evolving habitat, but there are no guarantees. This large wetland restoration effort presents us with a rare opportunity to measure the effects of restoring tidal marshland on the sizes of wintering shorebird populations. Audubon Canyon Ranch (ACR), in cooperation with the Point Reyes National Seashore, has begun the process of evaluating the ecological benefits of the restoration to shorebirds.

ACR began documenting shorebird use of Tomales Bay in 1989, in an effort to establish this area's regional importance as wintering habitat (Kelly 2001, *Western Birds* 22:145-166). To this effect, a series of six winter counts are conducted each year, three during the early winter period (November–December) and three during the late winter

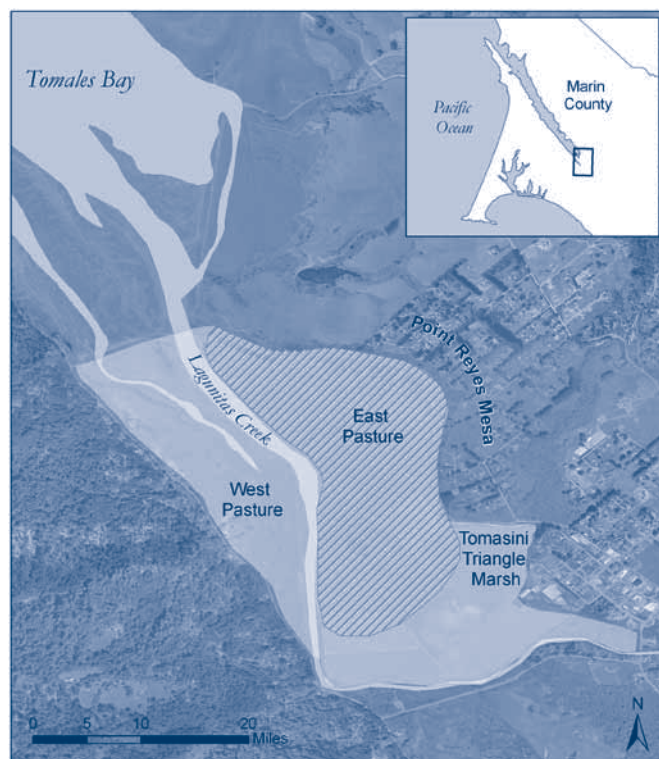


Figure 1. Shorebird census areas in the Giacomini Wetlands. The hatched region shows the area monitored from the Point Reyes Mesa, before the levees were breached in October of 2008. The shaded region shows the expanded, post-restoration monitoring area.

period (January–February). Two additional counts, one each during spring and fall migration, provide a glimpse of stopover use by transient shorebirds, although the dynamic pace of migration leads to considerable variation in the number of shorebirds recorded during these periods.

The Tomales Bay shorebird census was designed to cover almost all the bay's intertidal mudflat and a substantial portion of the rocky shoreline. The bay is divided into nine census areas, each monitored by a team of observers. Together, the teams count virtually all the shorebirds in the bay in 60 to 90 minutes, during a standardized tide window defined by medium, rising tide (2.4–4.0 feet above mean lower low water). All flock movements, departures, and

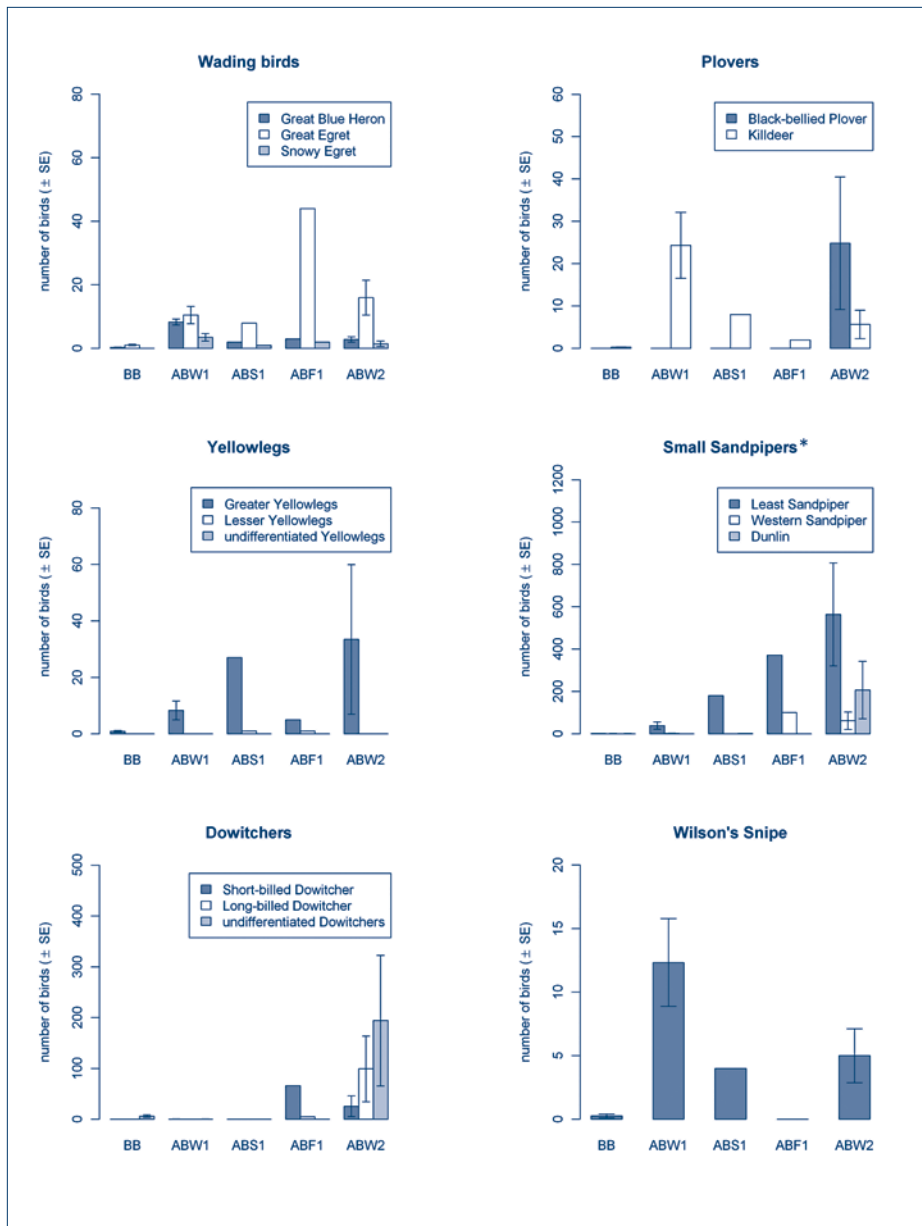


Figure 2. Mean abundances and standard errors of shorebirds observed in the Giacomini Wetlands. Abundances without error bars are based on single counts. Seasons are chronological from left to right: BB=before breach: all years and seasons prior to restoration of water flow in October of 2008 ($n = 124$ counts); ABW1=after breach, first winter (2008–2009, $n = 6$); ABS1=after breach, first spring migration (April 2009, $n = 1$); ABF1= after breach, first fall migration (August 2009, $n = 1$); ABW2=after breach, second winter (2009–2010, $n = 6$). * A small number of undifferentiated small sandpipers (Least, Western, or Dunlin) were also observed but are not shown

monitor the area, we divided the wetlands into three sub-areas. Small birds and more reclusive species in the West Pasture and Triangle Marsh areas are observed by volunteers who walk the marsh. The mudflat in the East Pasture drains slowly and is currently often flooded during census tides, making it difficult to cover on foot. The East Pasture is therefore observed using spotting scopes from various lookouts on the Point Reyes Mesa.

In the months immediately following the breach, shorebird use of the Giacomini Wetlands was minimal relative to other established feeding areas on Tomales Bay. Raptors, however, immediately responded with increased numbers, as the flooding evicted an abundance of small mammal prey from their pasture homes. On one early December count, an impressive 19 White-tailed Kites and 17 Red-tailed Hawks were observed in the restoration area. Other species that took early advantage of the newly flooded habitat were Great Blue Herons, Great Egrets, Snowy Egrets, Greater Yellowlegs, Killdeer, and Wilson's Snipe—all known to feed in flooded pastures.

As the vegetation and flooding regime changed over the winter months, the abundance and diversity of shorebirds seemed to increase slightly. Least Sandpipers, which were observed in low numbers during our first early-winter counts, turned up in higher numbers during mid-winter. Our late-winter counts revealed a pulse of Sanderling use and suggested slight increases in numbers of Great Egrets, Snowy Egrets, Killdeer, and Wilson's Snipe, relative to early-winter numbers. Overall, abundances of shorebirds in the first winter after the levee breach were slightly higher than our counts prior to the restoration but not markedly so (Figure 2). This is consistent with what we know of the way shorebirds choose their wintering sites.

During fall migration, first-year birds select the wintering areas they will to return to in subsequent years. Little is known about this selection process, but most of them probably make this choice by mid-November. As the Giacomini Wetlands were first flooded by tides at the end of October 2008, the gradual habitat changes in the restoration area probably had little effect on recruitment choices of shorebirds in that first winter following the breach.

During the 2009 spring and fall migration counts, we saw increased overall shorebird abundance relative to the previous winter's numbers (Figure 2), with our fall

arrivals are tracked to minimize the chance of counting birds twice.

In 1992, ACR expanded shorebird monitoring on Tomales Bay to include the Giacomini Pasture (Figure 1). Although at the time this area harbored little in the way of the shorebird habitat, plans for a large-scale wetland restoration indicated the need for at least some rudimentary baseline data. Shorebird use was minimal and the Giacomini Pasture could be easily observed using spotting scopes from a lookout on the Point Reyes Mesa. Species known to forage

in the densely vegetated wetland edges of the pasture, such as yellowlegs and snipe, were undoubtedly underrepresented in these counts, along with flocks that used the area as a refuge during heavy storm events outside of census periods. However, shorebird flocks foraging within the diked pasture were easily, although rarely, documented.

Once tidal circulation was restored to the area in 2008, ACR adjusted its monitoring protocol to meet the challenge of adequately tracking shorebird use within the developing wetlands (Figure 1). To intensively

count totaling nearly three times as many birds as our highest first-winter estimate. This increase in overall numbers was related primarily to a spike in the number of Least Sandpipers observed. In addition to the species seen during the winter of 2008–2009, Western Sandpipers, Dunlin, and Willets began to appear. As shown in Figure 2, a notable influx of 27 Greater Yellowlegs was recorded on the spring count along with a single Lesser Yellowlegs (a migrant species that was also observed on the fall count). Forty-four Great Egrets were counted in the restoration area on the fall count, nearly a year after the breach, a number that may have been enhanced by juvenile birds fledging from nearby nesting sites on the shores of Tomales Bay.

During the second winter following the breach, most species continued to show an upward trend in abundance (Figure 2). Great Blue Heron numbers were lower than in the previous winter when rodent prey were abundant, though they were still higher than the pre-restoration average. In contrast, Great Egrets were apparently more abundant in the second winter than they were the first winter, even though they are also proficient predators of voles. A number of Black-bellied Plovers were noted during the early-winter counts in the second year, a species that had not been seen on previous post-restoration censuses. Greater Yellowlegs once again occurred in high (but variable) numbers. Least Sandpipers



Greater Yellowlegs.

were the most abundant small sandpiper during the second winter. More Western Sandpipers were present this winter than in previous post-breach counts, and Dunlin, the most abundant species on Tomales Bay (Kelly 2001), were first observed using the new wetlands during this winter period. Dowitchers were also numerous during the second winter, with nearly 1,000 individuals observed on one count in early December. In addition to these species, small numbers of Snowy Egrets, Marbled Godwits, and Semipalmated Plovers were also present in the new wetlands during the second winter.

So far, shorebird use of the restoration area has concentrated in the East Giacomini Marsh (also known as the East Pasture) and the Tomasini Triangle Marsh. These ponded areas of the newly restored wetland provide suitable habitat for a number of species. The new wetlands are currently more extensively flooded than was predicted by modeling,

but scientists at the Point Reyes National Seashore predict that the wetlands will eventually evolve toward a higher proportion of mudflat and fewer perennially ponded areas. In a report to the Point Reyes National Seashore, Kamman Hydrology and Engineering (2006) suggested that the restored estuarine habitat will be robust to the longer-term threat of inundation by rising sea level, partly because of the elevation gradient in the restored area and partly because of high rates of sedimentation from the watershed. As the marsh evolves, a high proportion of brackish habitat suitable for foraging shorebirds is expected to remain.

It is still far too early to address the question of whether or not the restored Giacomini Wetlands will actually enhance the shorebird populations of Tomales Bay. Although we have seen an increase in the abundance of some shorebird species in the restoration area to date, local shorebirds may simply be shifting to new feeding areas in the newly restored habitat. As the wetland habitat develops, we hope that both the abundance and diversity of shorebirds will increase as new and different types of feeding areas become available and prey communities mature. At this point, the Giacomini Wetlands seem to be increasing the quality and extent of shorebird feeding areas on Tomales Bay, upon which wintering shorebird populations depend.

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.

Carbon addition and mowing as restoration measures in a coastal California grassland. Brody Sandel, UC Berkeley.

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.

Black Brant counts at Drakes Estero, Tomales Bay, and Bodega Bay. Rod Hug, Santa Rosa, California.

Effects of planktivorous fish predation on larvae release patterns of estuarine crabs. Leif Rasmuson, University of Puget Sound.

A camera trap survey of mammals and birds at Audubon Canyon Ranch. Rich Tenaza, University of the Pacific, and Chris Wemmer, California Academy of Sciences.

Initial survey of vegetation used for questing by Ixodes pacificus (Acari: Ixodidae). Martin Castro, California Department of Health Services, Vector-borne Disease Section.

Radon survey along the San Andreas Fault. Tom Gleeson, Queens University and University of British Columbia.

Determination of erotypic variation in the California native shrub Heteromeles arbutifolia. Michal Shulman, UC Berkeley.

Functional trait distribution in California plant communities. Susan Harrison, Brian Anacker, Barbara Going, and Andrew Kleinhasselink, UC Davis.

Assessing impairment of Tomales Bay due to mercury: Risk to invertivores at the Walker Creek Delta. Kat Ridolfi, San Francisco Estuary Institute.

Development of macroalgal assessment framework to diagnose eutrophication in estuaries. Lauri Green, UC Los Angeles.

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 ▶ The fates of all nesting attempts at ACR's Picher Canyon heronry have been monitored annually since 1967, to track long-term variation in nesting behavior and reproduction.

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 ▶ Annual monitoring of reproductive activities at all known heron and egret nesting colonies in five northern Bay Area counties began in 1990. ACR's 250-page *Annotated Atlas and Implications for the Conservation of Heron and Egret Nesting Colonies in the San Francisco Bay Area* is available online (www.egret.org/atlas.html), along with a reference that uses Google Earth to show the locations and status of individual heronries (www.egret.org/googleearth2.html). We are currently investigating the effects of climate change on regional nesting abundances.

Impacts of Wild Turkeys on Forest Ecosystems ▶ Dan Gluesenkamp is conducting a study to experimentally measure the effects of ground foraging by invasive, non-native Wild Turkeys on vegetation and invertebrates in the forest ecosystem of Bouverie Preserve.

Four Canyons Project ▶ ACR's Martin Griffin Preserve contains four canyons that drain the western slope of Bolinas Ridge. We are restoring the natural complexity of native vegetation in the lower reaches of these canyons, repairing disturbed sites, and eradicating or controlling invasive plant species. Native plant propagation facilities in Volunteer Canyon are being used to grow locally collected plant materials for restoration.

Monitoring and Control of Non-Native Crayfish ▶ Jeanne Wirka and others are studying the distribution of non-native signal crayfish (*Pacifastacus lenisculus*) in Stuart Creek at Bouverie Preserve and investigating the use of barriers and traps to control the impacts of crayfish on native amphibians and other species.

Highway-Generated Nitrogen Deposition in Vernal Wetlands ▶ Enhanced availability of nitrogen near highways might facilitate invasion by non-native plant species in sensitive vernal wetlands. Dan Gluesenkamp, Stuart Weiss, and Jeanne Wirka are quantifying the potential effects of highway-generated nitrogen deposition on Sonoma Valley vernal pools.

Plant Species Inventory ▶ Resident biologists maintain inventories of plant species known to occur on ACR's Tomales Bay properties and at the Bouverie and Martin Griffin preserves.

Annual Surveys and Removal of Non-Native *Spartina* and Hybrids ▶ In collaboration with the San Francisco Estuary Invasive *Spartina* Project, Emiko Condeso and Gwen Heistand coordinate and conduct field surveys for invasive, non-native *Spartina* in the shoreline marshes of Tomales Bay and Bolinas Lagoon.

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 ▶ We have eradicated nonnative ice plant from marshes and upland edges at Toms Point on Tomales Bay, although management to remove resprouts and new patches continues.

Eradication of *Elytrigia pontica* ssp. *pontica* ▶ At Bouverie Preserve, we are removing a patch of *Elytrigia*, an invasive, non-native perennial grass that forms dense populations in seasonal wetlands.

Nest Boxes ▶ Tony Gilbert maintains several Western Bluebird nest boxes in the Cypress Grove grasslands.

Removal of *Ammophila arenaria* in Coastal Dunes ▶ Removal of invasive dune grass (*Ammophila arenaria*) is helping to restore and protect native species that depend on mobile dune ecosystems.

Vernal Pool Restoration and Reintroduction of Imperiled Plants ▶ In the vernal pools at Bouverie Preserve, we are removing invasive plants and re-establishing the federally listed Sonoma sunshine (*Blennosperma bakeri*) and the California species of conservation concern, dwarf downingia (*Downingia pusilla*). The work involves manual effort by volunteers, propagation and planting of native plants, use of prescribed fire, cattle grazing, and monitoring of vegetation and hydrology.

Yellow Starthistle at Modini Ingalls Ecological Preserve (MIEP) ▶ 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.

Amphibian Survey at MIEP ▶ Sherry Adams is conducting field surveys at ponds, along creeks, and in riparian and woodland habitats where amphibians are likely to occur.

Vegetation Mapping at MIEP ▶ Sherry Adams and Emiko Condeso developed and ground-verified a vegetation map for MIEP that can be used to guide other biological studies.

Serpentine and Rare Plant Survey at MIEP ▶ 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 MIEP ▶ Using breeding-bird atlas and point-count methods, we are assessing the breeding status, abundance, and distribution of each bird species at MIEP. This work will contribute to an understanding of regional bird use in the central Mayacamas Mountains.

Comparison of Bird Use at MMAS ▶ Using bird surveys conducted by volunteers from the Madrone Audubon Society, John Kelly compared bird use at the Mayacamas Mountains Audubon Sanctuary in northern Sonoma County, before and after the 2004 fire. Results revealed the mixed effects of fire and associated changes in vegetation, with some bird species declining and many others increasing in abundance.

Project GROW ▶ Gathering to Restore Oak Woodlands (GROW) is a partnership between ACR and the Southern Sonoma County Resource Conservation District to restore eight acres of oak woodlands at the Bouverie Preserve. Community members and Sonoma Valley High School students helped plant several species of oak trees and other species. Habitat enhancements include planting native grasses and installing brush piles and nest boxes to support wildlife.



Audubon Canyon Ranch
4900 Shoreline Highway One
Stinson Beach, CA 94970

Cypress Grove Research Center
P.O. Box 808
Marshall, CA 94940
(415) 663-8203

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THE ARDEID

Ardeid (Ar-DEE-id), N., refers to any member of the family Ardeidae, which includes herons, egrets, and bitterns.

The Ardeid is published annually by Audubon Canyon Ranch as an offering to Conservation Science and Habitat Protection field observers, volunteers, and members. To learn more about this program and how to support Audubon Canyon Ranch, please contact the Cypress Grove Research Center (cgrc@egret.org or 415.663.8203) or ACR's headquarters (acr@egret.org or 415.868.9244).

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How will herons and egrets adapt to climate change? see page 1