Research and
Resource Management
at Audubon Canyon Ranch

THE ARDEID

- sharing the landscape with herons and egrets

Common Water

- expanding Olema Marsh restoration

Habitat Connectivity

- protecting rare and uncommon plants

Stewardship Ethic

- research & resource management plan

Beyond Gardening

2005

In this issue

Cover photo: Black-crowned Night-heron by Peter LaTourrette ◗ Ardeid *masthead Great Blue Heron ink wash painting by Claudia Chapline*

The Watch

Volunteers for ACR research or habitat restoration projects since *The Ardeid* 2004. Please call (415) 663-8203 if your name should have been included in this list.

PROJECT CLASSIFICATIONS:

C = Coastal Habitat Restoration at Toms Point ◆ E = *Ehrharta erecta* Removal at Bolinas Lagoon Preserve ◆ G = Grassland Management at Bouverie Preserve ◆ H = Heron/Egret Project ◆ M = Livermore Marsh and Olema Marsh Surveys ◆ ◆ P = Photo Points ◆ R = Habitat Restoration ◆ S = Tomales Bay Shorebird Censuses ◆ T = Turkey Research at Bouverie Preserve ◆ W = Tomales Bay Waterbird Census

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Sharing the landscape with herons and egrets

Common Water

by John P. Kelly

If you watch herons and egrets carefully, for a long time, over a wide area, it becomes obvious that their lives are closely linked to ours. This is not surprising, because the lives of herons and egrets are sensitive to the health of our bays, marshes, beaches, and creeks, and therefore, how we manage water. Herons and egrets feed in ranch ponds, levee marshes, flood control channels, seasonal farmland, recreational parks, city creeks, water treatment ponds, and wetland restoration sites. In addition to building nests in tule marshes, on isolated islands, and in forested coastal canyons, they establish colonies in suburban neighborhoods, in rural patches of introduced eucalyptus, and on dredge-spoil islands. They can be seen almost anywhere. Nonetheless, the delight one experiences upon noticing the enchanting profile of an egret, whether along a secluded shoreline or in a roadside ditch, is at least partly inspired by the sudden sense of shared space. This recognition is at the heart of ACR's Heron and Egret Project, which seeks to understand not only the lives of these beautiful birds but also our relationship to the wetland systems they seem to symbolize.

The popular use of herons and egrets in the iconography of wetland conservation is well substantiated by the ecologically important roles they play. Their importance as powerful wetland predators is matched by their sensitivity to subtle changes in ecosystem productivity, hydrology, vegetation, and human activity. Ecologists recognize such relationships and consider the lives of herons and egrets to be valuable indicators of processes that sustain or threaten healthy wetlands. Because these birds range over large areas, their responses to environmental changes may be useful in understanding processes that affect whole landscapes, including the effects of wetland restoration projects on surrounding areas. This exciting prospect, however, is still a work in progress (see sidebar on page 3).

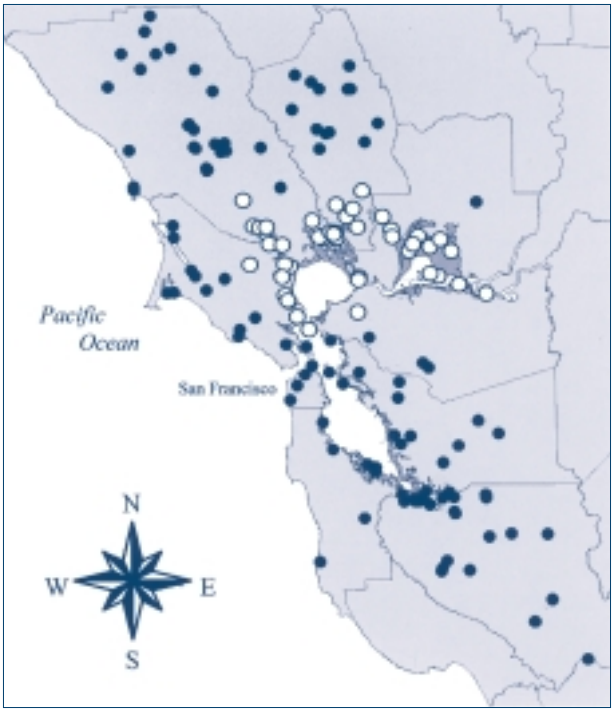

Figure 1. Heron and egret nesting colony sites included in ACR's annotated atlas of heronries in the San Francisco Bay area (solid and open circles). Colony sites within 10 km of the historic tidal marshes (shaded areas) of San Pablo Bay and Suisun Bay (open circles) were used to analyze landscape use by herons and egrets in the northern San Francisco Estuary.

An atlas of heronries

Audubon Canyon Ranch is completing an annotated atlas that illustrates and describes the distribution, status, and trends of herons and egrets in the San Francisco Bay area. The work is based on 14 years of observations at more than 100 heronries known to exist in the region (Figure 1). Longer periods of monitoring are reported from selected sites such as Mallard Slough in the South Bay (19 years), Marin Islands near San Rafael (25 years), and ACR's Picher Canyon heronry near Bolinas Lagoon (37 years). The atlas includes important contributions by the San Francisco Bay Bird Observatory, based on long-term monitoring in South San Francisco Bay. The completed report provides a regional assessment, detailed colony-site accounts, a searchable database, and maps of heron and egret nesting populations. The results are presented in formats that can be imported by county planners into geographic information systems (GIS), referenced by policy makers and conservation groups, and distributed widely to other interested individuals and organizations. Soon, it will be freely available for download from the ACR web site (http//www.egret.org).

The initial section of the atlas provides a detailed look at the status and trends of regional heron and egret populations. Overall, numbers have been fairly stable (Figure 2), but they can reveal regional phenomena that affect populations. For example, the 1999 decline in nesting Great Blue Herons, Great Egrets, and Snowy Egrets (Figure 2), which was especially evident in Suisun Marsh and South San Francisco Bay, was apparently associated with reduced recruitment of first-time breeders born two years earlier. Extremely dry conditions during late winter and spring of 1997 (Figure 3) may have severely limited the extent of water available in levee marshes in the South Bay and Suisun Bay, and nest failure rates that year were unusually high. In addition, those nestlings that survived the 1997 breeding season subsequently faced an intense beating by El Niño storms while learning how to feed proficiently enough to survive their first winter. Based on this information, it seems reasonable that breeding season droughts followed by heavy winters might predict declines in regional nesting populations. This, in

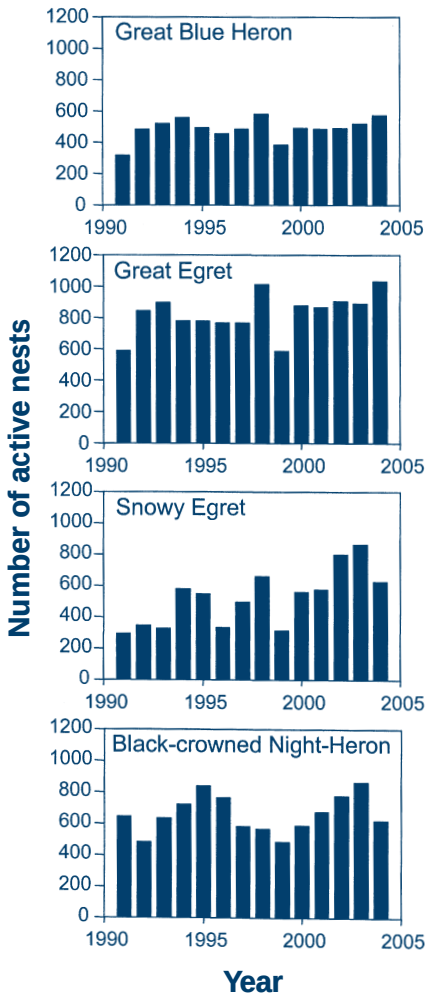

Figure 2. Annual sum of the peak number of active heron and egret nests observed at heronries in the San Francisco Bay area, 1991–2004.

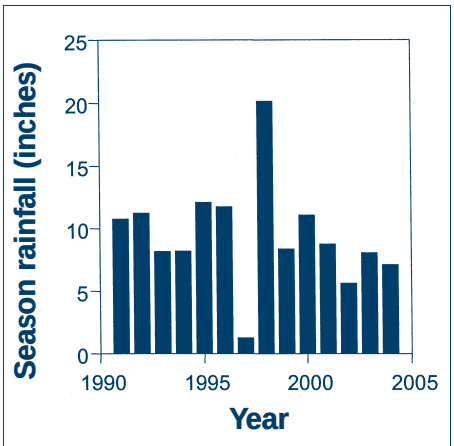

Figure 3. Cumulative rainfall during the nesting season, February through June, 1991–2004, recorded in San Francisco (California Data Exchange Center, Department of Water Resources).

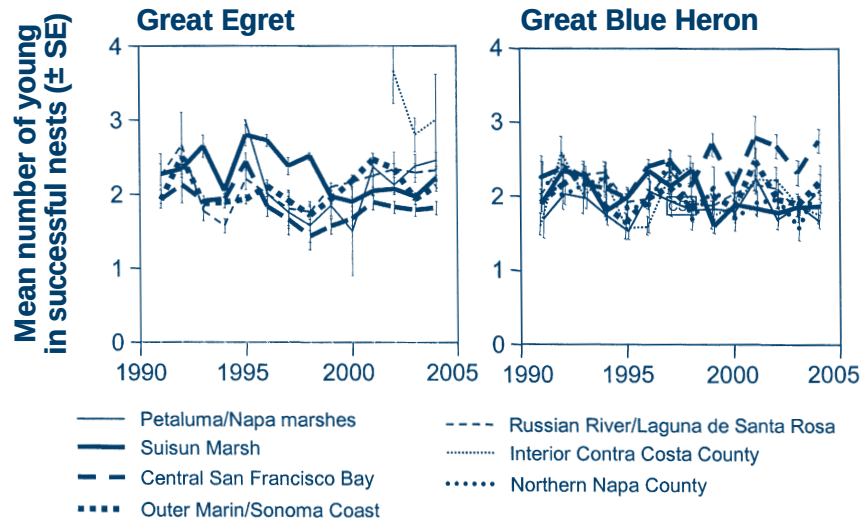

Figure 4. Mean number of young produced in successful Great Egret and Great Blue Heron nests, by subregion, in the San Francisco Bay area, 1991–2004.

turn, might lead to reduced levels of predation in regional wetlands.

Differences in heron and egret activity at subregional or local scales often reveal distributional shifts that can be traced to localized disturbances by predators or humans. For example, a dramatic influx of Snowy Egrets in Napa County was associated with a major decline in nesting Snowies at the Marin Islands, near San Rafael, in 1994 and 1995. This decline was apparently the result of persistent, mischievous disturbance by a single Red-tailed Hawk (see *Ardeid*, winter 1995). In 2000, Great Egrets colonized a new site in Drakes Estero, in the Point Reyes National Seashore. This occurred within a week of the abandonment of a colony in Inverness Park, which was apparently caused by intense disturbance and nest predation by resident Common Ravens.

If monitoring efforts are limited to particular heronries, the movements of birds among sites are likely to mask any underlying regional trends. Because region-wide monitoring did not occur until the 1990s, we are just now positioned to detect possible long-term responses of regional heron and egret populations to wetland protection and restoration.

Shared patterns of activity among heronries within a subregion can be of particular interest. We are currently watching closely to see if recent increases in the numbers of nesting herons and egrets in the Petaluma and Napa marshes signal benefits related to nearby wetland restoration projects. Evidence of shared benefits generated by groups of restoration projects could inspire new approaches in restoration planning.

Since the mid-19th century, over 95% of the Bay Area's tidal marshes have been drained or filled for agriculture or development, converted to salt ponds, or altered by levee construction (Atwater et al. 1979, *in* Conomos, *San Francisco Bay: the Urbanized Estuary*). Now, after decades of Clean Water Act protections and "restoration" of former wetlands, heron and egret numbers seem to be stable, showing no obvious declines but also no evidence of continuing recovery in response to the mounting numbers of wetland restoration projects. One possible explanation is that the restoration of wetland quality comparable to natural systems may be largely unrealized. For herons and egrets, this means that each restored marsh must produce more prey or provide better foraging conditions for catching them—a simple but very challenging goal!

Measuring success

Finding enough food is only one of several requirements for successful nesting. Reproductive performance may involve multiple ecological processes, each influencing a different component of nesting success. For example, the likelihood that a heron or egret nest will fledge at least one young depends primarily on the combined risks of predation and severe weather—either of these can destroy an entire clutch or brood. A strong wind can blow nests, eggs, and young right out of a tree.

In contrast, the *number* of young produced by successful nests depends pri-

Herons and egrets as a landscape process

How do herons and egrets influence and respond to ecological changes in the wetland landscape? Recently, we identified potentially important associations between heronries and the regional landscape. As contributors to the Integrated Regional Wetland Monitoring Program for the San Francisco Estuary (California Bay-Delta Authority, http://www.irwm.org), we worked with landscape ecologist Diana Stralberg (PRBO Conservation Science) to generate information about the wetlands surrounding each heronry near the Petaluma, Napa, and Suisun marshes.

We analyzed landscape associations based on the areal extents of land cover types (from Landsat images, 2000–2002) and on several metrics related to wetland patch shape, size, and configuration, within 1, 3, 5, 7, and 10 km of each heronry. Comparisons with randomly selected, unoccupied sites indicated that herons and egrets actively select nesting areas with more estuarine emergent wetland and open water nearby than normally available in the wetland landscape (Figure 5). In contrast, long-term patterns of productivity among successful nests were significantly related to wetland landscape conditions at relatively large spatial scales of 5–10 km from heronries (Figure 6).

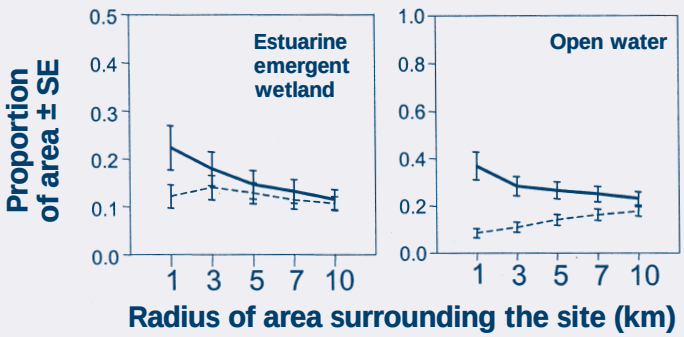

Figure 5. Local influences: herons and egrets establish colonies at sites with significantly more estuarine-emergent and open-water habitat within 1 km (solid lines) than available by chance (dashed lines) in the wetland landscape.

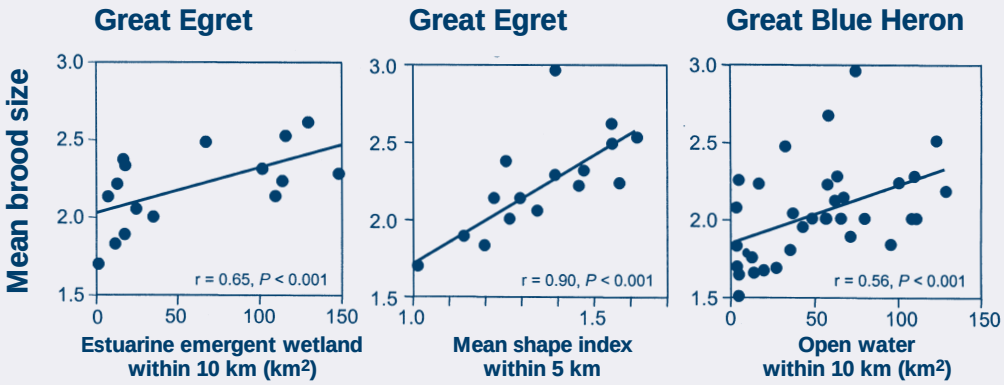

Figure 6. Large-scale influences: mean brood sizes over 14 years indicate that Great Egrets produce more young if heronries are surrounded by more estuarine emergent wetland within 10 km and more wetland edge (relative to patch area) within 5 km. Great Blue Herons produce more young at heronries with more open water habitat within 10 km. Local habitat conditions have no additional influence on brood size.

We also used aircraft to track the foraging flights of Great Egrets departing from heronries. With these data, we modeled foraging dispersion according to (1) the distance from heronries and (2) the extent of available tidal/nontidal wetland habitat. Preliminary results indicated that most Great Egrets foraged within a few km of heronries or within distances that encompassed less than 15 km^2 of emergent wetland habitat. Further analysis of this information revealed spatial differences in potential predation by Great Egrets foraging at particular sites in the wetland landscape.

We are excited about this direction of investigation and hope to find new ways to use information on herons and egrets to improve the management and restoration of wetlands. Future investigation will focus on incorporating measurements of foraging habitat quality and validating models of foraging dispersion with surveys of particular wetland sites. Insights into landscape values important to herons and egrets could help ensure that these beautiful birds continue to occupy our marshes.

marily on food availability and chick provisioning rates and, consequently, on wetland productivity and foraging conditions. When more food is available, parents can raise larger broods.

To help distinguish between ecological processes that affect reproduction, we track nest survivorship (the proportion of nests that fledge at least one young) and prefledging brood size (the number of young produced in successful nests) separately. Multiplying these two measures together gives the number of young likely to be produced from any nest attempt—a good measure of overall reproductive performance. We can use this information, based on subsets of monitored nests, to estimate the productivity of entire nesting colonies.

Regional trends in the productivity of successful nests show that subregions vary together (Figure 4). In some years, nests tend to produce more young in all subregions, presumably because most or all of the associated wetlands are more productive. In other years, lower productivity prevails across the region. These patterns provide good evidence that heron and egret productivity is sensitive to large-scale processes such as weather patterns.

The effects of subregional differences in habitat quality on heron and egret

continued on page 11

Expanding restoration opportunities for Olema Marsh

Habitat Connectivity

by Katie Etienne

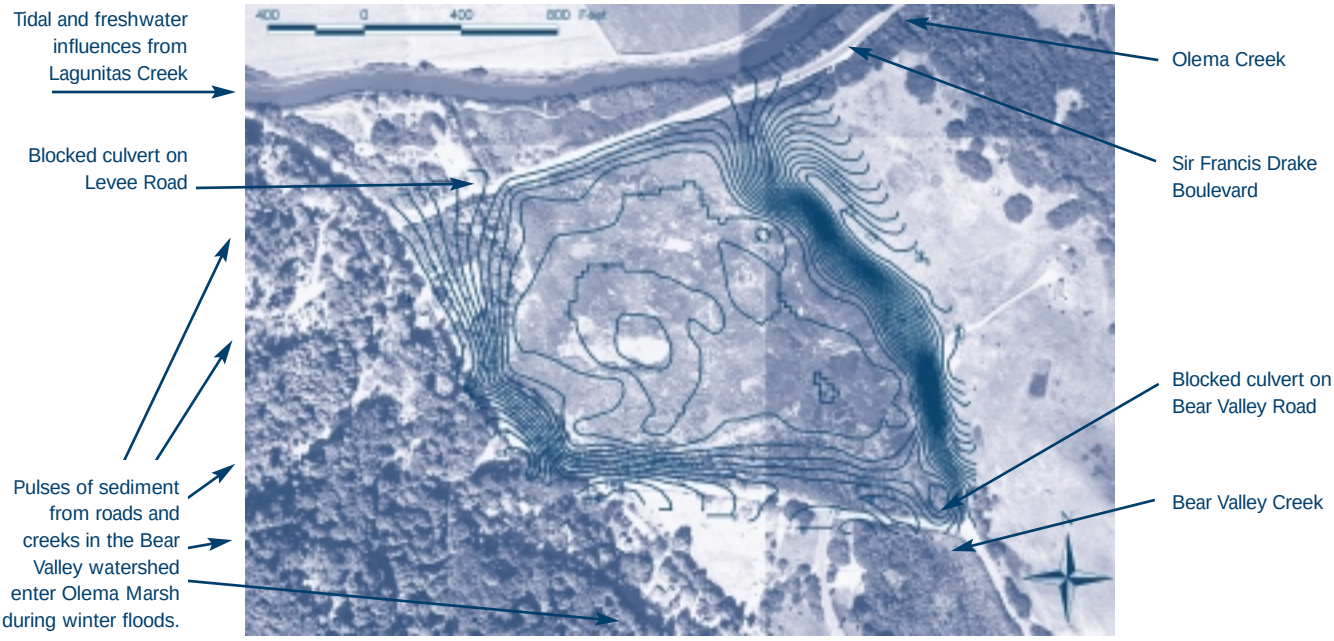

Figure 1. Olema Marsh has been included in the study area for the Giacomini Wetland Restoration Project in the southern end of Tomales Bay. Leveed roads and blocked culverts impede freshwater and tidal circulation, which alters vegetation patterns and animal distribution.

The dramatic beauty of coastal Marin provides an inspiring panorama for illustrating some concepts in conservation biology pertinent to the future of ACR's Olema Marsh. When considering management options for Olema Marsh, it is important not to limit our perspective to the quality of local habitats, because populations of organisms are rarely restricted to a physically circumscribed place or time and usually need to disperse or migrate in response to changing environmental conditions. In addition to sea level rise, regional, landscape and local habitat processes influence Olema Marsh, which in turn, affects its contribution to other coastal systems.

Defining an appropriate region for Olema Marsh and the Tomales Bay watershed depends upon the species of interest. The North American Pacific Flyway is of critical importance for many species of migrating birds, which depend upon numerous wetlands and coastal embayments to rest and feed. Unfortunately, the majority of coastal wetlands have been destroyed, and distances between suitable habitats are increasing. Thus, improving the condition of Tomales Bay marshes and their watersheds can provide benefits for species whose range of distribution extends far beyond the local landscape that we cherish.

Evolutionary Significant Units (ESU) for Pacific salmon provide regional classifications that are particularly relevant to the future of Olema Marsh. Evolutionary Significant Units reflect relationships between geography and biological functions that are important in population genetics. ESUs also demonstrate the importance of habitat quality and connectivity that can be used to focus restoration and conservation efforts at the landscape level to benefit salmonids and other species (see sidebar on page 5).

The Tomales Bay watershed is an appropriate boundary to describe the landscape surrounding Olema Marsh. Landscape-level investigations examine interactions among habitats, such as nutrient transport, predation pressure, and gene flow, that are critical to the survival of populations. Habitat connectivity is particularly important in aquatic systems. Plants and animals are influenced by the condition of surrounding habitats even if they never occupy these areas. The characteristics of specific habitats that support native plants and animals should be evaluated carefully when assessing the impacts of disturbance or designing habitat restoration projects for the benefit of communities of organisms or species of concern.

Olema Marsh: past, present, future

To understand how Olema Marsh interacts with the larger landscape or region, it is important to review changes in land-use patterns, management, and restoration efforts. Two hundred years

ago, Olema Marsh was part of an extensive delta salt marsh extending up Bear Valley and Olema Valley from the mouth of Lagunitas Creek. In the early 1900s, a levee was constructed across these valleys to create Levee Road (a short section of Sir Francis Drake Boulevard; see map). Olema Marsh receives water from the smaller Bear Valley watershed, located west of the Olema Valley.

Before Audubon Canyon Ranch acquired the property in 1972, the owners of a duck club regularly burned the marsh vegetation to create areas of open water and improve opportunities for duck hunting. By 1982, cattail and tules covered most of the marsh, so Audubon Canyon Ranch developed an enhancement plan for Olema Marsh with funds from the California Coastal Conservancy. The primary objectives were to restore open-water habitat for birds and improve circulation of water in the 40-acre marsh. Circulation channels were constructed, sediment was removed from existing ponds, and additional deep-water ponds were created with steep banks to limit encroachment of vegetation. The ponds were connected to a main channel to improve water circulation, and dredged material was formed into islands.

As predicted, bird and vegetation monitoring indicated that increased circulation and the extent of open water were beneficial for marsh birds. Analysis of marsh use by the ten most common species showed upward trends over a nine-year period (Evens and Stallcup 1985, 1991, 1992, 1993, 1994). The recruitment of willows along the margins of the ponds provided additional habitat for songbirds, including the Salt Marsh Common Yellowthroat, which adapts its foraging behavior to the seasonal dynamics of wetland habitats (Kelly and Wood 1996).

Although the 1983 marsh enhancement project improved conditions for some birds, it is clear that habitat values cannot be sustained without active management. In addition, management efforts must consider physical processes that occur at larger scales. For example, sediment from the Bear Valley watershed is deposited in Olema Marsh during winters with heavy rainfall and is rapidly colonized by cattails, bulrushes, and willows that impede water circulation. During the El Niño storms of 1997–1998, sediment from roads in the Silver Hills residential area contributed to the blockage of the west culvert under Levee Road and average water levels in the marsh increased approximately two feet. Water circulation decreased in the riparian portion of the marsh next to Bear Valley Road, creating numerous snags, but some healthy alders and willows survived. Currently, winter runoff flows across Olema Marsh and enters Lagunitas Creek through the eastern culvert under Levee Road. However, additional recruitment of willows along Levee Road has reduced water velocity and promoted sediment deposition around both culverts.

In 2003 and 2004, ACR staff met several times with wetland experts and biologists at the Point Reyes National Seashore to share information and consider how the alternatives being developed for the Giacomini Wetland Restoration Project (GWRP) might influence Olema Marsh. It was decided that Olema Marsh should be included within the project boundary for the GWRP, to improve ecological function at the landscape level. Another reason for including Olema Marsh in the GWRP was that a large proportion of special-status species relevant to the project occur in Olema Marsh (Avocet Research, 2003)

To evaluate the current condition of Olema Marsh, ACR Research Associate Rich Stallcup conducted breeding and winter bird surveys in 2004 and 2005. Gary Fellers conducted a survey of the federally threatened California red-legged frog *(Rana aurora draytonii)*. Darren Fong, biologist for Golden Gate National Recreation Area, looked for the federally endangered tidewater goby *(Eucyclogobious newberryi)*, which he previously found in a small creek on the Giacomini Ranch. Lorraine Parsons, Project Manager for the GWRP, conducted the wetland delineation and will include results of these and other studies in the EIR/EIS for the Restoration Plan.

The Plan depends primarily on topographic studies by Kamman Hydrology, Inc. The 2004 topographic analysis shows that Olema Marsh is essentially flat, with most elevations ranging between six and seven feet well above the mean higher-high tide level (6–7 ft NGVD29). This explains why there is little, if any, salt-water intrusion. Therefore, two of the proposed alternatives are likely to involve replacing the east culvert in Levee Road with a bridge or causeway that would improve physical and biological connections between Olema Marsh and Tomales Bay. The undersized culvert under Bear Valley Road also impedes freshwater flow through the marsh and contributes to prolonged flooding upstream from Bear Valley Road.

The big question is whether the velocity of water from Bear Valley Creek is sufficient to maintain a constructed stream channel through Olema Marsh. Fortunately, the Point Reyes National Seashore has received a grant from the

continued on page 12

Evolutionary Significant Units provide models for management at a regional scale.

A regional approach to stewardship is critical for the survival of salmon, which depend upon the quality and connectivity of different habitats throughout their life cycles.

Efforts to sustain wild populations have led to the identification of Evolutionary Significant Units for managing salmonids with similar genetic characteristics that evolved in response to common ecological conditions. The Central California Coast Evolutionary Significant Unit (CCCESU) for coho salmon *(Onchorynchus kisutch)* includes coastal tributaries from Punta Gorda, near Cape Mendocino, to the San Lorenzo River near Santa Cruz. The CCCESU for steelhead *(Onchorynchus mykiss)* differs because it includes habitat for both anadromous steelhead and resident freshwater rainbow trout that use inland tributaries of the Russian River, San Francisco Bay, and Monterey Bay watersheds, as well as coastal streams.

Despite apparent declines in coho abundance in the southern portion of the CCCESU, Lagunitas Creek and some of its tributaries continue to provide essential spawning and rearing habitat for both coho and steelhead. The prospects for restoring native fish populations in Bear Valley Creek are particularly promising, because most of the watershed is under the protection of Point Reyes National Seashore and Audubon Canyon Ranch. Our shared commitment to improve hydrologic connectivity between Bear Valley Creek, Olema Marsh, Lagunitas Creek, and Tomales Bay, and the presence of adults of both species in nearby Lagunitas and Olema Creeks, increase the possibility that habitat for native fish populations can be sustained in the future.

Protecting the rare and uncommon plants of ACR lands

Stewardship Ethic

by Daniel Gluesenkamp

On December 28, 1973, Richard Nixon signed the Endangered Species Act, far-reaching legislation approved by nearly unanimous votes in the House and Senate, which made protection of endangered species a major priority of government. While the commitment of resources entailed in the ESA was unprecedented, the underlying philosophy is simply a modern codification of an essentially spiritual responsibility. This philosophy was present in the earliest of human writings, including the directive in Genesis to "tend and keep" the Garden—a phrase that combines Hebrew verbs for "slavish work and cultivation" and "maintaining, cherishing, observing, and protecting." The ethic of environmental stewardship is reflected in many traditions: it is a human ethic.

The primary mission of Audubon Canyon Ranch is to preserve and protect our lands as sanctuaries for native plants and animals, and ACR has saved some of the most diverse and beautiful parts of our region. While protecting wild habitats from urbanization and human development is a critical first step, long-term preservation requires much more. Even on protected lands, ecosystems are altered by changes in grazing and disturbance regimes and by the rapidly accelerating biological invasion crisis. Without active and ongoing management, many of the species we cherish are likely to disappear; this fate is particularly likely for species that are already rare. In this article I review ACR rare plant stewardship, assess challenges, and discuss the work required to save these rare botanical treasures.

Rarity is actually a rather common condition for plants in California. Of approximately 7975 plant taxa that occur in the state (The Calflora Database, Berkeley, CA. http://www.calflora.org), an estimated 2016 (25%) are classified by the California Native Plant Society as rare and uncommon (CNPS 2005. Inventory of Rare and Engangered Plants. http://www.cnps.org/inventory); the

The fortunate reappearance of *Downingia pusilla*

Downingia pusilla is a belly plant, a slim centimeter of stem bearing a hopeful white blossom. This wildflower occurs within Sonoma's vernal pools, a miraculous California habitat type that is found only where topography collects rainwater into small basins and soil characteristics prevent drainage. Each pool is a discrete watershed, fed by rainwater and drained only by evaporation, that supports a beautiful and highly adapted suite of native plants. In May of 1921, when the legendary botanist Willis Linn Jepson collected *Downingia pusilla* specimens in Sonoma Valley, the Valley contained hundreds of vernal pools in which the tiny plant could thrive. Today the valley floor is occupied by humans and their structures, roads and vineyards have replaced the tiny flower-filled pools that were once dwarf downingia's home.

Recent botanical surveys at ACR's Bouverie Preserve have discovered a new and unexpected home for this bitty blossom. While the plant is likely lost from Bouverie's vernal pools, which are dominated by European grasses, *Downingia pusilla* is abundant in one of Bouverie's abandoned quarries. As with naturally occurring vernal pools, the depression left by 19th-century quarrying operations floods each winter and dries each summer, leaving behind a small mud plain that is virtually devoid of topsoil, uncolonized by invasive weeds, and rich in short-stature vernal pool plants. Ironically, vernal pool plants find more suitable habitat conditions in this human-created refuge than in the adjacent "natural" vernal pools.

The absence of these plants from adjacent vernal pools, their home for millennia, indicates the extent to which the system has changed. The "natural" pools are currently dominated by invasive European grasses and forbs, highly competitive plants which easily exclude short-stature native wildflowers. The invasive European plants may also be fertilized by the nearby highway; recent studies have shown that automobiles emit very large quantities of plant available nitrogen that can alter the competitive balance in nutrient-poor systems such as vernal pools. We are currently experimenting with grassland management to reduce the biomass of competitive European grasses, and we hope to collaborate with scientists and neighboring vernal pool managers to assess the level of highway-generated nitrogen deposition. Results of these projects should provide information to plan the restoration of ACR's damaged vernal pools.

Table 1. Rare and uncommon plants known or likely to occur on Audubon Canyon Ranch lands. The dearth of information for ACR's flagship preserve, the Bolinas Lagoon Preserve, emphasizes the need for a system-wide rare species inventory and monitoring effort.

Scientific name	Common name	Rarity (CNPS List Status)	Preserve	Inventory
Amorpha californica var. *napensis*	false indigo	1b	Bouverie	Confirmed
Blennosperma bakeri	Sonoma sunshine	1b	Bouverie	Extirpated
Brodiaea californica var. *leptandra*	Sonoma brodaiea	1b	Bouverie	Potential
Castilleja ambigua ssp. *humboltiensis*	Humboldt Bay owl's clover	1b	Tomales	Reported
Ceanothus confusus	Rincon Ridge ceanothus	1b	Bouverie	Reported
Ceanothus sonomensis	Sonoma ceanothus	1b	Bouverie	Confirmed
Chorizanthe cuspidata var. *villosa*	San Francisco spineflower	1b	Tomales	Confirmed
Cirsium andrewsii	Franciscan thistle	1b	Tomales	Reported
Cordylanthus maritimus ssp. *palustris*	Point Reyes bird's-beak	1b	Tomales	Confirmed
Downingia pusilla	dwarf downingia	2	Bouverie	Confirmed
Elymus californicus	California bottle brush grass	4	Bolinas	Confirmed
Fritillaria liliacea	fragrant fritillary	1b	Tomales	Confirmed
Gilia capitata ssp. *chamissonis*	dune gilia	1b	Tomales	Confirmed
Lilium rubescens	Redwood lily	4	Bouverie	Confirmed
Stellaria littoralis	shore chickweed	4	Tomales	Confirmed

number of rare native plants is even greater than the overwhelming number of introduced plants (Figure 1). Inventory of rare plants at ACR depends strongly on work conducted by ACR biologists and volunteers, including scientific studies of rare plants and species lists that integrate decades of botanical observations. Careful review of these lists has led to the "discovery" of two rare species: *Downingia pusilla* and *Stellaria littoralis*. These species were not rare when first discovered on ACR lands but are now considered rare by CNPS. To date, we have identified 15 rare and uncommon plant species known or likely to occur on ACR lands (Table 1).

Once identified, rare plant populations must be inventoried and regularly monitored in order to detect threats and ensure long-term protection. Volunteers have long played a critical role in the inventory and monitoring of rare plants on ACR lands. Careful research by John Kelly and Grant Fletcher (1993, Madroño 41: 316-327) on the rare Point Reyes bird's-beak *(Cordylanthus maritimus* subspecies *palustris)* provided important insights into the distribution and population dynamics of this threatened parasitic marsh wildflower. In Sonoma County, California Native Plant Society volunteers recently visited Bouverie Preserve populations of *Amorpha californica* var. *napensis* and *Lilium rubescens,* completing rare plant survey forms for inclusion in the CNPS Inventory of Rare and Endangered Plants. These volunteer efforts have joined periodic monitoring by ACR biologists.

While ACR volunteers and staff have made tremendous contributions to protecting ACR's rare plant populations, effective protection of rare plants requires a dedicated program that combines passive monitoring and active protection. This realization came partly as a result of a worrisome discovery made by CNPS Rare Plant Program Director Ann Howald, volunteering her time to visit Bouverie Preserve's population of Sonoma ceanothus *(Ceanothus sonomensis)*. This population was last inventoried in 1985 by botanists from the environmental consulting firm Biosystems, at which time they located 19 individuals of this endangered shrub. Twenty years later, Ann Howald, working with ACR biologist Rebecca Anderson-Jones, found only a single individual remaining. While we hope to locate more individuals, it is clear that the population has declined significantly and may be on the brink of extirpation.

The dramatic and unseen decline of the Sonoma ceanothus spurred renewed efforts to monitor ACR's special status species. In the last year, Rebecca Anderson-Jones has worked with consulting biologists to inventory high priority targets, including comprehensive surveys of the Bouverie Preserve's vernal pools and amphibian surveys throughout the preserve. This work has provided reasons for hope and causes for concern. For example, vernal pool rare plant surveys found an estimated 136,000 individuals of the tiny ephemeral flower *Downingia pusilla*, but all of these individuals are found in few square meters of soil at a single site (see sidebar, page 6).

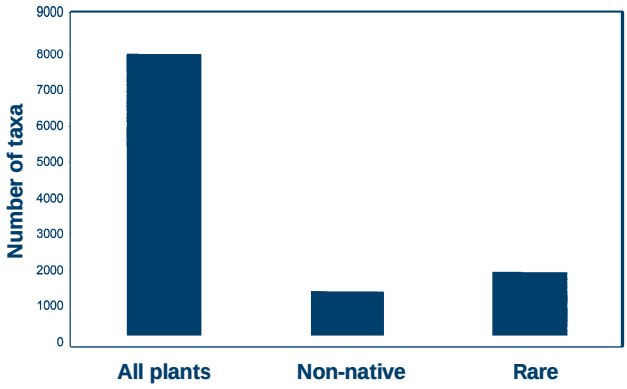

Figure 1. Total number of plant taxa in,California, number of taxa that are non-native, and number of taxa that are classified as rare by the California Native Plant Society. Data are from the Calflora Project (2005).

Chorizanthe cuspidata variety *villosa:* splendor in the sand

I recall with painful clarity my first encounter with *Chorizanthe cuspidata* variety *villosa*, the San Francisco spineflower; a perfectly good shirt was lost to a nap on sand that hid *Chorizanthe* seeds. These spiny seeds are a key element of *Chorizanthe*'s life history, and their ability to stick to mobile vertebrates is key to the recovery of ACR spineflower populations.

Chorizanthe cuspidata var. *villosa* is a sand dune annual, one of a suite of unusual California plants adapted to the extreme and dynamic life of living dunes. Wild coastal dunes are the interface between land and sea, where oceanic wind drives a conveyor belt of scouring sand across swales and over dunes. Dunes are sand blasted by year-round winds and misted with saline spray, and when freshwater rain arrives it rapidly disappears through the sand. Traits which confer plant competitive ability in less extreme conditions are a liability in this extreme system, and so the dunes provide a refuge for tough, resistant plants such as *Chorizanthe*.

Unfortunately, humans have long endeavored to calm the unruly nature of wild dunes. California's dunes have been bound in straightjackets of European beachgrass *(Ammophila arenaria)* and South African iceplant *(Carpobrotus edulis)*, species imported for their ability to spread rapidly and suppress the active sand that keeps dune systems alive. These introduced plants have spread widely and now threaten even the few dune systems protected against developers and off-highway vehicles.

Audubon Canyon Ranch protects several acres of coastal sand dunes at Toms Point. These dunes support at least two rare and uncommon plant taxa, San Francisco spineflower *(Chorizanthe cuspidata* var. *villosa)* and dune gilia *(Gilia capitata* ssp. *chamissonis)*. Unfortunately, the dunes are dominated by European beachgrass, and the rare dune plants are essentially restricted to a small section that has not yet been dominated by the invader. In June of 2004 I initiated a dune restoration project to remove European beachgrass and reclaim the site for the uncommon dune plants. The strategy is to restore habitat in small segments over several years, pacing invasives removal such that there is sufficient time for natives to colonize the freshly liberated sand.

We are already seeing encouraging results, and populations of *Chorizanthe* and *Gilia* have increased dramatically after just a single year. These preliminary results confirm that dune natives can naturally recolonize restored sites, and we are hopeful that our efforts will save these fascinating species and the dynamic system in which they thrive.

The same surveys also indicated the absence of the endangered *Blennosperma bakeri*, even though this beautiful miniature sunflower is present in identical pools ten meters west of Bouverie's fenceline.

I am conducting exploratory surveys and have visited populations of most of ACR's rare plants to assess threats to their continued persistence. Invasive species are clearly the most significant threat to ACR's rare plant populations. This corresponds with global patterns, as biodiversity loss worldwide is driven first by habitat loss and secondly by invasive species (IUCN 2004, IUCN Red List of Threatened Species. http://www.iucnredlist.org). While most of our rare plant populations appear stable, several populations clearly require active restoration to ensure persistence. Details of the threats faced by two species are presented in the accompanying text boxes.

As these two examples illustrate, most of ACR's rare plants are capable of surviving in extremely adverse conditions and can even become very abundant locally. They are not intrinsically "weak" species that need coddling. Rather, these lineages demonstrate an inspiring will to live, as demonstrated by *Downingia* colonizing an abandoned pit and *Chorizanthe* expanding into newly reclaimed sand dunes. Each of these taxa is the product of a singular evolutionary history, each individual flower the millionth descendant of a unique lineage which developed only once in the history of Earth, and that has been selected to thrive in only one type of place: *Downingia* in seasonally flooded vernal pools, *Chorizanthe* in coastal sand dunes. When suitable habitat is present these species will thrive, and so the disappearance of these taxa from ACR lands reflects not the loss of a poorly adapted species, but rather the loss of an entire kind of place.

There is inspiration in the ability of these lineages to persist in a human-altered landscape, and with each season of germination we redouble our efforts to save the places where these taxa thrive. This ethic of caring for our shared natural legacy is the passion that founded Audubon Canyon Ranch, and we remain committed to sustaining this most noble of human drives with sound scientific research, empowering education, and mindful habitat stewardship.

An updated plan for research and resource management at ACR

Beyond Gardening

by John P. Kelly

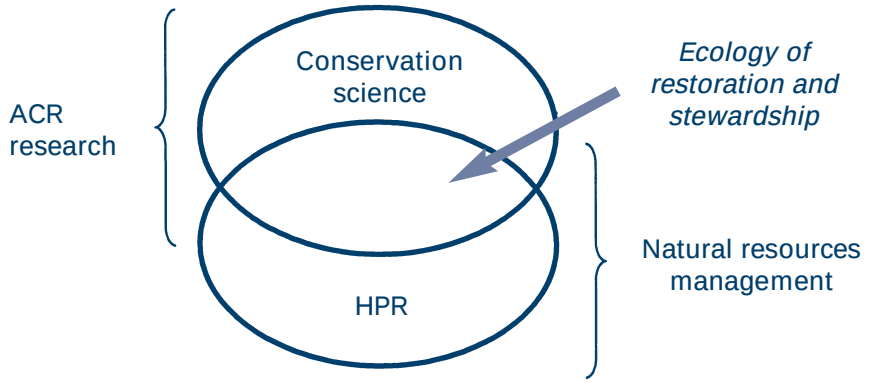

Figure 1. ACR's Research and Resource Management Program includes projects in conservation science as well as habitat protection and restoration (HPR) on ACR lands. These areas overlap in projects that investigate issues in the ecology of restoration or stewardship.

How can Audubon Canyon Ranch best protect the herons and egrets that nest at Bolinas Lagoon Preserve? The answer to this question is actually rather complicated, involving far more than owning the site and restricting human visitation. It involves, for example, the protection of shallow feeding areas and suitable prey species in Bolinas Lagoon. Other difficult questions of interest to ACR include how to protect watershed processes that sustain our sanctuaries, how to distinguish natural from human-caused vegetation change, how to control numerous invasive pests, how to advance the conservation of shorebirds that feed along our shorelines, and even how to maintain the periodic flurries of butterflies that dance among the wildflowers at the Bouverie Preserve.

Countless such concerns influence the ecological health of ACR sanctuaries and challenge our approach to stewardship. Such challenges are reflected in a major revision of ACR's Research and Resource Management (RRM) Plan (Table 1). Although the RRM Plan is filled with prescriptions for management, it recognizes that solutions are often difficult and that stewardship should be conducted cautiously to allow for uncertainties in how the kaleidoscopic processes of nature respond and change over time.

Three stewardship themes have emerged in the RRM Plan. First, the Plan emphasizes the intrinsic natural values of ecosystems over human use values, a guiding principle that has characterized ACR since it began over 40 years ago. Although students, volunteers, and the public benefit greatly from experiences with nature at ACR, our sanctuaries are managed primarily as natural areas, not parks.

Table 1. Some topics addressed in the Research and Resource Management Plan of Audubon Canyon Ranch.

- Research and resource management policies
- Resource management (natural and human use) zones
- Human use impacts
- Fire as a management tool
- Long-range plan for the Cypress Grove Research Center
- Habitat protection and restoration
- Herbicide use
- Tomales Bay marshes
- Toms Point
- Bouverie Preserve grasslands
- Douglas fir succession
- Bolinas Lagoon Preserve outlying properties
- Potential scientific investigations of special interest
- Potential stewardship projects of special interest
- Overview of natural resources at ACR
- Key management species
- Special status species
- Special features
- Cultural resources
- Guidelines for planting

Table 2. Habitat protection and restoration goals at Audubon Canyon Ranch.

- Identify, inventory, map, and monitor species populations of concern on ACR lands, including rare or special-status species, species of management concern, and invasive pest species.
- Assess the impacts of non-native species on ACR lands.
- Organize hands-on volunteer activities and administer active conservation efforts and hands-on volunteer activities to protect and restore natural resources on ACR lands, including the removal of non-native species and the restoration of native species populations.
- Conduct applied conservation research and publish scientific results that directly promote the protection or restoration of natural resources on ACR lands and surrounding landscapes.
- Contribute to regional conservation efforts and collaborate with natural resource agencies and land managers to mitigate for the negative effects of invasive species. Of particular importance are watersheds of Sonoma and Stuart creeks, Tomales Bay, and Bolinas Lagoon.
- Provide scientific leadership in interagency research and conservation programs at local, regional, and state levels.

Second, the RRM Plan indicates that ACR seeks not only to measure how effectively we manage natural resources but, whenever possible, to understand the underlying ecological effects on native plants and animals. This is a serious challenge but one that is inherent in linking the long-term protection of our sanctuaries with the general conservation crisis. Specifically, the relevance of stewardship at ACR depends on a scientific approach that will translate local experience into general guidelines for conservation.

Finally, the stewardship of natural resources at ACR is strongly influenced by processes that operate at scales larger than our sanctuaries. Great Egrets may travel far from their natal heronries before choosing where to nest, and they depend on prey from surrounding estuaries to feed their young. Invasive weeds expand across broad ecological fronts, invading vulnerable habitats over whole landscapes and regions. Streams, runoff, and coastal currents transport organisms and materials, touching everything. And perhaps as ubiquitous as water are the effects of humans, which may impact our sanctuaries from afar. It's an old epiphany—that everything is connected—but one that continues to inspire responsible action. So from this, ACR's RRM Plan recognizes that parallel programs in science, natural areas management, education, and conservation policy may be necessary to sustain the life on our sanctuaries.

DANIEL GLUESENKAMP

Volunteers pull iceplant to help ACR restore salt marsh vegetation at Toms Point.

Implications of stewardship

Obviously, the themes described above can lead to a broad and demanding agenda. Over recent years, natural areas have been swamped by an increasing onslaught of invasive pest species that, like an enormous wildfire, is difficult to control. We take heart in incremental successes, like the removal of iceplant from the beaches of Toms Point on Tomales Bay, the restoration of native ground cover along the creek in Volunteer Canyon, and the reestablishment of native oaks at Bouverie Preserve.

Scientific projects at ACR target selected issues in conservation biology, such as Dan Gluesenkamp's investigation into the effects of foraging by non-native Wild Turkeys on forest-floor organisms (*Ardeid* 2003). Other projects have investigated the regional status, home ranges, and predatory behaviors of ravens (*Ardeid* 2001–2004); the hydro-geomorphology of developing tidal marshes (*Ardeid* 2001, 2004); and the influence of freshwater inflow and tidal circulation on shorebird use of estuaries (*Ardeid* 2001).

Natural resources agencies often use the results of ACR research to assess and manage heronries, coastal lagoons and marshes, recreation areas, and other natural areas beyond our boundaries. In fact, the protection (or loss) of natural resources in other parts of the landscape probably influences the life in our sanctuaries more dramatically than many of our on-site stewardship activities do. Because of such influences, ACR biologists address regional conservation issues and maintain active roles in watershed management councils, conservation planning teams, and technical advisory groups.

Nature's laboratories

One increasingly valuable use of protected lands is to provide natural laboratories for conservation research. Advanced students and visiting scientists are showing a growing interest in the undisturbed natural areas of ACR (*Ardeid* 2003). We generally host 10-30 active field studies, addressing topics ranging from coastal prairie restoration ecology, to indicators of estuarine health, to the effects of vineyards on habitat values for birds. By providing places to investigate undisturbed natural systems, ACR lands have become important resources in conservation science. However, to protect these natural values we carefully limit the number of and types of investigations.

"HPR"

"Habitat Protection and Restoration" (HPR) has become a rallying call for active stewardship at ACR. The HPR Program, led by Dan Gluesenkamp, targets problems that directly threaten our sanctuaries, by implementing projects designed to understand as well as treat problems in ecological management (Table 2). With this approach, HPR is an essential part of ACR's overall scientific program (Figure 1).

The results of HPR investigations, such as the evaluation of methods for controlling invasions of aggressive, non-native *Erharta erecta* grass (see *Ardeid* 2004), contribute to general solutions in restoration ecology. HPR activities bring individuals and organizations together on projects that combine science, restoration, and educational outreach. Because well-understood solutions for practical problems are often not available, HPR projects frequently use adaptive designs, with experimental methods and incremental assessments that can be used to redirect management strategies.

An effective HPR program must conduct ongoing reconnaissance, as well as design and implement projects that reduce threats to local resources. With so many potential problems, this is never easy. However, standardizing stewardship procedures can reduce the likelihood of new threats. For example, the RRM Plan includes guidelines for planting that facilitate appropriate revegetation of damaged sites. Such standards protect native systems by guarding against the introduction of invasive plant species, avoiding adverse impacts to pollination systems, and preserving the genetic integrity of native plants on ACR lands. Routine procedures for cleaning the cutting blades of hand tools and washing down truck or tractor tires when returning from other locations help limit the introduction of invasive weeds as well as environmental pathogens such as Sudden Oak Death.

Rapid response

One objective of the RRM Plan is to develop a rapid-response procedure that will allow more effective management of ecological emergencies. What constitutes an "ecological emergency?" Consider the scattered colonization over a large area by an aggressive non-native pest plant (such as yellow star thistle), the discovery of an extremely rare species, or the catastrophic impacts of an oil or chemical spill. Rapid response may involve hiring specialists or laborers, conducting ad-hoc surveys, or using unusual means to avoid catastrophic habitat loss or debilitating management problems.

ACR strongly avoids the use of herbicides, preferring more expensive, manual methods to fight invasions of non-native *Spartina* (cord grass) in western Marin County marshes (*Ardeid* 2002) or to remove *Elytrigia pontia*, an invasive non-native perennial grass that smothers seasonal wetlands at Bouverie Preserve. However, under unusual circumstances, the careful, "stitch-in-time" use of herbicide may provide the only feasible way to prevent an ecological disaster.

Natural fire

Most ecosystems in California have evolved under periodic disturbance by fire (see *Ardeid* 2001). Other natural disturbances include windstorms, landslides, and floods. Natural levels of disturbance contribute to biological diversity by creating conditions suitable for species that thrive under various stages of post-disturbance recovery, while other areas maintain more stable conditions suitable for species that are long-lived or able to regenerate and persist in the absence of disturbance. Regional fire suppression as well as catastrophic wildland fires will continue to influence the patterns of life on ACR sanctuaries and surrounding lands. The RRM Plan addresses the role of natural fire in structuring California landscapes and details the potential benefits of using controlled fire to manage natural areas.

The prescribed use of fire can promote natural fire cycles and maintain natural landscape patterns. Fire can also be used to meet specific management objectives—to restore habitat patches, enhance local diversity, or control invasive weeds. The RRM Plan provides a template for the complicated process of planning and preparing for a controlled burn. Although ACR has no current plans for using prescribed fire, the potential benefits for restoring some areas, such as the native coastal prairie bordering Tomales Bay, are considerable.

Cypress Grove Research Center

The diverse challenges set forth in the RRM Plan create great hope for the expanding role of ACR as a conservation organization. The long-range strategy for ACR's Research and Resource Management Program, headquartered at the Cypress Grove Research Center (CGRC) on Tomales Bay, focuses on four program areas: (1) wetlands ecology; (2) restoration and stewardship ecology; (3) ecology of bird populations, habitats, and behavior; and (4) conservation ecology of herons and egrets. The first two areas represent appropriate unifying themes for future work, based on the dominance of wetland issues in regional conservation and the importance of remnant native habitats in surrounding (urbanized) landscapes. ACR plans to develop additional staff expertise in wetlands and landscape ecology and to enhance office space, guest housing, and laboratory facilities at CGRC.

It takes more than a good barn and a well-equipped tool shed to care for the natural character of the land. The depth of local knowledge, extent of hands-on activity, and level of scientific expertise needed for such work can be considerable—especially if responsible stewardship is viewed as a practice embedded in the surrounding ecological and social/ political landscape. Such a perspective presents a huge challenge, but one that ACR's RRM Plan considers to be essential.

Heron Atlas, *from page 3*

reproduction are also evident. For example, Great Egrets produce slightly (but significantly) more young per nest, on average(± standard error), in the Suisun Marsh area (2.2 ± 0.02 young per nest) than in the Petaluma/Napa marshes (1.9 ± 0.03), the Outer Marin/Sonoma Coast (2.0 ± 0.02), or the Russian River/ Laguna de Santa Rosa (2.0 ± 0.02).

On a local scale, particular colonies of Great Blue Herons consistently outperform other colonies. Such a pattern is evident at the DeSilva Island heronry in Marin County where successful nests produce an average of 2.4 ± 0.10 young compared to only 2.05 ± 0.03 young elsewhere in the region. Understanding such differences may provide insights into the ecological processes affecting feeding and nesting areas.

Regional patterns in nest survival (chance of successfully fledging at least one young) are less evident. This is because the geography of nest failure seems to vary among years. Nest failure rates are normally low for Great Blue Herons (21 ± 1.4%, n = 342) and Great Egrets (22 ± 2.2%, n = 143), but catastrophic colony failures of more than 90 percent occur at one or more heronries in most (75%) survey years. These events are usually the result of human disturbance or intense predation by eagles, ravens, or other nest predators, and can apparently occur anywhere in the region. So, like earthquakes and fires, catastrophic losses to predators or disturbance are difficult to predict. At one site in Suisun Marsh, a tree full of nests with developing young simply toppled into a slough.

The regional heron and egret atlas marks a new beginning for ACR research. Plans are now underway to enhance the underlying database to help in understanding how herons and egrets respond to changes in wetland quality. We are developing additional studies on foraging activities, flight patterns, and habitat preferences. By viewing the activities of nesting herons and egrets as an ecosystem process, we hope to find new ways to understand their wetland habitats. We are inspired by this approach because, of course, their wetlands are also ours.

Olema Marsh, *from page 5*

California Coastal Conservancy to conduct a watershed assessment of Bear Valley Creek that will address this question. The primary purpose of the study is to increase spawning and rearing habitat for salmonids in the Central California Coast Evolutionary Significant Unit. The study will identify actions to improve landscape connectivity between Bear Valley Creek, Olema Marsh and Tomales Bay and will probably recommend repairing culverts and stream crossings that limit fish passage between Tomales Bay and the Bear Valley watershed.

ACR's Plan for Olema Marsh

ACR's primary goal for Olema Marsh is to promote natural wetland processes that will improve and maintain habitat for breeding and wintering marsh birds, particularly passerines, rails, and shorebirds. Special consideration is given to the requirements of the California Black Rail, Virginia Rail, Sora, migrant freshwater shorebirds, Marsh Wren, Red-winged Blackbird, Tri-colored Blackbird, and Salt Marsh Common Yellowthroat. To accomplish these objectives, management efforts will focus on restoring hydrologic circulation that will sustain a variety of riparian and marsh vegetation. ACR also recognizes the importance of enhancing wetland habitat values that benefit a variety of other native and special-status species, including salmonids, tidewater goby, California red-legged frog, northwestern pond turtle, San Francisco forktail damselfly, California freshwater shrimp, and southwestern river otter.

ACR will continue to take an active role in the restoration and protection of our sanctuaries and looks forward to successful collaboration with managers of adjacent land. Such collaboration is essential to protect natural ecological processes throughout the local landscape. Through these and other efforts, we can set a good example for improving stewardship at larger scales required to sustain native plant and animal populations.

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Visiting investigators

Effects of invasive species on nitrogen retention and other issues in the ecology and restoration of coastal prairie. Jeff Corbin and Carla d'Antonio, UC Berkeley.

Species diversity, rare plant persistence, and parasitism in mid-Pacific coast salt marshes: functional significance of interplant parasitism. Brenda Grewell, UC Davis.

Effects of dispersal on insect population dynamics and parasitoid diversity in galls of Rhopalomyia californica *on* Baccharis pilularis. Martha Hoopes and Cheryl Briggs, UC Berkeley.

Multi-scaled vegetation data to predict wildlife species distributions using a wildlife habitat relationship model. Jennifer Shulzitski, USGS Golden Gate Field Station.

Impact of butterfly gardens on pipevine swallowtail populations. Jacqueline Levy, San Francisco State University.

The effect of landscape changes on native bee fauna and pollination of native plants in Napa and Sonoma counties. Gretchen LeBuhn, San Francisco State University.

Ecological indicators in West Coast estuaries. Steven Morgan, Susan Anderson, and others, UC Davis Bodega Marine Lab, UC Santa Barbara.

Consequences of species invasion under global climate change. Elizabeth Brusati, UC Davis.

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

Factors causing summer mortality in Pacific oysters. Fred Griffin, UC Davis Bodega Marine Lab.

Effects of Sudden Oak Death on woodland vegetation structure. Letty Brown, UC Berkeley.

Effects of SOD-induced habitat change on vertebrate communities. Kyle Apigian and Don Dahlson, UC Berkeley.

The differential ability of annual and perennial grasslands in California by a non-indigenous invader, Foeniculum vulgare. Joel Abraham and Jeff Corbin, UB Berkeley.

Differences in arthropod community composition in native and exotic dominated grasslands. Natalie Robinson, UC Berkeley.

A comparison of carbon cycling and material exchange in grasslands dominated by native and exotic grasses in northern California. Laurie Koteen, UC Berkeley.

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

Monitoring avian productivity and survivorship (MAPS) station at Livermore Marsh. Denise Jones, Institute for Bird Populations.

Strophariaceae of California. Peter Werner, Dennis Desjardin, San Francisco State University.

Reintroduction of Stellaria littoralis *to the Presidio.* Lewis Stringer, Golden Gate National Recreation Area.

Bouverie Preserve amphibian study. David Cook, Santa Rosa, CA.

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Tomales Bay harbor seal monitoring. Mary Ellen King, Santa Rosa, CA.

Effects of landscape context and recreational use on carnivores in northern California. Sara Reed, UC Berkeley.

Effects of macroalgal bloom on seagrass bed productivity in Tomales Bay. Brittany Huffington, San Francisco State University.

In progress: project updates

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

Livermore Marsh ◗ As ACR's Livermore Marsh, on Tomales Bay, transforms from a freshwater system into a tidal salt marsh, we are completing a study of the relationship between increasing tidal prism and marsh channel development. Monitoring of winter and breeding bird use began in 1985. The data will be linked to measurements of vegetation to reveal changes associated with the developing tidal marsh. We also monitor the depth and duration of ground water which strongly influences biological conditions in the upper marsh.

Tomales Bay Shorebird Project ◗ 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. A team of 15-20 volunteer field observers is needed to conduct each count. The data are used to investigate winter population patterns of shorebirds, local habitat values, and conservation implications.

Tomales Bay Waterbird Survey ◗ Since 1989–90, teams of 12–15 observers have conducted winter waterbird censuses from survey boats on Tomales Bay. The results provide information on habitat values and conservation needs of 51 species, totaling up to 25,000 birds. Future work will focus on trends and determinants of waterbird variation on Tomales Bay.

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. The data are used to examine regional patterns of reproductive performance, disturbance, habitat use, seasonal timing and spatial relationships among heronries. The project has been incorporated into the Integrated Regional Wetland Monitoring (IRWM) program, a CALFED project to develop regional monitoring for San Francisco Bay. An annotated regional atlas of heronries is in preparation. Based on this work, we are collaborating with other scientists and wetland managers on the development of the California Waterbird Conservation Plan.

Common Ravens in heronries ◗ We have been observing and radio-tracking nesting ravens in Marin County and measuring their predatory behaviors in heron and egret nesting colonies. We have produced scientific papers on the status of ravens and crows in the San Francisco Bay area, on home range use, and on raven predatory behaviors. Future work will address diurnal movements of ravens, methods in radio telemetry, and techniques for managing raven predation.

Impacts of Wild Turkeys on forest ecosystems ◗ Invasive, non-native Wild Turkeys are common at Bouverie Preserve and throughout most of Sonoma County. The goal of this study is to experimentally measure the effects of ground foraging by Wild Turkeys on vegetation, invertebrates, and herpetofauna in the forest ecosystem of Bouverie Preserve. The results will provide information that can be used by agencies to improve management and control of turkey populations.

***Ehrharta erecta* management and research** ◗ *Ehrharta erecta* is a highly invasive perennial grass native to South Africa. It is currently invading west Marin County and is abundant in ACR's Pike County Gulch. The goals of this project are to understand the effects of *Ehrharta invasion,* develop tools for control of *Ehrharta,* and restore habitat invaded by *Ehrharta* at Bolinas Lagoon Preserve.

Plant species inventory ◗ Resident biologists maintain inventories of plant species known to occur on ACR's Tomales Bay properties and at Bouverie and Bolinas Lagoon preserves.

Cape ivy control, Volunteer Canyon ◗ Manual removal has proven to be very successful in reducing nonnative cape ivy from the riparian vegetation in ACR's Volunteer Canyon. Continued vigilance in weeded areas has been important, to combat resprouts of black nightshade, *Vinca,* and Japanese hedge parsley.

Annual surveys and removal of non-native *Spartina* and hybrids ◗ Protection of ACR's shoreline properties from invasion by nonnative *Spartina* is critical to the protection of ACR lands and provides a critical contribution to the overall monitoring and management of Tomales Bay and Bolinas Lagoon. In addition to conducting surveys on ACR lands, Katie Etienne is collaborating on surveys of other shoreline properties in these estuaries.

Influence of terrestrial invertebrates on grasslands ◗ This project will determine whether the dominance of European plant species in grasslands at the Bouverie Preserve is caused by herbivory by two types of ground-dwelling invertebrates: African earwigs *(Emborellia cincticollis)* and European slugs *(Derocerius* sp.*)*.

Vernal wetland botanical surveys at Bouverie Preserve ◗ As part of ACR's effort to determine the ecological values of vernal wetlands at Bouverie Preserve, Ramona Robison conducted a floristic survey designed to target rare plants. The surveys provided plant species lists, vegetation cover values, and GPS delineation of wetland habitats and locations of rare plants.

Salt marsh ice plant removal ◗ Non-native ice plant is being removed from marshes and upland edges at Toms Point on Tomales Bay, using manual removal, shading with black plastic, and glyphosate.

Eradication of *Elytrigia pontica* spp. *pontica* ◗ *Elytrigia* is an invasive, non-native perennial grass that forms dense populations in seasonal wetland sites. At Bouverie Preserve, we are using manual removal by groups of volunteers, light starvation and solarization using black plastic tarps), and glyphosate spot treatments to remove outlier and moderate size patches of *Elytrigia.*

Nest boxes ◗ Rich Stallcup has installed and maintains several Wood Duck nest boxes along Bear Valley Creek in ACR's Olema Marsh. Tony Gilbert has installed and maintains Western Bluebird nest boxes in the Cypress Grove grasslands.

Eucalyptus removal ◗ Eucalyptus trees are being removed with incremental annual cutting from Bouverie Preserve.

Restoration of coastal dunes by removal of *Ammophila arenaria* ◗ *Ammophila arenaria* is a highly invasive, non-native plant that alters the topography and function of coastal dunes. This project is restoring important dune habitat at ACR's Toms Point and protecting many native species that depend on the dynamic conditions found in mobile dunes.

Douglas fir control in oak woodland ◗ We are removing seedling and sapling Douglas fir trees at Bouverie Preserve to protect existing oak woodland habitat from encroachment and conversion to Douglas fir forest.

Grazing of Bouverie grasslands ◗ A prescribed grazing program has been implemented to maintain or increase the abundance of native grassland plant species and to protect the vernal wetlands at Bouverie Preserve

THE ARDEID

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

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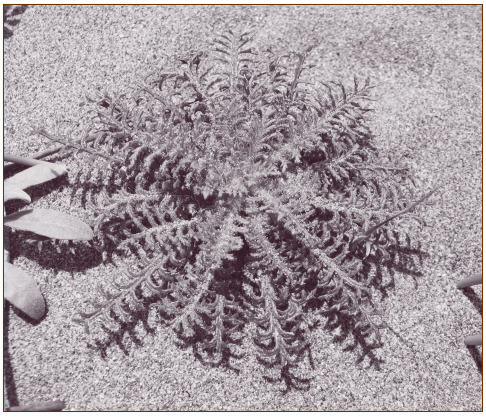
ACR stewardship encompasses such rare plant species as dune gilia at Toms Point.



DANIEL GLUESENKAMP

Protecting Rarities see page 6

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