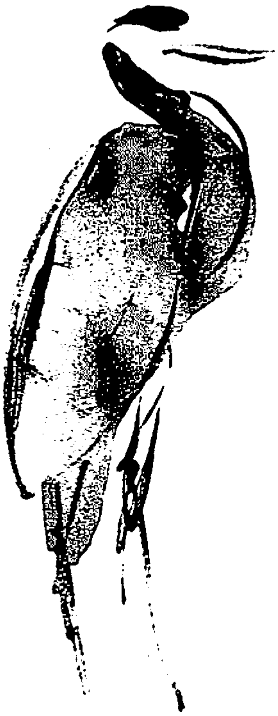


THE ARDEID

Research and Resource Management at Audubon Canyon Ranch

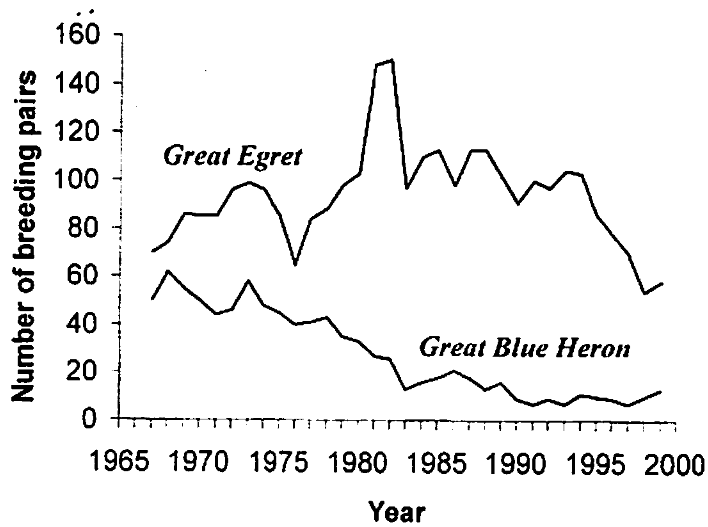
Spring 2000

30 Years of Research at Picher Canyon

Helen's Herons

by John P. Kelly

"It is usually difficult if not impossible for humans to see these birds on their nests, because herons and egrets establish their colonies high in tall trees or on inaccessible islands—out of reach of most ground predators, and incidentally, of humans."—Helen Pratt



In the spring of 1967, an unusual opportunity to view the lives of herons and egrets from above their nesting trees in a narrow redwood canyon inspired a long-term effort that would bring their natural history within reach of everyone who visits Audubon Canyon Ranch—and incidentally, to the rest of the world.

For over 30 years, Helen Pratt has studied ACR's herons and egrets, and her scientific papers have established much of the current knowledge about Great Blue Herons and Great Egrets (see sidebar). During this period, as California wetlands suffered devastating losses, Helen's work frequently linked the viability of heron and egret populations to wetland health. In her own words, "protecting the health of wetlands is as important as protecting the wetlands themselves."

Helen's first two years of field study indicated that the productivity of egrets at ACR was unexpectedly low. Eggs mysteriously disappeared during incubation from 30% of nests in 1967, increasing annually to 54% in 1970. The year Helen began her work at ACR coincided with Ratcliffe's 1967 publication in *Nature* (215:208-210), which linked widespread reproductive failure in Peregrine Falcons with egg-shell thinning caused by DDE and other DDT compounds. Helen soon discovered several symptoms of pesticide poisoning at ACR (Pratt 1972).

For example, some egret eggs found beneath the colony were soft-shelled and similar to collapsed eggs of (poisoned) Brown Pelicans and Double-crested Cormorants found on Anacapa Island (Channel Islands). And over 80% of the egret eggshells found beneath the colony were broken, not hatched. This led to a co-authored paper with Raymond Faber of University of Wisconsin, and Robert Risebrough, of U.C. Berkeley, that identified substantial contamination of Great Egrets and their eggs by DDT compounds, dieldrin, endrin, and polychlorinated biphenyls (PCBs; Faber et al. 1972). Eggs of Great Blue Herons and Great Egrets, broken during incubation, were 17% below normal thickness. Elsewhere, Helen reported unusual early nest abandonment in incubating herons and suggested possible hormonal disturbance related to pesticide levels (Pratt 1973). Low DDE:PCB ratios in fish collected in Bolinas Lagoon did not generally match the ratios in dead egrets found beneath the heronry. It is likely therefore, that egrets were contaminated on wintering grounds rather than in the immediate vicinity of the colony.

During those early years at ACR, Helen discovered a pattern of successive egg loss suggestive of breakage in the nest (Pratt 1972). Citing a recent finding that DDE poisoning caused delayed ovulation in the Bengalese Finch

Photograph by Philip Greene

◆ *Herons, continued*

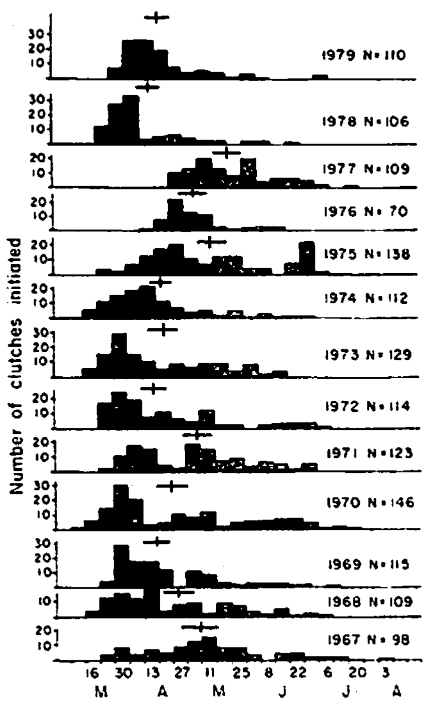


Figure 1. Frequency distribution for Great Egret clutch initiations at Picher Canyon, Audubon Canyon Ranch, 1967–1979. Means and 95% confidence intervals are plotted above each histogram. *From Pratt and Winkler 1985.*

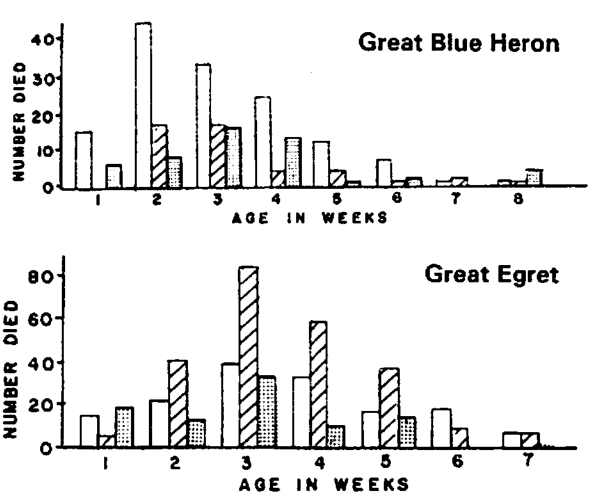
(*Lonchura striata*; Jefferies 1967, *Ibis* 109:266-272), and her own discovery of high levels of DDE in eggs and egrets at ACR, she decided to closely examine the chronology of egg laying for evidence of unusual delays (Pratt 1972). She found no direct evidence of pesticide influences on egg laying, but continued to track the chronology of nesting each year. Eventually she found that timing of nest initiations seemed related to unusually cold, wet conditions early in the season, and to early nesting failures followed by renesting attempts. The 30-year database Helen has created probably holds further insights into how weather affects reproductive performance and timing in herons and egrets.

Helen's article on the "Breeding Biology of Great Blue Herons and Common Egrets in Central California" (1970) has become one of the most widely cited papers on the natural history of these species. In this work, she described several fundamental features of heron and egret reproductive behavior, including incubation period, clutch size, parental behaviors, chronologies of nest initiation, laying intervals, hatching, nest attentiveness, brooding, feeding of young, and chick mortality. In another paper she reported the first accounts of nesting attempts by juvenile Great Blue Herons (Pratt 1973). Such information has provided many researchers with a head start in thinking about ecological challenges encountered by herons and egrets.

To provide a baseline for future comparisons of heron and egret populations, with a concern for "progressive loss of essential habitat," Helen tracked the sizes of 11 heron colonies in Marin County from 1967 to 1981 (Pratt 1983). She found wide annual variations in colony sizes, and concluded that inter-annual shifts of breeding birds between colony sites was the most likely explanation, rather than differences in mortality or variation in breeding success. She suggested that Marin County herons probably intermingle with birds nesting in other counties in the San Francisco Bay area, and recommended that regional surveys should be continued to determine the status of populations as pressures from development increase. This suggestion inspired ACR's North Bay Counties Heron and Egret Project, which has been tracking the distribution and reproductive performance of over 60 heronries in the San Francisco Bay area since 1990 (Kelly, Pratt, and Greene 1993).

In 1985, Helen published a powerful analysis of heron and egret reproduction. Based on 13 years of data from ACR, she and co-author David Winkler of U.C. Berkeley analyzed relationships among clutch size, time of laying, and fledging success, and evaluated the relative influences of starvation and predation on fledging success. Frequency distributions for clutch initiations (Figure 1) and chronologies of nestling mortality (Figure 2) provided a sharp focus on important aspects of reproduction. Helen recognized bimodal peaks in nest initiations as chance occurrences of late arrivals and renesting by pairs that failed early in the season (Figure 1). Despite the isolation provided to Great Egrets nesting high in redwood trees, nest predation proved to be an important source of chick mortality (Figure 2). Food supply also appeared to limit breeding success in both herons and egrets.

Figure 2. Mortality of Great Blue Heron chicks and Great Egret chicks per week, at Picher Canyon, Audubon Canyon Ranch. Open bars = starved; hatched bars = preyed upon; shaded bars = other. *From Pratt and Winkler 1985.*



Why do colony sizes fluctuate?

One conclusion from Helen's work has had particular influence on our current thinking about the conservation of herons and egrets: changes in colony size were not correlated with measures of reproductive success (Pratt and Winkler 1985). This finding was consistent with her suggestion that fluctuations in colony size could be explained by predation pressure and movements of individuals among breeding sites. Although we cannot measure nest initiations in the region as precisely as Helen did at Picher Canyon, we recognize the processes she identified—late initiations can signal regional nest failure or movements of birds from other (possibly disturbed) sites.

Interest among scientists in the ecology and evolution of coloniality as a breeding strategy has been huge. One of the more interesting hypotheses suggests that colonies serve as "information centres" to assist members in finding food. According to the hypothesis, colonial nesting may be advantageous to species that depend on food that is distributed unevenly in patches of temporary abundance, such as wetland prey exploited by herons and egrets. Helen tested the associated prediction that individuals follow successful neighbors to good feeding sites to reduce searching time and enhance foraging success (Pratt 1980). To do this, she and several assistants tracked the movements of Great Blue Herons flying out of the Picher Canyon heronry. Observers stationed at the nest overlook and on the hill overlooking the Bolinas Lagoon used CB transceivers to communicate the identities of individuals departing from known nest sites. The timing and directions of departures from the heronry indicated that herons were behaving independently, rather than following other birds.

◆ *Herons, continued*

Photograph by Philip Greene

Helen reasoned that nest attendance patterns in herons and the transience of estuarine (tidal) prey concentrations prevent individuals from exploiting foraging information from other birds. Herons departing from Picher Canyon selected foraging sites in two ways. Some birds landed near foraging herons. In addition to revealing the locations of profitable feeding areas, such aggregations might provide "local enhancement" if prey are more easily caught by birds foraging near other herons. Some herons flew repeatedly in direct, purposeful flights to favorite feeding areas in the lagoon. The feeding ranges of other herons extended to a much wider area, with birds making regular flights toward Tomales Bay, Limantour and Drakes esteros, and San Francisco Bay.

While tracking the departure flights of herons, Helen discovered that unusually hot weather can cause some herons to leave eggs, or chicks less than three weeks old, unattended for short periods in order to drink (Pratt 1977). Great Blue Herons ordinarily attend nests continuously from the onset of incubation until the chicks are 21-28 days old. Extremely hot weather can force herons to replace water lost in evaporative cooling ("gular fluttering") before their mate returns for a nest relief. Helen explained that such behavior can result in theft of nest sticks by neighbors or opportunistic nest predation by ravens, gulls or, in some colonies, Black-crowned Night-Herons.

Most of Helen's reports address population trends and patterns of nesting success, and have become an important source of information for natural resource agencies interested in herons and egrets. In 1979, she and others from the Marin Audubon Society began to monitor annual changes in the number of herons and egrets nesting on West Marin Island, a spectacular heronry near San Rafael that supports up to 900 nests. This information subsequently contributed to the permanent protection of the site in 1992 as Marin Islands National Wildlife Refuge. More recently, the National Park Service incorporated her accounts of seasonal timing in Great Egrets into the draft environmental impact report for Alcatraz Island, where thousands of visitors wander among nesting Black-crowned Night-Herons, Snowy Egrets and Great Egrets.

Helen's work has established a solid standard of excellence in monitoring the nesting colony at ACR, and inspired much of our interest in the biology of these birds. Her model of dedicated observation and sophisticated thinking continues to guide research and biological monitoring at Audubon Canyon Ranch. ■

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Developing a management plan for a changing wetland

The Futures of Bolinas Lagoon

by Greg de Nevers

Bolinas Lagoon is a spectacular landscape feature and a biologically important wetland. Because Bolinas Lagoon is subject to tidal fluctuation, it is technically not a lagoon at all, but a coastal estuary. Bolinas Lagoon has existed in something like its present form for seven or eight thousand years (Bolinas Lagoon Management Plan Update, 1995). Its existence is a result of the post-Pleistocene sea level rise associated with global warming of climate. The generalized evolution of this type of landscape feature is to have sea level set the depositional point for coastal streams, which then fill the drowned river valley with sediment at or slightly above sea level. The tide flats along the Petaluma River east of Hwy. 101 between Novato and the county line are a classic example of this type of recent landscape feature. Coastal wetlands such as estuaries, lagoons and salt marshes are typically ephemeral features associated with coastal depositional processes. As deposition continues, the wetlands are filled and become uplands. However, the future of Bolinas Lagoon is unknown.

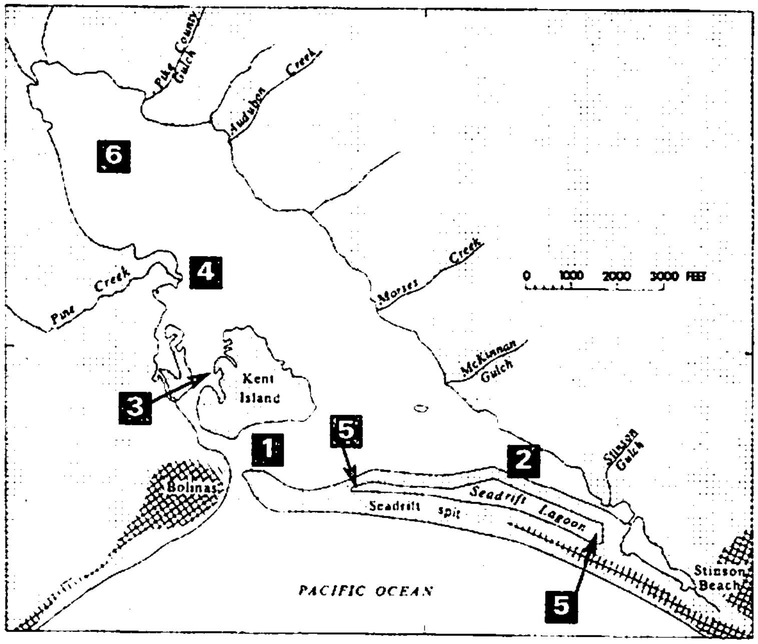

Figure 1. Action proposals being studied to increase the tidal prism in Bolinas Lagoon all have a dredging component. They include: **1)** deepening the main channel; **2)** removing fill along Hwy. 1 and Dipsea Road; **3)** creating a channel through Kent Island; **4)** removing sediment from the Pine Gulch Creek Delta area; **5)** opening Seadrift Lagoon to tidal flow and deepening Seadrift Lagoon; **6)** dredging the north basin.

The unique feature of Bolinas Lagoon (and Tomales Bay) that has allowed it to persist is that it lies directly along the San Andreas Fault. Each time the fault moves the floor of the lagoon drops. The lagoon sits on a graben, or a bounded block. The 1906 earthquake dropped the graben beneath Bolinas Lagoon between 12 and 14 inches (Lawson 1908; Rowntree 1975). The previous large movement on the San Andreas, about 600 years earlier, dropped the graben beneath the lagoon a similar amount (Knudsen et al. 1999). Essentially, there are two competing processes operating in dynamic equilibrium in the lagoon. Deposition by streams fills the lagoon and moves it toward becoming a meadow and then a forest. This is counterposed by fault movement deepening the lagoon, increasing the tidal prism (the total volume of water exchanged during a tidal cycle), and allowing it to persist as a liquid landscape feature. This equilibrium has persisted in something like its present configuration for the last seven millennia.

Euroamericans began moving into the Bolinas area around 1835. The gold rush of 1849 precipitated dramatic changes in California, including the harvest of lumber to build the growing town of San Francisco. The watershed of Bolinas Lagoon was quickly deforested. One of the unintended consequences was a pulse of sediment delivery to the lagoon. The Johnson Brothers operated a shipyard at the mouth of McKennan Gulch (mile marker 14.41, between ACR's Bolinas Lagoon Preserve and Stinson Beach) between 1850 and 1885 (Toogood 1980). By 1885 the shipyard had to be abandoned because the lagoon had lost depth to such an extent that ships could no longer negotiate the channel. Core sampling has been used to establish the background rate of sedimentation in the lagoon at 0.7 million cubic feet/year (refs. in Winkleman 1999 and Knudsen 1999). A relatively small 1967 logging event in the Pine Gulch Creek watershed resulted in sediment delivery to the lagoon of 2.27 million feet/year (Winkleman 1999). As the watershed recovered from this logging event, and forests grew larger and more continuous, sediment delivery once again decreased. Sediment delivery to the lagoon today approximates the undisturbed background rate (0.71 million cubic feet/year).

Decadal bathymetry studies of the lagoon over the last 30 years (Ritter 1969, 1973; Winkleman 1999) have shown continued loss of tidal prism, and loss in areal extent of subtidal and intertidal habitat. Associated with these habitat changes are changes in use by different guilds of birds. Diving ducks, which utilize deeper water, have diminished in abundance. Dabbling ducks, which favor shallower habitats, have increased in number. Projections modeling the loss of tidal prism raise the possibility that the lagoon will diminish in volume to the point that the mouth of the lagoon may close, either intermittently or permanently, and transform the current estuary into a real lagoon (Bolinas Lagoon Management Plan Update 1995; Winkleman 1999). The estimates of when such a closure might occur vary widely. This dramatic change would have far reaching implications for the ecology of the estuary. Many organisms would cease to use the area (harbor seals, bat rays, smelt, ghost shrimp, clams). Others would benefit, and some would be unaffected.

Faced with projections of a dramatically changed wetland, the question of the human role in all of this change has been raised. One analysis posits that we

◆ Bolinas Lagoon, continued

humans have pushed the equilibrium out of balance, and thus should make an attempt to engineer a solution that redresses the perceived problems we have precipitated. The County of Marin manages the lagoon as open space and a nature sanctuary. The County has been studying the issue for a number of years in consultation with the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, State Fish and Game, the College of Marin, Gulf of the Farallones National Marine Sanctuary, Point Reyes Bird Observatory, U.S. Geological Survey, Audubon Canyon Ranch, Golden Gate National Recreation Area, and Point Reyes National Seashore. The Corps of Engineers will soon convene an expert panel composed of biologists, hydrologists and geologists from these organizations to consider alternatives for lagoon management.

Proposals for Action

The critical factor that we can measure, and over which we might exert some influence, is tidal prism. The volume of water flowing in and out with each tidal cycle is critical to sediment transport into and out of the lagoon. The configuration of channels to different parts of the lagoon also seems to be important. For instance, an historic channel north of Kent Island that serviced the north basin and the mouth of Pine Gulch Creek is now largely filled in and functions only at the highest tide levels.

All of the action proposals being studied have a dredging component (see Figure 1). The Army Corps is currently running computer models of the projected effects that each dredging component, as well as combinations, would have on tidal prism, sediment mobilization, transport and deposition, and on habitat. Any action proposal would have to be considered superior to a "no action" alternative, and follow a formal Environmental Impact Report process.

Perhaps the most challenging aspect of the studies we have in hand is the paucity of hard data actually available. Here are a couple of examples. We would like to know the relative contribution of individual streams entering the lagoon to the total volume of fresh water and stream sediment that enters the lagoon. We have one season of fairly continuous stream gauge data for Pine Gulch Creek, and intermittent stream flow data from one season for Picher Canyon and Morse's Gulch. All of these data were collected in 1968 (Ritter 1973). Models based on these three estimates show Pine Gulch Creek delivering as much water as all of the east shore creeks combined. The model also shows Pine Gulch Creek delivering about 8 times as much sediment as all of the east shore creeks combined. This is reasonable, given the soft sediments through which Pine Gulch Creek flows, in contrast to the hard metamorphic rocks through which the east shore creeks flow. One wonders, however, if the snapshot indicated by one season would be corroborated by 10 or 20 years of data on intermittent or long term processes.

Additionally, it is critical to know the relative quantity of sediment delivered to the lagoon by ocean transport. This includes both long-shore currents in the Stinson Gyre and erosion from the soft cliffs at the mouth of the lagoon in Bolinas. Hydrologic and sediment movement studies at the mouth of the lagoon are conceptually simple but, in practice, taxing to conduct. Ritter (1973) collected tidal exchange and sediment transport data for two days in 1968 at the mouth of the lagoon. This is the sum total of actual measurement available to build the lagoon model currently in use.

The shape and size of the inlet cross-section, as well as the ratio of the inlet cross section to the lagoon volume (tidal prism), are critical factors in modeling the possibility that the lagoon will close off from the ocean. Anecdotal reports indicate that the mouth of the lagoon has become shallower over the past 30 years. Again, we have few measurements of the shape and size of the inlet (1950's, 1968, 1998). Available data seem to corroborate the anecdotal observations. However, inlet shape is dynamic, changing from day to day and season to season. In 1998 the lagoon inlet cross-sectional shape and area differed dramatically from spring to fall (Winkleman 1999).

ACR's current research at Livermore Marsh on Tomales Bay addresses this same question, with a particular focus on smaller tidal systems (Ardeid, Spring 1999): what is the relationship between tidal prism and size of the inlet channel?

Given the complexity of the task of managing Bolinas Lagoon, and the paucity of data, it is little wonder that the future of Bolinas Lagoon remains a mystery. ■

Greg de Nevers is Resident Biologist at ACR's Bolinas Lagoon Preserve.

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THE ARDEID

Research and Resource Management at Audubon Canyon Ranch

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

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BOLINAS LAGOON PRESERVE • CYPRESS GROVE PRESERVE • BOUVERIE PRESERVE

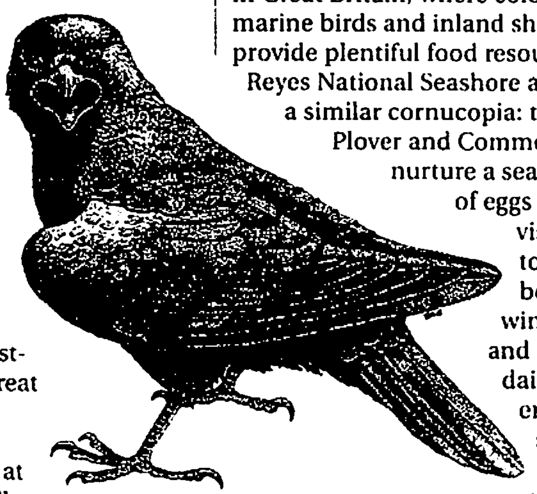
The behaviors of birds and biologists

Raven is Near

by Mark McCaustland

As I cleaned out the laboratory on my first day at ACR's Bolinas Lagoon Preserve, those three words scrolled across the computer monitor, a cryptic screen saver left by the previous season's team of raven techs. Was this a riddle? A taunt? It required less than a week of fieldwork to verify that the phrase was this and more. Raven is near… and something fascinating and inexplicable was about to happen.

When one visits ACR's Picher Canyon, a Common Raven (*Corvus corax*) is always near. In 1998, persistent forays into the colony by the Picher Canyon ravens resulted in near total nesting failure among the Great Egrets and the Snowy Egrets. Three- and four-week-old chicks, an age at which egrets are normally strong enough to be left unattended, were simply carried away from their nests. As if to add insult to injury, the ravens raised their own brood from a nest within earshot of the main egret colony.



Drawing by Ane Carla Rovetta

Last year, in response to this devastation, Audubon Canyon Ranch initiated a collaborative project with the Point Reyes Bird Observatory to determine the breeding density, movements, and habitat use of the Common Raven within adjacent areas of West Marin. A recent analysis of local Christmas bird counts by the San Francisco Bay Bird Observatory showed that an explosion in the Bay Area raven population started in the early '80s and continued through the '90s. This increase is likely due to greater food resources created by human influences, e.g., agriculture and garbage dumps. But are ravens expanding at the expense of other species? If so, to what extent does nest predation by ravens threaten colonial waterbird populations in the region? To gain insight into these questions, we have been trapping wild ravens, attaching transmitters to them, and tracking their movements and behaviors.

As part of this effort, the project team placed transmitters on three of the four known pairs of breeding ravens between Chimney Rock and the Point Reyes Lighthouse—a distance of 5.5 kilometers, as the corvid flies. Such a high nesting density is comparable to that found along stretches of the Cornwall coast and the Shetland Islands in Great Britain, where colonies of marine birds and inland shepherding provide plentiful food resources. Point Reyes National Seashore affords ravens a similar cornucopia: the Snowy Plover and Common Murre nurture a seasonal bounty of eggs and chicks; visiting tourists leave behind a windfall of food and garbage; dairy ranches ensure a constant supply of grain spillage, carcasses, cattle dung, and during the calving season, afterbirth. Indeed, a feast fit for ravens.

On March 26th, we set out to trap the fourth pair of ravens near the Lighthouse. For over a week we'd baited them with raw meat scraps left near the dung heap by the "wye" in the Chimney Rock road—for ravens are extremely neophobic, wary of anything new. They approach even their favorite foods—raw meat and Cheetos—with a caution humans reserve for unexploded bombs.

The plan was simple: bury a ring of padded leghold traps around a fresh pile of bait, leave one observer on a nearby hill while the others waited, hidden in the truck. As is usual, the ravens did not behave according to plan. We hadn't walked more than a 100 meters from the bait when a pair of large, black dots appeared to the south, moving low and fast, flying straight towards the dung heap. Anxiously we hurried downhill, our cover blown. The ravens circled over the bait. One made a loud *quork*—the standard call of a content raven—and the other performed a half barrel roll. They seemed as excited as we were. Our baiting regime had worked, if perhaps a bit too well.

As we piled into the truck, the birds dropped behind the dung heap, near the meat scraps but beyond our view. By now Eric, our observer, had reached the lookout and the walkie talkie crackled with his first report.

"They're walking around the bait—wait. She's back on the dung heap... Looks like the male's doing jumping jacks." Jumping jacks are the most obvious outward expression of neophobia. Ravens perform backward hops around newly found food, presumably to ensure that it is not sleeping, but safely dead and ready to eat. We listened with baited breath as Eric continued, "He just flew back to the dung heap… Now he's doing jumping jacks again…."

And so it went for ten minutes until they took the first chunk of meat. In the truck we could see the bird fly up with a yellow strip of fat dangling from it's bill. The raven cached the meat beneath a tuft of bunchgrass, and then returned for a second helping. Catching but the briefest glimpse of the action made our anticipation even more unbearable. It was possible for the raven to take all the bait without ever stepping on one of the six buried traps. Again a bird flared into view. It landed barely forty meters from the truck, caching a second piece of meat. We felt as though our hearts beat loud enough for the raven to hear, but the bird flew back to the meat, undeterred.

"He's taking the same route every time," Eric broadcasted with a tone of discouragement. The raven swiftly made another cache farther uphill. We started to worry that we hadn't put out enough bait when suddenly the radio hissed, "Wait. The mate's finally coming down again. Looks like she's getting brave. She's…." There followed burst of static, and then "She's caught, I think!"

We turned the ignition and gunned the motor, but before the truck was in gear, two ravens were circling above the bait, yelling with rapid, high-pitched tones, something like a barking chihuahua. Alarm calls. We looked at each other blankly until the radio solved the mystery.

◆ *Raven, continued*

Eric cursed and then sighed, "She got out. I don't know how."

Our dejection quickly morphed into confusion as the ravens continued to circle the bait, barking and yelling. The pair suddenly veered towards us, and began to circle over the truck. This was behavior none of us had seen previously. Every other raven we'd captured remained totally silent, and those few that had escaped immediately fled the area. The calling and circling continued unabated when, quite unexpectedly, more raven voices were heard. To the north, a mob of eighteen ravens was winging our way. Two more came from the east, and yet another pair from the west. Within moments, a whirlwind of ravens swirled above the dung heap, swooping and yelling like a cauldron of birds brought to a boil. It was a spectacle at once wondrous and puzzling, for within 60 seconds, the crowd dispersed as quickly as it had gathered. None of the birds even attempted to claim the choice tidbits of meat lying in plain view.

We scratched our heads and fell speechless. Why did the other ravens come?

What had been communicated among them? The Wye pair continued circling above us, calling frantically. Obviously they had more to say about the morning's events. If I had to guess, it probably began something along the lines of, "Human is near…" ■

Mark McCaustland is a field biologist at ACR. His ability to "think like a raven" has become an important part of ACR's raven research.

It's not a campground!

Boy scouts have not invaded ACR! The curious tented structures at ACRs Bolinas Lagoon and Cypress Grove preserves (photo at right) are temporary exclosures used in a study of native insect populations. Martha Hoopes and Cheryl Briggs of UC Berkeley are investigating the role of dispersal in the persistence of small populations. The study focuses on a common gall-forming midge (*Rhopalomyia californica*) and several of its local parasitoids. (Parasitoids are mostly wasp species with lifestyles intermediate between parasitism and predation, characterized by laying eggs inside the eggs, larvae, or galls of host species.) The female midge lays clusters of eggs on the terminal buds and tips of coyote bush. When the larvae hatch and work their way in between the bud scales, the plant is stimulated to form a gall around the cluster of larvae. Six species of parasitoids exploit these galls at very high rates.

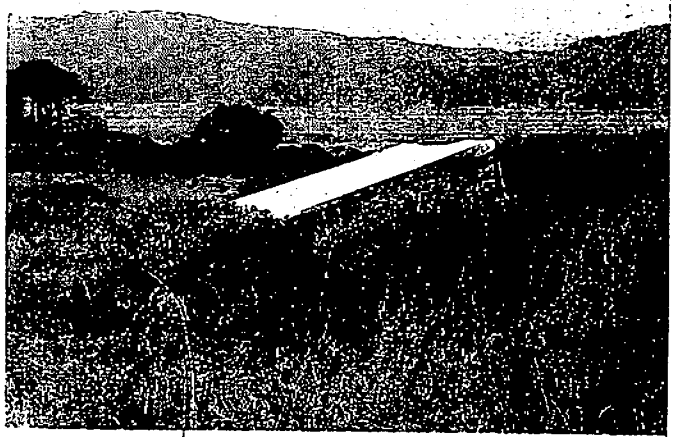


Photo by John Kelly

Rhopalomyia midges are common, sedentary insects that form small fragmented populations throughout coastal California. Consequently, they provide an excellent opportunity to study ecological processes in a common species that could be crucial in understanding threats to species that have become rare because of habitat loss or habitat fragmentation. The research addresses important aspects of a fundamental principle in ecology: species that occur in small populations have a high likelihood of extinction. Dispersal between such populations creates populations of populations, or metapopulations, that might have a higher chance of persistence. Such subdivision of populations can also provide mechanisms by which competing species, or predators and their prey, can co-exist.

This will be one of the first field studies to directly address these problems. The tented exclosures allow experimental control for measuring dispersal rates and population effects of the various species. ■

The Watch

The following list includes ACR field observers and habitat restoration volunteers since the previous Ardeid. Please call (415) 663-8203 if your name should have been included in this list.

PROJECT CLASSIFICATIONS:

- B = Breeding Birds in Oak Revegetation
- C = Common Raven Study
- H = Heron/Egret Project
- I = Plant Species Inventories
- M = Livermore Marsh Monitoring
- N = Newt Survey
- P = Photo Points
- R = Habitat Restoration
- S = Tomales Bay Shorebird Project
- W = Tomales Bay Waterbird Census

Dawn Adams (S); Sarah Allen (S); Bob Baez (SW); Norah & Hugh Bain (SH); Tom Baty (W); Charles Benedict (H); Gordon Bennett (S); Gay Bishop (S); Noelle Bon (N); Len Blumin (R); Patti Blumin (H); Ellen Blustein (MS); Noelle Bon (H); Janet Bosshard (H); Elaine Boston (H); Woody Boston (H); Maureen Bourbin (H); Tom Bradner (R); Joan Breece (R); Emily Brockman (H); Ken Burton (CSW); Denise Cadman (H); Caeser Chavez 5th grade (R); Barbara Carlson (N); Bill Carlson (N); Anne Cassidy (H); Jeff Corbin (R); Rigdon Currie (S); Carolyn Dixon (H); Roberta Downey (R); Joan Dranginis (H); Joe Drennan (W); David Easton (H); Ted Elliot (H); Serge Etienne (HS); Bob Evans (H); Jules Evens (S); Katie Fehring (CMS); David Ferrera (W); Binny Fischer (H); Grant Fletcher (HISWP); Virginia Fletcher (HSP); Ken Fox (R); Carol Fraker (H); Kathy Francone (H); Dan Froehlich (SW) Harry Fuller (W); Tony Gilbert (W); Beryl Glitz (H); Dohn Glitz (H); Della Gilmore (N); Ellen Goldstone (N); Irene Grauten (R); Philip Greene (H); Sadja Greenwood (R); Leslie Grella (S); Madelon Halpern (H); David Hastings (W); Anne Heron (H); Diane Hichwa (H); Edna Hickok (H); Terry Horrigan (S); Jeri Jacobsen (H); Jefferson Elementary 5th grade (R); Juniper Club (N); Gail Kabat (W); Lynnette Kahn (HS); Greg Kamman (MR); Rachel Kamman (M); Guy Kay (H); Carol Keiper (HS); Marion Kirby (N); Richard Kirschman (S); Brian Kirven (HW); Monty Kirven (W); Ellen Krebs (H); Carol Kuelper (RS); Alexis Lee (H); Laura Leek (W); Eileen Libby (H); Elizabeth Lynn (CM); Flora Maclise (H); Guy Maclise (H); Jo Maillard (H); Michelle Manos (H); Alan Margolis, M.D. (R); Amy McAndrews (HSW); Chris McAuliffe (H); Pat McClorie (N); Nicole Michel (HSW); Jean Miller (H); Dan Murphy (W); Laurie Ness (S); Wally Neville (H); Terry Nordbye (HSW); Richard Panzer (H); Ray Paula (H); Karen Paull (W); Kate Peterlein (S); Myrlee Potosnak (H); Mary Przyblyski (N); Jeff Reichel (H); Linda Reichel (H); Rudi Richardson (W); Arnold Roessler (H); Susan Ruschmeyer (M); Ellen Sabine (H); Diane Samples (N); Carl Sanders (H); Don Sanders (H); Marilyn Sanders (H); Fran Scarlett (H); Dave Schurr (S); Carol Schwartz (R); Craig Scott (W); Ann Smith (H); Duane Smith (H); Joseph H. Smith (HW); Anne Spencer (S); Bob Stafford (W); Rich Stallcup (S); Jean Starkweather (H); Michel Stevens (W); Stinson Beach 3rd grade (R); Judy Temko (HS); Philip Temko (S); Paula Terry (H); Janet Thiessen (HW); Wayne Thompson (W); Kathy Tyler (N); Gil Thomson (H); Tanis Walters (S); Ralph Webb (H); Rosalee Webb (H); Jack Welch (H); Adeline Whitmore (H); Ken Wilson (H); Jon Winter (H).

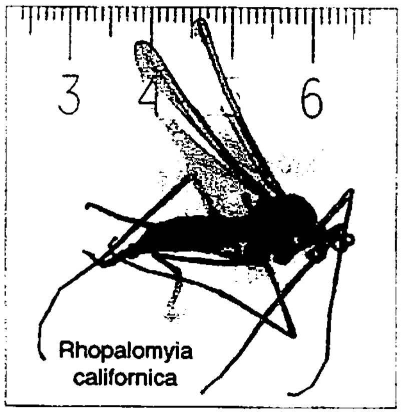
In progress: project updates

Photograph by John Latto

Cape ivy control ▶ Len Blumin continues to remove nonnative cape ivy from ACR's Volunteer Canyon. Greg de Nevers recently hired a herd of goats to consume the invasive weed in the dense riparian undergrowth.

Common Raven study ▶ ACR's regional road survey in the San Francisco Bay area revealed concentrations of Common Ravens in urban/suburban areas and along the outer coast. In collaboration with the Point Reyes Bird Observatory, ACR biologists are radio-tracking nesting ravens and observing raven predatory behaviors at waterbird colonies. We are also planning to test the use of conditioned taste aversion as a tool for limiting nest predation by ravens in heronries.

Livermore Marsh monitoring ▶ As the previously freshwater marsh at Cypress Grove Preserve is transforming into tidal salt marsh conditions, Katie Etienne and Rachel Kamman are studying relationships between tidal prism and marsh topography, as well as changes in bird use and vegetation, that will contribute to future restoration designs.



The gall forming midge *Rhopalomyia californica* (left) and several species of parasitoid wasps that exploit it are the subjects of research by Martha Hoopes and Cheryl Briggs, University of California, Berkeley, on the importance of dispersal and isolation in the persistence of fragmented populations. See page 7 for more details.

Newt population study ▶ Rebecca Anderson-Jones is analyzing 12 years of newt surveys along the Stuart Creek trail at the Bouverie Preserve.

North Bay counties heron and egret project ▶ We are completing the tenth year of tracking nesting activities in heron and egret colonies across five Bay Area counties. The data are used to examine regional patterns of reproductive performance, disturbance, habitat use, and spatial relationships among heronries.

Vernal swales ▶ Rebecca Anderson-Jones is developing an inventory and study of vernal swales in the seasonal wetlands of the lower grassland at Bouverie Preserve.

Shorebirds ▶ ACR field observers completed the eleventh year of shorebird censuses on Tomales Bay. John Kelly is also investigating the effects of winter storms on energy balance and habitat use by Dunlins.

Tomales Bay plant species database ▶ Grant Fletcher is tracking populations of *Castilleja ambigua ssp. humboldtiensis* and *Cordylanthus maritimus ssp. palustris*, rare salt marsh annuals in Tomales Bay and Mendocino County.

Tomales Bay waterbirds ▶ Since 1989-90, teams of field 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.

Picher Canyon heronry ▶ Greg de Nevers, Ray Paula, John Kelly and others are continuing the intensive study of heron and egret nesting activities established by Helen Pratt in 1967 (see lead article).

Visiting investigators at ACR

Yvonne Chan and Peter Arcese (Univ. Wisconsin), *Subspecific differentiation and genetic population structure of song sparrows in the San Francisco Bay area*

Jeff Corbin and Carla D'Antonio (UC Berkeley), *Effects of invasive species on nitrogen retention in coastal prairie*

Sarah Eppley (UC Davis), *Spatial segregation of sexes in* Distichlis spicata

Peggy Fong (UCLA), *Algal indicators of nutrient enrichment in estuaries*

Brenda Grewell (UC Davis), *Species diversity, rare plant persistence, and parasitism in mid-Pacific coast salt marshes*

Jodi Hilty (UC Berkeley), *Carnivore use of riparian corridors in vinyards*

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

Joe Jones (UC Santa Cruz), *Population structure of the California roach*

Elizabeth Lynn (UC Davis), *Correlations between riparian soil and vegetation*

Bibit Traut (UC Davis), *Structure and function of coastal high salt marsh ecotone*

THE ARDEID

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