Conservation Science and Habitat Protection at Audubon Canyon Ranch

THE ARDEID

◗ growing nature together

oak woodland restoration

◗ life on the edge

night-heron status

◗ wildlife photo index

camera grid

◗ collateral damage

boating disturbance

2013

In this issue

Cover: *A juvenile Black-crowned Night-Heron. Photo by Tom Grey.*
Ardeid masthead: *Great Blue Heron ink wash painting by Claudia Chapline.*

Audubon Canyon Ranch Staff

J. Scott Feierabend, *Executive Director*
John Petersen, *Chief Operating Officer*
Maurice A. "Skip" Schwartz, *Senior Staff Advisor and Executive Director Emeritus*

Administration
Yvonne Pierce, *Executive Administrator and Manager, Martin Griffin Preserve*
Leslie Sproul, *Receptionist/Office Assistant, Martin Griffin Preserve*
Nancy Trbovich, *Manager, Bouverie Preserve*
Barbara Wechsberg, *Cashier/Receptionist and Facilities Assistant, Martin Griffin Preserve*

Finance and Development
Judy Prokupek, *(Interim) Director of Development and Communications*
Trisha Fontan, *Administrative Aide*
Paula Maxfield, *Publicist*
Jennifer Newman, *Annual Fund and Communication Officer*
Stephen Pozsgai, *Controller*

Conservation Science and Education
John Kelly, PhD, *Director of Conservation Science*
Anne Burnett, *Director of Education*
Sherry Adams, *Resident Biologist/Manager, Modini Ingalls Ecological Preserve /Mayacamas Mountains Sanctuary*
Emiko Condeso, *Ecologist/GIS Specialist, Cypress Grove Research Center*
Gwen Heistand, *Resident Biologist, Martin Griffin Preserve*
Julie Keating, *Weekend Program Facilitator, Martin Griffin Preserve*
Theo Michaels, *Resource Ecologist, Bouverie Preserve*
Sarah Millus, *Helen Pratt Field Biologist*
Birkin Newell, *Resource Ecologist, Martin Griffin Preserve*
Jennifer Potts, *Resource Ecologist, Bouverie Preserve*
David Self, *Naturalist, Mayacamas Mountains Sanctuary*
Jeanne Wirka, *Resident Biologist, Bouverie Preserve*
Raquel Ximenes, *Community Outreach Coordinator*

Preserve Stewardship
David Greene, *Land Steward, Cypress Grove Research Center*
John Martin, *Land Steward, Bouverie Preserve*
Tomas Ruiz, *Land Steward, Modini Ingalls Ecological Preserve*
Steve Trivelpiece, *Land Steward, Martin Griffin Preserve*

The Watch

Volunteers for ACR research or habitat restoration projects since *The Ardeid* 2012. Please call (415) 663-8203 if your name should have been included. **Project Classifications: B**—Bouverie Stewards ♦ **C**—Cypress Grove Research Center office volunteer ♦ **G**—Project GROW ♦ **H**—Heron and Egret Project ♦ **M**—Modini Ingalls Ecological Preserve projects ♦ **MA**—Mayacamas Sanctuary projects ♦ **MG**—Martin Griffin Preserve Stewards ♦ **R**—Habitat Protection and Restoration projects ♦ **S**—Tomales Bay Shorebird Census ♦ **W**—Tomales Bay Waterbird Census.

Mary Abbott (S), Rick Abbott (M), Nancy Abreu (H), Ken Ackerman (B), Agilent Technologies (G), Bob Ahders (B), Sarah Allen (S,W), Janica Anderson (H), Bob Battagin (S), Katy Baty (W), Tom Baty (H,W), Gordon Beebe (M,S), Gordon Bennett (W), Ron Berchin (H), Gay Bishop (S), Len Blumin (S), Patti Blumin (H), Ellen Blustein (M,MA,S), Janet Bosshard (H,S), Cynthia Boyer (S), Anna-Marie Bratton (C), Bill Bridges (H), Hedda Brorstrom (S), Phil Burton (H), Dennis Buss (H), Denise Cadman (H), Tom Cashman (MA), Ann Cassidy (H), Joanna Castaneda (H), Dave Chalk (B), Dave Chenoweth (MG), George Clyde (W), Peter Coates (H), Hugo Condeso (S), Jhonen Condeso (S), Judith Corning (S,W), Bob Cox (B), Rig Currie (S), Peter de Jung (W), Al DeMartini (W), Beverley Diplock (B), Judy Dugan (S), Cedric Duhalde (W), Bob Dyer (H), Chris Engel (B), Janeann Erickson (H,S), Jules Evens (S,W), Janel Feierabend (W), Ginny Fifield (M), Binny Fischer (H,W), Mary Anne Flett (S), Jobina Forder (B), Rowena Forest (S), Ruth Friedman (H), Dennis Fujita (B,M), Abbie Gabrielson (S), Patricia Gaither (H), Tom Gaman (S), Daniel George (W), Anthony Gilbert (S), Beryl Glitz (H), Dohn Glitz (H), Natasha Granoff (M), Chlele Gummer (H), Bob Hahn (B), Elizabeth Hall (H), Madelon Halpern (H), Lauren Hammack (H), Steven Hammerich (R), Hanna Boys Center (R), Deyea Harper (H), Hugh Help (B), Earl Herr (B), Diane Hichwa (H), Howard Higley (MA), Lisa Hug (M,S,W), Eugene Hunn (MA,S), Sue Johnson (H), Junipers Summer Program (R), Gail Kabat (W), Cindy Kamm (W), JoAnne Kazimi (M), Charles Klein (S), Ellen Krebs (H), Carol Kuelper (S), Joan Lamphier (H,S,W), Brett Lane (H), Dennis Lang (B), Stephanie Lennox (H), Robin Leong (H), Peter Leveque (MA), Eileen Libby (H), Carolyn Longstreth (S,W), John Longstreth (S,W), Ron Mallory (H), Meg Marriott (H), Jean Matin (H), Mark McCaustland (W), Micha McConnell (R), Peter Metropulos (W), Maryanne Michaels (R), Patrick Michaels (R), Jean Miller (H), Jeff Miller (W), Ian Morrison (M,MA,S,W), Gerry Mugele (S,W), Kathleen Mugele (H,S), Dan Murphy (S), Len Nelson (H), Wally Neville (H), Rebecca Olsen (M,W), Tony Paz (MG), Susan Poirier-Klein (S), Peter Pyle (S), Nadja Quiroz (R), Devii Rao (W), Renee Rausin (H), Greg Raynor (H), Don Reinberg (S), Tom Reynolds (M), Brian Roberts (R), Ann Romer (H), John Rosenbaum (W), Glenda Ross (B), John Rudell (M), Ruth Rudesill (MA), Ellen Sabine (H), Santa Rosa Junior College (G), Linda Schmid (H), John Schonke (B), Victoria Seher (H), Richard Shipps (B), Paul Skaj (W), Jeffrey Smith (M), Joe Smith (W), Pat Smith (H), John Somers (H,S), Jackie Sones (W), Bob Spofford (H), Sue Spofford (H), Jude Stalker (H,W), Bob Stokstad (H), Julianne Stokstad (H), Kandace Strako (W), Emilie Strauss (S,W), Summer Search (R), Lisa Summers (B), Kate Symonds (H), Mark Szydlo (H), Anne Taylor (H), Nic Titus (R), Francis Toldi (W), Gwendolyn Toney (S), Amy Trainer (W), Lizzie Trout (R), Dick Vandlen (M), Barbara Jean Veronda (H), Bud Vieira (H), Claudia Vieira (H), Gregory Vose (W), Richard Wasson (M), Anna Weinstein (W), Jim White (W), Tom White (S), Alan Wight (MA), Adele Wikner (C,H), Peter Willmott (W), Ken Wilson (M,W), Will Wilson (S), David Wimpfheimer (S,W), Patrick Woodworth (C,H,M,S,W).

Restoring oak woodland habitat at Bouverie Preserve

Growing Nature Back Together

by Jennifer Potts

From an aircraft flying overhead, you might think that you're looking down on a highly creative installation art project. In truth, you are looking down at Project GROW, an eight-acre oak woodland restoration project at the Bouverie Preserve, complete with a maze of irrigation lines, protective tree tubes, wire cages, and draped shade cloth. While the site may look a little unusual from the air, you can clearly see the beginnings of a healthy oak woodland where David Bouverie's former vineyard used to stretch across the hillslope.

Project GROW began eight years ago, when the California Department of Transportation (Caltrans) approached ACR staff about a mitigation for 117 oak trees that were removed during Highway 12 construction. Those trees included 51 coast live oaks, 34 blue oaks, 29 valley oaks, and 7 black oaks (Table 1 and Figure 1). Fortunately, ACR had already identified five locations at the Bouverie Preserve as future high-priority restoration sites. Caltrans subsequently developed a cooperative agreement with the Southern Sonoma County Resource Conservation District (SSCRCD), which subcontracted the restoration work to ACR. After several years of planning and negotiations, on-the-ground field work finally began in 2009.

The exceptional biological richness of oak woodlands makes restoration work critically important. They support the highest number of plant and wildlife species of any habitat in California, including over 2,000 plant species; 330 species of birds, mammals, reptiles and amphibians; and 5,000 species of insects (California Department of Fish and Game 1996). Over 50 species of birds and mammals depend on acorns as their dietary staple, and numerous others rely on oaks for nesting cavities and shelter. Not only have these rich woodlands been significantly compromised by human land use, agricultural clearing, firewood harvesting, livestock production, and development in the past century, but oak

CREATIVE COMMONS

Figure 1. Coast live oak foliage and acorns.

Table 1. Project GROW plant list.

Growth Form	Species	Common Name
Tree	*Quercus agrifolia*	Coast live oak
	Quercus douglasii	Blue oak
	Quercus lobata	Valley oak
	Quercus kelloggii	Black oak
	Quercus garryana	Oregon oak
	Aesculus californica	California buckeye
	Acer macrophyllum	Big leaf maple
	Arbutus menziesii	Pacific madrone
Shrub	*Heteromeles arbutifolia*	Toyon
	Mimulus aurantiacus	Sticky monkeyflower
	Rosa gymnocarpa	Wood rose
	Sambucus mexicana	Blue elderberry
Vine	*Aristolochia californica*	California pipevine
	Lonicera hispidula	California honeysuckle
	Rubus ursinus	California blackberry
	Symphoricarpos mollis	Creeping snowberry
Forb	*Mimulus guttatus*	Monkey flower
	Sanicula crassicaulis	Pacific snakeroot
	Wyethia angustifolia	Narrow-leaved mules ears
Grass/Bulb	*Carex densa*	Dense sedge
	Chlorogalum pomeridianum	Soaproot
	Elymus glaucus	Blue wildrye
	Hordeum brachyantherum	Meadow barley
	Juncus xiphioides	Iris leaved rush
	Melica californica	California oniongrass
	Stipa pulchra	Purple needle grass
	Triteleia hyacinthina	White hyacinth

Figure 2. Black oak extending above tree tube used to protect young shoots from browsing.

Figure 3. Bluebird nestlings in Project GROW nest box.

JENNIFER POTTS (L). HUGH HELM (R).

woodlands are also facing decline because of inadequate seedling recruitment. Among the reasons why new oaks fail to sprout and grow are acorn and sapling predation from cattle, deer, and other herbivores, fire suppression, and competition from non-native plants (McCreary 2001). Sudden Oak Death is further challenging the viability of oak populations by eliminating mature acorn-producing individuals throughout California and Oregon (Rizzo and Garbelotto 2003). Finally, if that's not enough for concern, analyses based on regional climate models predict that the distributions of blue oak and valley oak woodlands are likely to contract substantially over much of the state in future decades (Kueppers et al. 2005). So the value of the restoration opportunity at Bouverie Preserve is huge!

So where to start?

Putting nature back together isn't easy, but with careful stewardship and time, the foundation pieces that we reintroduce can integrate into a functioning system. We are not only replanting the five species of oaks that were removed during the Highway 12 construction, but we have added Oregon oak, California buckeye, and Pacific madrone to round out the future woodland canopy. To further increase habitat complexity, we are also investing in numerous understory species (Table 1). In total, we have added over 12,000 new plants in our restoration sites.

We developed our planting palette by carefully surveying the mature oak woodlands around each restoration site. These "reference plots" provided us with key information on plant composition and vegetation structure, which guided our framework for species diversity and spatial arrangement within the planting sites. In anticipation of natural mortality and failed germination, we introduced a higher number of plants per acre than found in the reference sites. By doing this, we also encouraged competition among individuals and crowded out unwanted species. We intentionally chose not to plant California bay, which serves as a vector for Sudden Oak Death infection.

To ensure that local genetics were maintained, we started all Project GROW plants from seeds or cuttings collected from the Bouverie Preserve or neighboring lands. We were particularly interested in rescuing plants represented by only a single or few small populations. For example, we included Mexican elderberry, which only occurs as a single tree in two locations on the Bouverie Preserve.

To maximize restoration success, we established a plant support system, including irrigation, herbivory protection, weed removal, and nursery propagation. According to the oak regeneration 'bible' of California, Regenerating Rangeland Oaks in California (McCreary 2001), a proper plant support system can result in 70–80% survival after the first two years after planting.

Digging In

Setting out with buckets, bags, and loppers, the Bouverie volunteers and staff collected acorns, buckeye seeds, vine cuttings, and piles of native plant seeds. Next, we sent thousands of seeds to the Martin Griffin Preserve, where nursery managers and volunteers propagated seedlings of 20 different species. After seedlings reached sufficient size, they were transported back to the Bouverie Preserve to acclimatize before planting.

Outfitted with trenching machines and augers, ACR staff pre-drilled 500 holes for acorn planting and dug several miles of shallow ditches for irrigation tubing. Coyotes, voles, and other wildlife have an affinity for chewing above-ground irrigation tubes, to access water in the dry summer months, so we laid all irrigation systems below ground. Each planting site was then fitted with spaghetti tubing to bring water to the surface and with a pressure-compensating emitter to ensure the correct water rate. Since planting, we have irrigated seedlings throughout the summer months using infrequent, slow-rate watering to encourage deep root development.

After the first soaking fall rains, we planted hundreds of acorns and buckeye seeds directly into the soil. Over each seed, we fitted a specially designed tree tube to protect its young shoots from browsing by deer, turkeys, and rodents and to act as a greenhouse to encourage growth (Figure 2). Each tube was then capped with a mesh net that prevented Western Bluebirds, Black Phoebes, and other insect-catching birds from diving down into the tube in search of a meal. We also planted 100 trees in sites where cattle are strategically used to remove annual grass thatch that can stifle oak germination. Because of the potential for heavy browsing and trampling there, we further protected these trees with heavy-duty five-foot-tall wire cages.

Laying out 50 three-meter square plots on the landscape, we planted a complementary mix of understory shrubs, vines, and herbaceous species in each plot. Since tender young plants are tempting for any browser and are sensitive to the elements, we surrounded each plot with six-foot-high mesh fencing, padded the ground with

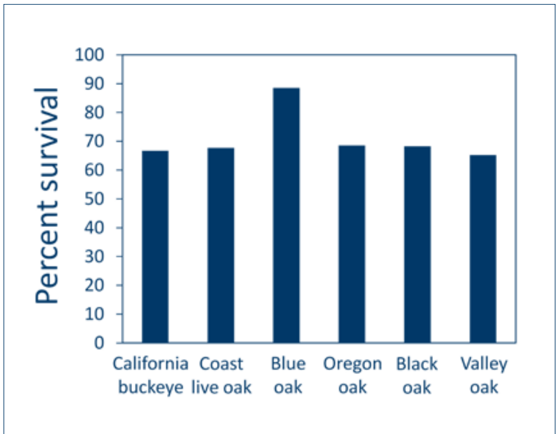

Figure 4. The percent survival of most tree species in the Project GROW restoration was 65–70% as of April 2013, with over 90% survival among blue oaks.

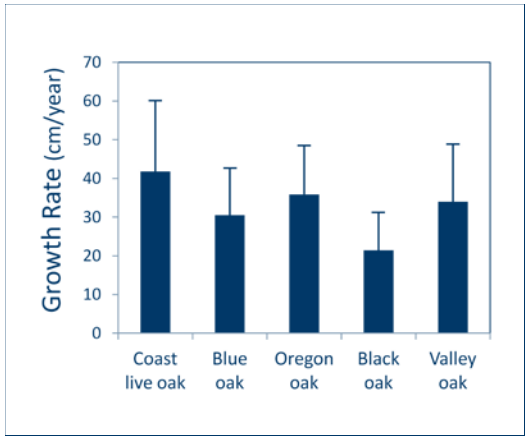

Figure 5. Growth rates (average cm growth per year ± standard deviation) of oak trees planted in Project GROW since 2010.

insulating straw mulch, and added shade cloth for the hot summer sun. Since native perennial grasses are much better adapted to cope with nature's elements, we did not need to add irrigation or herbivory protection for these species. With the help of Bouverie Stewards and Sonoma Valley High School students, we planted over 11,000 grass plugs at a density high enough to produce a sustaining native grassland understory.

Attracting good neighbors

Since it will take years and even decades to restore important mature oak woodland habitat elements, such as the overstory canopy, downed woody debris, and standing snags, we added habitat features that would serve as short-term "stand-ins" to invite wildlife into our restoration site. Using brush cuttings from around the Preserve, we created large brush piles to attract shelter-seeking and perch-seeking birds, rodents, and reptiles that play vital roles in our developing ecosystem.

We also built and installed 25 songbird nest boxes, which are now providing nesting sites and winter shelter for cavity-dependent species such as Western Bluebirds, Violet-green Swallows, Tree Swallows, and House Wrens (Figure 3). In each nesting season, the ACR staff, Bouverie Stewards, and volunteers collect data about species occupancy and breeding success. Our data are then shared with the Cornell Ornithology Lab's NestWatch Program, a citizen science database that collects breeding data from around the globe.

While it is one thing to attract good neighbors, we also need to keep our eye on harmful non-native plants that can affect the sustainability and health of our restored areas. Species high on our invasives list include purple velvet grass *(Holcus lanatus)*, yellow star thistle *(Centaurea solstitialis)*, tall wheatgrass *(Thinopyrum ponticum)*, and Himalaya blackberry *(Rubus armeniacus)*. Using GPS mapping, an assortment of weed removal techniques, and a weed tracking database, we established a seasonal weed management routine to monitor and remove these species.

Tracking our success

We have implemented monitoring protocols to track plant survival, plant growth, and bird nest box use, and established six permanent photopoints to document vegetation change. Over the last three years, we have assessed survival for all 542 planted trees (Figure 4). As of April 2013, 388 (72%) of the trees are healthy and surviving. Of those trees, 113 (29%) are taller than the four-foot tree tube that surrounds them and 38 (10%) are between five and seven feet tall. We also calculated average growth rates for a subsample of oak trees between 2010 and 2013 (Figure 5).

Looking forward, we are developing a long-term management plan that includes grazing, prescribed fire, and weed management to support further oak woodland establishment and regeneration. Our goal is to have self-sustaining oak woodland habitats in each of our five restoration sites within a decade, and we are committed to maintaining the oak trees in perpetuity.

Reaching beyond the field work

While the initial purpose of Project GROW is to restore habitat in eight acres of oak woodland, the approach is strongly based on the value of education, experiential learning, and community involvement. In the last four years, Project GROW has benefited from a broad range of volunteer groups, including the Bouverie Stewards and Bouverie Junior Naturalist (Juniper) programs; volunteers from Agilent Technologies, Medtronic, and JDS Uniphase; Santa Rosa Junior College and Sonoma State University class groups and interns; Conservation Corps North Bay's Project Regen (a teen environmental learning program); California Conservation Corps; and Summer Search youth (a leadership program for low-income Bay Area high school students). Sponsorship by the Southern Sonoma RCD has further enabled us to partner with the Center for Land-Based Learning's SLEWS Program (Student and Landowner Education and Watershed Stewardship), which links high school classes with restoration projects. With funding provided by the Community Foundation of Sonoma County, we are developing a learning curriculum with field-day experiences with the Hanna Boys Center, a school for at-risk teens in Sonoma Valley, under the new acronym, Project YES (Youth Environment Sonoma).

What stands out about the Project GROW volunteer experience is that we have been able to involve volunteers repeatedly, over time, so that they witness the rewards of their work. Cultivating an environmental ethic and providing hands-on learning opportunities for hundreds of people may perhaps be as valuable as the restoration field work itself.

References cited

California Department of Fish and Game (California Interagency Wildlife Task Group). 1996. CWHR version 5.0. Sacramento, CA.

Kueppers, L. M., M. A. Snyder, L. C. Sloan, E. S. Zavaleta, and B. Fulfrost. 2005. Modeled regional climate change and California endemic oak ranges. Proceedings of the National Academy of Sciences 102:16281-16286.

McCreary, D.D. 2001. Regenerating Rangeland Oaks in California. University of California Agriculture & Natural Resources Publication 21601.

Rizzo, D.M and M. Garbelotto. 2003. Sudden oak death: endangering California and Oregon forest ecosystems. Frontiers in Ecology and the Environment 1:197-204.

Jennifer Potts is a Resource Ecologist at ACR's Bouverie Preserve.

The status of Black-crowned Night-Herons in the northern San Francisco Bay area

Life on the Edge

by Emiko Condeso

Some herons
were fishing
in the robes
of the night…

from "Night Herons" by Mary Oliver

The Laguna de Santa Rosa, the largest freshwater wetland complex on the Northern California coast, is vibrant and green in late spring. Each evening, as the light dims, night-herons appear in the shallows. On this bright morning, I am crunching along through thick mats of *Ludwigia* with long-time ACR volunteers and local experts Lisa Hug and Denise Cadman, searching for undocumented Black-crowned Night-Heron *(Nycticorax nycticorax)* nesting sites among the willows. We know that night-herons feed in the Laguna and that they prefer to nest close to their foraging grounds. Recent observations of night-heron movements suggest that they may have established a new colony site, hidden somewhere in the thick wetland vegetation. New colonies can form at any time, so we are compelled to investigate.

The Black-crowned Night-Heron is one the five species of herons and egrets that are monitored annually as part of ACR's North Bay Heron and Egret Project. For the last 23 years, Audubon Canyon Ranch has been keeping tabs on all known colonially nesting herons and egrets in Marin, Sonoma, Napa, Solano, and Contra Costa counties, as well as in Central San Francisco Bay. This region is home to approximately 79% of the Bay Area's nesting Black-crowned Night-Herons (Figure 1), with the balance of nesting pairs concentrated in South San Francisco Bay (Kelly et al. 2007, Waterbirds 4:455–478). Black-crowned Night-Herons are one of the more challenging species to monitor, as the chicks mature quickly, requiring frequent visits to the heronry by volunteer observers. In addition, the nesting sites themselves can be difficult to detect. We do not know if we will find a new night-heron colony in the Laguna today, but such searches are a necessary part of the Heron and Egret Project.

Outside of the breeding season, the habits of night-herons make them less obvious than diurnal or day-herons (Davis, W.E., Jr. 1993, Birds of North America No. 74). As their name implies, these birds are more active at night, normally roosting quietly during the day (Figure 2). At the tail end of the nesting season, adult night-herons are more active during the day due to the need to frequently provision large chicks. If you are in the right neighborhood, you may see Black-crowneds flying toward their nesting colony for a feeding. The presence of streaky brown chicks in the area is a great tip-off that nesting is occurring nearby, as young birds tend not to stray too far from their nests (Figure 3). By the end of spring, nesting sites also tend to be fully decorated with accumulated guano on the trees or shrubs and on the ground below. As Lisa, Denise, and I make our way through the Laguna, we are looking for any or all of the above—adults, chicks, nest structures, or white-washed trees.

One of the challenges of long-term monitoring is making sure that the study area is "covered," with observers watching

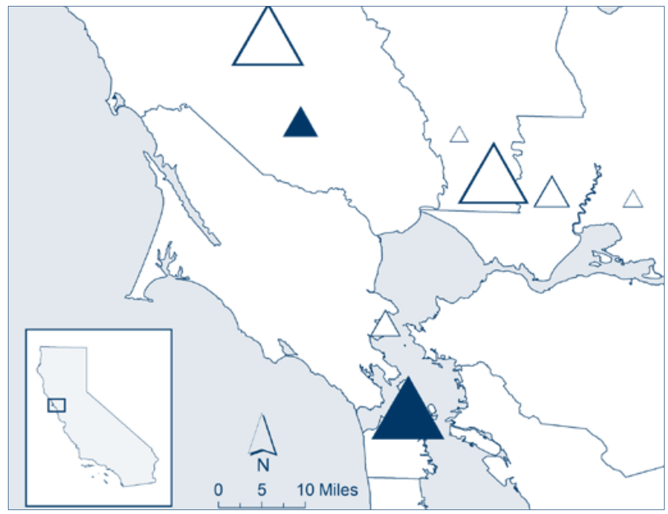

Figure 1. Black-crowned Night-Heron colonies in the northern San Francisco Bay area that were active in 2011. Symbol size represents the 2011 deviation of colony size from the 1991–2010 average. Colonies with open symbols were larger than their long-term average size; colonies with filled symbols were smaller than their long-term-average.

Figure 2. An adult Black-crowned Night-Heron. As the name suggests, night-herons are primarily active at dawn, dusk, and through the night. During the day they gather in communal roosts.

Figure 3. Young Black-crowned Night-Herons are brown with pale spots above and heavy streaking below.

LEN BLUMIN (L) RON WOLF (R)

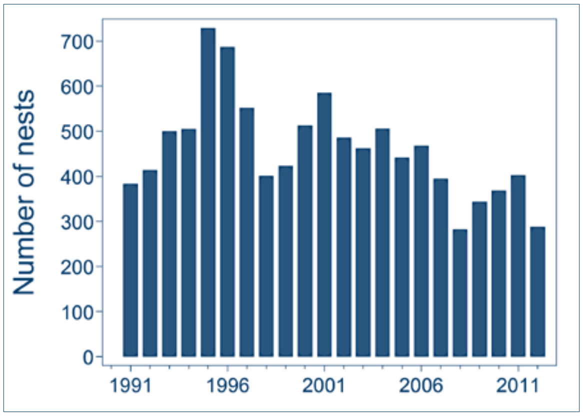

Figure 4. The peak number of active Black-crowned Night-Heron nests in the northern San Francisco Bay area, 1991–2012. The trend in (log) nest abundance since 1995 suggests an average annual decline of 3.8% (b = -0.039, P <0.001, n = 18).

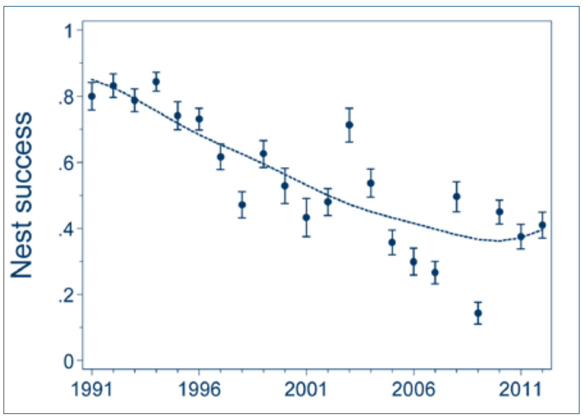

Figure 5. The estimated proportion of nests that survive each year to fledge at least one chick (±SE), based on samples of focal nests monitored in each colony. The dotted line represents a LOWESS (locally weighted) smoothing of the trend (f = 0.9). The linear trend from 1991 to 2012 suggests a long-term decline in nest success, with nests approximately 3% less likely to fledge at least one young, on average, in each successive year (b = -0.031, SE = 0.004, P < 0.001, n = 22; results controlled for differences among colony sites, nesting densities, and sampling intensity). However, after 2005, it is unclear if the nest survivorship continues to decline.

every known colony, and that we are aware of all of the major nesting sites in the region. We need both of these components reflected in our monitoring data to make reliable inferences about the status of the breeding population. For example, we have strong evidence that birds move between colonies among, and even within, years (Kelly et al. 2007, Waterbirds 4:455–478). We have documented that a decline in numbers at one site, often related to disturbance by nest predators or human activity, frequently coincides with increases at other colonies, often within a kilometer of the original site. So it is impossible to know the importance of an increase or decrease in abundance at a particular colony site without the context that regionwide monitoring provides.

We are increasingly aware of the potential importance of "missing" nesting sites. Our regional data have revealed a declining trend in the number of nesting pairs of Black-crowned Night-Herons in the North Bay since 1995 (Figure 4). Similarly, we have seen a regionwide downward trend in "nest success," measured as the proportion of nests that fledge at least one young. Black-crowned Night-Heron nests in the northern San Francisco Bay area were 3% less likely, on average, to fledge at least one young in each successive year, according to our findings from 1991–2012 (Figure 5). What does this mean for future abundances of nesting night-herons in our region or the status of their wetland habitat? At this point we know very little—only enough to inspire a general concern and encourage further investigation.

We do know that the trends we see are regional—they are not limited to a single or a small subset of the nesting colonies included in our study. However, the underlying cause of these trends is unknown, and the potential explanations are many. We also know that the brood sizes in successful nests show no evidence of decline, which suggests a clue to the mystery: the food supply and foraging habitat quality seem to consistently support normal broods, suggesting that the increasing rates of nest failure may reflect instances of complete nest loss, as expected from predation or other types of disturbance. Potential causes of disturbance could include nest predators (such as avian or mammalian predators), weather (changes in the pattern, intensity, or seasonality of wind or rain storms), and human disturbance (development, hazing, or activity near colonies). Any of these or other processes could be limiting nest survival.

We do not know whether the decline in regional nest abundance is related to the apparent decline in nest success. We must emphasize that these two trends may be unrelated—the decline in abundance may reflect other unknown processes, such as recruitment rates (new breeders choosing to nest in the region) or emigration rates (movement of juvenile or adult birds out of the region). There may also be unknown effects on the survival of juvenile or adult birds that could ultimately impact the abundance of nesting night-herons in the North Bay. Such effects might include the impacts of weather, parasites, disease, or pollutants in the environment.

The scientific method requires all likely hypotheses to be disproven before a reasonable explanation can be supported. ACR's long-term monitoring effort strengthens our ability to explore potential explanations for the apparent decline. However, more immediate actions may also be required. Even though we do not yet know the drivers of these trends and cannot exclude the possibility of a natural recovery of regional night-heron nesting activity, the declining status of these birds should not be ignored. We believe that land-owners and managers of areas used by night-herons should take a precautionary approach to any actions that may put further stress on the nesting birds

Unlike the Great Egret, the Black-crowned Night-Heron is not the graceful, long-legged "poster child" that we have come to think of as a symbol for wetland conservation. However, they are amazing birds in their own right and are potentially just as powerful an indicator of wetland health. They may, in fact, be the most sensitive ardeid in the Bay Area, in terms of how readily their breeding population responds to changes in their environment.

When our morning search on the Laguna came to an end, we had not found any new Black-crowned Night-Heron nesting sites. Although the Laguna seems like an ideal place for them to nest, it is clear that we do not have a perfect understanding of how these birds perceive the world. What is it that indicates to the night-herons that a place is suitable for nesting? How do they measure their chances for success at a given location? We have much to learn about the ecological processes that influence Black-crowned Night-Heron populations. At ACR we continue to search for answers about these birds by following the volatile dynamics of their nesting activity, as they live life on the edge.

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

Photo Index at Modini and Mayacamas Preserves

Using Cameras to Understand Wildlife

by Sherry Adams and Susan Townsend

A new research project in the central Mayacamas Mountains promises to shed light on key questions in regional conservation in northern Sonoma County. How abundant are mountain lions at the Modini Ingalls Ecological Preserve? What about black bears in the Mayacamas Mountains Sanctuary? How many different medium-to-large animals are found on these preserves? Is gray fox abundance fluctuating, decreasing, or staying the same? Is there a connection between the abundance of feral pigs and mountain lions? What habitats on the preserves support bobcat? Do local wildlife species at these ACR preserves occur at different rates than in similar habitat 10 miles to the south?

Audubon Canyon Ranch recently teamed up with researcher Susan Townsend and the Pepperwood Preserve to install a grid of motion-detection cameras across our Modini and Mayacamas Preserves (Figure 1). Pepperwood is an independent nature preserve 10 miles from ACR's new preserves in the central Mayacamas Mountains. Pepperwood's mission is similar to ACR's, and we consider its staff to be important partners and allies in the conservation work of the region. In this collaboration, we are relying on an internationally recognized methodology known as Wildlife Photo Index (WPI). This landscape-level monitoring method combines the use of camera stations with statistical modeling of "occupancy" to watch for trends in wildlife use.

A major benefit of using cameras to detect animals is that a human is only at the site for a brief time each month to change batteries and memory cards. The rest of the time, the impact of human presence does not bias the chances of detecting the animal. Another benefit of using cameras is that animals are not stressed by direct handling. In addition, the field work can be conducted by people who are not experts in animal identification.

Occupancy: the probability that a site or patch is occupied by a particular species.

TOM REYNOLDS

Figure 1. Susan Townsend (left) trains volunteers Ginny Fifield and Ken-ichi Ueda on camera installation and maintenance. Camera set-up is carefully standardized. For example, Dr. Townsend has found that adding metal such as a T-post or cage can alter animal behavior, so cameras are installed on wooden stakes.

In contrast, estimating the population size of a species has often been conducted using methods such as mark/recapture. In this method, individual animals must be captured, accurately identified, marked, and recaptured during a later visit; animal abundance is then calculated from the number of marked individuals that are recaptured. Estimating species' abundances using such labor-intensive methods can be expensive, as it typically requires trained biologists to conduct all of the field work. Furthermore, such studies may suffer from poor accuracy, due to unknown differences in the probability of detection or a lack of precision because of unexplained variation in the number of animals counted.

Recent advances in quantitative ecology have enabled ecologists to more accurately account for differences in detectability among species, times, and places, using techniques such as occupancy modeling. This method uses presence/absence data—a record of whether a species is detected or not in a given time and place. This sort of data can help us to better understand ecosystem interactions when multiple species are involved. Estimates of wildlife use derived from occupancy modeling account for the fact that an animal may be present but not detected.

PHOTOS: BOUVERIE PRESERVE/ACR

Figure 2. Motion-detection camera images (top to bottom) of mule deer, coyote, and mountain lion at Modini Ingalls Ecological Preserve.

Occupancy estimates have widespread applications in resource management. For example, if we are interested in California tiger salamander in vernal pools of the Santa Rosa plain, data that record the pools where they are detected over several years can be used to estimate occupancy rates. Another example of an application of occupancy modeling would be comparing estimates of Spotted Owl and Barred Owl in areas repeatedly surveyed through time across different habitats. This could be used to better understand how these animals may be interacting with each other and their environment. If Barred Owls are successfully outcompeting Spotted Owls, one would expect Barred Owl occupancy to increase over time with a corresponding decrease in Spotted Owl occupancy. Alternatively, such a study might reveal that certain habitats support both species with relatively consistent rates of occupancy over time.

The camera grid

Working with Dr. Townsend, biologists at Pepperwood have established a 20-km^2 grid of cameras installed at 1-km intervals across their preserve using the WPI protocol. We are excited to collaborate with them on expanding the WPI project in the region to include a grid of 20 cameras just installed across the Modini-Mayacamas Preserves. In addition, our neighbors Dick and Mary Vandlen have chosen to be a part of this work, hosting several cameras on their property, helping extensively during the installation phase, and volunteering to maintain the cameras on their property.

Our camera grid is a long-term project for monitoring change in biodiversity. We think an important application of these data is to track changes over time. Natural systems are dynamic, and species are influenced by variations in many physical and biological processes. A long-term study such as this one has the potential to shed light on the effects of some of those processes. For example, Modini Land Steward Tomas Ruiz records rainfall data at the preserve, and this record may explain some of the variability in the occupancy rate of certain animals between years.

In addition to the exciting prospect of better understanding the preserves, this work has the potential to inform regional conservation questions. Consider the challenge of protecting habitat connectivity across a landscape. The idea is that we have some relatively large chunks of land that are not developed and, in these areas, certain wildlife species will be able to complete some or all of the components of their life cycle. But to avoid inbreeding and other implications of genetic isolation, or to compensate for patches that do not meet all of the needs of a species, regional conservation planners work to connect these "core" areas using "corridors." In many cases, corridors are not expected to provide more than a passageway for animal transit. For example, they may not provide a food source or breeding habitat, but as a route of safe passage between a food source and breeding habitat, a corridor may provide a crucial linkage for that species.

While the conservation planning involved with these important connectivity issues must operate at a large scale, it needs to be informed by on-the-ground observations. Are the animals using the areas we think they are? By expanding the Wildlife Photo Index work onto ACR lands, we will be collecting and sharing wildlife "observations" that have the potential to enhance conservation planning throughout the central Mayacamas region.

Habitat connectivity: the extent to which a landscape functions as an ecological network, facilitating animal movement, migration, colonization, and geographic shifts in plant and animal populations in response to climate change.

Acknowledgements: This project would not be possible without the support of The Pepperwood Preserve, Sonoma County Agricultural Preservation and Open Space District, the Sonoma County Fish and Wildlife Commission, and Dr. Susan Townsend's generous donation of her time. Thank you to all of the wonderful volunteers who make this project possible.

Sherry Adams is the Preserve Biologist and Manager at Modini Ingalls Ecological Preserve and Mayacamas Mountains Sanctuary.

Susan Townsend is a wildlife biologist who has extensive experience with camera traps.

A brief review of boating disturbance to waterbirds in California estuaries

Collateral Damage

by John P. Kelly and Jules G. Evens

Every living being exhibits a mysterious mixture of tolerance and sensitivity in relating to the surrounding world. Human interactions with nature, throughout history, seem confounded by this mystery, often failing to determine or even consider how much, how close, or how often an activity can be implemented without harm. An extensive scientific literature confirms that the nearly ubiquitous use of motorized boats in coastal waters frequently exceeds the tolerances of other species, imposing potentially important threats to the conservation of wintering and migrating waterbirds (e.g., Kaiser and Fritzell 1984, Burger 1998, Davidson and Rothwell 1993, Madsen 1994, Galicia and Baldasserre 1997, Loong 2002, Takekawa 2008, Borgmann 2010). Mathews (1982) studied water-based recreation in Britain and ranked motorized boating as the greatest disturbance to wintering waterfowl, followed by sailing, wind-surfing, rowing, and canoeing.

Local and regional conservation plans in coastal California acknowledge the adverse effects of boat disturbance to waterbirds, but the impacts are poorly documented and practical management objectives remain out of reach (PRBO Conservation Science and the San Francisco Bay Joint Venture 2004, Shuford 2011, Pitkin and Wood 2011, Gulf of the Farallones National Marine Sanctuary et al. 2013). Nonetheless, a careful look at boating disturbance may reveal opportunities for making simple adjustments in current management or, even more simply, avoiding new activities likely to increase collateral damage.

ACR PHOTO

Figure 1. Waterbird disturbance by ACR's survey boat on Tomales Bay, where boat traffic is relatively light. Increases in the use of motorized boats can threaten the energy needs, migratory behavior, and local status of waterbirds through repeated interruptions of their foraging activities.

Table 1. Recommended buffer distances needed to protect non-breeding waterbirds from disturbance by an approaching kayak, based on disturbance trials (n) conducted in San Francisco Bay (ARA 2009).

	Trials (n)	Response[a] Mean ± SD	Flush distance Mean[b] (m)	Recommended buffer distance[c] (m)
Scaup species	30	4.5 ± 0.55	94	271
Surf Scoter	37	4.1 ± 0.76	61	254
Greater Scaup	31	4.6 ± 0.43	99	242
Red-breasted Merganser	13	3.3 ± 1.14	28	219
Common Loon	16	3.9 ± 0.76	51	218
Double-crested Cormorant	23	4.1 ± 0.63	61	213
Ruddy Duck	56	4.1 ± 0.62	60	209
Lesser Scaup	16	3.9 ± 0.70	51	202
Canada Goose	19	4.0 ± 0.60	54	186
Bufflehead	51	4.1 ± 0.56	58	185
Clark's Grebe	23	3.7 ± 0.67	41	164
Common Goldeneye	24	3.6 ± 0.72	37	163
Western Grebe	30	3.7 ± 0.65	40	156
Horned Grebe	37	3.2 ± 0.78	24	126
American Coot	28	3.2 ± 0.62	24	107
Mallard	19	2.9 ± 0.53	18	83

[a]Mean ± standard deviation of log-transformed flush distance (m)
[b]Back-transformed mean of (log) distance
[c]Upper 0.95 standard normal deviate of flush distances + 40 m.

Tomales Bay waterbird surveys

ACR's ongoing surveys of loons, grebes, cormorants, ducks, and other waterbirds on Tomales Bay, conducted three to four times each winter since 1989 (Kelly and Tappen 1998), offer a glimpse into the consequences of waterbird disturbance by motorized boats (Figure 1). Each survey involves a team of 16 to 18 highly proficient birders riding on three motorized boats in a systematic effort to count every bird on the bay. This is no simple task, as parts of the bay are often jammed by spectacular concentrations of avian life. Baywide numbers often top out at 35,000 waterbirds, not including gulls or shorebirds, of more than 50 species—counted at distances of up to a quarter mile on seas that, even when relatively flat, can conceal the presence of small grebes or other birds.

To effectively count the waterbirds on Tomales Bay, we must avoid forcing them into the air; that results in a beautiful but confusing mayhem and causes considerable risk of counting birds twice when they fly to other areas in the bay. Peregrine Falcons often follow fast-moving boats, using them as mobile blinds from which they launch attacks on ducks fleeing from the boat disturbances. Even at slower speeds, however, our survey boats can disrupt waterbirds' foraging activities, their use of important feeding areas, and other behaviors that may be necessary for their continuing use of the bay. So we creep along our standard transects at about four knots, often slowing to count heavy concentrations of birds. In spite of this cautious survey effort, some waterbirds flush ahead of the boats. To more accurately measure the natural (undisturbed) feeding distributions of waterbirds, we use an elaborate method of accounting for birds that fly ahead of the boats into other sections of the bay. During these baywide cruises, we occasionally witness the effects of disturbance by other motorized boats and human activities.

In contrast to most other coastal lagoons and estuaries in California, Tomales Bay has surprisingly little boat traffic. However, areas used by waterbirds and boats are often the same, leading to alternating (interrupted) use by birds. Published evidence strongly suggests that estuarine birds may be seriously affected by even occasional disturbance during key parts of the feeding cycle. For example, when American Wigeon, an abundant duck species in many California estuaries, are flushed from eelgrass *(Zostera maritima)* feeding areas, they will abandon the area until the next tidal cycle, unless the disturbance occurs early in tidal feeding period (Fox et al. 1993). Similar disturbance events are conspicuously revealed by Brant (small marine geese), which frequently lift into large flocks that signal distributional shifts limiting their access to eelgrass foraging areas (Henry 1984, Stock 1993; see sidebar below).

Disturbance trials in San Francisco Bay

In a collaborative study with colleagues at Avocet Research Associates (ARA 2009), we measured the disturbance behaviors of waterbirds in San Francisco Bay. Our

Model Species: Migrating and Wintering Brant

Brant *(Branta bernicla)* are small marine geese that provide an appropriate model for minimizing disturbance to waterbirds because they are less tolerant of human activity than smaller species. They form large, easily provoked flocks and, as game birds, are especially sensitive to anthropogenic disturbance (Reed et al. 1998, Rodgers and Schwikert 2002, Takekawa et al. 2008). "Black" Brant *(B. b. nigricans),* the Pacific Coast subspecies of Brant, is a California Bird Species of Special Concern (Davis and Deuel 2008). Well over a thousand Brant winter on Tomales Bay, increasing to migratory peaks of nearly 5,000 each spring (ACR, unpublished data). Similar migratory peaks occur in Morro Bay, and numbers of staging Brant in Humboldt Bay may exceed 25,000 (Davis and Duel 2008). However, these abundances underestimate their use of California estuaries, because over 130,000 Brant depend on the network of coastal refueling sites as they wing northward each spring, from wintering areas in Mexico and California to their arctic breeding areas (Pacific Flyway Council 2002, Davis and Duel 2008).

Brant in flight.

COURESY MIKE YIP / WWW.VANCOUVERISLANDBIRDS.COM

Brant are obligate feeders on eelgrass *(Zostera marina),* and their survival and reproductive fitness is determined largely by their access to this primary forage plant (Reed et al. 1998). Recent increases in numbers of wintering Brant (Davis and Deuel 2008) have been attributed to a long-term reduction in disturbance (Moore and Black 2006) and the more recent recovery of eelgrass habitats along the California Coast (Unitt 2004). However, traditional wintering areas in Mexico have been subjected to intensive development and hunting disturbance, severe enough to drive wintering Brant offshore into nearby ocean waters (Smith et al. 1989). Therefore, local increases in California might reflect the movement of birds away from degraded wintering areas in Mexico, and the relative importance of non-urbanized, low-disturbance habitat along our coast. However, the reasons for recent abundance shifts by Brant remain unknown.

Sources of human disturbance that adversely affect Brant include motorized boats, kayaks, jet skis, wind surfing, recreational and commercial shellfish harvest, fishing, commercial and residential development, and even the development of trails (Pacific Flyway Council 2002). To safely avoid disturbance to Brant, motorized boats would have to operate no closer than a few hundred meters or more from intensively used habitat areas (Laursen et al. 2005). Disturbance to Brant during winter and staging is of particular concern because it can negatively affect their ability to build energy reserves for migration and breeding. This can, in turn, lower their reproductive success (Henry 1980, Derksen and Ward 1993, Reed et al. 1998, Ward et al. 2005), and limit or reduce population growth (Pacific Flyway Council 2002).

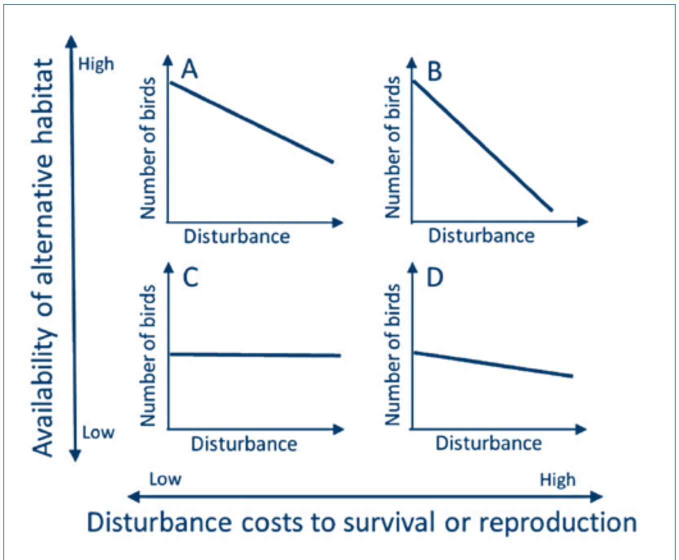

Figure 2. Four scenarios regarding disturbance effects on waterbird abundance (adapted from Gill et a. 2001). If alternative (undisturbed) feeding or roosting habitat is available (A and B), individuals move away from disturbed sites. Similarly, if the costs to survival or reproductive potential are high (B and D), birds move away from disturbed sites. If a lack of alternative habitat forces waterbirds to remain in disturbed areas in spite of increasing disturbance, the number of waterbirds may remain relatively stable (C), but increasing costs to their survival or reproduction may create an "ecological trap."

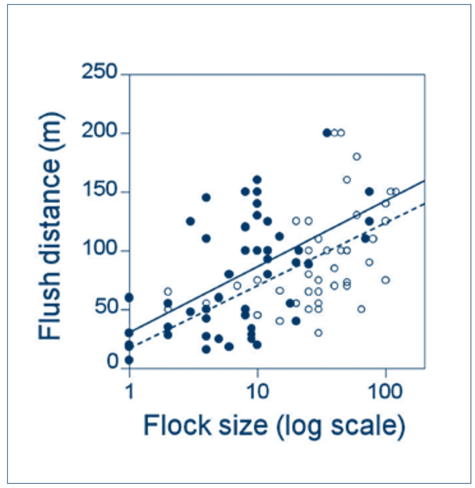

Figure 3. Waterbird disturbance trials in Berkeley's Eastshore State Park, San Francisco Bay, revealed that larger waterbird flocks flush at greater distances than smaller flocks in response to an approaching kayak (Surf Scoter: solid circles, solid line; Greater Scaup: open circles, dashed line; ARA 2009). Disturbance distances are likely to be substantially greater in locations with extensive waterbird use, such as Tomales Bay, where birds form much larger flocks and are subject to interference by motorized boats.

results showed that many waterbird species require long distances just to avoid interference by an approaching kayak (Table 1). It seems clear that far greater buffer distances would be needed to avoid disturbance by motorized boats. Hume (1976) found that Common Goldeneyes were especially sensitive, flushing from their positions when motor boats came within 350–720 m. Obviously, ensuring this level of protection would be difficult or impossible in most urbanized estuaries. On a practical level, the effective protection of wintering or migrating waterbirds from direct disturbance by boats in coastal California may depend on opportunities for conservation planning in relatively undisturbed waters, such as Tomales Bay.

Avian responses to human disturbance, or "habitat intrusion," are analogous to their responses to predators. In waterbirds, escape flight ("flushing") is the most observable response to disturbance, but prior to taking flight waterbirds often swim, above or below the surface, to keep a safe distance from boats. In addition, other more subtle behavioral or physiological responses may precede this escape response, including "head alerts," reduced feeding rates, the production of stress hormones, and increased heart rates (Tarlow and Blumstein 2007). Each of these subtle responses exacts an energetic cost. For this reason, following procedures used by Rodgers and Schwickert (2003), we calculated buffer distances needed to (1) protect birds from at least 95 percent of the expected flushing responses and (2), by adding 40 m to the recommended distances, avoid physiological or behavioral stress before birds actually flush (Table 1).

Numerous studies document that waterbirds compensate for increased levels of disturbance either by increasing their food intake, to balance the energetically expensive flight responses, or by flying to other less profitable but less disturbed areas to feed (Tuite et al. 1983, Knapton et al. 2000; Figure 2). Repeated flushing during winter may prevent waterbirds from accumulating enough fat and protein reserves to override periods of low food availability, prepare for migration, and/or store energy needed for breeding (Ward and Andrews 1993, Galicia and Baldassarre 1997, Kelly et al. 2002). Disturbance-related energy costs may even delay migration and arrival in the breeding grounds and, ultimately, reduce reproductive success (Owen and Reinecke 1979, Schummer and Eddleman 2003). If waterbird feeding opportunities are already limited, increased disturbance may lead to abandonment of the area, lower reproductive success, or even starvation (Davidson and Rothwell 1993, Baldassarre and Bolen 1994).

Habituation is unlikely

Some species of birds may "habituate" to human activity, lowering their sensitivity to interference (Nisbet 2000, Whittaker and Knight 1998, Chatwin et al. 2013). However, the biology of wildlife habituation, which is concerned with potential declines in the responses of individuals to repeated stimuli, is frequently misunderstood and used inappropriately to explain how animals respond to humans (Bejder et al. 2009). Apparent "habituation" may simply reflect differences in the tolerances of different waterbird species or individuals to different stimuli in different times, locations, or other ecological contexts (Burger 1981). In our study in San Francisco Bay, we found no trends in the responses of waterbirds to repeated disturbance during winter and, therefore, no evidence of habituation (ARA 2009). In fact, scientific evidence is lacking to support predictions that wintering and migrating waterbirds might habituate to disturbances by motorized boats (Banks and Rehfisch 2005, Burger and Gochfeld 1991). The absence of a substantial capacity for habituation by wintering or migrating waterbirds is further supported by evidence that waterbirds react to disturbances by boats by flushing at similar distances in different areas (Rodgers and Smith 1997, Rodgers and Schwikert 2002, Takekawa et al. 2008, ARA 2009, Borgmann 2010). In contrast to predictions of habituation, waterbirds exposed to repeated disturbance by motorized (or non-motorized) boats are more likely to decrease their feeding rates, expend more energy on vigilance, and decline in abundance (Figure 1; Hume 1976, Skagen et al. 1991; Pfister et al. 1992; Burger and Gochfeld 1998, Robinson and Cranswick 2003).

The challenge of protection

Rodgers and Schwikert (2002) recommended that the size of protected areas used by mixed-species assemblages should be based on the largest flush distances of the most sensitive species and allow for the increased sensitivity of larger flocks. The results of our disturbance trials in San Francisco Bay are consistent with this recommendation (Figure 3). Mori et al. (2001) provided similar support and, in addition, found that flushing distances also increased with species diversity. Based on our results from San Francisco Bay and available information from other investigators, we recommend a minimum buffer zone of 250 meters as a general, "one-size-fits-all" guideline to protect high-use waterbird areas from disturbance by non-motorized boats—but substantially larger buffer zones would be necessary to protect important waterbird areas from disturbance by motorized boats. Given this, our remaining coastal wetlands of special value to waterbirds (e.g., sites recognized by the Ramsar Convention on Wetlands of International Importance) are worthy of increased protection if they are to remain viable habitats for waterbirds.

References cited

ARA (Avocet Research Associates). 2009. North Basin Waterbird Study, Eastshore State Park, Berkeley, California: 2004–2007. Prepared for the California Department of Parks and Recreation, Eastshore State Park. 30 September 2009.

Baldassarre, G. A., and Bolen, E. G. 1994. Waterfowl Ecology and Management. John Wiley & Sons, Inc. New York.

Banks, A. N, and M. M. Rehfisch. 2005. Overwintering waterbirds and waterskiing at Dosthill Lake. The British Trust for Ornithology, Thetford, Norfolk, UK.

Bejder, L.,A. Samuels, H. Whitehead, H. Finn, and S. Allen. 2009. Impact assessment research: use and misuse of habituation, sensitization and tolerance in describing wildlife responses to anthropogenic stimuli. Marine Ecology Progress Series 395:177–185.

Borgmann, K. L. 2010. A Review of Human Disturbance Impacts on Waterbirds. Audubon California, 376 Tiburon, California 94920.

Burger, J. 1981.The effect of human activity on birds at a coastal bay. Biological Conservation. 21:231–241.

Burger, J. 1998. The effects of motor boats and personal watercraft on flight behavior over a colony of Common Terns. Condor 100:528–534.

Burger, J., and M. Gochfeld. 1991. Human distance and birds: tolerance and response distances of resident and migrant species in India. Environmental Conservation 18:158–165.

Burger, J., and M. Gochfeld. 1998. Effects of ecotourists on bird behaviour at Loxahatchee National Wildlife Refuge, Florida. Environmental Conservation, 25:13–21.

Chatwin, T., A. R. Joy, and A. F. Burger. 2013. Set-back distances to protect nesting and roosting seabirds off Vancouver Island from boat disturbance. Waterbirds 36:43–52.

Davidson, N. C. & P. I. Rothwell. 1993. Disturbance to waterfowl on estuaries: the conservation and coastal management implications of current knowledge. Wader Study Group Bulletin 68:97–105.

Davis, J. N. and B. E. Deuel. 2008. Brant *(Branta bernicla)* in Shuford, W. D., and Gardali, T., editors. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Derksen, D.V. and D. H. Ward. 1993. Life history and habitat needs of the Black Brant. Fish and Wildlife Leaflet 13.1.15

Fox, A. D., Bell, D. V., and Mudge, G. P. 1993. A preliminary study of the effects of disturbance on feeding wigeon grazing on eel-grass *Zostera.* Wader Study Group Bulletin 68: 67–71.

Galicia, E., and G. A. Baldassarre. 1997. Effects of motorized tour boats on the behavior of non-breeding American flamingos in Yucatan, Mexico. Conservation Biology 11:1159–1165.

Gill, J. A., K. Norris, and W. J. Sutherland. 2001. Why behavioral responses may not reflect the population consequences of human disturbance. Biological Conservation 97:265–268.

Gulf of the Farallones National Marine Sanctuary, California State Lands Commission, and the Tomales Bay Interagency Committee. 2013. Tomales Bay Vessel Management Plan. http://farallones.noaa.gov/eco/tomales/tomales.html

Henry, W. 1980. Populations and behavior of black brant at Humboldt Bay, California. MS Thesis, Humboldt State University.

Hume, R.A. 1976. Reactions of goldeneyes to boating. British Birds 69:178–179.

Kaiser, M., and E. Fritzell. 1984. Effects of river recreationists on green-backed heron behavior. Journal of Wildlife Management 48:561–567.

Kelly, J. P., N. Warnock, G. W. Page, and W. W. Weathers. 2002. Effects of weather on daily body mass regulation in wintering Dunlin. Journal of Experimental Biology 205:109–120.

Kelly, J., and S. Tappen. 1998. Distribution, abundance, and implications for conservation of winter waterbirds on Tomales Bay, California. Western Birds 29:103–120.

Knapton, R. W., S. A. Petrie, and G. Herring. 2000. Human disturbance of diving ducks on Long Point Bay, Lake Erie. Wildlife Society Bulletin 28:923–930.

Loong, D. 2002. Impacts of motorized watercraft on the aquatic birdlife of Ross River and Ross Dam: a literature review. Australian Center for Tropical Freshwater Research, James Cook University, Townsville QLD. Rpt. No. 02/02.

Mathews, G. V. T. 1982. The control of recreational disturbance. In D. A. Scott, ed., Managing Wetlands and their Birds. Proceedings 3rd Technical Meeting on Western Palearctic Migratory Bird Management, Biologische Station Rieselfelder Münster, Germany.

Madsen, J. 1994. Impacts of disturbance on migratory waterfowl. Ibis 137:567–574.

Moore, J. E., and J. M. Black. 2006. Historical changes in Black Brant *Branta bernicla nigricans* use on Humboldt Bay, California. Wildlife Biology 12:151–162.

Mori, Y. N. S. Sodhi, S. Kawanishi, and S. Yamagishi. 2001. The effect of human disturbance and flock composition on the flight distances of waterfowl species. Journal of Ethology 19:115–119.

Nisbet, I. C. T. 2000. Disturbance, habituation, and management of waterbird colonies. Waterbirds 23: 312–332.

Owen, R. B., and K. J. Reinecke. 1979. Bioenergetics of breeding dabbling ducks. Pp. 71–74, in T. A. Brookhout, ed., Wildfowl and Wetlands—an Integrated Review. La Crosse Printing, La Crosse, Wisconsin.

Pacific Flyway Council. 2002. Pacific Flyway management plan for Pacific Brant. Pacific Flyway Study Committee. U.S. Fish & Wildlife Service, Department of Migratory Bird Management, Portland, OR.

Pfister, C., B. A. Harrington, and M. Lavine. 1992. The impact of human disturbance on shorebirds at a migration staging area. Biological Conservation 60:115–126.

Pitkin, M. and Wood, J. (Editors). 2011. The State of the Birds, San Francisco Bay. PRBO Conservation Science and the San Francisco Bay Joint Venture.

PRBO Conservation Science and the San Francisco Bay Joint Venture. 2004. Conservation Objectives for the San Francisco Bay Estuary as outlined in the planning documents of North America's major Bird Conservation Initiatives. www.sfbayjv.org

Reed, A., D. H. Ward, D. V. Derksen and J. S. Sedinger. 1998. Brant *(Branta bernicla),* The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America. **http://bna.birds.cornell.edu/bna/species/337**

Robinson, J. A., and P. A. Cranswick. 2003. Large-scale monitoring of the effects of human disturbance on waterbirds: a review and recommendations for survey design. Ornis Hungarica 12–13:199–207.

Rodgers, J. A., and H. T. Smith. 1997. Buffer zone distances to protect foraging and loafing waterbirds from human disturbance in Florida. Wildlife Society Bulletin 25:139–145.

Rodgers, J. A. and S. T. Schwikert. 2002. Buffer-zone distances to protect foraging and loafing waterbirds from disturbance by personal watercraft and outboard-powered boats. Conservation Biology 16:216–224.

Schummer, M. L., and W. R. Eddleman. 2003. Effects of disturbance on activity and energy budgets of migrating waterbirds in South-central Oklahoma. Journal of Wildlife Management 67:789–795.

Shuford. W. D. 2011. The Coastal California (BCR 32) Waterbird Conservation Plan. PRBO Conservation Science.

Skagen, S. K., R. L. Knight and G. H. Orians. 1991. Human disturbances of an avian scavenging guild. Ecological Applications 1: 215–25.

Smith, L. M., R. L. Pederson, and R. M. Kaminski. 1989. Habitat Management for Migrating and Wintering Waterfowl in North America. Texas Tech University Press, Lubbock, TX.

Stock, M. 1993. Studies on the effects of disturbances on staging Brent Geese: a progress report. Wader Study Group Bulletin 68:29–34.

Takekawa, J., J. Evens, K. Lafferty. 2008. Waterbirds and Human Disturbance in Urbanized Areas. http://www.sfbayjv.org/pdfs/disturbancereview061908c.pdf

Tarlow, E. M., and D. T. Blumstein. 2007. Evaluating methods to quantify anthropogenic stressors on wild animals. Applied Animal Behaviour Science 102:429–451.

Tuite, C., M. Owen, and D. Paynter. 1983. Interactions between wildfowl and recreation at Llangorse Lake and Talybont Reservoir, South Wales. Wildfowl 34:48–63.

Unitt, P. 2004. San Diego County Bird Atlas. Proc. San Diego Soc. Nat Hist. 39.

Ward, D. and J. Andrews. 1993. Waterfowl and recreational disturbance on inland waters. British Wildlife 4:221– 229.

Ward, D. H., A. Reed, J. S. Sedinger, J. M. Black, D.V. Derksen, and P. M. Castelli. 2005. North American Brant: effects of changes in habitat and climate on population dynamics. Global Change Biology 11:869–880.

Whittaker, D., and R. L. Knight. 1998. Understanding wildlife responses to humans. Wildlife Society Bulletin, 26:312–317.

John Kelly is the Director of Conservation Science at Audubon Canyon Ranch.

Jules Evens is a long-term Research Associate of Audubon Canyon Ranch, author of The Natural History of the Point Reyes Peninsula *and* Introduction to California Birdlife *(both UC Press), and founder and Principal of Avocet Research Associates, in Point Reyes Station, California.*

Seeing Nature First: Rich Stallcup

When Rich Stallcup died, in December of 2012, Audubon Canyon Ranch lost a very dear friend, teacher, and long-time collaborator. Rich's celebrated gift for sharing personal connections with nature embodied the spirit of ACR. His generous way of bringing nature to people closely modeled ACR's vision—to develop a community of people who love the wonder and beauty of the natural world (because people will protect what they love).

As an ACR Research Associate, Rich collaborated on many projects, coauthored numerous reports and publications, and provided helpful advice that always put nature first. Over 30 years ago, when helping to mobilize our work to restore avian habitat values in Olema Marsh, Rich told ACR that the effort would fulfill "a fundamental and spiritual obligation to revitalize this precious spot." Based on this view of our mission, he continued to bring his unparalleled talent for perceiving the most subtle elements and processes in nature to much of ACR's work. He tracked bird responses to habitat restoration, helped design and conduct our long-term shorebird and waterbird monitoring projects in Tomales Bay, collaborated on the protection of Bay Area heronries, helped measure the effects of mariculture on shorebirds, provided key field observations used in public conservation planning, and advised us on difficult challenges in preserve management, such as the protection of ACR's heron and egret nesting colony from nest predatory ravens.

PHOTO COURTESY WEBB JOHNSON

Rich Stallcup shows a small salamander to participants in one of his beloved natural history outings.

Rich's legendary field seminars, which introduced thousands of people to countless detailed and inspiring aspects of nature, included many offerings at ACR. His warm and wise presence was often a turning point in how people at ACR relate to science and nature, moving them, in turn, to share their love of the natural world with others. We miss Rich's company but continue to be inspired by his life's work. Thank you Rich!

—*John Kelly*

Visiting investigators

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

Survival of wild adult female harbor seals (Phoca vitulina) *in San Francisco and Tomales Bays, California*. Susanne Manugian, Moss Landing Marine Laboratories.

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

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

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

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

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

In Progress:
project updates

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

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

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

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

North Bay Counties Heron and Egret Project. ◗ Annual monitoring of all known heron and egret nesting colonies in five northern Bay Area counties began in 1990. ACR's 250-page regional atlas of heronries in the San Francisco Bay Area is available online (**http://www.egret.org/atlas**) along with an updated Google-Earth program showing the locations and status of individual heronries (**www.egret.org/googleearthheronries**). We are currently working on the effects of climate change on regional nesting abundances and the effects of colony-site disturbance on nesting distributions.

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

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

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

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

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

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

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

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

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

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

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

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

Project GROW. ◗ Gathering to Restore Oak Woodlands (GROW) is a partnership between ACR and the Southern Sonoma County Resource Conservation District to restore eight acres of oak woodlands at the Bouverie Preserve. Community members and Sonoma Valley High School students have helped plant five species of oak trees, thousands of native grass individuals and hundreds of native understory plants. Habitat enhancements include installing brush piles and nest boxes to support wildlife.

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

Trail Improvements at Bouverie Preserve. ◗ We worked with volunteers and the Sonoma County Trails Council to enhance trails, installing rolling grade dips, building a rock causeway, and improving handicap access, and to prevent sediment from entering Stuart Creek.

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

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

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

PRESERVATION EDUCATION SCIENCE

NON-PROFIT
U.S. POSTAGE
PAID
PETALUMA, CA
PERMIT NO. 201

THE ARDEID

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

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

Managing Editor, John Kelly. Layout design by Claire Peaslee. | www.egret.org

Conservation Science
and Habitat Protection
at Audubon Canyon Ranch

AUDUBON CANYON RANCH PROTECTS NATURE THROUGH LAND PRESERVATION, ENVIRONMENTAL EDUCATION, AND CONSERVATION SCIENCE.

MARTIN GRIFFIN PRESERVE • CYPRESS GROVE RESEARCH CENTER • BOUVERIE PRESERVE • MAYACAMAS MOUNTAINS SANCTUARY • MODINI INGALLS ECOLOGICAL PRESERVE

Acorns gathered by volunteers helping to restore oak woodlands at Bouverie Preserve.

JENNIFER POTTS

Growing nature back together see page 1

Printed locally with vegetable oil-based inks, using recycled paper and fiber from a sustainable and responsibly managed forest.