

LEVERAGING THE CONSERVATION VALUE OF HERONS AND EGRETS TO PROTECT WETLANDS IN A RAPIDLY CHANGING WORLD

How can using GPS technology to follow top wetland predators through their daily lives guide conservation planners and strengthen community commitment to wetland conservation?

Hérons and egrets are charismatic symbols of more than a century of wetland conservation (Parnell et al. 1988, Kushlan and Hancock 2005). A growing consensus on the ecological importance of top predators, such as herons and



egrets, indicates that these species may play a central role in healthy wetlands (Vander Zanden et al. 2006). The study of herons and egrets is a powerful portal to a better understanding of wetland ecosystems (Erwin and Custer 2000, Ogden et al 2014). Protecting wetlands is important for maintaining the ecosystem services they provide, such as water filtration, flood protection, carbon sequestration, and the aesthetic benefits that natural places provide to many people.

Recent technological advances in GPS telemetry provide an unprecedented opportunity to measure fine scale movements of animals across the landscape. With nearly five decades as a leader in heron and egret research and regional conservation action, ACR is uniquely poised to leverage the power of these advances to better understand the interactions between these birds and their wetland ecosystems. We will equip birds with miniature GPS tags to measure how individuals interact with their environment--where they find food and how they survive and raise young--information that will fuel conservation action in two complementary ways. First, the results will guide conservation planning by describing what is needed to protect wading bird populations and regional wetlands. Second, with the ability to share maps showing the location and movement of GPS-tagged birds on any internet-connected device, we will capitalize on ACR's successful and well-known education programs by providing incredible opportunities to visualize the "secret lives" of these amazing birds. This comprehensive conservation research and outreach program will engage the public, natural resource management agencies, and policy makers, providing science-based guidance to tackle critical issues in wetland conservation, such as the changing climate and shifting human land use.

RESEARCH GOALS TO STRENGTHEN WETLAND CONSERVATION

We will expand upon ACR's expertise in wading bird population patterns by addressing two reciprocal goals:

Identify aspects of wetland ecosystems needed for the effective conservation of herons and egrets. We will determine key wetland elements and processes impacting the survival and reproduction ("fitness") of individual birds, and how specific combinations of environmental conditions sustain their populations.

Identify aspects of heron and egret ecology needed for the conservation of healthy wetlands. We will determine how changes in the populations of herons and egrets over large landscapes are likely to influence their prey populations and, in addition, develop insights into how such influences cascade across wetland food webs to shape the structure of wetland communities.

MEASURING THE CONSERVATION VALUE OF HERONS AND EGRETS

We will achieve our research goals by conducting a multi-part study to address key questions about how individual herons vary in their use of the landscape and the extent to which changes in heron and egret abundances affect the health of wetland ecosystems.

GPS telemetry and mapping. The foundation of this study will involve equipping herons and egrets with GPS telemetry tags. We will follow each of these tagged individuals for at least 2-3 years to document their seasonal and yearly patterns of habitat use. These data can be used to address questions such as:

How do herons and egrets move across the complex Bay Area landscape to meet their foraging needs?

Are there specific foraging habitats or travel corridors that are consistently used by herons and egrets?

What are the relationships between heron and egret movement and environmental conditions such as temperature, rainfall, and hydrology, and how might these relationships change if environmental conditions shift?

Movement and fitness. We will use the telemetry data to build analytical models to evaluate how landscape conditions affect heron and egret movement, survival and reproduction. These

ACR AS A REGIONAL RESEARCH AND CONSERVATION LEADER

Audubon Canyon Ranch was founded in 1962 to save one of the largest heronries on the West Coast and to prevent intensive commercial development of Bolinas Lagoon. From our roots in direct preservation, we have grown into a regional leader in ecological research and have produced numerous scientific contributions on the ecology and conservation of herons and egrets

(www.egret.org/scientific_contributions). We produced an annotated regional atlas of heronries in the San Francisco Bay area (Kelly et al. 2006) and contributed to a recent evaluation of the State of The San Francisco Estuary (Kelly and Nur 2015). We have monitored the performance of every heron and egret nest attempt on the Bolinas Lagoon since 1967 and, in 1990, expanded this effort into a Bay Area-wide program. The long-term data resulting from this region-wide project provides us with a unique perspective to understand how species interact with their environment. ACR's broad spectrum of education and public outreach programs provide volunteer and lifelong learning opportunities for diverse populations, including elementary- through university-age students and adults of all ages.

models can help answer questions such as:

How important are intact, natural wetlands to the survival and reproductive success of herons and egrets?

How important are intact, natural wetlands to the regional abundances of herons and egrets?

How important are the Central Valley wetlands to Bay Area herons and egrets?

Functional responses. We will observe and model the foraging behavior of tagged birds, and compare foraging success under varying conditions. The results will help answer questions such as:

How does foraging success vary with dependence on human-altered versus natural wetlands?

How does foraging success vary with water depth, vegetation cover, or other correlates of prey availability?

Experimental investigation. We will manipulate heron and egret density with experimental exclusions and other techniques to test for the effects of egrets on prey species and other elements of wetland food webs. These experiments can help answer questions such as:

To what extent do foraging herons and egrets affect the abundance or behavior of their prey?

How do the effects of foraging herons and egrets on their prey cascade across wetland food webs?

SYNTHESIS OF RESULTS FOR CONSERVATION ACTION

The answers to questions in this multi-part study will be combined with our ongoing, long-term regional monitoring results to synthesize new perspectives in wetland conservation. By integrating this broad scientific effort with conservation outreach, we will leverage both the popular appeal of herons and egrets and compelling information on their ecological importance to address new challenges in the conservation of Bay Area wetlands.

Examples of how we will synthesize the results of our research into new opportunities for conservation action include: combining information on movement, survival and functional responses into simulation models that will predict heron and egret population responses to future conditions; integrating the breeding distribution, movements, and foraging behaviors of individual herons and egrets into captivating maps that identify hotspots for conservation; and applying new information on how foraging herons and egrets affect other species to generate compelling predictions about their importance in sustaining future wetland communities.

Results will be communicated to other conservation scientists and restoration ecologists through publication in peer-reviewed scientific journals. ACR will also provide conservation planners, natural resource management agencies, and policy-makers with accessible scientific guidance to address pressing issues, such as the mitigation of climate change impacts or the design and implementation of wetland protection and restoration projects. In addition, implications for wetland conservation will be shared with wide-ranging audiences through ACR's longstanding and successful education program.

Ultimately, this project will dramatically strengthen ACR's continuing scientific work on herons and egrets, which has informed regional conservation for decades and inspired generations of people to value these beautiful birds and the wetlands that sustain us.

PROJECT LEADERS

John P. Kelly, PhD (Lead Investigator), is ACR's Director of Conservation Science. His scientific work focuses on habitat relationships, population dynamics, foraging behavior, and energetics of coastal and estuarine birds, primarily in central coastal California, including 27 years of research on herons and egrets.

Scott Jennings, MS (Co-lead Investigator/Project Manager), is an Avian Ecologist at ACR. Over the last 11 years, Scott has conducted research on the nesting behaviors and reproductive ecology of numerous bird species in the San Francisco Bay area, in addition to several Austral summers in Antarctica studying colonial penguins.

T. Emiko Condeso, MS (GIS Specialist) is ACR's GIS Specialist/Biologist. She provides critical expertise in Geographic Information Systems, landscape ecology, and remote (satellite) sensing, with particular interests in how the spatial patterns of human-altered landscapes influence biological communities.

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