

Insights from birds with GPS tags

A Year Following Egrets

by David Lumpkin

To a Great Egret (*Ardea alba*), Tomales Bay is full of food, but that food is not always available. Every two weeks, around the full and new moons, the lowest tides and greatest foraging opportunity coincide with the early morning, making breakfast on the bay an easy affair. During low tides, hundreds of acres of intertidal eelgrass are exposed, allowing egrets to stab at herring during spawning events or to hunt pipefish, which try to wrap themselves around the egret's bill to avoid being swallowed. As the tide cycle shifts and morning tides become higher, the eelgrass is exposed for fewer hours per day, reducing foraging opportunities on the bay. During these times, egrets switch to inland ponds and creeks to hunt small fish or walk the surrounding pastures in groups to capture rodents.

In June 2017, ACR's team at the Cypress Grove Research Center put Global Positioning System (GPS) satellite tags on three Great Egrets (described in *The Ardeid* 2017). While we already knew that Great Egrets on Tomales Bay alter their behavior with the tides, we didn't realize how in-tune with tidal cycles they are until we began using GPS tags to study the movements of individual birds. In the last year, ACR's Heron and Egret Telemetry Project has provided us with incredible insight into the habits of local Great Egrets, confirming some of our suspicions but also shattering many of our expectations. We haven't yet collected enough data for formal analyses, but the information these tags are providing is already teaching us a tremendous amount about how these birds move across the landscape, and about the interconnections of conservation efforts near and far.

Missing in action

As it turns out, cell reception is limited on Tomales Bay, hindering our tags' automatic data uploads. But fortunately we can also locally download data from the tags using a handheld receiver. In the first few weeks following

the deployment of our tags, all three egrets remained near Toms Point in northern Tomales Bay, where we could regularly download data with the handheld receiver then eagerly rush back to the office to upload the data to a computer and see what the birds had been doing. About a month after tagging, suddenly two of the three egrets could no longer be found on Tomales Bay. Worried something might have happened to them, and perplexed that they might leave an area where they likely had active nests, I drove parts of Marin and Sonoma counties with poor cell reception with a roof-mounted antenna connected to the handheld receiver, hoping to stumble across a signal.

Eventually, along Chileno Valley Road, Egret 3 (we named each egret sequentially in capture order) flew out of a ditch just long enough for a brief look at the bird and a chance to download a few GPS points from the tag. We learned that she (sex is determined genetically from a drop of blood collected during tagging) had been sleeping each night in a patch of trees on a remote Chileno Valley ranch and foraging along nearby creeks and farm ponds each day. Over the next few months, both Egret 2 and Egret 3 exhibited similar patterns: they would spend roughly a week on Tomales Bay, then fly inland for about the same length of time. When on the bay, they spent the mornings chasing prey along the shallow mudflats, following the tide in and out to match their preferred water depth of about 20–30 cm (Figure 2). When inland, both birds sought creeks and farm ponds, periodically roosting in tall patches of trees. When the tides transitioned to a more extreme part of the cycle, with eelgrass beds exposed earlier in the morning, they returned to Tomales Bay.

In contrast, Egret 1 never traveled far from Toms Point. He displayed a different approach to dealing with higher tides, often focusing on



Figure 1. Egret 9 flying over Cypress Grove the day after it was captured in September 2018.

a freshwater pond at Toms Point. I watched him forage there several times. Though this pond was well covered by aquatic plants, he was consistently able to find small fish, picking them out from tiny gaps in foliage.

New discoveries in fall and winter

Great Egrets tagged by researchers in the eastern United States migrate large distances to avoid harsh winters: egrets tagged in Kansas spend winter in southern Mexico; birds breeding in New York winter in the Carolinas. One individual tagged on the Outer Banks of North Carolina even traveled all the way to Columbia, by way of Cuba. In contrast, Great Egrets are present year-round in the San Francisco Bay area. To our knowledge, it had not yet been determined if the individual birds that nest in the Bay area remain all winter, or if the local breeders leave the region and are replaced, perhaps by birds from farther north.

On the night of July 5th 2017, Egret 3 gave us a bit of data to puzzle over by flying towards Petaluma after sunset, spending the night in Helen Putnam Regional Park, then returning to her normal stomping grounds near the coast. Egrets 2 and 3 had often moves between inland and coastal areas in the morning or evening, though seldom after dark. In contrast, at the end of this flight to Petaluma, Egret 3 didn't seem to spend any time foraging, and she had passed plenty of regular roost sites that were much nearer to her usual foraging areas, so the flight showed no obvious purpose. On 14 August, Egret 3 flew to Petaluma in the evening. She

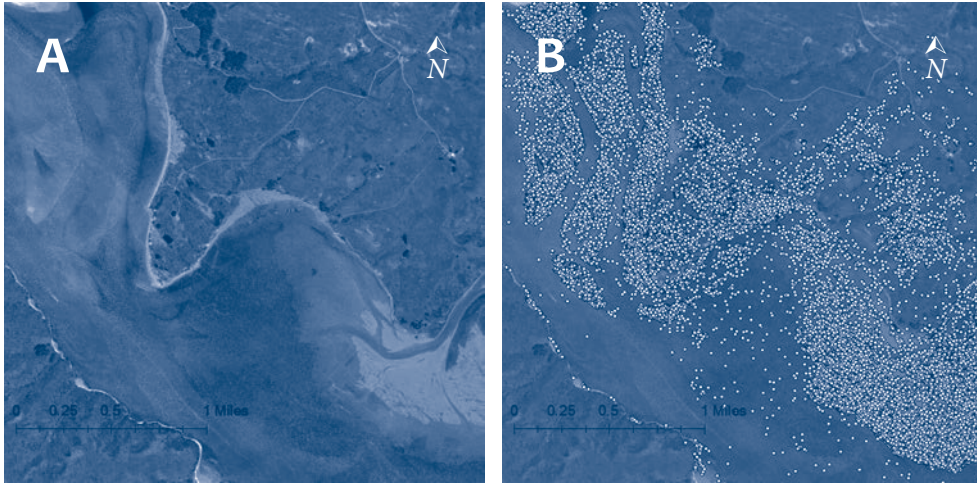


Figure 2. (A) The waters around Toms Point in northern Tomales Bay, with deep channels winding between shallow eelgrass beds (dark areas) and unvegetated mud flats. (B) The same area with points from GPS-tagged Great Egrets, showing the birds' use of eelgrass beds and other shallow areas.

roosted there for a few hours, then as darkness fell she flew east over the Napa Marsh, across the Sacramento River delta, and all the way to the east side of the Central Valley in the foothills of the Sierras (Figure 3C). The 98-mile flight took 3.5 hours.

Egret 3's timing seemed plausible for fall migration, but we were surprised that she would travel here during the area's driest time of year, when we assume food resources for a wetland predator would be at their annual minimum. Tagging studies in eastern North America revealed that many Great Egrets breeding there migrate hundreds of miles south in staged trips

lasting multiple days. We awaited each data download in anticipation about whether this was simply the first stage of a longer journey or the Sierra foothills would be Egret 3's final destination. In November she spent a few weeks hunting in fields on the outskirts of Sacramento, just a stone's throw from I-80. But she soon returned to the same foothill location—near a creek where she spent the remainder of the winter, on a stretch just a couple of miles long.

Eventually Egret 1 left Marin County as well. He traveled south along Tomales Bay, crossed San Francisco Bay near the Richmond Bridge, and followed the San Joaquin River all the way

down to the Tulare Basin, in the southern San Joaquin Valley. In contrast to Egret 3, he took several days to make the trip, foraging in wetland wildlife refuges along the way. His movements paint a fascinating picture of the landscape. The outline of the historic, vast and seasonal Tulare Lake is still visible in satellite imagery of the southern end of the San Joaquin Valley. But now the region has been converted to one of the most productive agricultural areas of the world, gridded by a network of irrigation canals and roads. Egret 1 spent the winter in the ditches and canals of this industrialized landscape, traveling in straight lines and 90-degree angles. Like Egret 3, Egret 1 made a brief trip away from his primary wintering area in November. On the 24th and 25th, he made an approximately 60-mile loop, following the California Aqueduct northward, then turned around following the San Joaquin River back southward, ending up where his flight started (Figure 3A).

We didn't receive any data from Egret 2's tag between November and early April, and following the other two egrets' departures from Tomales Bay, we wondered where Egret 2 had gone for winter. However, it turned out she stayed relatively local for the winter, spending the entire time in the Two Rock Valley between Tomales Bay and Petaluma. Although she foraged almost exclusively at a pond just 300 meters from my commute, her whereabouts had remained a mystery because cell reception in that area is poor and her favorite pond was sheltered by topography, such that her tag's signal couldn't reach the road (Figure 3B).

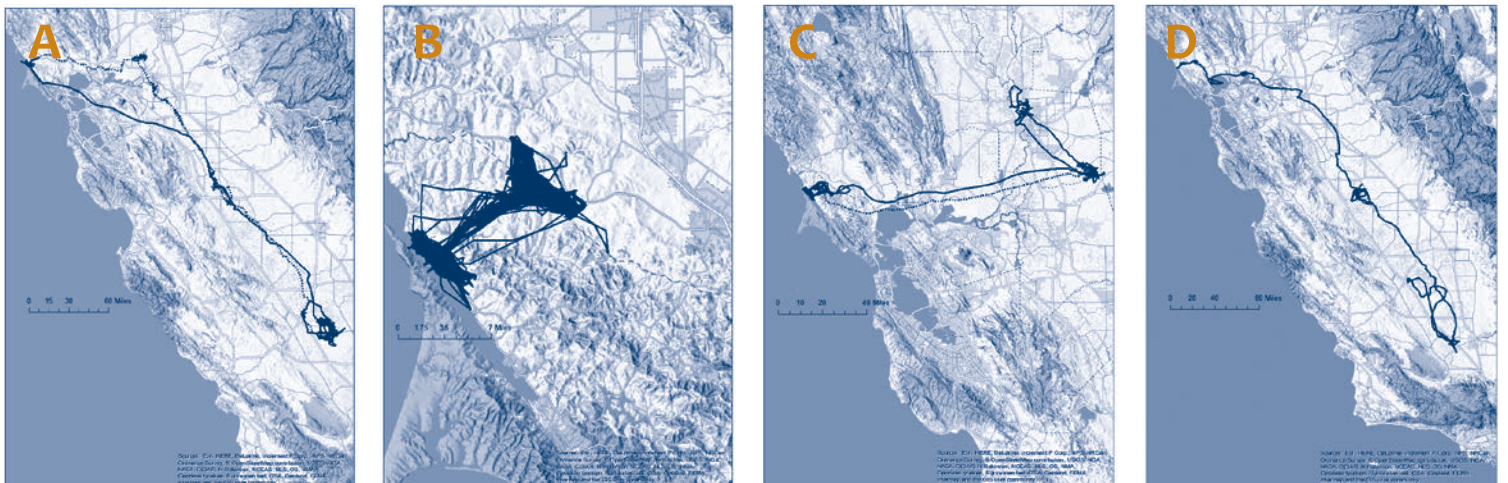


Figure 3. Movement paths of GPS-tagged Great Egrets. (A) Path travelled by Egret 1 to the southern San Joaquin Valley then back to Tomales Bay. (B) Local movements near Tomales Bay by non-migrating Egret 2. (C) Migration by Egret 3 to the Sacramento Valley then back to Tomales Bay. (D) Summer movement to the San Joaquin Valley by Egret 4. Solid lines for Egrets 1 and 3 represent late summer movements and fall migration; dotted lines represent spring return migration and summer movements.

Fire season

I lost count of how many times I've been asked what our birds did when the October 2017 fires in Sonoma County were blazing. Our other tagged egrets had left the region by then, but Egret 2 was still spending most of her time some 12 km (8 miles) inland from Tomales Bay. During the first week after the fires started, Egret 2 mostly stayed put on lower Walker Creek. The tidal cycle was such that this was a period of low eelgrass availability on Tomales Bay; for most previous periods with similar tides she had flown inland. In fact, several times between the 8th and 14th of October, when the fires and smoke were most intense, she did fly towards the inland location, but she returned to the coast within three hours each time, rather than spending several consecutive nights inland as she normally had. Of course, I can't speak for the bird's motivations, but during the fires, I was certainly happy to have the excuse to work at Cypress Grove, just south of Walker Creek, where the air quality was much better than it was farther inland.

The breeding season

In mid-April, Egret 2 returned to Tomales Bay. She began making frequent short trips to the colony at Blakes Landing on the east shore of Tomales Bay between Walker Creek and ACR's Cypress Grove Research Center, suggesting she might be building a nest. After several days of combing carefully through the colony with my telescope I eventually found the tag's small antenna poking out through her plumage. By early July, both chicks in her nest had successfully fledged.

Conservation Keys

- Great Egret foraging behavior appears to be determined by daily and weekly tidal patterns. Tagged egrets exploit intertidal eelgrass on Tomales Bay during favorable low tides, and forage in upland habitats or inland streams and ponds on days with limited low tides.
- California's Central Valley provides important winter foraging habitat for a portion of the population of Great Egrets breeding on Tomales Bay.
- By combining GPS tracking data with observations of birds at colonies, we can correlate use of space with reproductive success to inform conservation policies and land management.

Egret 3 returned to Tomales Bay in mid-April, retracing her fall path to the Central Valley. She spent the spring and summer foraging along Walker Creek and in Tomales Bay's eelgrass beds and roosting in a grove of trees on the bay's east shore. This grove was once an egret colony but now is a regular nighttime roost with no evidence of Egret 3 or any other egret attempting to nest there.

Egret 1 departed the Tulare Basin in late March, around when we would expect a migrating egret to return to its breeding ground to begin nesting. However, he took nearly the entire spring to travel north along the San Joaquin River, spending up to a few weeks in each of several locations along the way. He spent a month in the lower Sacramento River beginning in mid-May, then took a slow trip through Suisun Marsh to finally reach Tomales Bay in mid-June, near the end of the breeding season. Over the course of the spring, he visited several known Great Egret nesting colonies, but he didn't make repeated visits to any of those sites and appears not to have attempted nesting.

New egrets join the flock

We captured seven more egrets during the spring, summer, and early fall of 2018. Our first captures of 2018 were in the late spring, and the first few months of these birds' movements have already taught us new things about our local area and provided new information on how the landscape influences productivity.

Egret 4 led us to an unknown colony, located between Tomales and Petaluma, with several nesting pairs of Great Egrets and Great Blue Herons. For two weeks, Egret 4 had a consistent routine, spending each night in the colony and foraging nearby, leading us to think she might be nesting there. On 3 June, however, right in the middle of the breeding season, she ceased visiting the colony and instead began a slow, 20-mile-per-day trip east to Stockton then south through the Central Valley, stopping and foraging in wetlands (Figure 3D).

We tagged Egret 5 on 8 June and soon learned he had an active nest at the Blakes Landing colony. Locating this nest in the colony turned out to be much easier than Egret 2's. Serendipitously, I arrived at the colony one day just in time to watch Egret 5 fly to his nest, feed the three large chicks, and depart, all within the span of four minutes. It appears these three chicks fledged successfully as well. Determining the fate of all nesting attempts by tagged egrets will allow us to link movement and habitat use behaviors to reproductive success.

Looking forward

In just our first year tracking Great Egrets, we have already learned a tremendous amount. With ten egrets now tagged and transmitting data back to us, we are poised to begin learning even more about how the Bay Area breeding population interacts with and influences the landscape around us.

Our tagged birds have demonstrated an ecological link between Tomales Bay and other habitats in California. Drought conditions, other climate change effects, and land use and conservation decisions in the Central Valley may have repercussions for egrets breeding on Tomales Bay. Within the northern Bay area we have discovered the importance of neighboring upland habitat—largely privately owned rangeland—to egrets nesting on Tomales Bay. This highlights important opportunities for conservation partnerships between ACR and local land management agencies and private landowners.

The GPS-tagged egrets have raised many interesting questions. Why do some Tomales Bay egrets migrate to the Central Valley while others spend the winter locally? What is the relationship between migration and the likelihood of attempting to breed or the number of chicks produced? Selective benefits of migration are well established, but the two migrating egrets in our study did not pass along any genetic material in 2018. The causes of their movement and lack of breeding remain mysteries to us. As we tag more birds, and collect additional years of data, we will learn how their behaviors influence breeding success, and how habitat quality and availability directly affect egret populations.

Our tags provide us with novel individual-level information that can help us interpret the trends we observe in monitoring egret and heron colonies in the northern Bay area. Identifying the links between foraging habitat and breeding success will allow us to inform conservation decisions to benefit egrets and herons and the habitats they rely on. Ultimately, this new research will dramatically enhance our understanding of ardeid behavior and the conditions these birds need to thrive in a changing world.

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