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GPS Tags and Kōlea: What a Punchbowl Study Tells Us About Tracking Hawai‘i’s Shorebirds

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Few birds are as familiar to Island residents as the kōlea—the Pacific Golden-Plover (*Pluvialis fulva*)—that spends most of the year on our lawns, parks, and shorelines before departing each spring for nesting grounds in Alaska. For years, researchers have wanted to follow individual kōlea on their nonstop overwater flights of roughly 4,800–4,900 kilometers (about 3,000 miles) and beyond, but a persistent question has hovered over such work: Do the tracking devices we attach to birds actually harm them?

A study recently published in *Wader Study* by Oscar Johnson and colleagues—including Hawai‘i Audubon Society (HAS) members—offers the most rigorous answer yet for this species: GPS tags carried by kōlea wintering at O‘ahu’s National Memorial Cemetery of the Pacific (the Punchbowl) did not measurably harm the birds. The results carry meaningful implications for conservation research across Hawai‘i and the broader Pacific.

A Unique Urban Flock

The Punchbowl is home to roughly 70 kōlea each winter. What makes this study possible and scientifically valuable is the kōlea’s unusual site fidelity. Individual birds return year after year to the same patch of cemetery lawn, and inter-season survival rates at this site have historically hovered around 90%. That predictability creates a natural accounting system. If a banded or tagged bird fails to reappear after migration, researchers can conclude with reasonable confidence that it has died.

A GPS-tagged male kōlea in the Punchbowl Cemetery, April 2022. ©Susan Scott

Taking advantage of this setting, the research team captured 30 kōlea at the Punchbowl between March and April 2022 and divided them into three equal groups. The first group received active GPS-Argos tags, devices that both recorded precise locations and

transmitted data to satellites. The second group received physically identical but deactivated tags: same weight, same harness, same profile, but no operating electronics. The third group was leg-banded only, with no hardware attached. Each device, tag plus harness, weighed about 4.2 grams, roughly 2.5% of a kōlea's estimated body weight at spring departure. The device weight was within accepted guidelines for bird-borne tracking devices.

This three-way design was carefully chosen. Comparing active versus inactive tags allowed the team to isolate whether the electronic transmissions (electromagnetic fields) affected the birds differently from simply carrying the physical weight and drag of a device. Comparing all tagged birds against the banded-only control group tested whether the devices caused any harm at all.

The Birds Came Back

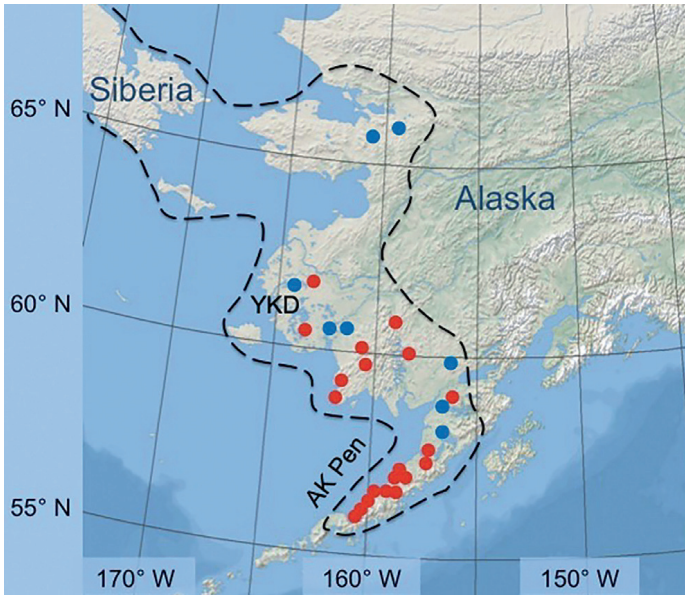
When fall 2022 arrived and kōlea began returning to the Punchbowl, the results were encouraging. Overall, 23 of the original 30 birds (77%) returned and reoccupied their territories. Across the groups, 7 of 8 birds carrying active tags returned (87.5%); 7 of 12 with inactive tags returned (58%); and 9 of 10 banded-only birds returned (90%). Crucially, statistical analysis found no significant difference in return rates among the three groups. The lower figure for the inactive tag group most likely reflects the ordinary, unpredictable hazards of long-distance migration—weather, predation, chance—rather than any effect of wearing a tag.

When researchers recovered tags from returning birds, they found only minor feather ruffling where the device had rested on the lower back, and no evidence of injury from the leg-loop harness.

A year later, in fall 2023, the story continued positively. Of the 23 birds that had returned in 2022, 21 (91%) came back for a second consecutive season. Every returning bird reoccupied the same territory it had held in prior years. None of the birds absent in 2022 reappeared in 2023, consistent with the conclusion that non-returning individuals had died rather than simply moved elsewhere.

New Insights on Migration Routes

The active GPS tags delivered an additional finding: precise nesting locations in Alaska. Earlier research using light-level geolocators had established that Hawai'i kōlea nest primarily in southwestern Alaska, from the Alaska Peninsula north to the Yukon–Kuskokwim Delta (YKD) region. The new GPS data confirmed those destinations but extended the known breeding range: two of the eight tracked birds nested considerably farther north, near 66° latitude, well beyond the northernmost nest previously documented at 62°. Our picture of kōlea breeding distribution is still expanding.



The dashed lines mark the eastern end of the Pacific Gloden-Plover's range. Hawai'i's plovers nest mostly in the Alaska Peninsula (AK Pen) and the Yukon Kushokwim Delta (YKD). Blue dots show nesting locations of the eight active GPS-tagged birds in this study. Red dots show nesting sites of Hawai'i plovers in previous studies (Johnson et al. 2011).

Why This Matters for Hawai'i's Birds

The broader question driving this study—whether GPS tags are safe for migratory birds—carries real stakes for conservation across the Pacific. An earlier study of GPS-tagged kōlea at Moorea, French Polynesia, found that most birds lost contact with researchers during or after migration,

raising concern that tags were contributing to mortality. The Punchbowl study, with its controlled three-group design and site-faithful flock, provides compelling evidence that those Moorea disappearances were more likely caused by tag malfunction, battery failure, or harness breakage than by harm to the birds themselves.

That reassurance matters. Modern GPS and satellite telemetry have become essential tools for understanding the movements and needs of Hawai‘i’s migratory and resident birds. For shorebirds and seabirds that traverse open ocean on routes invisible to humans, remote tracking technology is often the only way to learn where birds go, where they stop, and where threats lie. Confirming that small GPS tags do not measurably reduce kōlea survival strengthens confidence in data from tagged birds and supports continued, responsible use of this technology in conservation research.

An active GPS tag and harness removed on November 2023. The bird carried the device for 20 months. The inactive tags looked the same but did not collect GPS data nor transmit to Argos. ©Susan Scott

This work also underscores the irreplaceable value of long-term monitoring. The Punchbowl study was possible only because Oscar Johnson and colleagues had been recording individual kōlea at that site for decades, building the survival baseline against which tagged birds could meaningfully be compared. The kōlea that winter on Honolulu’s lawns, parks, cemeteries and neighborhoods are not merely familiar seasonal visitors. They are living links to nesting grounds in Alaska and to a vast Pacific migration system that Hawai‘i is uniquely positioned to study and safeguard.

Acknowledgements

This article draws on: Johnson, O. W., Weber, M. F., Bybee, D. R., Tibbitts, T. L., Scott, S., Fisher, J. P., Kuntz, W. A., Spiessberger, S., Southworth, S. B., Maynard, E. K., Zoller, L., & Smith, C. D. (2024). Return rates of GPS-tagged Pacific Golden-Plovers: a controlled study in Hawaii. *Wader Study*,131(2),152–155. https://doi.org/10.18194/ws.00348

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Author note

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****END****

Kōlea and the Hawai‘i Audubon Society: An 85-Year Partnership

By Keith Swindle and Susan Scott

Hawai‘i Audubon Society, Honolulu, Hawai‘i

“My kōlea is back!” This cheery report comes from residents every August as the much-loved Pacific Golden-Plovers (*Pluvialis fulva*), called kōlea in ‘ōlelo Hawai‘i (the Hawaiian language), return to Hawai‘i’s yards, parks, cemeteries, and golf courses.

For nine months of the year—August through April—Hawai‘i is home to a population of this migratory shorebird, a species famous for individuals returning annually to the same site. The birds spend the other three months—May, June and July—in insect-rich Alaska, where the plovers build nests, find mates, and raise chicks. Then it’s back to Hawai‘i for fall and winter, the birds completing their round-trip annual migrations of about 6,000 miles (10,000 kilometers).

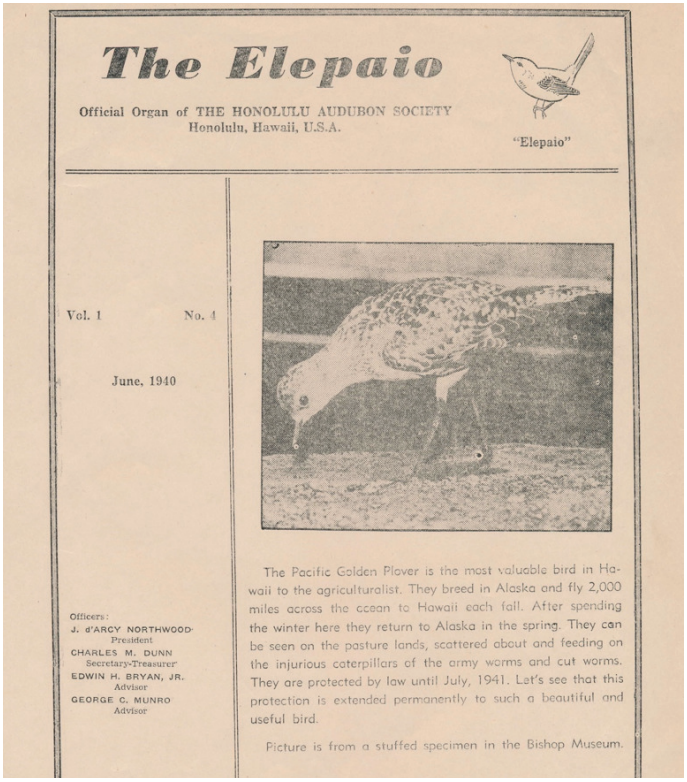
For Island residents, the kōlea is one of the most recognizable native birds. The kānaka ‘ō‘iwi (native Hawaiians) also knew it well, a fact we know from a proverb about the bird’s migratory behavior: *kōlea ‘ai waiū o ka ‘āina*—the plover that drinks the milk of the land—a phrase used for people who come to benefit from a place and then depart.

Because of its visibility, regularity, and beauty, the kōlea has been an 85-year focus of observation, advocacy, science, and joy for the Hawai‘i Audubon Society.

A Bird Worth Protecting

In 1939, when the Honolulu (its initial name) Audubon Society published the first *‘Elepaio* issue, the kōlea had only recently gained temporary legal protection from being shot for profit and sport near coastal ponds, where flocks gathered at dusk.

In June of 1940, the Society’s founders, including George C. Munro, called for permanent plover protection (below *‘Elepaio* (Vol 1, No. 4). The unsigned note—almost certainly Munro’s—declared the kōlea “the most valuable bird in Hawaii” for its work of consuming caterpillars and cutworms in pastures and crop lands.



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Vol. 1 No. 4

June, 1940

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The Pacific Golden Plover is the most valuable bird in Hawaii to the agriculturalist. They breed in Alaska and fly 2,000 miles across the ocean to Hawaii each fall. After spending the winter here they return to Alaska in the spring. They can be seen on the pasture lands, scattered about and feeding on the injurious caterpillars of the army worms and cut worms. They are protected by law until July, 1941. Let's see that this protection is extended permanently to such a beautiful and useful bird.

Picture is from a stuffed specimen in the Bishop Museum.

Munro returned to the subject repeatedly over the next decades. His 1949 article “Pacific Golden Plover” (Vol. 10, No. 6) drew on a lifetime of field observations describing the bird’s food habits, seasonal movements, and cultural significance. In 1955’s *Pluvialis dominica fulva* (Vol. 16, No. 2), Munro recorded the bird’s behaviors season after season at Kapi‘olani Park, noting that birds were recognizable by their habits and territorial boundaries. One individual, he wrote, would stand its ground, before taking flight, until Munro had walked within twenty paces, and did so consistently across two wintering seasons. This was the first documentation of what would later be understood as the kōlea’s exceptional site fidelity and unique relationship with humans in Hawai‘i.

Watching Birds, Building Knowledge

The 1970s brought a new era of residents’ engagement with kōlea. Beginning with Volume 34 (1973–74), the *‘Elepaio* began publishing a series of

reader-submitted "Plover Watching" notes, including accounts from Sigrid Southworth at Kamehameha School, Erika Wilson at Fort Shafter and Diamond Head, and Barbara Macaulay in Kapiʻolani Park.

These residents noticed what Munro had noticed—that the same birds came back year after year to the same lawns. Southworth also described her campus birds changing to breeding plumage throughout April, and gave the name Kali to an annual plover visitor at her parents' Maui property.

In one memorable note (Vol. 36, No. 1, 1975), Southworth described arriving at Mokuleia to find "dozens and dozens of kōlea" gathered in a pasture the week before migration, a pre-departure aggregation that residents still watch for each spring.

At the same time, formal science was catching up. The State Division of Fish and Game published a comprehensive plover survey in the *ʻElepaio* (Vol. 35, No. 4, 1974), collecting and examining 43 birds from multiple Oʻahu sites, documenting molt sequences, body weights, and gizzard contents.

A University of Hawaiʻi parasitology study, supported by an HAS research grant (Vol. 36, No. 5, 1975), found that parasitic infections varied significantly between collection sites, suggesting that individual plovers did not freely mix between wintering territories on the same island, an early indirect confirmation of territory fidelity. The kōlea's attachment to place was becoming measurable.

The Johnson Era

In 1979, an ornithologist, Dr. Oscar "Wally" Johnson, arrived at Bellows Air Force Station near Waimanalo with a plan. Working with his wife, Patricia Johnson, and BYU-Hawaiʻi biology professor, Phillip Bruner, Wally launched a systematic study of wintering golden plovers that would change the field and eventually make Dr. Johnson the world plover expert. The team's first *ʻElepaio* paper (Vol. 41, No. 12, 1981) introduced color-banding, census routes, and continuous monitoring of approximately 400 birds across two military reservations.

The study established formally what Munro and Southworth had observed informally: individual kōlea returned to the same sites year after year, arrived on a remarkably consistent schedule in August, and maintained discrete winter territories. Johnson presented his early migration findings at an HAS general meeting in August 1982 (Vol. 43, No. 2), as his project expanded beyond Oʻahu to Enewetak Atoll and eventually throughout the Pacific.

Over the following four decades, Johnson and his collaborators tracked kōlea from Hawaiʻi to Alaska and beyond. Early geolocator studies confirmed that Hawaiʻi birds nested primarily in southwestern Alaska on the Alaska Peninsula as well as in the Yukon–Kuskokwim Delta.

Satellite transmitters opened a window into the birds' routes. In 2016, the *ʻElepaio* reprinted Eric Wagner's account (Vol. 76, No. 6) of satellite-tagged Number 97, a male plover tracked from Nome to Okinawa to Sulawesi and back, more than 27,000 kilometers (16,777 miles) in a single year. The bird followed corridors no previous researcher had documented.

"I'd never seen a path like that," Johnson told Wagner. "It was amazing, more so because other plovers probably do it, too."

A Community Science Project Takes Wing

While Dr. Johnson pursued the birds across the Pacific, Susan Scott, a naturalist, longtime HAS board member, and Honolulu *Star-Advertiser* columnist, was deepening the public relationship with the kōlea closer to home.

In a move to make the information in Johnson's scientific papers accessible to the general public, Johnson and Scott coauthored the book, *Hawaiʻi's Kōlea, The Amazing Transpacific Life of the Pacific Golden-Plover* (2016, University of Hawaiʻi Press). The book encouraged more of Hawaiʻi's residents and visitors to share their observations and relationships with the birds.

People from across the state reported experiences with their individual birds, with stories about birds recognizing the human owners of their yards, and humans naming them and sharing breakfast (scrambled eggs or meal worms, a bird-healthy snack) with their resident kōlea.

Bert, a backyard kōlea in Kailua stepped into his owner's house for his mealworm breakfast. April, 2026 ©Jennifer Carver

In 2020, Scott, with Johnson as scientific advisor, created and launched Kōlea Count, a website-based citizen science project designed to collect plover facts, such as when the birds arrive, where they spend the winter, when they leave, how many do not migrate, and other observations. The pilot study results, published in the *ʻElepaio* (Vol. 81, No. 5, 2021), were striking: 611 participants submitted 4,196 observations across the islands, with reports from every major island.

Kōlea Count continues, generating the longest running community dataset on the species. In addition to collecting numbers, locations, and dates, the reports show, in added notes, the affection Hawaiʻi residents have for this special shorebird. That first year, for instance, 167 people reported that they named their backyard birds.

The Punchbowl Studies

The threads of this 85-year story converge at the National Memorial Cemetery of the Pacific, commonly known as Punchbowl. For generations, this federal expanse of lawn in urban Honolulu has been prime kōlea habitat, hosting about seventy birds every year.

Each bird defends its own grass patch with the same fidelity and tenacity that Munro observed at Kapiʻolani Park in the 1940s, and Southworth saw at Kamehameha School in the 1970s.

Over the years, Dr. Wally Johnson and HAS volunteers have been systematically monitoring Punchbowl's plovers, counting, banding, and equipping some with GPS transmitters. The most recent study in 2024, described in the companion article of this issue (published in full in *Wader Study* 131(2): 152–155), represents the most rigorous examination of what it means, and what it costs physically, for a kōlea to carry a tracking device across the Pacific.

In one way, this recent study is the culmination of the human relationship with kōlea that began with George Munro calling for the protection of the species in 1940. That connection has been sustained by HAS, this journal, and by residents, graduate students, field biologists, and community scientists who, in the kōlea, find a bird well worth watching, protecting, and caring for.

As a continuation of plover appreciation, HAS is currently sponsoring its fourth annual Nome field trip, called Kōlea Quest. So far, 46 members and staff and 9 college students have migrated to the arctic tundra during the last week of June to find kōlea in their breeding grounds, alongside trip leader Dr. Wendy Kuntz and local guides. As this issue went to press, Dr. Kuntz and 15 lucky members and student members were exploring the tundra trying to spot newly hatched kōlea chicks. We look forward to welcoming all of them, our kōlea and our fellow Hawaiʻi Audubon guardians home to Hawaiʻi.

Acknowledgements

The authors thank plover lovers Wally Johnson and residents of Hawaiʻi, Alaska, and Pacific Island nations for decades of kōlea observation, stories and research shared with HAS. Countless *ʻElepaio* correspondents, HAS members, and Kōlea Count participants have formed the backbone of this history of conservation that safeguards kōlea now and in the future.

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‘Ua‘u kani nesting season

We are excited to see ‘ua‘u kani (Wedge-tailed Shearwaters) nesting at Freeman Seabird Preserve once again. Soon, the parent birds will leave their chicks alone throughout the day to search for food.

Stay up-to-date by visiting us online:
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Save the date

Join our **Welcome Home Kōlea festival** on Saturday, September 19. This third annual event takes place at Magic Island in Ala Moana Beach Park (O‘ahu). Enjoy some plover fun and celebrate these amazing migratory birds with us.

Male kōlea in its breeding plumage ©Tom Dove

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Table of Contents

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