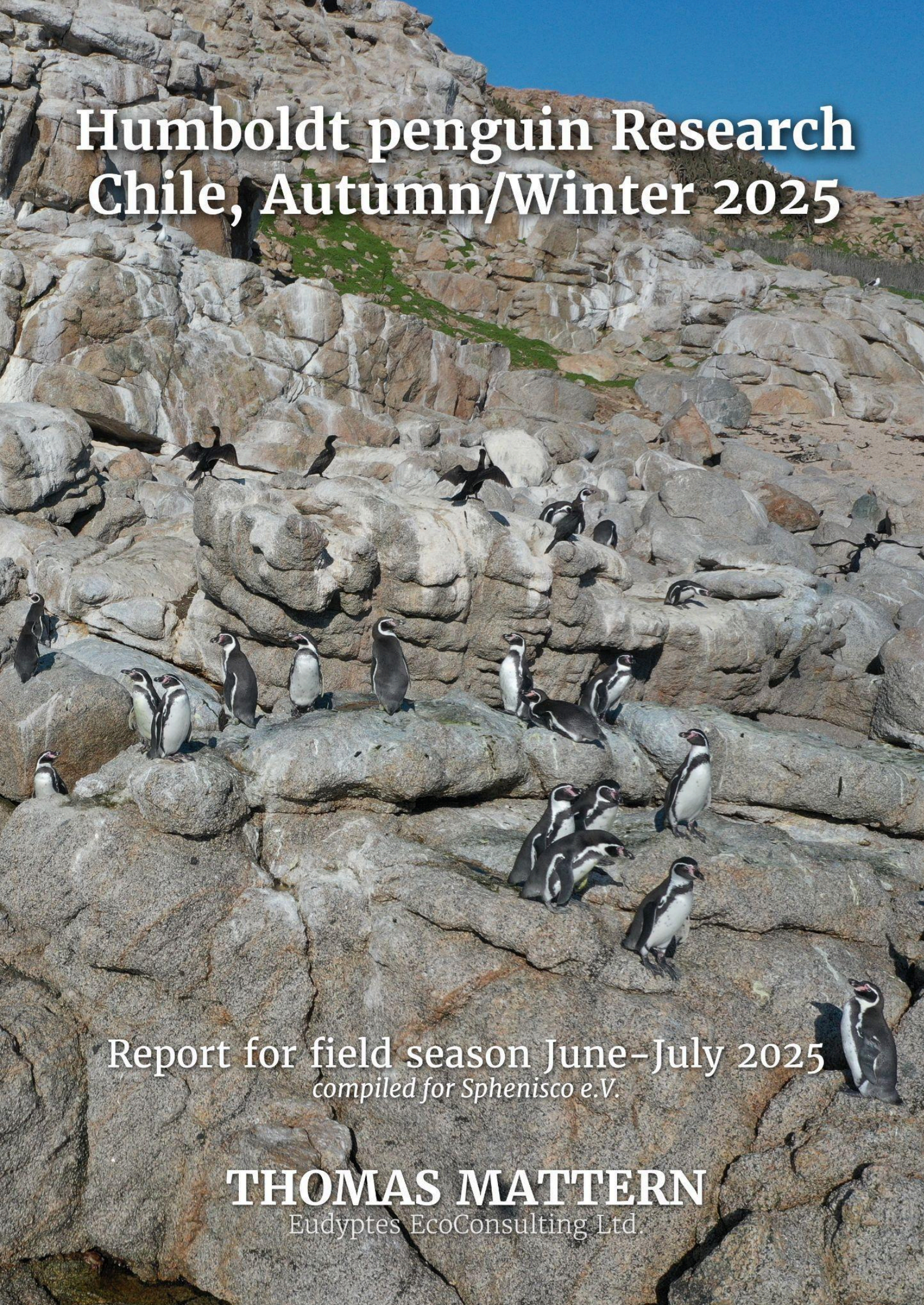
Humboldt penguin Research Chile, Autumn/Winter 2025



Report for field season June–July 2025

compiled for Sphenisco e.V.

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Introduction

The Humboldt penguin population in Chile has faced considerable challenges over the past two years. In 2023, the highly pathogenic avian influenza H5N1 reached Chile, causing widespread mortality among colonial breeding seabirds, particularly gulls, pelicans, and cormorants (https://www.sag.gob.cl/ia). While there is little evidence that penguins were significantly affected, the closure of nature reserves made it difficult to assess the true extent of the impact on their populations.

At the end of 2023 and into 2024, the world experienced the fifth most powerful El Niño event on record, which severely disrupted ocean productivity along the Chilean coast. This led to a complete cessation of breeding in Humboldt penguins during both the autumn and spring seasons of 2024.

These events significantly hampered the goals of the Sphenisco Project, which seeks to investigate the foraging ecology of Humboldt penguins in relation to coastal development and commercial fisheries. Fieldwork that began on Isla Choros in autumn 2022 (June/July) and continued into spring 2022 (November/December) was effectively put on hold for nearly two years. By spring 2024, penguins had still not resumed regular breeding on Isla Choros, prompting a shift in research efforts to Isla Cachagua. There, deployments of GPS dive loggers on chick-rearing birds revealed a tendency to forage southward toward the busy port area of Quintero, approximately 40 km from the island.

In June and July 2025, I returned to Chile for the first field season since July 2022. The objectives were to:

1. track breeding Humboldt penguins using GPS dive loggers and deploy camera loggers where feasible,

2. fit satellite transmitters donated by the Antarctic Research Trust to monitor adult movements during the post-breeding period, and

3. train the local team in the use of aerial survey drones to map nest areas and conduct moult censuses.

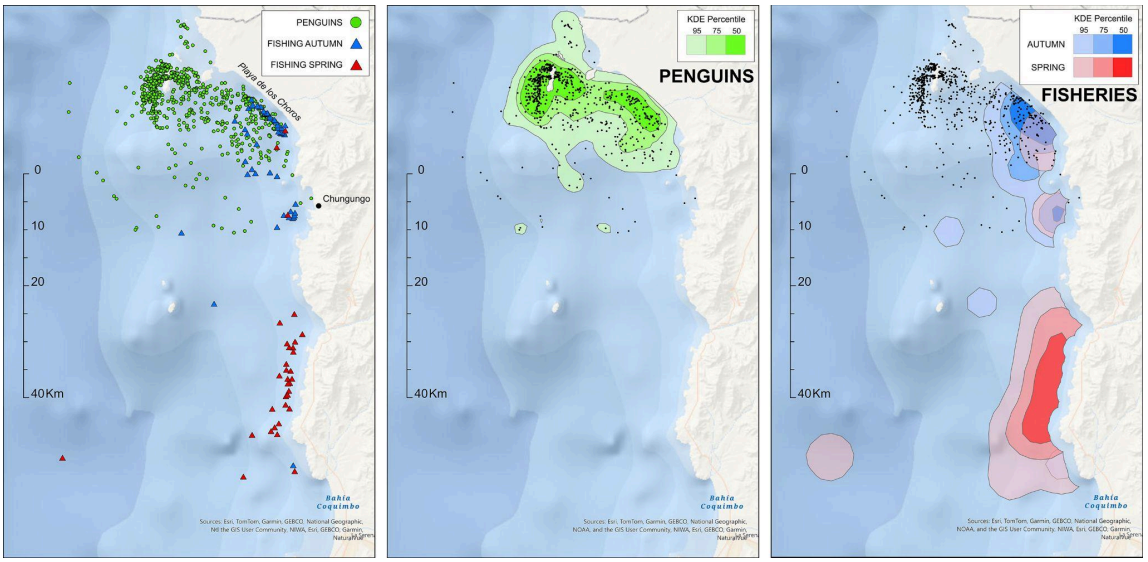
GPS Tracking of chick rearing Humboldt penguins

Initial plans called for the deployment of GPS loggers on Islote Pájaros Niños - an islet near Algarrobo, approximately 80 km west of Santiago - shortly after my arrival in Chile on 9 June. However, my arrival coincided with a series of unexpected weather fronts that brought extensive rainfall to the region. These conditions raised the risk of nest flooding and potential nest failure, which would have increased the likelihood of device loss due to nest abandonment. As a result, we postponed logger deployments.

Instead, the first week was dedicated to initiating drone piloting training with Maximiliano Daigre and collaborating with Alejandro Simeone and his student Isabel Bastías on the draft of a scientific manuscript. This paper analyzes the overlap between artisanal purse-seine fisheries operating out of Coquimbo and GPS tracking data collected in autumn and spring 2022 as part of the Sphenisco Project.

Scientific publication of 2022 GPS data

During my first week in Santiago, we reanalyzed much of the data previously used in Isabel's Master's thesis, incorporating new fisheries data recently obtained from SERNAPESCA. The updated analysis confirms significant spatial overlap between breeding Humboldt penguins and the autumn anchoveta fishery east of Isla Choros:



Below is the tentative title and abstract of the manuscript, which we plan to submit to the Open Access journal *PeerJ*.

Spatio-temporal overlap between purse seine fisheries and Humboldt penguin feeding areas in northern Chile

Abstract

Seabirds face increasing pressure from commercial fisheries through both direct mortality and indirect competition for shared prey resources. In Chile's Humboldt Current System, artisanal purse-seine fisheries target small pelagic fish species such as anchoveta (Engraulis ringens), which also comprise key components of the Humboldt penguin's (Spheniscus humboldti) diet. To investigate the potential for spatio-temporal overlap between purse-seine fisheries and penguin foraging areas, we tracked breeding Humboldt penguins from Isla Choros during the autumn and spring breeding seasons of 2022 using GPS dive loggers. We quantified penguin at-sea distribution and overlap with fishing effort data obtained from purse-seine vessels operating in the Coquimbo Region. Tracking data from 22 penguins revealed a bimodal foraging pattern linked to nest location. Penguins nesting on the eastern, mainland-facing side of Isla Choros foraged exclusively in coastal waters, while western-nesting individuals foraged both offshore and inshore, likely depending on environmental conditions. Kernel Density Estimation (KDE) analysis identified two core foraging zones: one along the mainland coast near Playa de los Choros and another southwest of the island. Purse-seine fishing effort in autumn was concentrated along the coast, overlapping substantially with the coastal foraging zone of the penguins. Nearly 60% of the penguins' coastal core foraging area overlapped with the 50% KDE of autumn purse-seine activity. In contrast, spring fishing effort was more dispersed and located farther south, with no overlap observed between spring fishing and penguin foraging areas. These findings suggest a high likelihood of indirect resource competition between Humboldt penguins and fisheries during the autumn breeding season - a critical time when penguins are energetically constrained as central place foragers. This study provides first empirical evidence of substantial seasonal overlap between penguins and fisheries and highlights the need for improved integration of seabird ecology into fisheries management. To protect vulnerable seabird populations such as the Humboldt penguin, marine spatial planning should consider critical foraging habitats and breeding schedules. Future work should aim to quantify dietary overlap, assess potential sub-lethal effects of prey depletion, and monitor the impact of small-scale, untracked fisheries within key penguin foraging areas.

GPS logger deployments - Islote Pájaros Niños

Our first visit to Islote Pájaros Niños took place on 11 June 2025. This one-day trip aimed to assess the number and condition of active nests prior to the arrival of a major weather front forecasted to pass through the region in the following days. We identified approximately 20 nests potentially suitable for GPS logger deployments; however, the majority still contained eggs or very small chicks, suggesting a slightly delayed onset of breeding. Consequently, the decision to postpone deployments until after the weather system passed proved unproblematic, as deployments would not have been feasible at that stage regardless.

We returned to Algarrobo a week later, on 18 June 2025, to evaluate any damage caused by the heavy rainfall and to attempt our first GPS logger deployments. Only two nests had been abandoned since our initial visit. Of the remaining viable nests, four contained chicks large enough to permit logger attachment. Under the supervision of a SERNAPESCA officer, we deployed GPS loggers on four male penguins. All four birds left their burrows and headed to sea the following day (19 June). As no additional nests were suitable for deployment, we used the remainder of the day for further drone training and a full island survey (see section: *Drone Training*).

Alejandro Simeone checks a penguin for an existing PIT tag prior to GPS logger deployment. Maximiliano Daigre holds the bird while Paulina Arce records data.

On our next visit to the island on 26 June 2025, we successfully deployed six more GPS loggers, bringing the total number of instruments deployed on Islote Pájaros Niños to ten.

We selected GPS loggers equipped with the largest available battery capacity (2000 mAh), anticipating that calmer sea conditions would soon allow deployments at Isla Cachagua and, subsequently, Isla Choros further north. Based on prior experience using these devices on Erect-crested penguins, we expected battery life to support deployments lasting at least three weeks.

Our next return visit took place on 8 July 2025. That afternoon and evening, we recovered five GPS loggers from birds still attending their nests. Two additional logger nests had failed: one contained two recently deceased chicks, while the other was empty with no trace of its former contents.

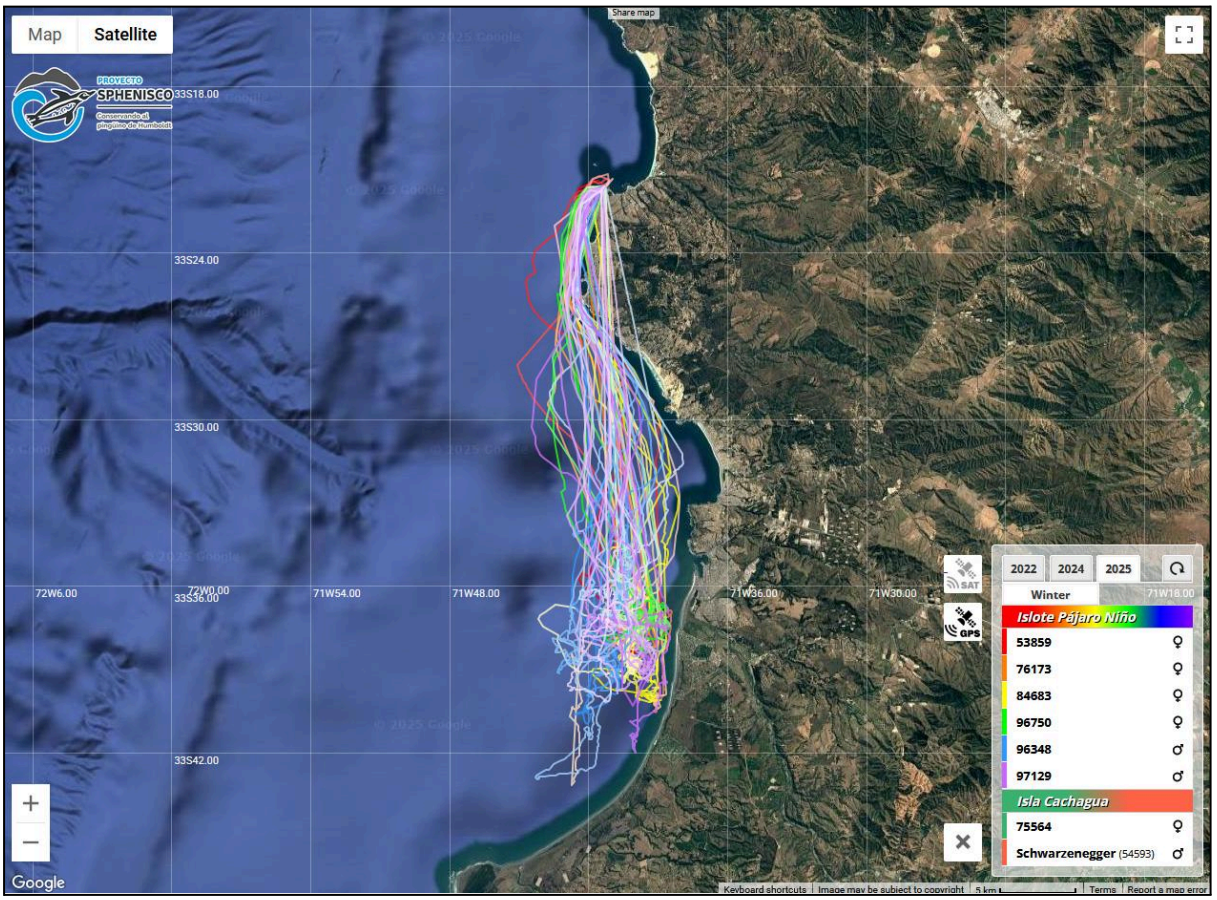
We remained on the island for the following four nights in an effort to retrieve the remaining devices. On 10 July, we recovered a sixth logger that was precariously attached to a bird - secured by only a single remaining cable tie, making this a particularly fortunate recovery.

A lucky device recovery: GPS logger on a Humboldt penguin 22 days after deployment.

Unfortunately, the logger birds from the failed nests were not observed returning. Moreover, two penguins had likely preened off their loggers while at sea, as the devices were not found in or near their burrows. In total, two devices are confirmed lost, and it is unlikely that the remaining two—associated with the failed nests—will be recovered unless the birds return and drop them near the nest.

Despite these setbacks, the data yield from the six recovered devices was substantial. Combined, the six loggers recorded a total of **42 complete foraging trips**, during which the birds performed **36,529 dives (depth range: 25-68m)**. The average trip duration was **22.6 hours**, with most birds departing their nests and entering the ocean at night.

Without exception, all six birds foraged within a **10 km radius of the coastline**, in waters off **San Antonio** and **Santo Domingo**, located between 25 and 35 km south of Algarrobo. Their core foraging area was concentrated near the **mouth of the Río Maipo**:



Foraging movements of six chick-rearing Humboldt penguins from Islote Pájaros Niños between 19 June and 8 July 2025. An interactive map is available at https://ptx.lat/hug25.

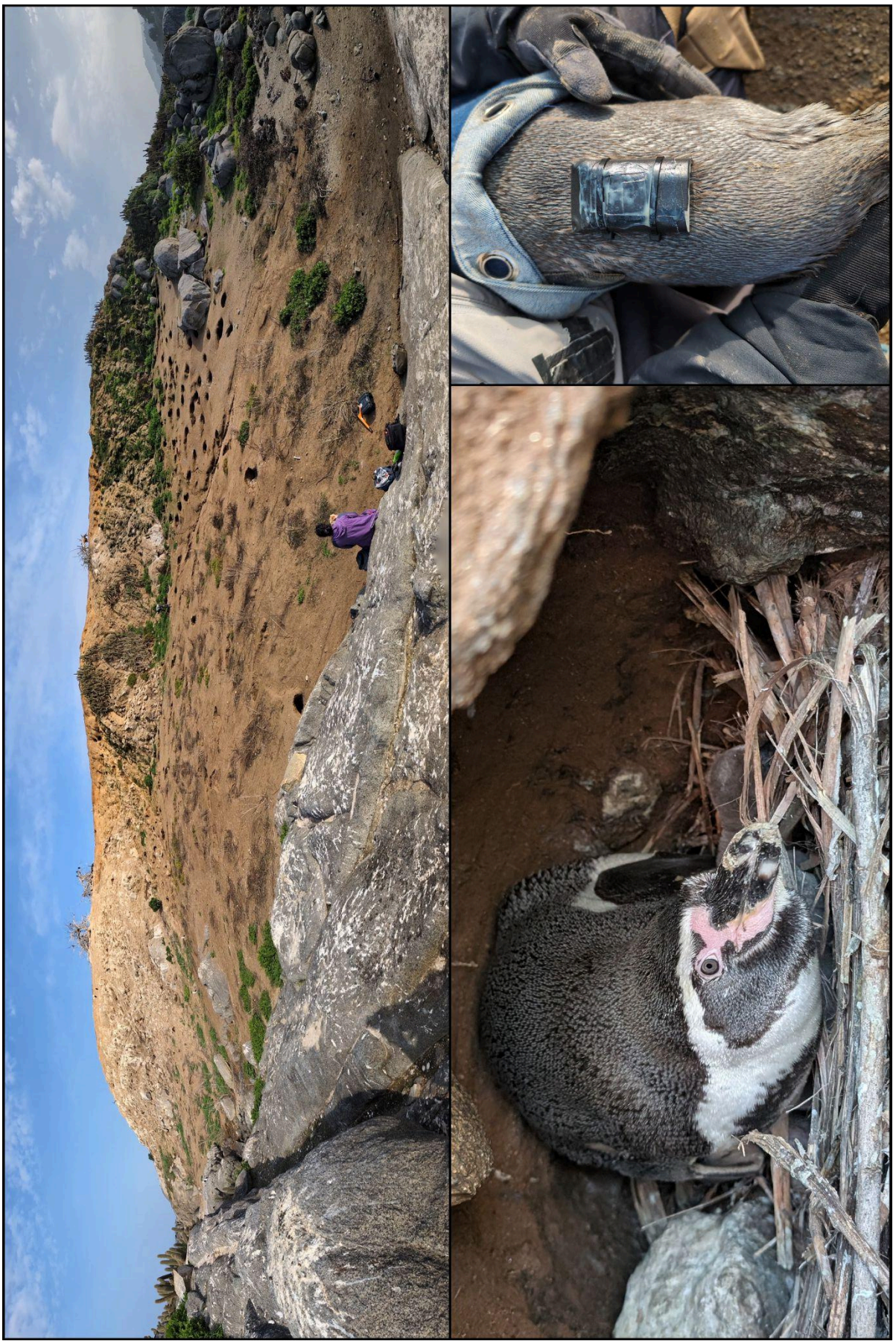
GPS logger deployments - Isla Cachagua

Favourable sea conditions allowed for a one-day visit to Isla Cachagua on 28 June 2025. Our three-person team was transported to the island early in the morning with the help of a local fisherman. While the crossing was somewhat rough, we landed without difficulty at around 9:00 a.m. With pickup scheduled for the late afternoon, we had approximately 7-8 hours available to survey the island and deploy ten GPS loggers.

Maximiliano Daigre & Paulina Arce shortly after landing on Isla Cachagua

The island was well occupied with breeding Humboldt penguins, and over the course of the day we recorded approximately 230 active nests. Having last deployed GPS loggers on the island in December 2024, we were particularly interested in identifying whether any of the birds previously tracked had returned to breed. Unfortunately, many of the nests monitored in December had collapsed due to the heavy rainfall in the preceding weeks, although none of them had been active at the time of collapse. In the end, we were able to identify only one bird from the December deployments, which was again fitted with a GPS logger.

Between 09:30 and 15:30, we deployed ten GPS loggers on adult Humboldt penguins attending chicks in earthen burrows:



As on Islote Pájaros Niños, we used GPS loggers with high battery capacity, anticipating that retrieval would occur approximately two weeks later following a planned visit to Isla Choros. However, persistent poor sea conditions led to a significant delay in the revisit.

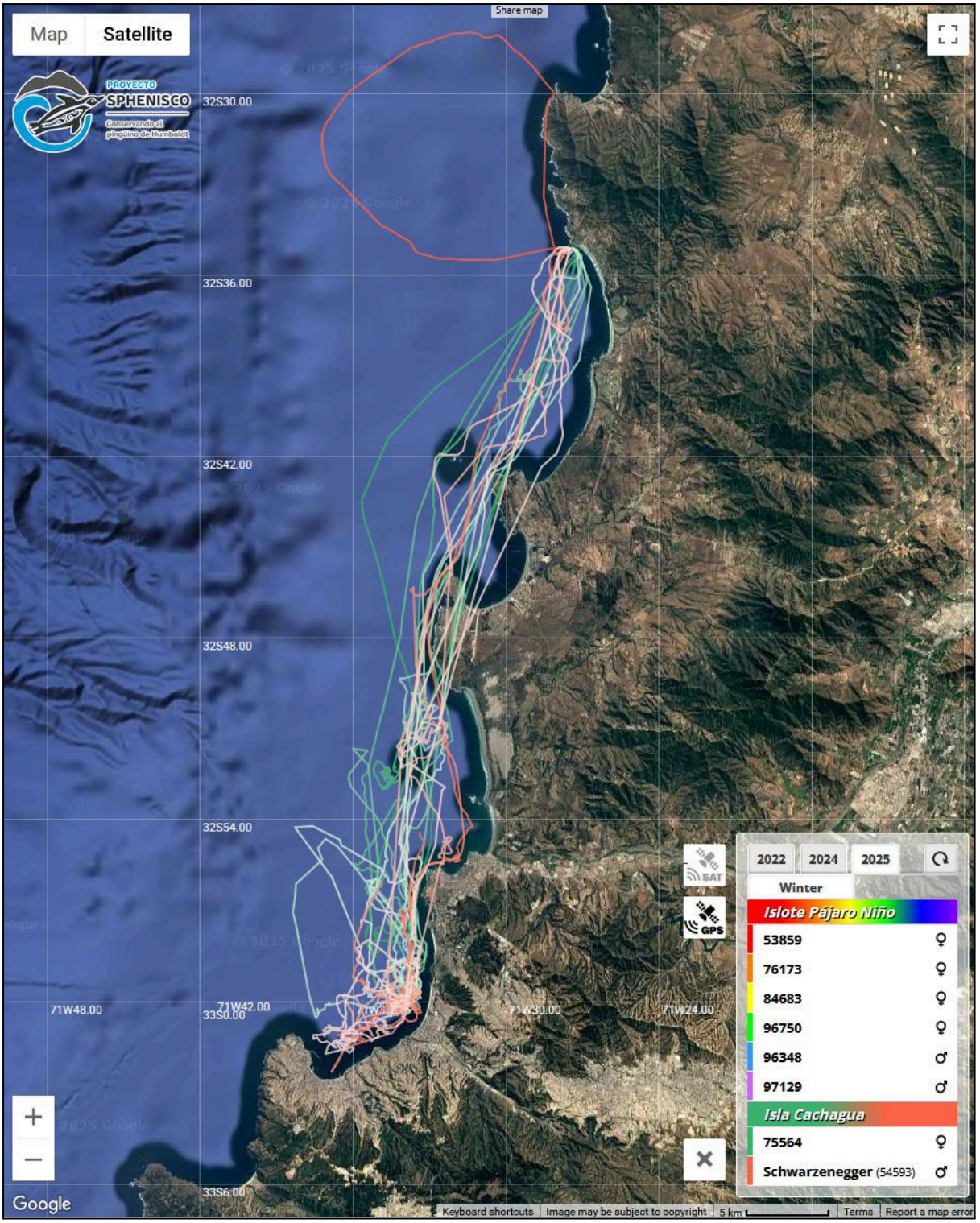
As a result, Maximiliano Daigre and Paulina Arce were only able to return to the island after my departure from Chile—**four weeks after deployment**, i.e., two weeks later than planned. They stayed on the island for two nights and discovered that **four of the logger birds were no longer carrying devices**. Such a high rate of device loss cannot be attributed to penguins preening them off alone. We suspect that the adhesive tape used to secure the loggers had degraded over time and was no longer fully functional, making the devices more prone to detachment from natural wear.

This suspicion was supported by the **recovery of two GPS loggers**: one was found lying on the nest floor while the corresponding bird was away foraging; the second was in a similar state to the "lucky recovery" documented on Islote Pájaros Niños. These findings strongly suggest that **age-related adhesive failure of the tape** was a major factor contributing to device loss.

The remaining four logger birds were not encountered during the visit and are still at large. At the time of writing, the team is planning a return trip to attempt recovery of the remaining devices.

Despite the setbacks, the **two recovered devices yielded complete data** sets spanning three weeks of foraging activity. Both birds showed general foraging patterns consistent with those recorded in December 2024, **remaining within 5 km of the coastline off Viña del Mar and Valparaíso, approximately 50 km south of Isla Cachagua**.

A total of 15 complete foraging trips were recorded. On average, the penguins spent around **1.5 days at sea**, with the longest trip exceeding four days. In total, the two birds performed **21,007 dives, primarily at depths between 56 and 95 metres** – considerably deeper than those recorded for their conspecifics breeding further south in Algarrobo.



Foraging movements of two chick-rearing Humboldt penguins from Isla Cachague between 29 June and 18 July 2025. An interactive map is available at https://ptx.lat/hug25.

Isla Choros - Nest surveys, no tracking possible

On 30 June 2025, our team travelled from Santiago to Punta Choros, at the southern edge of the Atacama Desert. Isla Choros has been a key site in past studies, supporting approximately 380 breeding pairs of Humboldt penguins in December 2022. However, following the 2023 El Niño, the population effectively collapsed — with no active nests recorded during summer 2024. Given recent signs of recovering ocean productivity, we hoped that breeding activity would resume if the penguins had merely paused reproduction over the past two years. Additionally, our previous tracking dataset was biased toward the island's western side, while most of the population breeds in the east.

Gathering new tracking data in the aftermath of El Niño was therefore a high priority.

On 1 July, Maximiliano Daigre and I travelled to the island with local tour guide and artisanal fisher "Tío Willy" and set up camp on the plateau above the main landing bay on the eastern shore.

Main landing bay on Isla Choros; camp location marked by arrow.

After lunch, we revisited several nests used during the 2022 tracking study on the slopes behind the camp. None showed signs of current or recent occupation

Typical state of a Humboldt penguin nest on Isla Choros, July 2025.

Later that afternoon, we surveyed one of the main eastern breeding zones just north of the landing bay, which had also hosted tracked birds in previous years. We found three active nests and one with abandoned eggs. Two nests had chicks - one recently hatched - while the third was still on eggs, which is unusually late given that breeding typically starts in May.

The penguins appeared nervous and easily disturbed, possibly due to a full-island survey carried out earlier that day by a large CONAF–SERNAPESCA team.

We managed to survey about half of the northern breeding region on Isla Choros that afternoon and found only a total of eight active nests - the majority of which were still on eggs. Another curious observation was that many of the nests contained signs of fairly recent moult (less than four weeks prior to our visit)..

Pile of feathers in a semi-open nest — clear sign of recent moult.

Humboldt penguins in northern Chile typically moult in February or March, but in 2025 the moult appeared delayed by up to two months. This, coupled with unusually late breeding, **suggested ongoing environmental stress**.

On 2 July, we continued the survey and confirmed that active nests remained rare. Many nests were abandoned or recently moulted in, with no signs of chick-rearing. Given the poor breeding conditions and visible stress among penguins, **we decided against GPS logger deployments**. The population clearly had not yet recovered, and we opted not to impose additional disturbance on the few pairs attempting to breed.

Instead, we focused on completing the nest survey before returning to Santiago. By the time we left the island on 5 July, we had recorded a **total of only 28 nests - seven of them abandoned - with the majority of the remaining nests still on eggs**.

Little sign of avian influenza

On a positive note, we found little evidence that the penguin population on the island had been affected significantly by the outbreak of avian influenza H5N1 in 2023. We found very few desiccated penguin carcasses in the breeding areas or on the beaches, which would be expected given that no collection of carcasses was conducted on the island.

Rescue of a female penguin entangled in gill net

While surveying the southern parts of the island, we received a phone call from SERNAPESCA. They informed us that a tourist vessel visiting the island had submitted a video showing a penguin struggling ashore, apparently entangled in a piece of fishing net. The footage forwarded allowed us to identify the beach and search for the penguin. From the top of the cliff we could see the bird, so we descended, carefully approached it, and managed to catch it.

Female Humboldt penguin entangled in a piece of gill net.

The bird was entangled to a point that it would have been impossible to free itself, with the head, beak and a flipper threaded through the mesh. We had to cut the net

with scissors to free the bird. It was very thin indicating that it might have been swimming around with the net for quite some time.

Upon closer inspection it became clear that the bird had been cut from the gill net and the set free. So presumably the fishers had observed it getting entangled, recovered the bird but then did not want to touch it to completely cut it from the net.

That the fisher recovered and released the bird is certainly positive. However, it would be very important to communicate to the fishing community that the birds need to be freed from nets completely as they lack the capabilities to free themselves. Perhaps an illustrated brochure advising fishers how to hold the bird to cut it free without being attacked by it would certainly have helped this penguin.

After we had cut away the net, we briefly discussed whether getting the bird to a rehabilitation facility would be possible. But the logistic problems were insurmountable so we decided to release the bird back into the water.

A short video of the rescue can be viewed here - https://youtu.be/0f4Mbbg6XY8.

Satellite transmitters on Isla Cachagua

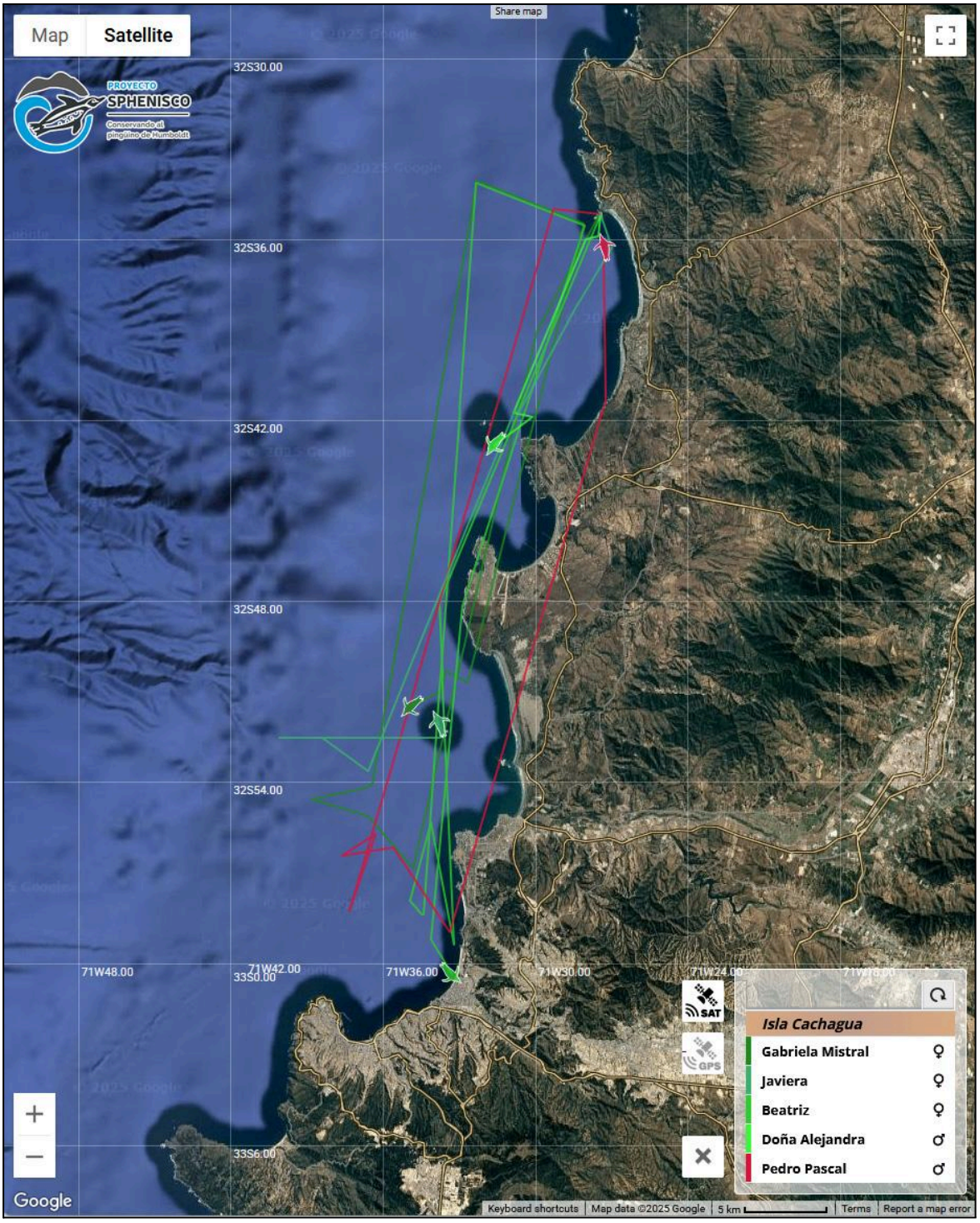
In collaboration with the Antarctic Research Trust and the Conservation Academy of Zoo Zürich, the team deployed five satellite transmitters on chick-rearing Humboldt penguins from Isla Cachagua during the GPS logger recovery efforts. The main objective of these transmitters is to track the penguins' movements at sea after the breeding season. While Humboldt penguins are generally considered migratory - similar to Magellanic penguins - this assumption has never been rigorously tested. This is the first attempt to determine whether the birds leave their breeding grounds after chick fledging or remain near the colony year-round.

Unlike GPS loggers, the **satellite devices transmit locations only infrequently** - typically a few fixes per day. However, they are expected to function for up to six months, potentially providing valuable long-term data, provided the attachment holds. To ensure durability, the team used a fresh roll of tape and sealed each device with a layer of epoxy resin to minimize premature detachment:

Since 23 July 2025, all five tagged birds have been transmitting their positions approximately every six hours. So far, their movement patterns are consistent with

GPS logger data, showing foraging trips toward Valparaíso. However, we expect chicks to fledge in mid-August, at which point the post-breeding phase—and the most revealing part of the tracking—will begin.

The progress of this satellite tracking study can be followed at: https://ptx.lat/hus25:



Drone training of local crew

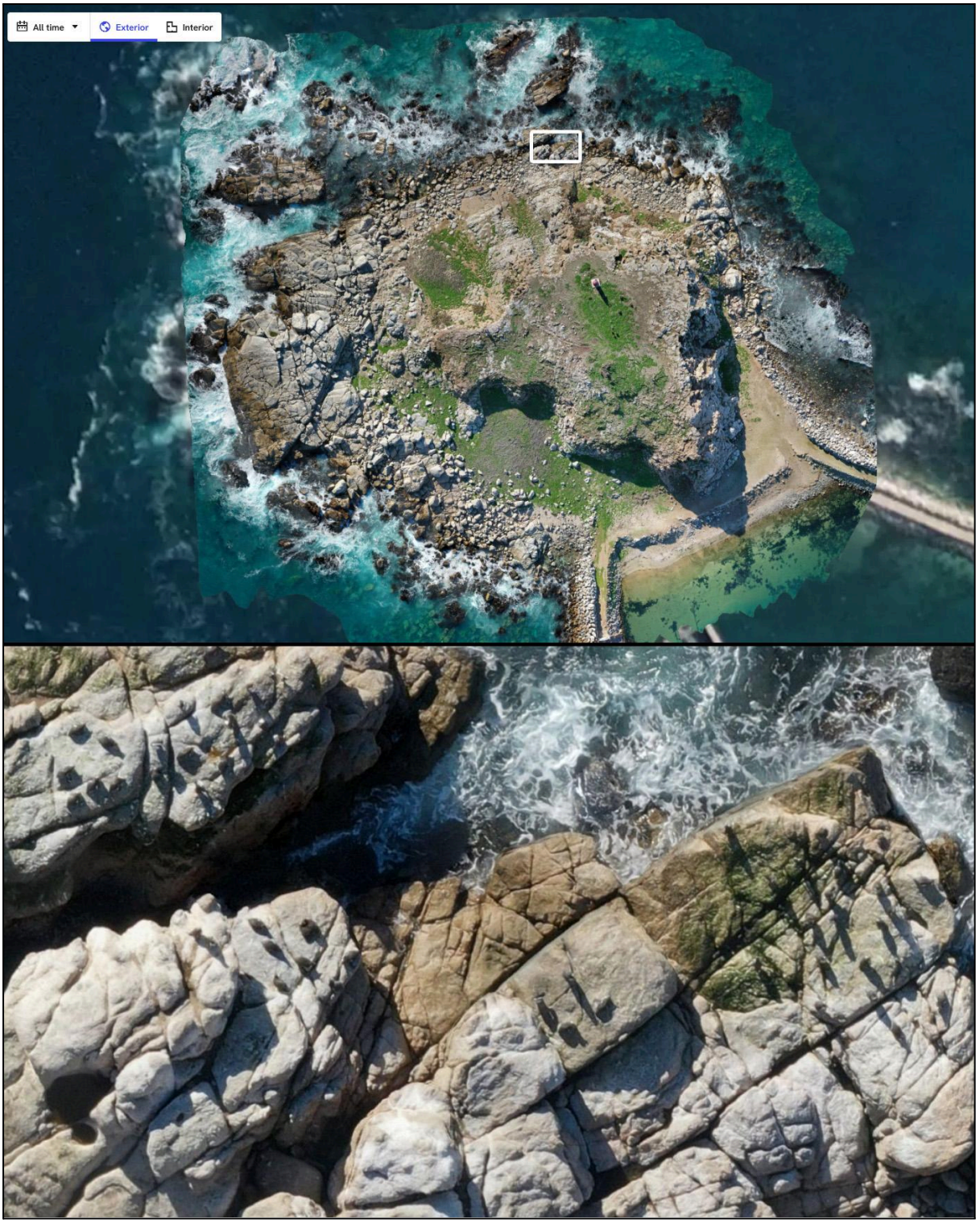
Given the uncertain status of Chile's Humboldt penguin population following the 2023 avian influenza outbreak and subsequent El Niño impacts, conducting population counts during the moulting period is essential. Even when penguins opt not to breed due to environmental conditions, they must still undergo their annual moult. As such, moult censuses can offer critical insight into regional population sizes, regardless of breeding activity.

Drones offer a highly efficient, cost-effective, and repeatable method for conducting these surveys. For example, island colonies such as Isla Cachagua or Isla Tilgo can be surveyed remotely from the mainland, eliminating reliance on local boat transport and favourable sea conditions.

When the start of fieldwork was delayed following my arrival in Chile, we used the opportunity to begin drone piloting training with Maximiliano Daigre. On 10 June 2025, we visited Parque Natural Las Hualtatas, where Max conducted his first test flights under my supervision.

Maximiliano Daigre during his first drone flight exercises at Las Hualtatas.

Further training opportunities arose during our visit to Islote Pájaros Niños, where I demonstrated the use of grid missions for systematic aerial surveys. The resulting images were processed using photogrammetry to generate high-resolution orthomosaics:



Orthomosaic generated from drone imagery (top) and detail of rocks with roosting Humboldt penguins (bottom). The white box in the top panel indicates the area shown below.

Throughout the following fieldwork on Isla Cachagua and Isla Choros, we made use of every opportunity to build further flight experience, expanding the training to

include Paulina Arce. Both Maximiliano and Paulina will form the core team responsible for conducting upcoming moult censuses:

Maximiliano Daigre and Paulina Arce during drone practice off Isla Tilgo, northern Chile.

In addition to orthomosaic generation, the team practiced coordinated flybys of roosting penguins to obtain optimal imagery for moult counts while minimizing disturbance to the birds.

Drone images of non-breeding Humboldt penguins on Islote Pájaros Niños.

Preliminary Conclusions

The fieldwork conducted in June and July 2025 has yielded valuable insights into the at-sea behaviour of Humboldt penguins in Chile. While a full analysis of the data - especially in relation to behaviour during the upcoming spring/summer breeding season (November-December 2025) - is still pending, several preliminary conclusions can already be drawn:

Foraging behaviour and habitat use

- Humboldt penguins from **Islote Pájaros Niños** and **Isla Cachagua** show **similar movement patterns at sea**:
    - They predominantly travel **southward**, and
    - tend to forage in areas with **reduced fishing activity**, likely due to high **pollutant loads** (e.g. Maipo River outlet) or **marine traffic** (e.g. Quintero, Valparaíso).

Regional differences in population status

- **Southern colonies** appear to be in **better condition** than those in the **north**:
    - Numbers of breeding pairs on Islote Pájaros Niños and Isla Cachagua are trending toward normal.
    - On **Isla Choros**, very few active nests were found.
    - **Nest abandonment** rates were apparently **higher on Isla Choros**, despite similar exposure to winter storms in the south.
    - Penguins on Isla Choros show a **delayed annual cycle**, with **late moult** and **late breeding**, indicative of continued environmental stress.

New questions raised

As is often the case, the data collected not only provides new insights, but also raises new questions:

- To what extent is **foraging behaviour influenced by fisheries**?
  Are penguins avoiding fishing pressure even if this means using **degraded or polluted areas**?
- Why are **southern colonies** faring better than **northern ones**?
  Has the **combined impact of El Niño and fisheries (resource competition, bycatch)** degraded the marine habitat in the north?
- Could this deterioration affect **juvenile survival**? In some banded penguin species, fledglings disperse northward. In African penguins, this has led to an **"ecological trap"**: juveniles migrate to Namibia, where overfishing has depleted prey stocks, leading to high first-year mortality. Observations by tour guides in Punta Choros suggest that most moulting penguins on Isla Choros in February 2025 were juveniles—possibly evidence of such a phenomenon.
- Given the **coastal foraging patterns** revealed by the data, what is the situation for **penguins breeding on offshore islands** like Pájaros in the north?

These questions should be addressed **urgently**, particularly if **northern populations** continue to show no signs of recovery. At this point, it is conceivable that the **IUCN Red List status** of the Humboldt penguin may need to be **revised from "Vulnerable" to "Endangered."**

Next steps

What needs to be done:

- Investigate foraging movements and diet composition during the **spring/summer breeding season**, using **GPS** and **camera loggers**.
- Assess **pollution exposure** in penguins from Islote Pájaros Niños using **feather and blood sample analysis**.
- Conduct **moult counts** using drones at key sites across the range, including: *Islote Pájaros Niños, Isla Cachagua, Isla Tilgo, Isla Choros, Isla Chañaral, and Pan de Azúcar.*
- Investigate **foraging behaviour on offshore islands**, particularly **Islas Pájaros**, especially in the context of fishing activities.
- Investigate the **dispersal of fledglings**, potentially using **GSM loggers** that transmit locations via mobile networks.
- **Continue long-term foraging studies** at key sites to assess whether observed patterns are consistent or anomalies.
- Produce and distribute **illustrated flyer with information for artisanal fishers** on how to handle remove netting and release entangled penguins

Outlook

The data collected so far highlight the vulnerability of marine top predators like the Humboldt penguin to multiple overlapping pressures - from climate anomalies and overfishing to local pollution. If current trends in the northern range continue, they may not only jeopardize the regional population but also warrant a reassessment of the species' global conservation status. Now is the time to better integrate research, targeted protection measures, and policy dialogue - before the Humboldt penguin becomes yet another symbol of a missed opportunity in biodiversity conservation.