ConCiencia

Magazine

Marine research – a GSC cornerstone.

Technology and storytelling to preserve history and biodiversity

Expanded research via external support

June 2025
Fifth Edition

GSC
GALAPAGOS SCIENCE CENTER
USFQ | UNC-CHAPEL HILL

GALAPAGOS SCIENCE CENTER
USFQ | UNC-CHAPEL HILL

@ ConCiencia Magazine
Fifth edition
Language: Spanish and English
Print run: 350 copies
San Cristóbal - Galapagos - Ecuador - 2025

CREDITS

COMPILATION AND EDITION:
Sofia Tacle
Karina Vivanco
Kelly Weaver

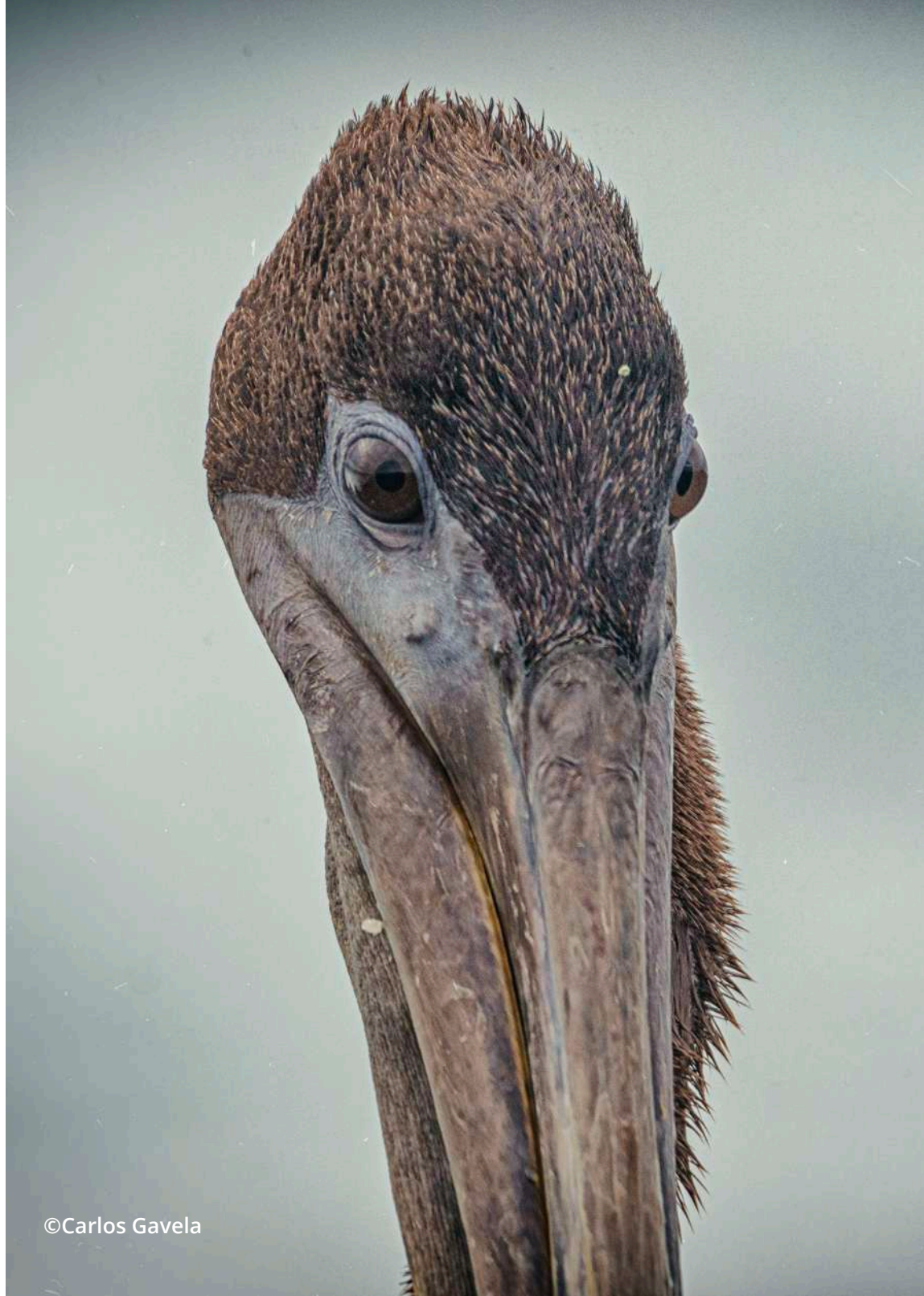
DESIGN AND LAYOUT
Emilia Sotomayor
Carlos Gavela / Archipelago Films

COVER AND BACK COVER PHOTOGRAPH
Maximilian Hirschfeld

PRINTING
Gragvi - El poder de la impresión

Galapagos Science Center @galapagosgsc GSCGalapagos

www.galapagosscience.org



ConCiencia Magazine:
Fifth edition

Editorial comments by Amanda Thompson and Carlos Mena, GSC Co-Directors

2025 ConCienca Intro Draft

The 5th edition of *ConCiencia* highlights the groundbreaking research, community engagement, and conservation efforts led by the Galapagos Science Center (GSC), a joint initiative of the Universidad San Francisco de Quito (USFQ) and the University of North Carolina at Chapel Hill. This year's issue showcases the GSC's commitment to interdisciplinary science and its role as a hub for innovation in one of the world's most ecologically significant regions.

Central to this year's edition is the development of a **Comprehensive Wildlife Health Model** for the Galapagos, described in the first article. Anchored in the One Health approach, this initiative integrates animal, human, and environmental health to address the growing threats of climate change, disease, and human-wildlife interaction. Through strategic partnerships, infrastructure development, and global training programs, the GSC is building a model that could inform conservation efforts in other fragile ecosystems worldwide. These conversation efforts are described in several articles including **People, petrels, and the land: A shared path to conservation in the Galapagos,** which demonstrates how community-based conservation and artificial nesting can support species recovery. Two articles, **Exploring the invisible microbial world surrounding the roots and leaves of the unique Galapagos tomatoes and Exploring the microbiome of an invasive plant in the Galapagos islands: A scientific expedition and future perspectives,** describe research exploring the microbiomes of endemic and invasive plants to uncover microbial allies that could enhance resilience or serve as biological control agents.

Marine research continues to be a cornerstone of the GSC's work. **Scientific expedition studies several megafauna species in Galapagos** describes how satellite and acoustic tags can track the movement and habitat use of key species such as manta rays, groupers, and cetaceans. **The Galapagos Bullhead Shark Project** describes how a decade-long study is unraveling the species' reproductive biology and genetic diversity, offering insights into how climate change may affect its survival. **Bruno Lab Research extends from Galapagos to North Carolina** exemplifies the global reach of Galapagos research, connecting the lab's field data on shark diets, reef fish, and marine snails to broader questions about ocean health and climate resilience.

This year's edition also celebrates the power of technology and storytelling for preserving the archipelago's history and biodiversity. **Digital Archaeology and Virtual Reality in the Wall of Tears, Isabela Island, Galapagos (1946-1959)** describes the use of virtual reality to reconstruct the site's history as a U.S. military base and Ecuadorian penal colony. This immersive experience, grounded in archaeological evidence, invites users to explore the past in a way that challenges myths and deepens understanding. The Galapagos Data Hub, described in the article **Galapagos Data Hub and the Importance of Open Science,** harnesses computing technology to create a digital platform to centralize environmental data for researchers, policymakers, and the public. With interactive maps, real-time weather dashboards, and 3D visualizations, the Hub embodies the principles of open science and data accessibility.

With support from the Royal Caribbean Group and the William R. Kenan, Jr. Charitable Trust, the GSC has expanded research opportunity for students and citizens. **Support from Royal Caribbean Group enhances research, local programs, and student experiences** describes how initiatives like Barcode+, a citizen science biodiversity cataloging project, REACCT, a community-based economic development program, and student field experiences have expanded the GSC's impact. The inaugural **Kenan Galapagos Fellows** are also featured for their work addressing maternal health and waterborne diseases. Alongside the article, **Reducing the dual burden of malnutrition through double-duty actions,** these projects underscore the importance of integrating environmental and public health in island communities. By co-designing interventions with local families, these researchers aim to improve human health and well-being, both advancing science and also empowering local communities. Finally, the **Connecting with Nature Program (CWNP)** celebrates its sixth year of fostering environmental identity and community well-being. Through family science events, reading sessions, and youth-led conservation projects, CWNP strengthens the human-nature connection and inspires a new generation of environmental stewards.

Together, these stories illustrate the GSC's holistic approach to science bridging disciplines, communities, and continents to protect the Galapagos and inform global sustainability efforts.

INDEX

1. **USFQ, through the Galapagos Science Center, promotes a comprehensive wildlife health model in the archipelago**
Authors: Cristina Calderón and Karina Vivanco — Page 8.

2. **Digital Archaeology and Virtual Reality in the Wall of Tears, Isabela Island, Galapagos (1946-1959)**
Authors: Fernando Astudillo and Paúl Rosero — Page 11.

3. **People, petrels, and the land: A shared path to conservation in the Galapagos**
Authors: Leo Zurita-Arthos, Carolina Proaño, Ramiro Adrián, Sebastián Melo and Jonathan Guillén — Page 15.

4. **Exploring the invisible microbial world surrounding the roots and leaves of the unique Galapagos tomatoes**
Authors: Iván Astudillo-Estévez, Jéssica Duchicela, Jos M. Raaijmakers and Pieter van 't Hof — Page 19.

5. **Exploring the microbiome of an invasive plant in the Galapagos Islands: A scientific expedition and future perspectives**
Authors: Antonio Leon-Reyes, Corné Pieterse and Noelia Barriga — Page 23.

6. **Scientific expedition studies several megafauna species in Galapagos**
Authors: Diana Pazmiño, Daniela Alarcón, Santiago Díaz, Ashley Altobelli and Michel Guerrero — Page 26.

7. **The Galapagos Bullhead Shark Project**
Author: Maximilian Hirschfeld — Page 30.

8. **Bruno Lab research extends from Galapagos to North Carolina**
Authors: Maya True Wasik and Kelly Weaver — Page 36.

9. **Galapagos Data Hub and the importance of open science**
Authors: María Belén Zapata Ramos and Henry Paúl Cárdenas Campoverde — Page 39.

10. **Support from Royal Caribbean Group enhances research, local programs, and student experiences**
Authors: Kelly Weaver and UNC Communications — Page 43.

11. **Inaugural Kenan Galapagos Fellows launch new research**
Authors: Kelly Weaver and UNC Communications — Page 46.

12. **Reducing the dual burden of malnutrition through double-duty actions**
Authors: Leidy Apolo and Lesly Cadena — Page 49.

13. **Promoting holistic well-being, education, and conservation in the Galapagos Islands**
Authors: Leidy Apolo and Lesly Cadena — Page 52.

Our Goals

The Galapagos Science Center (GSC) is an interdisciplinary research facility whose mission is to lead in the understanding of human and environmental interactions on a local and global scale through integrated scientific research, experiential education, and community outreach.

Experiential education

Provide hands-on learning experiences for local and international students across an array of interdisciplinary research projects thanks to partnerships with the Galapagos National Park Directorate and other local public institutions.

Research

Develop interdisciplinary research projects for the conservation and sustainability of the Galapagos Islands and globally through 5 basic pillars: environmental change, community & human health, conservation, oceans, and biodiversity.

Community Outreach

Contribute to sustainable development and greater environmental awareness in the local community to better understand the complex interactions among people and the environment in which they live.

Global Partnerships

Create a scientific network that is powered by a diversity of thought, perspectives, techniques, approaches, visions, and a data infrastructure that are leveraged through integrative science to create a collaborative global network of institutions and scholars for the innovative study of island ecosystems.

The Galapagos Science Center (GSC), run jointly by the University of North Carolina at Chapel Hill and the Universidad San Francisco de Quito in Ecuador, is the only university science facility of its kind on the Galapagos Islands. For over 13 years the GSC has been a hub of collaborative and interdisciplinary research, education, and community outreach. The GSC is committed to advance science and conservation in the Galapagos Islands and to extend a richer, more complete understanding of island ecosystems and the threats to their sustainability to the world.

The 20,000-square-foot GSC houses four state of the art laboratories, each with a dedicated research focus: genomic, marine sciences, human health and ecosystems, and data science and visualization. The GSC is located in Puerto Baquerizo Moreno, San Cristóbal Island, Galapagos Archipelago.

Interdisciplinary research that furthers science and contributes to the conservation and sustainable development of the Galapagos is our number one priority. The GSC brings together international researchers to tackle the grand challenges of our time and, in turn, inform policy decisions. Since 2011 we have conducted over 140 research projects across 5 main areas of research. Throughout this edition of ConSciencia we will highlight research across these areas and showcase their impact.

1.

USFQ, through the Galapagos Science Center, promotes a comprehensive wildlife health model in the archipelago

Author: Cristina Calderón and Karina Vivanco

The Universidad San Francisco de Quito (USFQ), through the Galapagos Science Center (GSC), is leading the strategic planning for a Comprehensive Wildlife Health System in the Galapagos Islands. Based on the One Health approach, this model recognizes the interconnection between animal, environmental, and human health.

The Galapagos Islands face increasing threats from climate change, the spread of infectious diseases, and greater connectivity, all of which put biodiversity and local communities at risk. Addressing these challenges requires integrated, sustainable solutions rather than fragmented efforts.

The GSC is developing a multidisciplinary program focused on health, conservation, and education. The initiative aims to strengthen local capacity, develop infrastructure, coordinate resources, and train professionals both locally and internationally.

As USFQ President Diego Quiroga explains:

> **"One Health is illustrated by the interactions between sea lions, domestic dogs, and humans—interactions that facilitate disease transmission. Understanding these links is key to preventing outbreaks and preparing effective responses."**

On February 14, 2025, a workshop was held in Puerto Ayora, Santa Cruz Island, with participation from the Galapagos National Park Directorate, the Galapagos Biosecurity Agency (ABG), and other partners. The event provided a platform to share information, identify challenges, and plan collaborative strategies for implementing the health system.

Key Strategies Include:

- **Health Monitoring & Surveillance:** Establishing protocols for early detection and control of diseases in key species.
- **Local Capacity Building:** Training veterinarians, lab technicians, and park staff in wildlife and ecosystem health.
- **Infrastructure Development:** Building clinics and veterinary labs on San Cristóbal, Santa Cruz, and Isabela islands, including mobile care units.
- **Global Academic Training:** Offering exchange programs and training in wildlife medicine for professionals and students.
- **Sustainability & Funding:** Securing long-term support through partnerships and education programs.

Strategic alliances include the Galapagos National Park Directorate, ABG, INSPI, USFQ, GAIAS Europa, North Carolina State University, and the Oceanogràfic Foundation. Rafael Jordá, Director of GAIAS Europa, emphasized the importance of international collaboration:

> **"We aim to bring European expertise closer to Ecuador to enhance conservation efforts."**

Daniel García, Scientific Director at the Oceanogràfic Foundation, highlighted their role in generating vital information:

> **"We want to understand which viruses are affecting animals and how they could impact humans, ensuring that all species are properly monitored through the One Health framework."**

This initiative not only addresses the specific needs of the Galapagos, but aims to serve as a model for other ecologically sensitive regions. By integrating science, conservation, and policy, USFQ and the GSC are building a foundation for global impact.

Carlos Mena, Co-Director of the GSC, summarized the vision:

> **"We want to open an animal health clinic to study how diseases move between humans, pets, and wildlife. Understanding these processes is crucial for managing ecosystem health in a coordinated way."**

2.

Digital Archaeology and Virtual Reality in the Wall of Tears, Isabela Island, Galapagos (1946-1959)

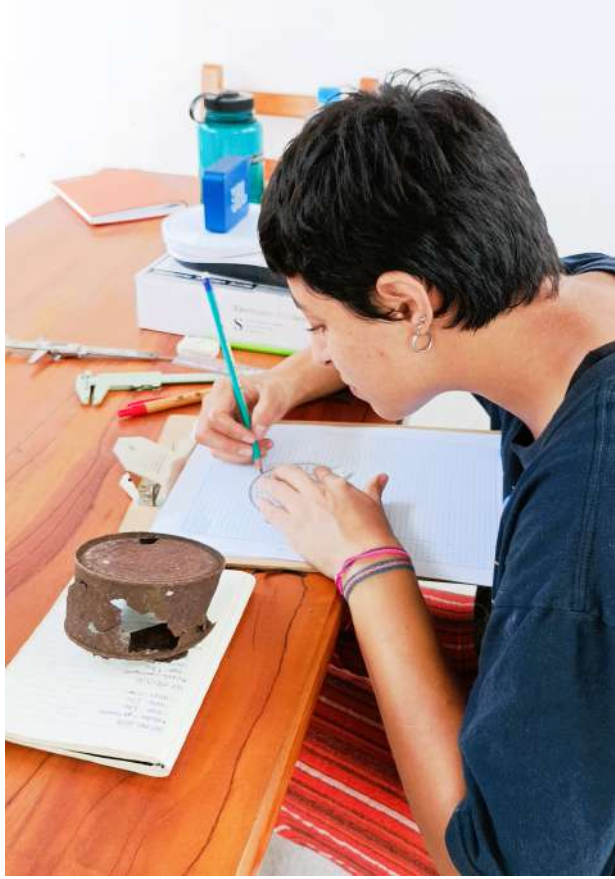
Authors: Fernando Astudillo and Paul Rosero

During World War II, the United States Army and Navy built military bases in countries near the Panama Canal to protect it from potential attacks. In Ecuador, the U.S. Army built a military base on Baltra Island (South Seymour Island), three radar stations on Isabela Island, and an air base in Salinas, located on mainland Ecuador. The Cerro Orchilla radar station on Isabela Island was abandoned at the end of the war in 1946 and immediately transformed into a Penal Colony administered by the Ecuadorian government, which was closed in 1959. Today, this historical and tourist site is known as the Wall of Tears.

information, and geographic data together, and combines them on digital platforms. The methods implemented included the analysis, identification, interpretation, and dating of material culture (objects); fauna identification; 3D digital terrain surveying with LiDAR data; digital modeling of structures; and the production of an immersive Virtual Reality (VR) experience.

There are more than 20 features and structures of different types associated with both the Cerro Orchilla Radar Station and the Isabela Penal Colony; for example, concrete floors, stone walls, concrete walls, paths, access roads, and intentional modification of the topography. The concrete structures are located in three sectors: Campamento, Antenna, and El Condenso, where some superficial collection points of objects were made. More than 600 fragments were collected. Glass beer and soda bottles, medicine containers, flasks, window glass, electrical insulators, table plates, machetes, knives, food and beverage cans, water pipes, nails, a spark plug, light bulbs, barbed wire, wire mesh, and ammunition casings of .30-06 and 9 mm Parabellum calibers have been identified. The artifacts were manufactured between 1931 and 1959 in the United States, Mexico, and Peru.

With LiDAR technology, we obtained a Digital Terrain Model (DTM) that was used as the base layer for the production of the VR experience, which is



In 2023, we began an archaeological investigation and digital modeling of the activities that occurred at this site between 1940 and 1959. The objectives were to analyze and interpret the existing material evidence at the site and produce immersive digital models of the two occupations of the site, thereby providing evidence of how people lived in the past. To achieve this, we combined archaeological and digital art methods.

Digital archaeology analyzes material evidence, archival documents, ethnographic

organized into three scenarios: Cerro Orchilla Station, Radar, and Isabela Penal Colony. The VR model allows users to navigate between scenes, explore structures, view their occupants, and interact with the local environment. The digital models are available for free in Spanish and English via apps optimized for Meta Quest 3 headsets, PCs, and Macs.

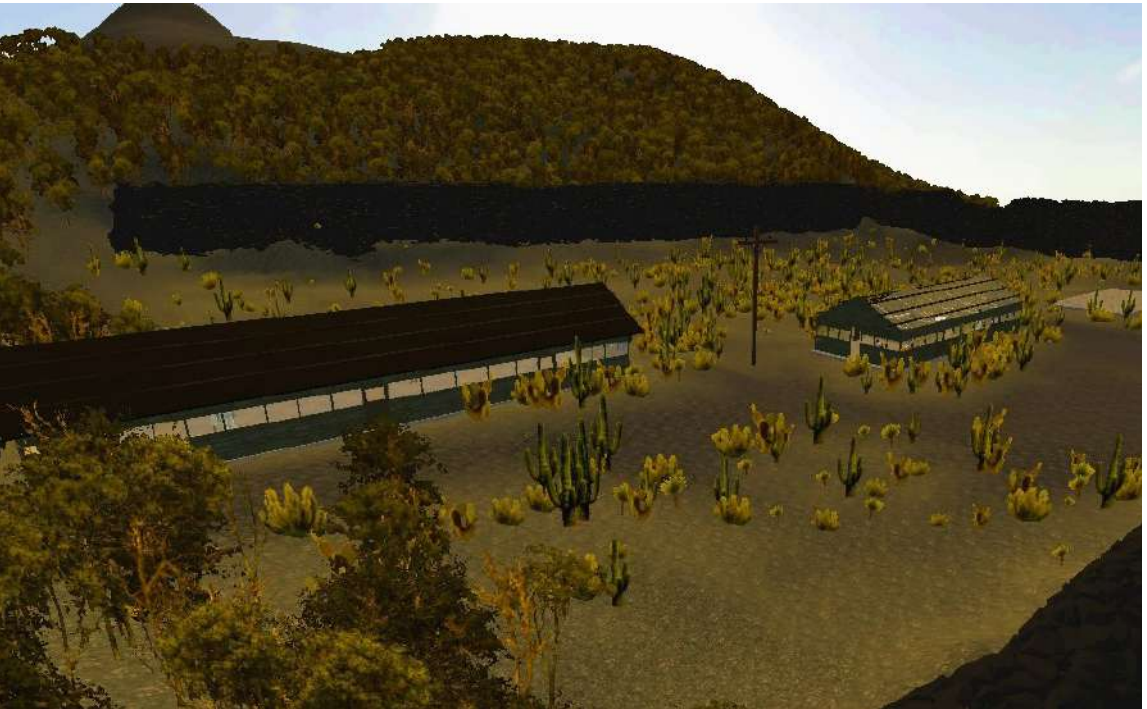
Our research confirms the existence of at least seven barracks, a power line, a water desalination system, and roadways built for the Cerro Orchilla Radar Station. The

artifacts found suggest that American soldiers relied on a permanent supply of food and recreational drinks shipped from Baltra. All of these services were eliminated beginning in 1946. Therefore, we believe that the radar station construction activities had a significant impact on the terrain, but less so over time, while the convicts' activities may have had a greater impact, as the inhabitants of the Isabela Penal Colony had to obtain food directly from nearby ecosystems over a longer period of time.

Finally, the digital models in Virtual Reality based on archaeological evidence allow access to an immersive experience of the past, which aims to question legends and myths about the occupation of the Wall of Tears, contrasting the testimonies with the material evidence existing on site.

People involved and overview of their background

The project had two components: (1) archaeology, led by Fernando Astudillo, USFQ anthropology professor, and (2) digital modeling, led by Paul Rosero, USFQ visual arts professor. The team of collaborators includes Carlos Mena, Carolina Sampedro, and María Belén Zapata from the USFQ Institute of Geography; Mark Bueno, USFQ interactive media design professor; Leonardo García and Roberto Maldonado from the DPNG; and students Juan Camilo Argoti and Martina Almeida (anthropology), Jonathan Paredes (visual arts), and Mauricio Rivera (interactive media design). The research was conducted with research permits from the Galapagos National Park Directorate and INPC and funded by Galapagos Grant GSC 2023 and Collaboration Grant USFQ 2023.



3.

People, petrels, and the land: A shared path to conservation in the Galapagos

Authors: Leo Zurita-Arthos, Carolina Proaño, Ramiro Adrián, Sebastián Melo and Jonathan Guillén

The Galapagos Islands are a unique and vulnerable natural garden, globally renowned for their distinctive biodiversity. Among the endemic threatened species is the Galapagos Petrel *Pterodroma phaeopygia*, a seabird that nests exclusively in the highlands of five of these islands. Despite their ecological importance, Galapagos Petrels are endangered due to increasing anthropogenic pressures. Habitat degradation from invasive plant species, introduced feral predators, and livestock trampling are central threats. Our long-term research and efforts focus on an innovative conservation initiative aimed at reversing the decline of petrel populations through community-based strategies and habitat restoration.

One of the main objectives of the project is to assess whether local farmer engagement and artificial nest creation can effectively support the conservation of the Galapagos Petrel. We want to provide information on how petrel nesting success can be improved through in situ on-farm conservation, and what role can artificial nesting sites play

in the species' recovery. Finally, we are gathering information on how this conservation effort may serve as a broader model for sustainable land use and biodiversity protection.

The project follows a participatory conservation model. First, we, as researchers, map known and potential petrel nesting sites using field surveys and reports from local farmers. Additionally, nesting burrows are monitored using visual inspection techniques and flexible optic video cameras inserted into the tunnels. Additionally, six artificial nests were already constructed from simple gardening materials to evaluate whether petrels would accept alternative nesting habitats. We are hoping to recruit more potential breeding pairs in the secure and safe areas that will be conserve over the long term (i.e. National Park areas and private land where there is an agreement of conservation).

We started working with the petrel nesting areas in San Cristóbal back in 2017, and extended our efforts to the farms in Santa Cruz, starting in 2019. The work with the local farmers takes time as the expected results with the artificial nests. We continue our seasonal efforts of monitoring in the field with the aid of camera traps that give us an incredible insight in the activities and behaviours of the petrels. Dialogue with farmers remains ongoing, laying the groundwork for scaling up nest protection and habitat restoration efforts in subsequent phases. Initial findings give us encouraging signs: farmers demonstrate strong interest in supporting the petrel conservation within their land, and nest mapping revealed viable breeding areas across multiple properties. While petrels had not yet occupied the artificial nests, we note that it might take several breeding seasons for birds to accept them. Nevertheless, there has been an increase in activity in several areas where we only used to find a few nests before. However, monitoring also confirmed that predation and trampling remained ongoing threats, emphasizing the need for more comprehensive land management strategies. Involving local communities is essential for effective conservation on inhabited islands. The Galapagos Petrel Project shows promise not only for species recovery but also for promoting sustainable land practices in sensitive ecosystems. The artificial nest approach, though in its infancy, represents a scalable tool that could complement broader habitat protection measures. Overall, the project illustrates how integrated conservation models can align ecological goals with community values.

People Involved and a Brief Overview of Their Background

The Galapagos Petrel Project involves a multidisciplinary team of conservation biologists, local landowners, and park authorities. Researchers from USFQ and other conservation-focused institutions lead the ecological assessments and data collection, while more than 50 local farmers from Santa Cruz and San Cristóbal Islands provided land access and traditional ecological knowledge that goes, in some cases, beyond one generation. The collaboration is based on mutual interest: we, as scientists, bring some technical expertise, while the farmers contributed site-specific knowledge and stewardship over their properties.

©Carlos Gavela

4.

Exploring the invisible microbial world surrounding the roots and leaves of the unique Galapagos tomatoes

Iván Astudillo-Estévez, Jéssica Duchicela, Jos M. Raaijmakers and Pieter van 't Hof

Darwin's plant collection during his global voyage with HMS the "Beagle" became the basis for the later description of the vegetation of the Galapagos, and has helped Darwin, who visited the islands in 1835, to develop his revolutionary theory of evolution by means of natural selection.

The wild Galapagos tomato *Solanum cheesmaniae* was amongst the originally collected plant species by Charles Darwin when the Beagle visited the Galápagos almost two centuries ago. Interestingly, his great-great-granddaughter Sarah Darwin described a second wild tomato species at the archipelago in her PhD thesis in 2009, which she named *S. galapagense*. Their unique evolution in inhospitable habitats throughout the archipelago, with little or no rain for months, has provided these endemic tomatoes with unique characteristics like a high tolerance to drought and salinity. These features are partly the result of their unique genetic make-up, but plants are also known to recruit and actively form associations with hundreds of millions of microbes surrounding their roots and leaves, including bacteria and fungi, which help the plant improve their

nutrient absorption, elevates its environmental stress tolerance, and helping the host plant to reach a higher level of protection against plagues and diseases. Surprisingly, however, very little is known to date on the taxonomic and functional diversity of the microbial communities associated with these two endemic tomato species at the Galápagos Islands.

The Galapagos tomato microbiome project is coordinated by Pieter van 't Hof, a biology professor at USFQ and GSC researcher; and by Jos Raaijmakers, Director of the Department of Microbial Ecology at the Netherlands Institute of Ecology (NIOO-KNAW), and professor at Leiden University in the Netherlands, which supervise the research teams revolving around the Ecuadorian PhD candidates Stalin Sarango Flores and Ivan Astudillo-Estevez in their quest to map the wild tomato microbiome in the Center of Origin of the *Lycopersicon* clade of tomatoes in Southern Ecuador, and at the Galapagos Islands, respectively.

Although *S. galapagense* has been granted the 'least concern' status by the IUCN, recent field observations published by Gibson et al. (2020) indicate rapid losses in the natural populations of the endemic Galápagos tomatoes, which could indicate that both endemic tomato species are confronted with an uncertain future because of the rapid proliferation of invasive plant species, including their closely related family member *S. pimpinellifolium* from mainland Ecuador. Exploring the taxonomic and functional diversity of microorganisms associated with tomato plants in their naturally challenging environments, or while competing with invasive species in the same habitats *(S. pimpinellifolium)* could lead to clues about the possibilities how we could help the Galapagos tomatoes in case the natural populations continue their decline. In Cordovez et al. (2024), the transfer of natural soils collected close to healthy *Scalesia* plants to (reintroduced) seedlings has been proposed to promote seed germination and enhance seedling growth and survival rates, which could also be effective for endemic tomato seedlings.

Furthermore, the results of this study may reveal that these

Galapagos tomatoes engage in unique microbial beneficial associations necessary for improving salinity and drought tolerance, which could shine a light on interesting microbial traits to improve climate-resilient future crops in a sustainable matter. We believe that fundamental knowledge on how plant-microbial interactions work will help in the development of future crops which will be more resistant to biotic and abiotic stresses with significant implications for enhancing both agricultural productivity and sustainability.

People Involved and a Brief Overview of Their Background

This Galapagos tomato microbiome research project is a collaboration between Universidad San Francisco de Quito (USFQ), the Galapagos Science Center (GSC), the Galapagos National Park directive (DPNG), and the Universidad de las Fuerzas Armadas (ESPE) in Ecuador; and the Netherlands Institute of Ecology (NIOO-KNAW), and the University of Leiden. The project has been carried out in partnership with ZymoResearch (California, United States of America), and was made possible with the help of the DARWIN200 initiative (darwin200.org) and SPUN-Society for the Protection of Underground Networks.

www.spun.earth.

5.

Exploring the microbiome of an invasive plant in the Galapagos Islands: A scientific expedition and future perspectives

Authors: Antonio Leon-Reyes, Corné Pieterse's and Noelia Barriga

In an effort to combat one of the most aggressive plant invasive species in the Galapagos Islands, a team of international researchers conducted a scientific expedition to collect samples associated with *Rubus niveus*, commonly known as the invasive raspberry. The primary goal of this mission was to identify endemic pathogens or other antagonistic microbiota — particularly fungi and bacteria—that may naturally affect *Rubus niveus* and could potentially be used in future biological control strategies.

Rubus niveus has rapidly colonized vast areas of the Galapagos, forming dense thickets that outcompete native vegetation, disrupt ecosystem dynamics, and threaten endemic species. Despite ongoing mechanical and chemical control efforts, the plant remains difficult to eradicate. As a result, biological control—using natural enemies such as pathogens or other antagonistic microbiota—has emerged as a promising alternative for long-term management.

During the 20-day expedition, which spanned five major islands in the archipelago (Santiago, Santa Cruz, Isabela, Floreana, and San Cristóbal), researchers collected three types of samples. These included soil from the rhizosphere, roots, and leaves—some appearing healthy, others showing visible signs of disease. These materials were carefully labeled and preserved under sterile conditions for later microbiological and molecular analysis. The study aims to characterize the microbiome—specifically the bacterial and fungal communities—associated with *Rubus niveus* across different environmental contexts in the islands.

By applying DNA sequencing technologies and microbial culturing, the team aims to identify microorganisms—either individually or as part of a microbial community—that exhibit antagonistic effects against *Rubus niveus*. If effective strains are identified, they could be developed into biological control agents to inhibit the growth and spread of this invasive plant. This approach would reduce reliance on herbicides and minimize the environmental impact of current control methods—offering a sustainable solution sourced directly from the islands themselves. This project highlights the importance of integrating molecular biology, field ecology, and conservation science. Using microbiome research as a tool for ecosystem restoration is still an emerging field, and this expedition represents a pioneering approach in the context of the Galapagos Islands.

In addition to its scientific outcomes, the expedition strengthens international collaboration and capacity-building in the region. The findings may contribute significantly to sustainable conservation strategies in Galapagos and offer a model for managing invasive species in other sensitive ecosystems worldwide.

People involved and overview of their background

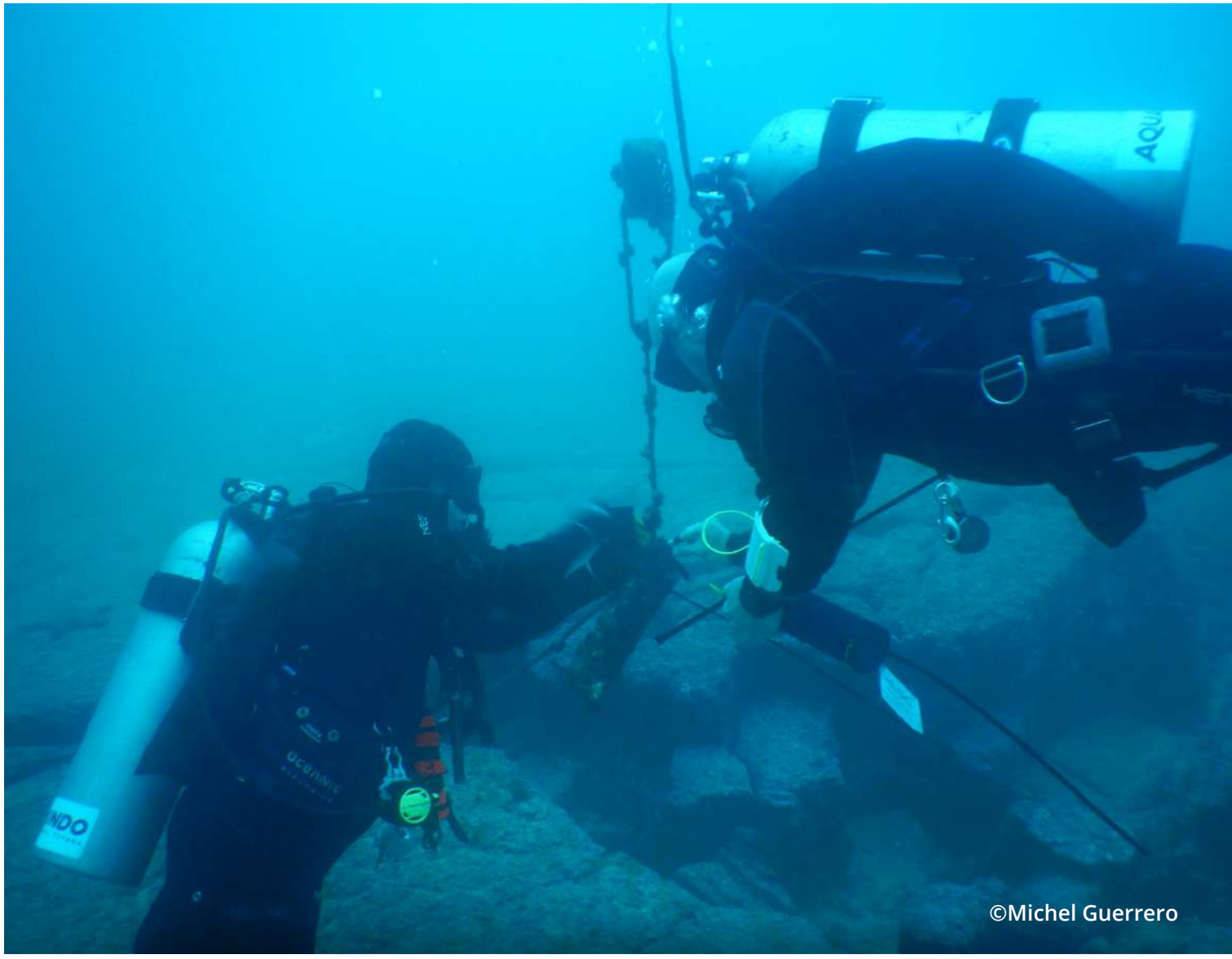
The research team, led by Prof. Antonio León-Reyes and Noelia Barriga PhDc from Universidad San Francisco de Quito, also included collaborators Prof. Corné Pieterse and Hans van Pelt from Utrecht University (Netherlands). This collaborative effort brought together expertise in plant microbiomes, pathogen interactions, and sustainable pathogen management. Also, a key collaborator within this project is the Galapagos National Park Directorate (GNPD), which helps in the knowledge of the habitat and places to collect, and the Galapagos Science Center (GSC) for logistics during the expedition.

6.

Scientific expedition studies several megafauna species in Galapagos

Authors: Diana Pazmiño, Daniela Alarcón, Santiago Díaz, Ashley Altobelli and Michel Guerrero

The Galapagos National Park Directorate (GNPD), in collaboration with Universidad San Francisco de Quito (USFQ), the Galapagos Science Center (GSC), and Proyecto Mantas Ecuador (PME), conducted a scientific expedition in the southern and eastern regions of Isabela Island. Supported by Brookfield Zoo Chicago, Sarasota Dolphin Research Program, Mote Marine Laboratory, Georgia Aquarium, and the Ocean Tracking Network, the expedition provided valuable data for at least four research projects.



©Michel Guerrero

The mission aimed to fill information gaps on various species, including commercially important fish and tourist-attractive megafauna such as oceanic manta rays, mobulas, groupers, and marine mammals. This collaborative effort, which took place from March 4 - 11, 2025 with the support of the crew aboard the vessel *Danubio Azul*, reaffirms the commitment of GNPD and USFQ to marine research and conservation in the Galapagos.

©Santiago Díaz

To track movement patterns and assess connectivity across the archipelago, the team deployed seven satellite tags and 11 acoustic tags on 15 oceanic manta rays *Mobula birostris*, a highly migratory marine species. In addition to satellite and acoustic tracking, drones were used to monitor key habitats for manta rays and other *Mobula* species. Eight acoustic receivers were deployed, and photo-identification data was collected for manta rays, other ray species, and cetaceans.

©Ashley Altobelli

The study confirmed key aggregation areas and cleaning stations for various *Mobula* species.

Capture, sampling, tagging, and release methods were also used for groupers *Mycteroperca olfax* to improve understanding of their biology and movement. Blood samples were collected to assess reproductive hormone levels, and external tags were attached for identification. Genetic samples of sharks, rays, and fish were also collected for population studies.

As part of cetacean monitoring, the team recorded sightings and photo-ID data to evaluate habitat use and distribution. This included continued monitoring of a known adult killer whale *(Orcinus orca)* first documented in the Galapagos in 2016. Several dolphin species were also recorded, including bottlenose dolphins *Tursiops truncatus*, the most frequently observed cetacean in the region. These sightings provide insights into the distribution of cetaceans in the southern and eastern waters of Isabela Island.

©Farah Hamdan

7.

The Galapagos Bullhead Shark Project

Author: Maximilian Hirschfeld

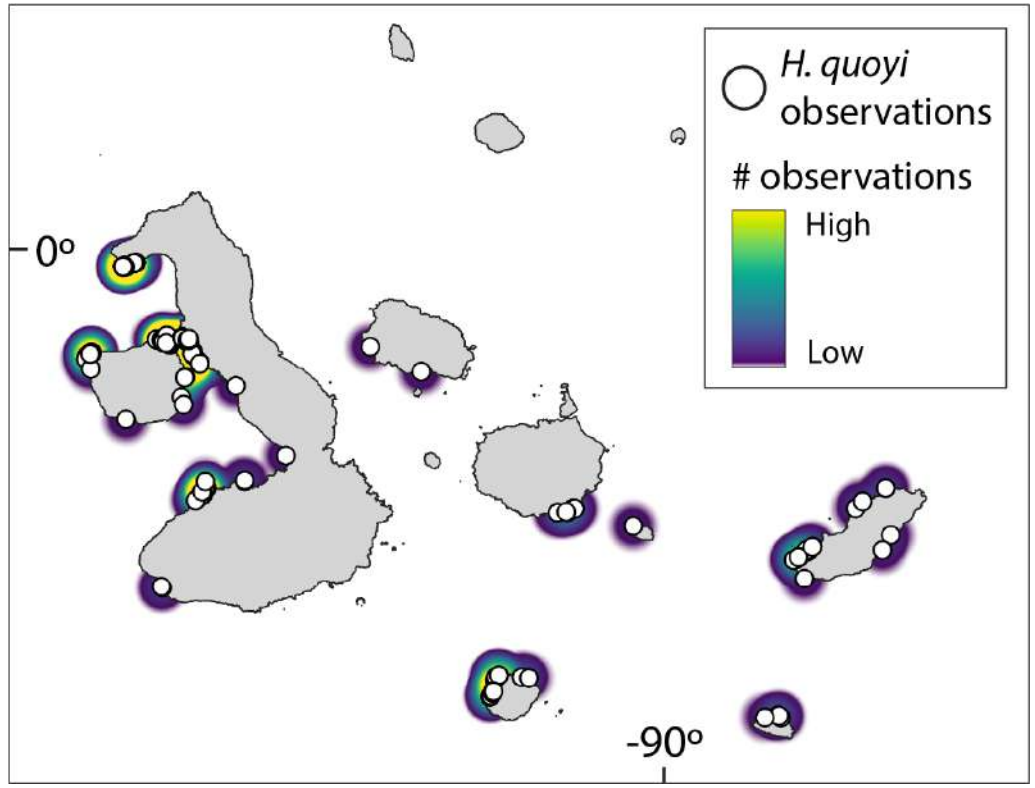
The Galapagos bullhead shark, *Heterodontus quoyi*, is a small species found on the ocean floor in shallow water surrounding the Galapagos and the coast of Perú. These sharks love cold water, are active in the dark, and often hide in caves and crevices during the day. Until recently, little was known about this species, making it difficult to develop strategies that protect their habitats.

Since 2015, the Galapagos Bullhead Shark Project aims to understand the distribution, genetic connectivity, population size, and reproductive biology of this little-known species.

Across the team, we cover a wide-range of research questions using techniques from various disciplines. We take tissue and blood samples while SCUBA diving, evaluate reproductive hormones and ultrasound images, run high-resolution genomic analyses, and work together with citizen scientists.

To date, we have sampled over 250 sharks from six islands and obtained over 300 observations, including from citizen scientists, covering the entire archipelago.

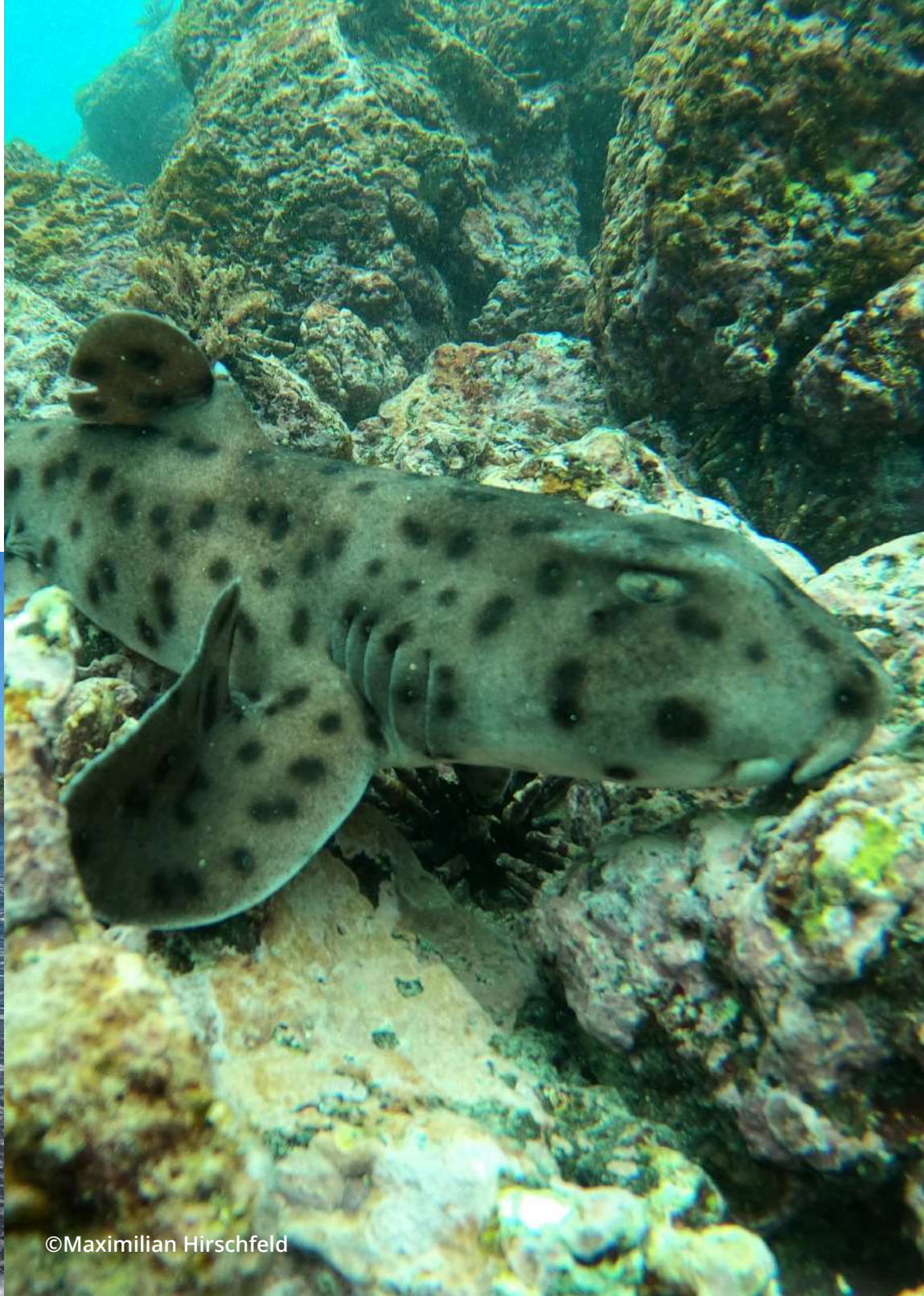
Galapagos bullhead sharks show a preference for cooler water, with higher numbers recorded along western coastlines that are influenced by upwelling. They can be found in the south-eastern (San Cristóbal, Española, and Floreana) and central (Santa Fé, Santa Cruz, Santiago) islands, are most concentrated in the Bolivar channel (Isabela and Fernandina), but are absent from the warmer waters around Genovesa, Marchena, Pinta, Darwin and Wolf. Deeper water between islands separates genetically distinct populations on San Cristóbal, Española, Floreana and the western archipelago (Isabela and Fernandina). On smaller islands shark numbers are lower and show reduced genetic diversity, which make them vulnerable to declines driven by climate change. As the ocean gets warmer their habitat shrinks, but surrounded by deep water, they have nowhere to go. Sharks can experience drastic population declines because they mature at a late age and have few offspring. Our latest results from Floreana show that female bullhead sharks reach sexual maturity between 41.9 and 44.8 cm body length. This may sound small, but not if we consider they hatch from 12 cm long eggs, grow slowly, and most adult females reach less than 70 cm.



Next, we plan to test genetic differences between Galapagos and Perú and use the new information to evaluate the conservation status and vulnerability to climate change to support the protection of Galapagos bullhead sharks.

People involved and overview of their background

The long-term project, led by Maximilian Hirschfeld, a researcher affiliated with the Galapagos Science Center, has been supported by the Galapagos National Park Directorate and the Galapagos Conservation Trust since its inception. In 2024, Sofía León joined the team to study shark reproductive maturity for her master's degree at Universidad San Francisco de Quito (USFQ), in collaboration with Elisa Bonaccorso from the Evolutionary Biology Lab at USFQ and Gregory Lewbart from North Carolina State University. That same year, Dagfin Sotomayor, Mathias Ulloa, and Darwin Cunalata joined the field crew to study the geographic distribution and morphology of *H. quoyi*, under the co-supervision of Dr. Diego Ortiz, as part of their theses in Environmental Management at USFQ Galápagos. Darwin also collaborated with the Galapagos National Park Directorate during the fieldwork.



8.

Bruno Lab research extends from Galapagos to North Carolina

Authors: Maya True Wasik and Kelly Weaver

Every year, a dedicated team of UNC-Chapel Hill scientists trades textbooks for tidepools, diving into the raw beauty of the Galapagos Islands to uncover the secrets of our oceans. Fueled by curiosity and a deep sense of urgency, these researchers are reshaping what we know about marine ecosystems in the face of climate change.

(L-R) Isabel Silva-Romero, Savannah Ryburn, Esteban Agudo and Salomé Jaramillo Gil in the Bruno lab. (Megan Mendenhall/UNC Research)

Isabel Silva, a Kenan Galapagos Fellow and doctoral student studying biology, left, and Savannah Ryburn, a doctoral student in the environment, ecology, and energy program within the UNC College of Arts and Sciences, right, work with samples in the Bruno lab. (Megan Mendenhall/UNC Research).

At the heart of this effort is the Bruno Lab, a hub of marine innovation led by UNC Professor John F. Bruno. It's here that science comes alive—where data from thousands of miles away finds meaning, and fieldwork turns into discovery. While lab members may study species unique to the archipelago, their research highlights its relevance to the larger ecosystem.

Take Isabel Silva, for instance. She's investigating how rising ocean temperatures influence the diets of various reef fish, including parrotfish—colorful reef dwellers vital to coral health. These fish play a vital role in maintaining healthy ecosystems by grazing and regulating algae abundance. Silva's research helps us understand how subtle shifts in climate ripple through entire ecosystems.

Then there's Savannah Ryburn, who's redefining shark science. Traditionally, studying shark diets required lethal sampling—but Ryburn has pioneered a groundbreaking, noninvasive method: analyzing DNA collected from shark fecal matter. This nonlethal method allows Ryburn to pinpoint exactly what species of fishes and crustaceans juvenile scalloped hammerheads and blacktips are eating, allowing her to

study their diets without harming them in the process.

Salomé Jaramillo Gil is tracking the majestic yet vulnerable scalloped hammerhead shark. By linking their migration patterns to sea surface temperatures, she's uncovering how these apex predators navigate an increasingly warm and unpredictable ocean—a crucial step for protecting them beyond the borders of marine reserves.

Meanwhile, Esteban Agudo is asking how heat affects cold-blooded marine life like the *churro blanco*, a species of large carnivorous snail. His findings—that extreme temperatures suppress feeding and reproduction—raise alarms about the fragility of marine food webs in a warming world.

Though their work begins in the crystal-clear waters of the Galapagos, the story doesn't end there. Back in Chapel Hill, the Bruno Lab transforms months of fieldwork into models, maps, and meaningful change. From decoding DNA to tracking sharks via satellite, these researchers are proving that science can be both deeply local and boldly global.

Salomé Jaramillo Gil on one of her many marine expeditions to collect marine life data.

9.

Galapagos Data Hub and the importance of open science

Authors: María Belén Zapata Ramos and Henry Paúl Cárdenas Campoverde

For decades, the Galapagos Islands have served as a natural laboratory for science. Nevertheless, for a long time the data generated by various scientific studies conducted in the archipelago remained scattered, without a common digital space to consolidate and explore the information. Faced with this necessity, the Galapagos Data Hub was created as a digital tool based in open science aimed at transforming the management and visualization of the territory.

Galapagos Data Hub

Engage with the island through accessible data

Being more user-friendly, the platform is structured in five main modules:

3D Viewer: Allows users to explore study areas through virtual tours.

Dashboards and Stories: Presents scientific findings through dynamic and interactive visual formats.

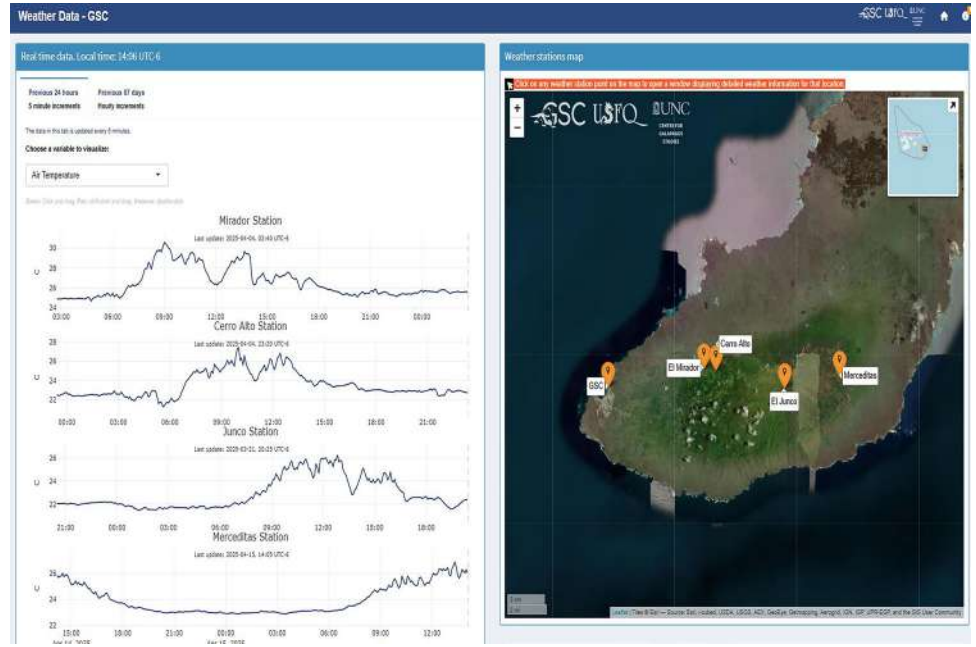
Weather Dashboard: Provides the ability to consult real-time weather conditions through the network of stations located in San Cristóbal. In addition, it allows you to download historical data, compare dynamics between stations, and soon, forecasts, bulletins and more stations will be incorporated.

GeoVisualizer: Offers access to maps on the marine reserve, land use, ecosystems, and more, with over 33 layers available for download in shapefile or raster format.

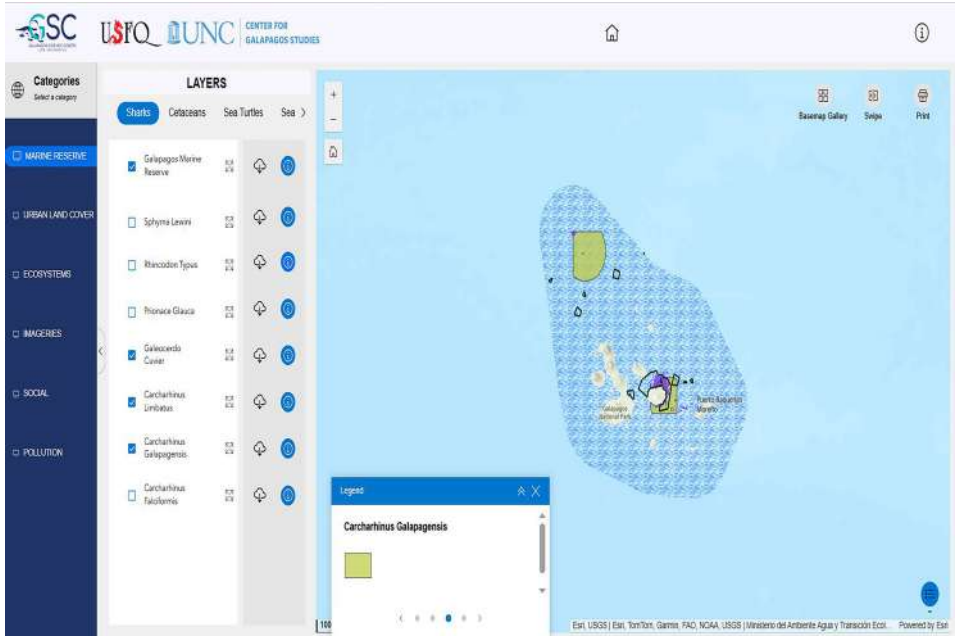
Dataverse: A repository of raster data and aerial imagery developed in collaboration with the University of North Carolina at Chapel Hill (UNC).

This platform centralizes key scientific information such as climate, land use, biodiversity, and satellite imagery, and enables its exploration through interactive dashboards, maps, 3D visualizations based on drone data and field sensor data collected from weather stations which include air temperature, precipitation, relative humidity, and solar radiation with records every five minutes.

The goal is to bridge scientific research with decision-making and citizens, making data accessible for local authorities, researchers, students, and conservation organizations alike.



Access the Weather Dashboard, please visit



The portal is built on ArcGIS Hub and ArcGIS Online (geographic information system's leader platform) with a personal design in HTML, CSS, and open-source interactive tools like R-Shiny. It integrates vector data, raster layers, and time series.

The Galapagos Data Hub is now available online, and its updates are regularly shared through social media to keep the community informed. Its purpose is clear: to make data a common good in support of the conservation of one of the planet's most extraordinary ecosystems.

People involved and overview of their background

The initiative was originally proposed by Carlos Mena, director of the Institute of Geography and Co-Director of the Galapagos Science Center, and the research team associated with the work includes Maria Belen Zapata – Project Leader, Henry Cárdenas – project research climate technician, Patricia Martínez – project research technician from USFQ and Francisco Lasso – creator of dataverse portal. The project was made possible through the information provided by the research from USFQ through the Institute of Geography and Galapagos Science Center.

For more information, visit

10.

Support from Royal Caribbean Group enhances research, local programs, and student experiences

Authors: Kelly Weaver and UNC Communications

The UNC Center for Galapagos Studies received a powerful contribution from Royal Caribbean Group to support research and learning initiatives, enabling the expansion of research projects, community outreach programs, and student engagement in the Galapagos.

The gift is supporting three Galapagos Science Center initiatives:

The Barcode+ Project: In 2020, when COVID-19 halted tourism and left many locals in Galapagos without employment, the GSC created the Galapagos Barcode Project. This project was the most ambitious citizen science project to be launched on the island, providing scientific training and employment to residents. Participants worked to catalog the incredible biodiversity of the islands, collecting thousands of plant, soil, water and animal samples for processing. With the funding from Royal Caribbean Group, this project has re-launched as Barcode+ and is expanding. It will also integrate with the Galapagos Science Center's Biobank which preserves the genetic resources of the region's existing biodiversity.

Reactivating the Economy Through Science, Community and Work (REACCT) Program: The REACCT program was created to benefit local communities on San Cristóbal Island while enhancing the understanding of topics that UNC-Chapel Hill and USFQ researchers are currently studying in the Galapagos Islands. Royal Caribbean Group's gift has provided seed funding for innovative projects by local community members, with the first recipients focused on sustainable agriculture.

Field-experience support for students: In The gift has also enabled field-experience support for students from UNC-Chapel Hill to study in the Galapagos. The new program will enable collaboration among undergraduates from both universities and the local community to work on research projects and receive training and mentorship. Through this funding, more students will be able to study in the Galapagos' unique ecosystem; gain valuable experiences in the classroom, field, and lab; and have a transformative global experience while advancing science and conservation efforts.

> **"I am proud Royal Caribbean Group gets to play a part in advancing UNC Center for Galapagos Studies' vision to expand local programs and make transformative experiences available to more dreamers and innovators," - Jason Liberty, president and CEO of Royal Caribbean Group.**

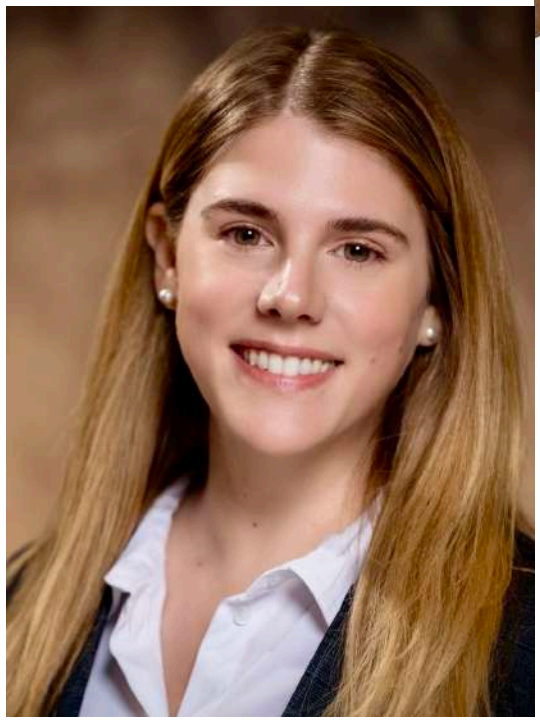
11.

Inaugural Kenan Galapagos Fellows launch new research

Authors: Kelly Weaver and UNC Communications

The initial Kenan Galapagos Fellows Program research projects span disciplines, yet all aim to help build healthy ecosystems on a changing planet. The geographically isolated, biodiverse nature of the Galapagos Islands makes the region an important model for understanding similarly challenged environments around the world. As a result, the Center offers unique opportunities for researchers to enhance their understanding of the ocean, biodiversity, ecosystems and human health.

Meet Sarah McGlothlin, one of the inaugural Kenan Galapagos Fellows who is a UNC-Chapel Hill doctoral student in social work and is examining how climate change affects maternal health on San Cristóbal Island. Specifically, McGlothlin is studying how climate-induced stressors –like temperature fluctuations, pollution, and water quality issues – influence community resilience and how that impacts maternal health.



Sarah McGlothlin (UNC School of Social Work)

The Kenan Galapagos Fellows Program allows PhD students from UNC-Chapel Hill research opportunities spanning oceans, biodiversity, and ecosystems and human health.

"My research will use a culturally co-designed process and explore the local maternal care landscape, including home visiting programs, through which I'm hoping to identify gaps in maternal care and the unique ways that environmental stressors impact maternal health," said McGlothlin. "Then, based on the needs that emerge, I hope to conduct a readiness assessment to determine the feasibility of merging a home visiting program with environmental health support to strengthen maternal well-being within the community."

Like McGlothlin, Kenan Galapagos Fellow Hanna Brosky is also studying human health in Galapagos. Brosky, a PhD student in the UNC Gillings School of Global Public Health, seeks to understand urinary tract infection transmission in relation to contaminated drinking water. Brosky hopes that by improving the understanding of waterborne UTI infections in the region, her findings can help researchers mitigate antimicrobial resistance and further the understanding of UTI risk factors.

"Research on urinary tract infections and environmental health must be purposefully designed to integrate efforts from governments, hospitals and laboratories," said Brosky. "By fostering these critical local collaborations, this work will advance our understanding of UTI transmission and antibiotic resistance, contributing to more effective public health strategies."

Hanna Brosky (UNC Gillings School of Global Public Health)

"This fellowship program and support from William R. Kenan, Jr. Charitable Trust provide excellent opportunities for UNC graduate students to conduct innovative science in one of the world's most iconic places and to bring their research results back to local and global communities, helping to address the most critical challenges of today and tomorrow," said Amanda Thompson, director of UNC Center for Galapagos Studies and co-director of the Galapagos Science Center. "We are deeply grateful for this funding that will help propel our work forward and increase our knowledge through research, education, and community outreach."

12.

Reducing the dual burden of malnutrition through double-duty actions

Authors: Heather Wasser and Ivonne Headley

The dual burden of malnutrition is the simultaneous occurrence of undernutrition and overnutrition and is of notable concern in Ecuador and the Galapagos islands. While Ecuador and many countries in the global south have historically focused nutrition programming efforts on reducing undernutrition (micronutrient deficiencies, poor growth), researchers affiliated with the Galapagos Science Center have documented sharp increases in obesity and diet-related chronic diseases, including diabetes, heart disease, and some cancers. Programs that leverage shared drivers of both undernutrition and overnutrition are called "double duty actions" and the World Health Organization has proposed them as cost-effective solutions for addressing the dual burden of malnutrition.

Since January 2024, Heather Wasser, PhD, MPH, RD, Ivonne Headley, MPH, RD, Stephanie Martin, PhD, CLC, Amanda Thompson, PhD, and María Belén Ocampo Ordóñez, MPH, RD have been working together, along with local mothers and community members, to co-design an evidence-based intervention to reduce the dual burden of malnutrition among families with young children living in San Cristóbal. While this team of nutritionists and anthropologists has decades of experience creating interventions aimed at improving two double duty actions important during this life phase—breastfeeding and higher diet quality—community members are the experts who have the lived experience engaging in these behaviors on the island. To date, the team has conducted a mix of in-home interviews and focus groups with San Cristóbal mothers, fathers, and grandparents of children ages 6-23 months to learn about barriers (things that make it difficult) and facilitators (things that make it easier) to meet the World Health Organization's recommendations for breastfeeding—only breastfeed or give expressed human milk for the first six months with continued breastfeeding until 2 years or more—and the Ecuadorian national dietary recommendations or Gueías Alimentarias Basadas en Alimentos (GABA).

During July and August 2024, Ms. Headley conducted 20 one-on-one interviews with mothers to discuss their breastfeeding-related experiences and to assess their own dietary intake. Based on their responses to the diet assessment, mothers received a healthy eating lesson based on GABA and chose 1-2 specific practices to try, such as "Eat 2 or more servings of non-starchy vegetables (tomato, carrot, broccoli) per day" or "Have 1 or fewer servings of sweetened beverages or desserts per day". During a final one-on-one interview, mothers discussed their experiences with implementing the practices as well as their ideas for designing a program to improve breastfeeding and diet quality among young families in San Cristóbal. The team also asked mothers about their typical food shopping patterns and conducted surveys of local markets to document availability and price of healthy food items. During February 2025, Ms. Headley and Dr. Wasser conducted follow-up sessions with mothers to share and confirm preliminary findings, and also interviewed fathers, grandmothers, and community members who work with local families with young children. Analyses and plans to share findings with participants and the wider San Cristóbal community are underway. Anyone interested in learning more about or participating in the project are encouraged to contact Dr. Wasser or Ms. Headley.

Dr. Wasser ivraquel@email.unc.edu or Ms. Headley. wasser@email.unc.edu

13. How can we STRENGTHEN OUR connection WITH NATURE?

Promoting holistic well-being, education, and conservation in the Galapagos Islands

Authors: Leidy Apolo and Lesly Cadena

The relationship between humans and nature has been the subject of reflection and research for decades, revealing its many benefits for physical and mental health, meaningful learning, and environmental awareness. In an increasingly urbanized world, strengthening this bond is essential to inspire respect for the environment, motivate conservation actions, and foster community engagement.

Moreover, connecting with our natural surroundings also means connecting with our community. Through contact with nature, we cultivate healthy relationships, develop social skills, and reaffirm our sense of belonging.

Within this context, the Connecting with Nature Program (CWNP) has been promoting a valuable initiative in the Galapagos Islands since 2019. More than 9,100 people — including children, youth, and adults — have taken part in educational and recreational experiences that strengthen their bond with the environment and promote a strong environmental identity. Below, we share some of the key activities from the program's sixth phase (February 2024 – January 2025).

Nature as a Pillar of Well-being

Multiple studies agree that contact with natural environments reduces stress, improves mood, and enhances cognitive development. Based on this evidence, CWNP designs activities that combine science, play, and outdoor exploration.

One of these experiences was the “Family Science” events, which created spaces for community connection while highlighting the many physical and emotional health benefits of being in nature. Activities like these reinforce our commitment to conservation through individual and collective well-being.

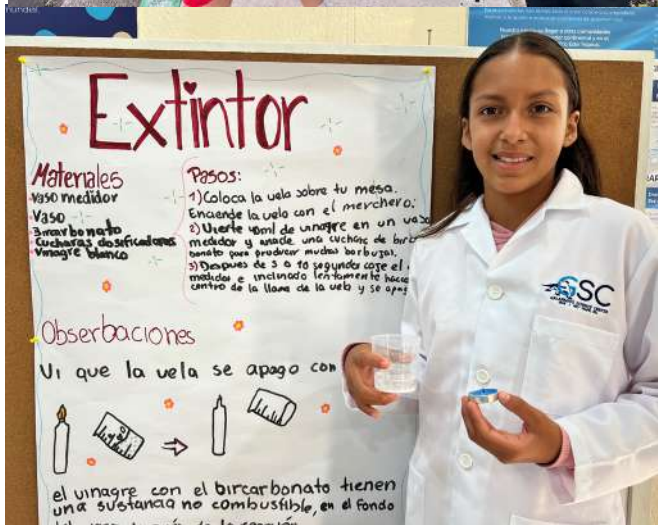
Another example is the “Reading Sessions with Tessa”, which gave children the chance to discover stories about local wildlife, such as the iconic giant tortoises. These readings fostered empathy, curiosity, and a sense of responsibility toward the natural world.

Experience as the Foundation of Education

Multiple studies agree that contact with natural environments reduces stress, improves mood, and enhances cognitive development. Based on this evidence, CWNP designs activities that combine science, play, and outdoor exploration.

One of these experiences was the “Family Science” events, which created spaces for community connection while highlighting the many physical and emotional health benefits of being in nature. Activities like these reinforce our commitment to conservation through individual and collective well-being.

Another example is the “Reading Sessions with Tessa”, which gave children the chance to discover stories about local wildlife, such as the iconic giant tortoises. These readings fostered empathy, curiosity, and a sense of responsibility toward the natural world.



Conservation as an Opportunity to Build Alliances

Effective conservation requires collaboration among individuals, communities, and institutions. Through PCCN, spaces for dialogue and participation have been created, strengthening the collective commitment to the islands' future.
A key example was the eleventh edition of Shark Day, focused on the theme "Sustainable Oceans" (SDG 14). With the involvement of government agencies, NGOs, scientists, and artists, marine conservation was promoted through interactive stations, scientific exhibitions, and cultural activities open to the entire community.

Today's environmental challenges require ongoing commitment. Only through education, science, strong public policy, and active participation can we build a future in which nature and humanity coexist in harmony.

Special thanks to:
Valery Hinojosa, Jerson Mideros, Ashleigh Klingman, María Fernanda Almeida, Alice Skehel, Gabriela Bautista, Marjorie Riofrío, Diego Páez, Andrés Moreira, María Andrade, Karem Zavala, Karla Mosquera, Sofía León, Darwin Cunalata, Renán Cunalata, Dagfin Sotomayor, Kathy Cacuango, Angélica Rodríguez, Mateo Zaldumbide, Kathy Coquinche, Lt. Abel Flores, Cristina Vintimilla, Silvia Zavala, Paúl Yépez, Nazaret Narváez, Yanex Álvarez, Camila Ortega, and Mathías Buenaño.

Connecting to Care

At times, the Galapagos Islands cease to be just the setting and become a protagonist in the learning process, inspiring imagination, environmental awareness, and a love for nature.

This space is dedicated to one of our Science with Family events developed during the sixth phase of the CWNP, where participants used simple drawings to express emotions and actions that reflect the benefits of connecting with the environment on individual, social, and environmental levels.

This active community participation inspires us to continue offering opportunities that encourage dialogue, reflection, and creative expression—promoting an environmental awareness that transcends generations.
The impact of the CWNP is undeniable. It has reminded us that a strong connection with both nature and society drives sustainable development in our islands. Caring for our environment also means caring for our health and securing a better future for all.


GSC
USFQ
UNC
CENTER FOR
GALAPAGOS STUDIES
Galapagos Science Center
@galapagosgsc
GSCGalapagos
www.galapagosscience.org