

Leveraging Empowered Circular Communities in the Galápagos Islands, Ecuador: A Promising Pathway to Sustainable Development and Conservation

Delgado Medina, Fátima; Leclercq, Els ; Díaz-Márquez, Angela M. ; Castrejón, Mauricio; Quadros, Laura ; Bezemer, Martijn

Publication date

2025

Document Version

Final published version

Citation (APA)

Delgado Medina, F., Leclercq, E., Díaz-Márquez, A. M., Castrejón, M., Quadros, L., & Bezemer, M. (2025). *Leveraging Empowered Circular Communities in the Galápagos Islands, Ecuador: A Promising Pathway to Sustainable Development and Conservation*.

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

FINAL REPORT

2023 - 2025



Leveraging Empowered Circular Communities in the Galápagos Islands,
Ecuador: A Promising Pathway to Sustainable Development and Conservation

LDE Global

Leiden-Delft-Erasmus Universities



Universiteit
Leiden

TUDelft

Erasmus
University
Rotterdam

Erasmus

CIRCULAR
COMMUNITY
FOUNDATION

udla



| Institute of Biology at Leiden University | Delft Centre of Entrepreneurship (DCE) at Delft University of Technology (TU Delft) |
Institute for Housing and Urban Development Studies (IHS) at Erasmus University Rotterdam | Circular Community Foundation
(CCF) | Universidad de Las Américas (UDLA) of Ecuador | Pelican Bay Fishing Cooperative of the Galápagos Islands |

Final report

LDE institutions

Institute of Biology at Leiden University

Dr. Martijn Bezemer t.m.bezemer@biology.leidenuniv.nl

Delft Centre of Entrepreneurship (DCE) at Delft University of Technology (TU Delft)

Dr. Fátima Delgado Medina F.DelgadoMedina@tudelft.nl

Institute for Housing and Urban Development Studies (IHS) at Erasmus University Rotterdam

Dr. Laura Quadros quadrosaniche@ihs.nl

Others institutions

Circular Community Foundation (CCF)

Dr. Els Leclercq els@designandpublics.com

Universidad de Las Américas (UDLA) of Ecuador

Dr. Angela M. Díaz-Márquez angela.diaz@udla.edu.ec

Dr. Mauricio Castrejón hugo.castrejon@udla.edu.ec

Pelican Bay Fishing Cooperative of the Galápagos Islands

How to cite this document:

Delgado, F., Leclercq, E., Díaz-Marquez, A., Castrejón, M., Quadros, L. & Bezemer, M. (2025). Leveraging Empowered Circular Communities in the Galápagos Islands, Ecuador: A Promising Pathway to Sustainable Development and Conservation (Final report). *LDE Global Fund*. The Netherlands.

© All images were generated as part of this project.

Booklet: <https://www.leiden-delft-erasmus.nl>

1. Executive Summary

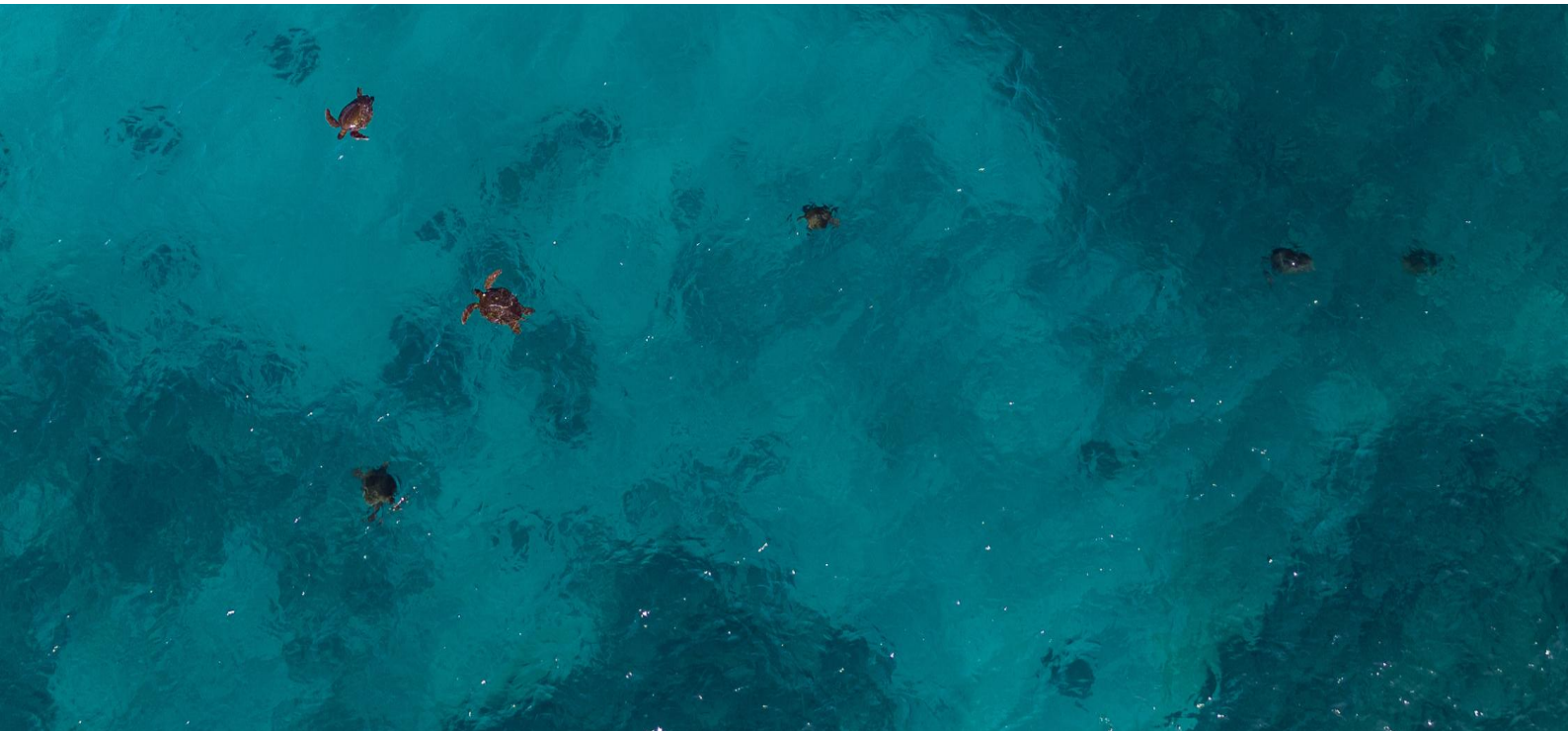


This report presents the action-based research project process and outcomes of the “Leveraging Empowered Circular Communities in the Galápagos Islands” project, funded by the [LDE Global program](#). Leiden-Delft-Erasmus (LDE) Universities support initiatives that foster research co-creation between LDE institutions and scholars from the Majority-World countries in Africa, South and Southeast Asia, and Latin America. Our project, launched in July 2023 and running through April 2025, aims to embed circular economy (CE) principles in the seafood system of Santa Cruz Island, Galápagos.

This initiative unites the [Universidad de Las Américas \(UDLA\)](#) of Ecuador, the Delft Centre of Entrepreneurship (DCE) at [Delft University of Technology \(TU Delft\)](#), the [Circular Community Foundation \(CCF\)](#), the Institute for Housing and Urban Development Studies (IHS) at [Erasmus University Rotterdam](#), the Institute of Biology at [Leiden University](#), and the [Pelican Bay Fishing Cooperative](#) of the Galápagos Islands.

The [LDE Global fund](#) backs initiatives to encourage inclusive research partnerships and innovative community outreach. The financial support for this particular research project has enabled multi-stakeholder workshops, fish waste assessment of several endemic species, the production of a short-documentary and reels snapshots, photos, local multi-stakeholder interviews, training and prototyping activities for fish leather, an outreach booklet, several research outcomes produced by bachelor and master students from TU Delft and Leiden universities, one fully submitted manuscript, and three in progress to be submitted by the end of 2025. By co-creating and co-developing circular and regenerative interventions with local fishers, entrepreneurs, municipal authorities, and chefs, the project aims to transform fish waste into value-added products, reduce environmental harm, and fortify economic opportunities for coastal communities on the island of Santa Cruz in the archipelago.

2. Introduction and Context



The Galápagos Islands, a UNESCO World Heritage site, face multiple socio-ecological pressures linked to their rapid population growth, tourism-driven development, and overexploited coastal fisheries (Escobar-Camacho et al., 2021). Recognizing that traditional single-purpose management approaches have not resolved these challenges (Jones, 2013; Burbano & Mulrennan, 2020), our team has undertaken this project to integrate [circular economy \(CE\)](#) concepts with local fisheries operations.

[Small-scale fisheries \(SSF\)](#) are integral to Galápagos residents' food security, livelihoods, and cultural identity. However, a key issue in Santa Cruz is the [2.25 tons of fish waste discarded weekly](#)—over [117 tons annually](#) (Moreno et al., 2020). This unmanaged fish waste poses ecological risks, from invasive species proliferation to water and soil contamination, while representing a lost economic opportunity. By introducing circular economy solutions, we hope to create income streams from fish by-products and reinforce a more sustainable seafood system. Transforming these wastes into new products could further reduce the environmental impacts of improper disposal (e.g., invasive species spread, foul odors, harmful gasses) while bolstering local incomes (Castrejón & Defeo, 2025).

The core methodology, the [Circular Value Flower \(CVF\)](#), provides a structured approach for analyzing and redesigning resource flows, encouraging stakeholders to join forces. This project adopted the CVF methodology to promote the Santa Cruz community to identify holistic circular interventions based upon the closure of resource loops, aiming to create multiple values. The CVF is a multi-layer analysis and design tool that unravels the complex totality of ambitions, challenges, actors, and technical, spatial, and social possibilities when collectively closing resource flows (Leclercq & Smit, 2023). This CVF methodology has already shown positive results in various regions, including the Netherlands, Africa, India, and Indonesia, by reducing negative ecological

impact, generating employment, and enhancing social cohesion. The CVF was created by the CCF, which stimulates communities worldwide to develop regenerative projects that create multiple values by making better and wiser use of resources. The CCF supports communities in improving their well-being through circular and regenerative economy principles and serves as a platform for sharing insights and experiences about these community-based projects.

On the other hand, the [Forecasting Strategic Study \(FSS\)](#), one of the project's methodological components, contributes to anticipating plausible futures for the small-scale fisheries (SSF) sector, particularly regarding the valorization of fish waste through circular innovations. This method explores future scenarios based on two key assumptions: that fish waste can be repurposed into value-added products, and that such transformation is economically feasible for local fishing cooperatives. By examining the interaction of ecological, economic, and social drivers, the study helps identify feasible scenarios that balance sustainability and livelihood goals in an ecologically sensitive and socioeconomically constrained context. Its potential lies in offering a structured lens to envision and compare possible trajectories, supporting informed decision-making for adaptive and regenerative strategies. It enhances strategic foresight among stakeholders and complements other participatory tools in the project.

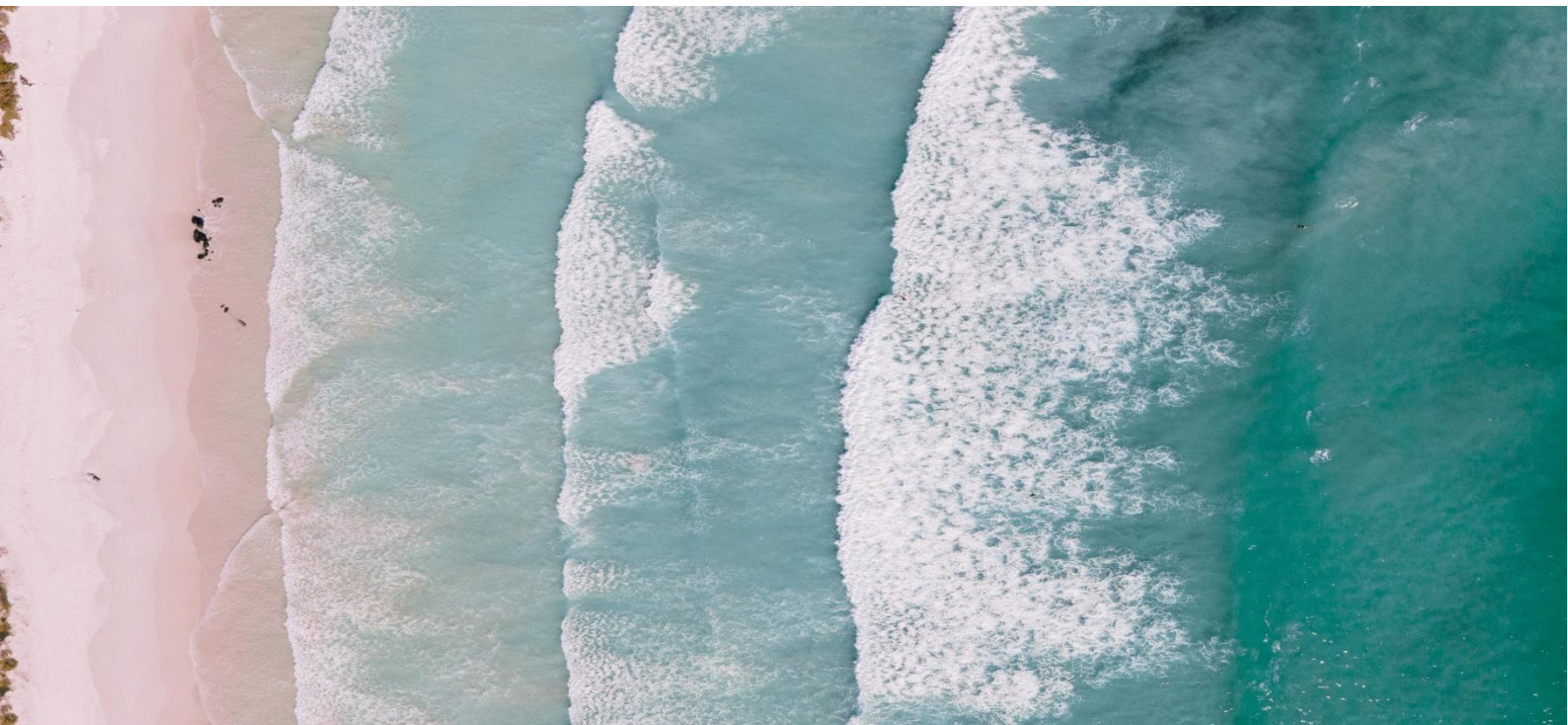
However, its limits are notable. The method depends on the quality and diversity of stakeholder input, which may be affected by power asymmetries or limited technical capacity. Moreover, forecasting does not guarantee implementation—its insights require alignment with policy, infrastructure, and long-term stakeholder commitment. In this project, the *Forecasting Strategic Study* is most effective when integrated with participatory frameworks such as the *Circular Value Flower (CVF)*, which grounds abstract scenarios in community-led action. In line with the original *LDE Global Proposal* (2023), our research agenda comprises two main components:

1. [Forecasting Strategic Study \(FSS\)](#): Assessing the feasibility of reusing fish by-products (e.g., skins, bones, viscera) to create added-value products, thereby lessening the ecological burden of landfill dumping.
2. [Circular Value Flower \(CVF\) Method](#): Adopting a participatory, multi-dimensional tool that assists communities in co-creating circular solutions, linking resource flows to social, economic, and ecological benefits.

Together, these components strengthen ties between UDLA in Ecuador, TU Delft, Leiden University, Erasmus University Rotterdam, the Circular Community Foundation, and local partners on Santa Cruz Island, culminating in a replicable model of circular community-building.

Integrating circular economy principles into the Galapagos small-scale fishing sector could enhance sustainability, maximize resource use, and create economic opportunities while minimizing environmental impact (Castrejón & Defeo, 2025). A key strategy is shifting focus from maximizing catch volumes to improving product quality. By valuing quality over quantity, fishers can enhance the marketability and profitability of their catches. This can be achieved by adopting better handling practices and developing value-added seafood products—such as tuna fillets, smoked fish, or fish burgers—which increase shelf life, reduce waste, and open access to higher-value markets.

3. Activities and Methodology



3.1 Phase 1: On-Site Exploration, Inventory, and Inquiry

In late 2023, the project team, together with [local consulting services](#) and the [Circular Community Foundation](#), embarked on mapping key stakeholders—fishing cooperatives, restaurants, municipal authorities, and NGOs such as the Charles Darwin Foundation—and reviewing existing data on fish waste. Although the [2.25-ton-per-week](#) estimate comes from prior research (Moreno et al., 2020), our team validated local concerns regarding unmanaged fish waste's adverse environmental and economic implications.

From [September 2023 to January 2024](#), a group of students from the *International Entrepreneurship & Development (IED)* minor also supported the exploration phase under the title “*From waste to wealth: Turning fish waste into opportunity in Pelican Bay, Puerto Ayora*” (de Bruijn et al., 2024), supervised by Fátima Delgado and Mauricio Castrejón (September 2023 – January 2024). Their research project focused on the Pelican Bay fishing community in Puerto Ayora. They quantified fish-waste practices while working closely with local fishers, recognizing that their cooperation was crucial to the study's success.

The students adopted a mixed-methods approach, combining qualitative insights (fostered through active relationship-building with the fishing community) and quantitative data from onsite measurements at Pelican Bay. Dedicated efforts to balance power dynamics between researchers and fishers included participating in awareness campaigns and social events like barbecues. Once trust was established, the research team collaboratively measured fish waste volumes using direct observation, interviews, and focus groups. This initiative demonstrated how a circular economy model could transform fish waste into both economic opportunities and environmental benefits.

After the student research team concluded their IED Minor project, the [LDE-funded research team continued Phase 1 activities](#). Building on the relationships and data gathered, TU Delft, UDLA, and CCF researchers conducted further field observations and convened a [multi-stakeholder workshop](#). Held on [January 27](#) and [February 3, 2024](#), these workshops included [25 participants](#) spanning fishers from the Pelican Bay Cooperative, restaurant owners, chefs, and representatives of the Government Council of the Galápagos Special Regime, the Ministry of Production, and the Autonomous Government of Santa Cruz Island.

“The workshops used the Circular Value Flower method, developed by Dutch experts to create circular communities through practical and sustainable strategies,” says [Dr. Fátima Delgado](#) from TU Delft.

This CVF approach guides community members in analyzing and closing resource loops—materials, energy, water, or nutrients—and reveals the potential benefits of circular initiatives from social, ecological, aesthetic, cultural, and economic standpoints. [Dr. Els Leclercq](#), the method’s creator, emphasizes the aim to foster “Circular Communities that collectively manage product life cycles at a local level.” By bringing together fishers, entrepreneurs, and municipal representatives, the workshops produced an [initial action plan](#) highlighting feasible ways to valorize fish waste.

3.2 Phase 2: Co-Design and Prototyping of Circular Interventions

Building on the stakeholder insights and community aspirations identified in [Phase 1](#), [Phase 2 focused](#) on a [co-design](#) workshop session on circular interventions/innovations (February 3rd, 2024) and 16 interviews with local stakeholders. Beyond the Pelican Bay Fishing Cooperative, the research team reached out to restaurant owners, local farmers, market tradesmen, NGO’s and municipal officers to pinpoint potential synergy in repurposing fish waste.

“The interviews aimed to understand the actions, roles, and responsibilities of various key actors within the fish waste production in Puerto Ayora, Galápagos,” explains [Dr. Fátima Delgado](#).

During these workshops and interviews:

- [Fish Leather](#) emerged as a top priority for exploration, turning discarded fish skins into artisan goods.
- [Supply-chain transparency](#) was also spotlighted to improve fish product quality and safety, paving the way for premium markets both locally and outside the islands.

Accompanying field activities, interviews, and co-design sessions support co-developing these preliminary circular intervention ideas to transform fish waste into marketable products (Figure 1) and create new income and employment resources for coastal communities on the Island of Santa Cruz (Castrejón et al., 2024).



Figure1. Infographic. "From Waste to Wealth. Transforming Fish Waste into Business Opportunities" (Castrejón et al., 2024).

With the support of two in-depth MSc student reports from the elective course "Idea to Startup – Climate Action" (lectured by Fátima Delgado and coached by Mauricio Castrejón, April - June 2024), critical findings and recommendations were generated:

[A roadmap towards sustainable fish leather production.](#) The roadmap for establishing a sustainable fish leather industry in the Galapagos Islands (Figure 2) comprises six critical phases, each designed to ensure environmental sustainability, economic feasibility, and community engagement. Initially, a comprehensive feasibility study is recommended, including thorough market research among tourists, local businesses, and artisans, alongside assessments of fish species sustainability and eco-friendly tanning methods. The subsequent initial development phase emphasizes small-scale testing and refinement of tanning recipes, incorporating feedback from local stakeholders to optimize product quality.

Detailed business planning should then define clear production processes, marketing strategies, and financial projections, along with securing intellectual property rights through legal channels (Taets van Amerongen et al., 2024). Establishing production involves creating environmentally compliant facilities, conducting impact assessments, and providing sustainable practice training to local employees. The launch and marketing phase recommends developing a compelling, sustainable brand identity, leveraging local and digital marketing channels, and engaging the community through educational activities. Finally, continuous evaluation and scaling, informed by customer feedback and market dynamics, are crucial for refining strategies, adjusting production capacity, and ensuring long-term growth and economic resilience.

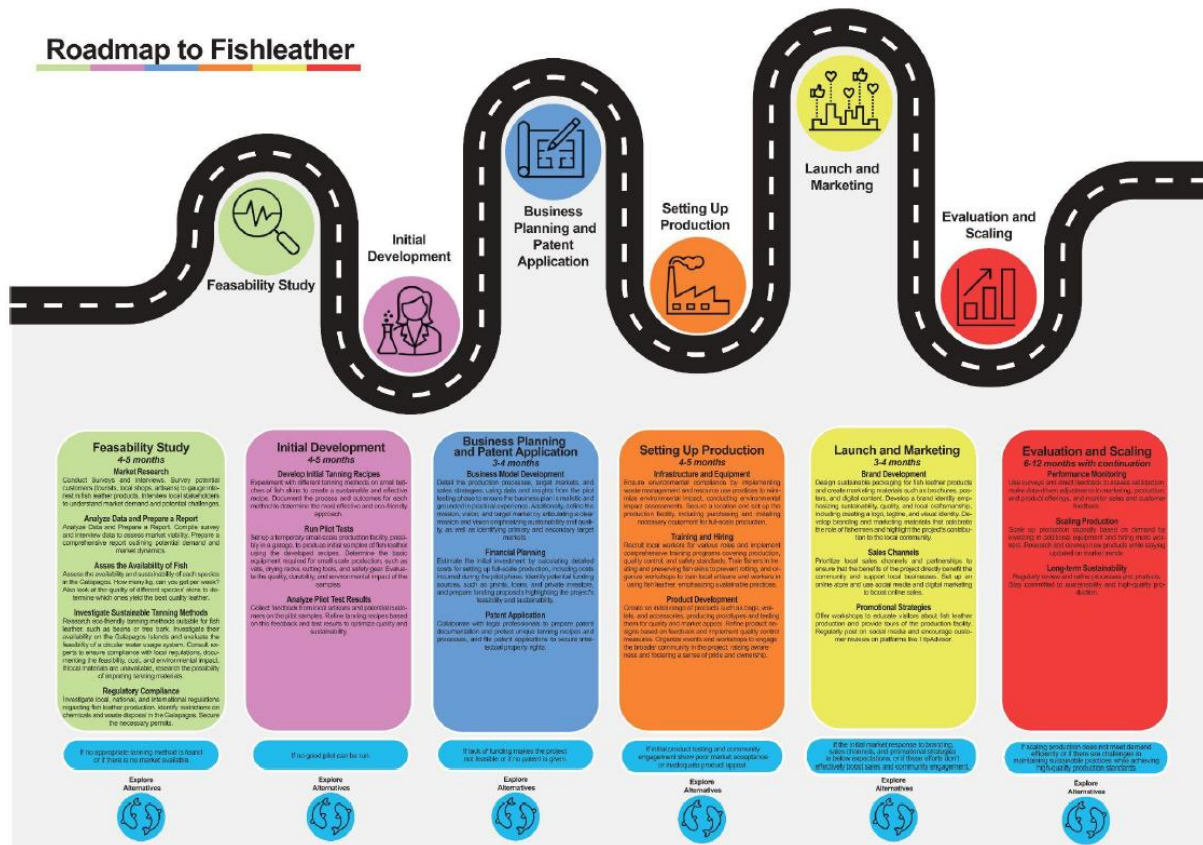


Figure 2. Roadmap towards sustainable fish leather production (Taets van Amerongen et al., 2024).

Regenerative business model strategies for fish leather. The roadmap for regenerative business model strategies for fish leather production in the Galápagos Islands (Figure 3) recommends a phased approach across short, medium, and long-term horizons. Initially, the focus should be on **value creation** and delivery, emphasizing **conscious fishing practices** to **mitigate existing ecosystem damage** and initiating pilot fish leather production.

Building a robust network of committed fishers and stakeholders is essential in this early phase. In the medium term, further development should involve expanding sustainable production practices, improving market visibility, and enhancing local capacity through educational workshops.

Over the long term, the strategy suggests **transitioning towards stronger value capture mechanisms**, such as reinvesting a portion of profits into local conservation initiatives and establishing transparent governance structures to manage resources sustainably (Kaur et al., 2024). This approach provides flexibility, addressing feasibility concerns by suggesting gradual investment in community engagement and capacity-building activities before progressively implementing profit-sharing models to support broader ecological and social goals.

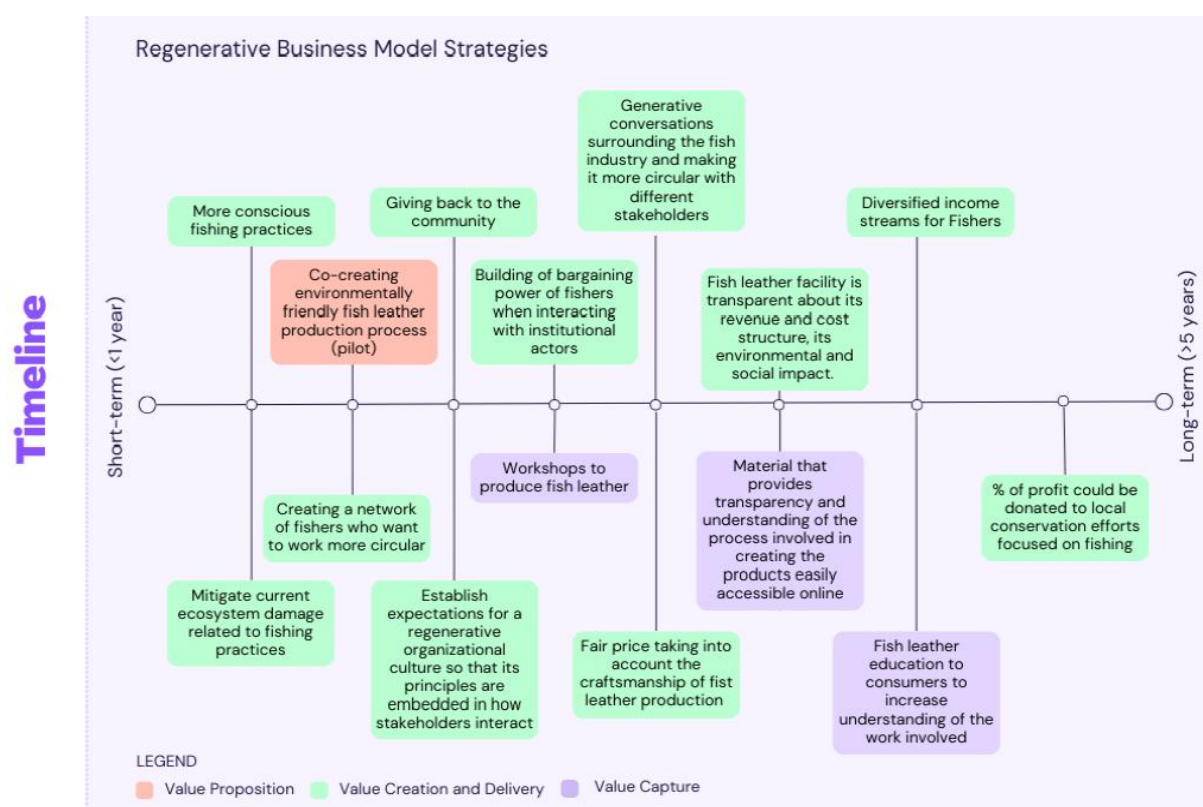


Figure 3. Roadmap Timeline Regenerative Business Model Strategies for Fish Leather (Kaur et al., 2024)

The CVF's multi-layer analysis was instrumental in balancing cultural acceptability, social equity, economic viability, and ecological sustainability. "Circular economy represents a solution to mitigate the environmental impacts generated by fish waste and other wasted organic matter (waste from cows and pigs) by transforming them into marketable products. This would create economic incentives to implement a more efficient and responsible environmental management system," states researcher [Mauricio Castrejón](#) (UDLA).

[Dr. Ángela Díaz](#), an innovation specialist at UDLA, underscores the importance of collaboration: "The circular economy project executed by Pelican Bay Cooperative with technical and scientific assistance from UDLA and TU Delft represents progress towards finding practical and sustainable solutions to the challenges faced by the Galápagos Islands' seafood system. Collaboration between fishermen, academia, chefs, and entrepreneurs is essential to ensure the success and sustainability of such innovative initiatives."

The outcomes of these co-design processes and field interviews are detailed in our newly published outreach booklet (Castrejón et al., 2024), highlighting the results of initial workshops and next steps for reinforcing circular practices in Santa Cruz.

3.2 Phase 3: Co-Prototyping of Circular Interventions

In September 2024 – January 2025, a second cohort of students from the International Entrepreneurship & Development (IED) minor, supervised by [Dr. Fátima Delgado](#) and [Dr. Mauricio Castrejón](#), carried forward the prototyping and feasibility work initiated during the preceding academic year. Their project, titled "*Galápagos Islands: Circular Fish Waste Solutions*" (Dambrink et al., 2025), aimed to refine and implement practical interventions for fish-waste valorization in Santa Cruz Island. Below is a summary of their objectives and achievements:

- **Building on Previous Foundations:** Leveraging the trust and data from the 2023 team (de Bruijn et al., 2024), the IED students sought deeper engagement with local fishers to advance circular economy initiatives. Their research focused on expanding waste-stream analysis, improving conversion factors for key species (e.g., bacalao, brujo, and yellowfin tuna), and strengthening local acceptance of upcycling strategies.
- **Refined Waste Quantification:** Through six documented landings, the students collected quantitative data on fish-waste volumes and developed accurate conversion factors to measure the percentage of by-products. These refined metrics serve as a basis for more effective planning and scaling of value-added product lines.
- **Trust Building and Stakeholder Engagement:** Building on relationships established by the earlier IED Minor and LDE team, the students organized workshops, participatory meetings, and pilot projects with fishers and community members. This approach facilitated a genuine exchange of perspectives and allowed the IED team to tailor their interventions to align with local priorities and cultural practices.
- **Waste Valorization Initiatives:** Three main streams guided the team's co-creation efforts:
 - **Fish Leather:** Adapting traditional tanning methods to local conditions, including using natural tannins (e.g., invasive plants). An online training course was developed to help fishers produce artisanal fish leather, and a practical workshop was held with **Fabian Trachter**—an Argentina-based expert in fish tanning, for more hands-on learning.
 - **Fertilizer Production:** In collaboration with Conservation International and local fishers, the students worked to perfect fish-based fertilizers that met safety standards and pursued ABG certification.
 - **Collagen Extraction:** Partnering with a local entrepreneur, **Victor Vásquez**, the team introduced scientific approaches to enhance small-scale collagen extraction, improving quality and scalability.
- **Knowledge and Capacity Building:** Community workshops and public awareness events strengthened local ownership. Fishers participated in an **Open House Day** to showcase upcycling techniques, such as artisanal fish-leather tanning, and discuss the initiative's economic and ecological benefits.
- **Pilot Project for Fish Leather:** The practical pilot centered on transforming fish skins into artisanal leather, offering new revenue streams without increasing fishing pressure. Key components included:
 - **Waste Quantification:** Interviews and data collection to quantify weekly fish-waste generation.
 - **Online Training:** Instructional sessions for fishers on artisanal fish-tanning methods.
 - **Material Procurement:** Basic supplies (e.g., tanning agents, equipment) for the pilot.

- **Seed Funding for Fishing Trips:** Financial support to offset operational costs, allowing fishers to commit time and effort to the fish-leather process.

“We discovered that while fish-leather tanning has a scientific element, it is also very much an art,” noted [Fabian Trachter](#), the Argentine expert. “It takes practice, trial, and error to achieve the perfect result.” By merging practical workshops with supportive funding, the project ensured that any waste repurposed would genuinely contribute to a circular economy rather than intensify fishing activities.

Through this expanded [Phase 3](#) effort, the IED minor and master's students and the LDE research team took crucial steps toward integrating circular economy strategies into the artisanal fishing sector in Galápagos. By quantifying fish waste, training fishers, and piloting upcycling methods such as fish leather and fertilizer production, the initiative furthered its goal of a [circular community](#) that values sustainability, economic viability, and local empowerment.



Student involvement in the field.

4. Project Outcomes and Results



4.1. Workshop Findings and Action Plans: The multi-stakeholder workshops on January 27 and February 3, 2024, revealed a strong local consensus that repurposing fish waste into fish leather, dietary supplements, or organic fertilizers holds significant promise for Santa Cruz Island. The CVF sessions illustrated that bridging economic incentives and environmental stewardship can generate new business opportunities while upholding conservation mandates.

4.2. Community Engagement and Interview Insights: By interviewing fishers, chefs, farmers, and municipal authorities, the research and students team gained a clearer view of the roles and responsibilities of local fish-waste production. Many stakeholders acknowledged that poor waste handling undermines the archipelago's tourism image and that circular solutions could bring much-needed extra income.

4.3. Prototype Development: While still in the early stages, fish-skin leather has captured considerable interest in artisanal goods, with the potential to expand into specialized markets. Additionally, supply-chain transparency measures—such as labeling products with origin and sustainability information—were identified as a key to capturing higher-value buyers.

4.4. Research and Dissemination Outcomes: The project generated a variety of practical and academic outputs that further disseminate its core findings and engage diverse audiences:

A. Booklet: [Empowering Circular Communities in the Galapagos Islands \(Castrejón et al., 2024\)](#). This bilingual booklet provides a clear, accessible overview of the Circular Value Flower (CVF) workshops, multi-stakeholder engagements, and the early-stage circular interventions identified for the Galápagos seafood system. Illustrated with photos, infographics, and local testimonials, the booklet aims to inform both local and international audiences about the project's methodology, initial achievements, and practical next steps to scale up circular solutions in Santa Cruz Island.

B. Manuscript in Preparation: [Towards an Ecosystem Approach to Fisheries in the Galapagos Marine Reserve \(Castrejón & Defeo, 2025\)](#). Building upon broader sustainable fisheries frameworks, this scholarly manuscript lays out a science-driven, adaptive co-management

roadmap for the Galápagos Marine Reserve. It details how circular economy practices fit within an ecosystem approach to fisheries (EAF), emphasizing climate-smart vessels, strategic governance reforms, habitat restoration, and market incentives. By highlighting the importance of local fisher participation and the synergy with circular community initiatives, the manuscript provides a valuable theoretical and policy-oriented foundation for future research and on-the-ground implementation.

C. Four more manuscripts are in progress to be submitted by the end of 2025.

- **Circular Value Flower (CVF) Method:** from analysis to design method. The paper will discuss the development of the CVF method and critically reflect upon this development process and the changes made throughout a 5-year period of iterations, based upon 16 case studies, workshops, and interviews.
- **Envisioning Circular Futures: Strategic Forecasting for Small-Scale Fisheries in the Galápagos:** The manuscript will present scenario-based insights derived from the Forecasting Strategic Study, highlighting feasible circular pathways for small-scale fisheries in Galápagos. It will analyze the method's role in identifying socio-ecological opportunities and constraints, and critically assess its integration with participatory tools to foster resilient, community-driven circular economy transitions.
- **From waste to wealth: Turning fish waste into business opportunities in the Galapagos Marine Reserve:** This study will assess the potential to transform fish waste from small-scale fisheries in the Galápagos into valuable products. Using surveys, focus groups, and waste measurements at Pelican Bay dock, it will quantify waste by species and identify business opportunities aligned with the circular economy. The findings will inform sustainable waste management strategies and propose practical solutions for environmental and economic benefits.
- **Toward Non-Extractive Academic-Community Partnerships: A Viewpoint on Decolonizing Research through Minga Pedagogies and Sumak Kawsay Principles:** This study advocates for a shift from traditional, extractive research models to collaborative, co-creative partnerships between researchers and communities by addressing the case study of the Galapagos seafood system, by emphasizing frameworks like "minga" and "sumak kawsay," which prioritize community involvement, mutual respect, and the integration of ancestral knowledge in research.

D. Documentary and Short Reels

- A short documentary, “**Empowering Circular Communities on the Galápagos Islands, Ecuador,**” provides an in-depth portrayal of the project's aims, challenges, and early successes. It showcases interviews with fishers, local authorities, and the research team.
 - [Documentary Link](#)
- Accompanying **ten short reels** (in Spanish and English) spotlight the personal perspectives of fishers, chefs, government representatives, and researchers. These mini-testimonials deepen community engagement and share succinct lessons learned.
 - [Playlist of Short Reels](#)

E. Student Research Outputs

- Three IED Minor Reports, Cohorts 2023-2024 & 2024-2025.

- “*From waste to wealth: Turning fish waste into opportunity in Pelican Bay, Puerto Ayora*” (de Bruij et al., 2024) established the project’s foundational data on fish-waste quantification and trust-building with the Pelican Bay fishing community (Phase 1).
 - “*Galápagos Islands: Circular Fish Waste Solutions*” (Dambrink et al., 2025) advanced pilot projects for fish leather, fertilizer production, and collagen extraction, laying the groundwork for local acceptance and scaling (Phase 3).
 - “*Fish leather step by step guideline*”: This manual provides a step-by-step guide for transforming fish skins into leather using natural tanning methods. It outlines procedures such as cleaning, de-scaling, soaking in lime, degreasing, enzymatic treatment, pickling with salt and acid, and tanning with plant-based or powdered tannins. It also includes instructions for oiling, drying, and conditioning the leather to produce a soft, durable final product. The guide emphasizes low-cost and eco-friendly practices suitable for small-scale applications.
- Two Master Student Reports (April–June 2024). Produced by participants in the TU Delft course “*Idea to Startup—Climate Action*,” these reports examined climate-focused business model development and the economic feasibility of fish-waste valorization under the guidance of Dr. Fátima Delgado and Dr. Mauricio Castrejón.
 - Three storymaps elaborated by minor and master students. These outcomes serve as a tool to craft and integrate diverse data and content types to construct an interactive narrative for the project, serving as a versatile dissemination tool for awareness of circular community efforts in the Galapagos Islands:
 - The Galápagos islands. Home to both nature and humans by Koole et al. (2024)
 - Fishing for the future. Fish Waste Transformation in Pelican Bay for a circular community by Agrawal et al. (2024)
 - A parasite-free Galápagos. A research project on the prevalence and mitigation of parasites on the Galapagos Islands by Dambrink et al. (2024)
 - **MSc Thesis in Industrial Ecology (TU Delft / Leiden University)**. Authored by Noa Buijsman, “*From Extractive to Regenerative Insular Food Systems: Uncovering the Entrepreneurial Barriers and Opportunities towards Shaping a Regenerative Productive Food System in the Galapagos Archipelago, Guided by the Principles of Circular Communities*,” the thesis holistically investigates policy, entrepreneurial, and ecological dimensions of transitioning island food systems to circular, regenerative models.

By combining **multimedia storytelling** (documentary, short reels), **academic research** (manuscript, thesis, student reports), and **practical prototyping** (workshops, pilot projects), these outputs have heightened awareness and elevated the conversation among local stakeholders and international audiences. They jointly showcase how circular economy interventions from a circular community approach, particularly fish-waste upcycling, can be deployed to strengthen the sustainability and resilience of the Galápagos Islands’ seafood system.

5. Challenges and Lessons Learned



Environmental Vulnerabilities: The Galápagos ecosystems' extreme sensitivity underscored how quickly unmanaged fish waste can trigger local pollution events and invasive-species outbreaks. Seasonal spikes in landings strained our ad hoc collection points and highlighted the absence of a reliable cold-chain to prevent spoilage. **Lesson learned:** future interventions must phase in modular, mobile processing units and cold-storage facilities—designed to scale up during high-season peaks—and pair them with real-time ecological monitoring to safeguard marine and terrestrial habitats.

Economic and Policy Barriers: Securing financing for circular pilots proved difficult in a context where fishers lack collateral and by-product valorization remains unregulated. Cumbersome permit processes for novel products (e.g., fish-leather tanning) delayed prototype testing, while marketing incentives for upcycled goods were non-existent. **Lesson learned:** building a successful circular model requires early alignment with municipal and national authorities to co-draft enabling regulations, plus establishment of a microfinance consortium or grant facility to underwrite start-up costs before community uptake.

Community Trust and Collaboration: Despite strong engagement from the Pelican Bay Cooperative, initial workshops revealed skepticism toward external experts and uneven participation across age groups and genders. Language nuances and local rituals were sometimes overlooked, hampering full buy-in. **Lesson learned:** investment in culturally sensitive, co-creative methods—such as embedding local champions in facilitation teams, delivering materials in Spanish and Kichwa, and adopting flexible, informal meeting formats—proved essential to rebuild trust, amplify community voices, and secure long-term ownership of circular interventions.

6. Future Perspectives and Sustainability



As the workshops and interviews underscored, Santa Cruz Island's [seafood system](#) demands urgent yet practical circular strategies that can scale over time. The synergy between [circular economy solutions](#) (e.g., fish leather prototypes) and [ecosystem-based management](#) fosters a pathway where waste minimization, product diversification, and stakeholder collaboration strengthen local resilience. [Integrating circular economy principles into the Galapagos small-scale fishing sector](#) could enhance sustainability, maximize resource use, and create economic opportunities while minimizing environmental impact (Castrejón & Defeo, 2025).

Shifting from maximizing catch volumes to improving product quality—via better handling practices and value-added seafood items—can reduce waste and open access to higher-value markets (Castrejón & Defeo, 2025). Repurposing fishery byproducts such as skins, bones, and viscera into high-value goods like fish leather or organic fertilizers (Moreno et al., 2020; Castrejón et al., 2024; Leclercq & Smit, 2023) can also empower circular communities, reduce ecological footprints, and bolster the economic resilience of local fishers.

Upgrading fishing infrastructure in accordance with CE principles (Castrejón & Defeo, 2025) is another near-term requirement. Landing sites, cold storage, ice production, and renewable energy solutions can boost both competitiveness and environmental performance. By weaving these efforts into a co-management framework, the Galápagos could emerge as a global example of how CE approaches can bolster conservation, food security, and community livelihoods (Castrejón et al., 2024; Castrejón & Defeo, 2025).

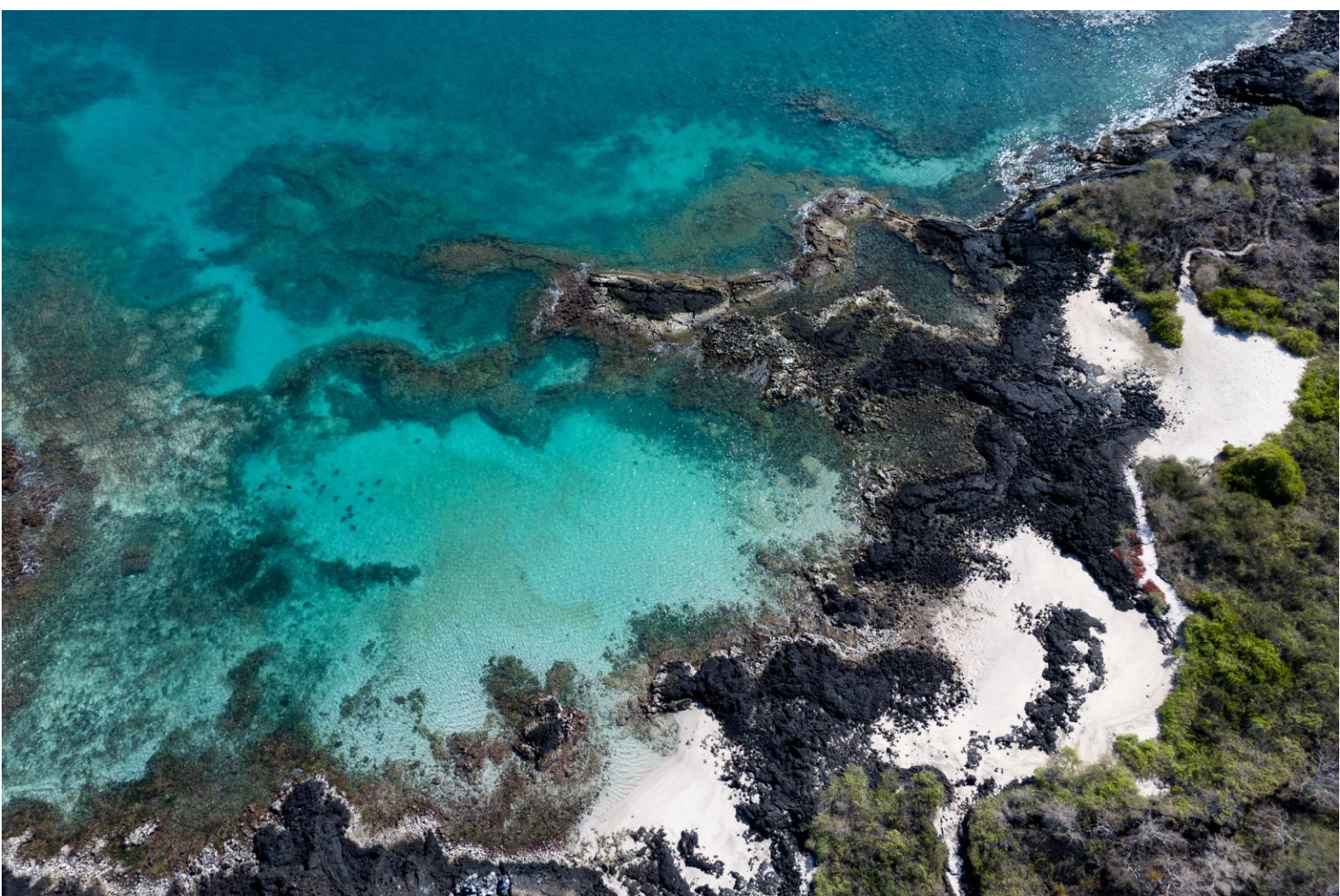
Additionally, the flagship project "INNOVAPESCA: *Pescando con ciencia del mar a la mesa*," has been pre-selected for funding by the Galápagos Life Fund (GLF) under its inaugural call for proposals. It proposes a comprehensive model to promote sustainable tuna fishing and circular economy practices in the Galápagos Marine Reserve.

Led by Dr. Castrejón through the startup INNOVAPESCA CIA. LTDA., in collaboration with TUDelft and other national and international partners, the project aims to reduce pressure on overexploited coastal species by shifting to selective fishing of oceanic species like tuna, improving post-capture handling, and implementing electronic monitoring and traceability systems. It will transform fish waste into value-added products such as fish leather and organic fertilizers, diversify fishers' incomes, and enhance market access for sustainable seafood.

With a 36-month timeline and nearly US\$750,000 in funding, the project aspires to position Galápagos as a global model for ecosystem-based fisheries management, marine conservation, and community-driven innovation.



7. Conclusion



The “Leveraging Empowered Circular Communities in the Galápagos Islands” project highlights [co-created](#) interventions for reducing fish waste, enhancing sustainability, and generating novel economic opportunities for Santa Cruz Island. Through multi-stakeholder workshops using the [Circular Value Flower](#) method, interviews with fishers and local institutions, and ongoing field activities, the team has begun converting environmental challenges into catalysts for innovation.

[Integrating circular economy principles](#) (Castrejón & Defeo, 2025) into small-scale fisheries can unlock new revenue streams (e.g., fish leather, organic fertilizer), reduce overall waste, and maintain the ecological integrity of the Galápagos Marine Reserve. This approach values product quality over sheer volume, encourages adaptive co-management, and emphasizes infrastructure upgrades to meet food safety and traceability standards. However, strengthening trust, improving policy frameworks, and offering capacity-building remain crucial next steps to ensure broad-based adoption and long-term sustainability.

8. Acknowledgements

LDE - Galápagos Project TEAM



FÁTIMA DELGADO
TU Delft

Sustainable & Circular
Entrepreneurship



ÁNGELA DÍAZ
UDLA

Urban Sustainability



MAURICIO CASTREJÓN
UDLA - GLAB

Marine Biology



ELS LECLERCQ
CCF

Circular Community



LAURA QUADROS
Erasmus

Urban Sustainability
and Climate Change



MARTIJN BEZEMER
Leiden

Ecology of Plant-
Microbe-Insect
Interactions

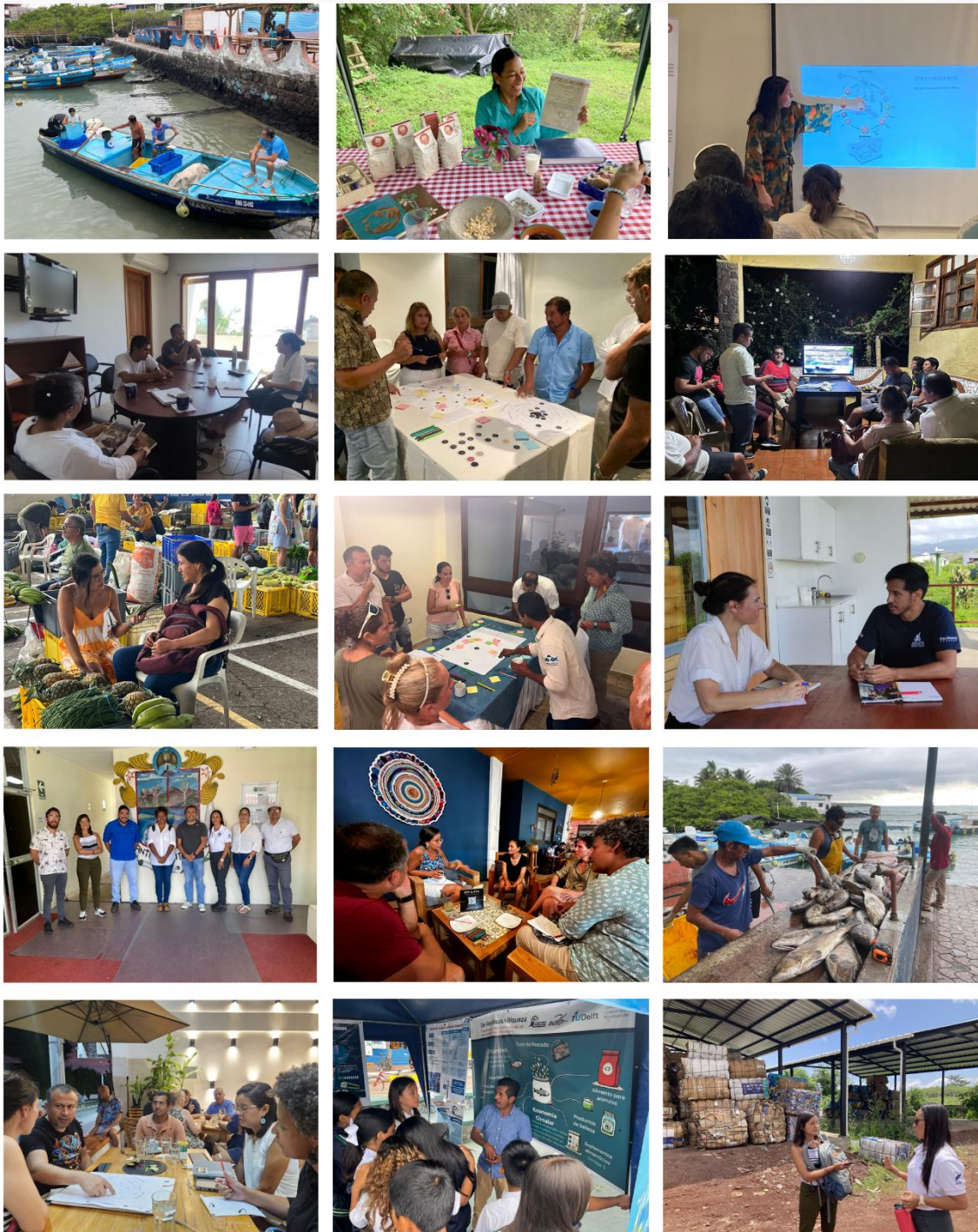
We would like to extend our deepest gratitude to the [LDE Global Fund](#). Your visionary support has been instrumental in catalyzing the synergies needed to drive high-impact projects in the Galápagos, and your confidence in our work has empowered every stage of this initiative.

We also thank our partner [universities](#) and [foundations](#) for their collaborative spirit, and the [professors](#), [researchers](#), and [students](#) whose expertise and enthusiasm enriched our analyses and field activities. A warm thank you goes to the [international NGOs](#) based in the Galápagos, [local government representatives](#), local and international [technicians](#) and [specialists](#), who generously granted us interviews and shared invaluable insights into local conservation and community dynamics. We would also like to thank all the [consultants](#) who worked on the project; their added value and energy have made an exceptional contribution.

To the small-scale [entrepreneurs](#) whose livelihoods are intertwined with fishing, and to the [Pelican Bay Cooperative](#) members and families and [Innovapesca](#), your openness and guidance were fundamental to understanding on-the-ground realities. Finally, we are deeply grateful to all the [residents](#) of the islands who welcomed us so warmly—your hospitality and local wisdom made this project not only possible, but truly meaningful.

© All images were generated as part of this project.

9. Appendix - graphic overview



LDE Global
Leiden-Delft-Erasmus Universities



10. References

- Anastacio-Solis, J., & Velasco-Plaza, M. (2023). *Estudio de mercado de la pesquería responsable de atún de aleta amarilla (Thunnus albacares) de Galápagos para identificar mercados con preferencia por un producto pesquero de calidad, legal y sostenible que contribuyan a la mejora de ingresos de los pescadores artesanales de la RMG. Producto 2. Puerto Ayora, Galapagos.*
- Agrawal, D., Taets van Amerongen, V., & Boudewijn, B. (2024, June 26). *Fishing for the future: Fish waste transformation in Pelican Bay for a circular community*. ArcGIS StoryMaps. Retrieved May 1, 2025, from <https://storymaps.com/nl/stories/1f8f9136ab1949cc88331d29729b9085>
- Berman, K., Kobylko, G., Kuratomi, T., Daniel, O., & Oswald, K. (2018). *Value chain analysis for artisanal fisheries in Galapagos, Ecuador*. UCLA Anderson School of Management and Conservation International.
- Burbano, D. V., Meredith, T. C., & Mulrennan, M. E. (2020). Exclusionary decision-making processes in marine governance: The rezoning plan for the protected areas of the 'iconic' Galapagos Islands, Ecuador. *Ocean & Coastal Management*, 185, 105066. <https://doi.org/10.1016/j.ocecoaman.2019.105066>
- Castrejón, M., Delgado, F., Leclercq, E., & Díaz, Á. (2024). *Empowering Circular Communities in the Galapagos Islands*. Quito, Ecuador.
- Castrejón, M., & Defeo, O. (2025). *Towards an ecosystem approach to fisheries in the Galapagos Marine Reserve: a science-driven and adaptive co-management framework [Manuscript in preparation]*. Grupo de Investigación en Biodiversidad, Medio Ambiente y Salud, Universidad de Las Américas; Laboratorio de Ciencias del Mar, Facultad de Ciencias, Montevideo.
- Castrejón, M., Pittman, J., Miño, C., Ramírez-González, J., Viteri, C., Moity, N., Andrade-Vera, S., Caceres, R., Tanner, M. K., Rodríguez, G., & Barragán-Paladines, M. J. (2024). The impact of the COVID-19 pandemic on the Galapagos Islands' seafood system from consumers' perspectives. *Scientific Reports*, 14, 1690. <https://doi.org/10.1038/s41598-024-52247-5>
- Dambrink, D., Docter, B., Eland, M., & Peters, J. (2025). *Galápagos Islands: Circular fish waste solutions* [Student report]. Delft University of Technology.
- Dambrink, D., Docter, B., Eland, M., & Peters, J. (2024, October 9). *A parasite free Galápagos: A research project on the prevalence and mitigation of parasites on the Galápagos Islands*. ArcGIS StoryMaps. Retrieved May 1, 2025, from <https://storymaps.com/nl/stories/4253c7741b68474c81ce4c0dbbc41db6>
- De Bruijn, M., Ooteman, M., Segers, H., & Verhalle, B. (2024). *From waste to wealth: Turning fish waste into opportunity in Pelican Bay, Puerto Ayora* [Student report]. Delft University of Technology.
- Escobar-Camacho, D., Rosero, P., Castrejón, M. *et al.* Oceanic islands and climate: using a multi-criteria model of drivers of change to select key conservation areas in Galapagos. *Reg Environ Change* 21, 47 (2021). <https://doi.org/10.1007/s10113-021-01768-0>

- Jones, P. J. (2013). A governance analysis of the Galápagos Marine Reserve. *Marine Policy*, 41, 65-71.
<https://doi.org/10.1016/j.marpol.2012.12.019>
- Kaur, K., Kats, L., Siegers, F., & de Wilde, A. (2024). *Regenerative business model strategies for fish leather in the Galápagos Islands* [Student report]. Delft University of Technology.
- Koole, L., Paramjit, K. K., Grieco, F., & Gambhire, A. (2024, July 18). *The Galápagos Islands: Home to both nature and humans*. ArcGIS StoryMaps. Retrieved May 1, 2025, from
<https://storymaps.arcgis.com/stories/f52ad6a33723470ab82bc50bb1b0cb60>
- LDE Global Proposal. *Leveraging Empowered Circular Communities in the Galápagos Islands, Ecuador: A Promising Pathway to Sustainable Development and Conservation* (2023).
- Leclercq, E., & Smit, M. (2023). *Circular communities: the value flower-design method for collective circular initiatives*. Marcel Witvoet, nai010, TU Delft Open, Rotterdam.
- Moreno, J., García, S., Vera, M., & Obregon, P. (2020). *Reporte sobre la identificación de los productos de desechos de pescado que se generan en la Cooperativa de Producción Pesquera Artesanal Galápagos (COPROPAG) y el Muelle Pelican Bay*. Puerto Ayora, Galapagos.
- Taets van Amerongen, V., Boudewijn, B., & Agrawal, D. (2024). *A roadmap towards sustainable fish leather production in the Galapagos Islands* [Student report]. Delft University of Technology.