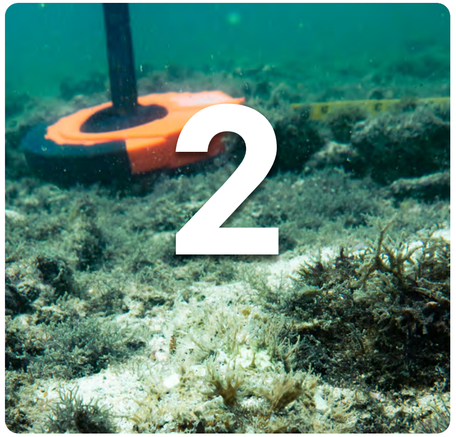

2026 – Islote Sucre, Ecuador
rreefs
rethinking
rebuilding
regenerating
impact
report

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abstract

This report presents the two-year progress of rrreefs' project on Ecuador's Islote Sucre, where a 25 m² reef has been regenerated using our modular clay reef system.

The project includes reef monitoring and community engagement initiatives led by our local partner, Conservación Marina Ecuador (CONMAR).

Two years on, the reef continues to show encouraging signs of coral settlement and sustained fish abundance, reflecting positive habitat development and ecosystem recovery driven by the new reef structures.

ecological indicators after 2 years

- Fish abundance rose further, peaking around one year before a slight decline, but still exceeding the natural reef and control sites overall
- Invertebrate abundance and diversity increased steadily, with the clay reef ultimately supporting the highest levels of sessile invertebrates of all three sites
- The reef structure remains home to a resident octopus population

location

Islote Sucre, an islet located off the west coast of Ecuador and part of the Machalilla National Park, is one of the most extensive protected areas on the Ecuadorian coast. This special place serves as the site for our reef regeneration project.



enablers of the project

Melitta®

CONMAR
CONSERVACIÓN MARINA ECUADOR

CONMAR: our local partner

sustainable development through reef regeneration

Since 2023, we have partnered with CONMAR, a non-profit organization dedicated to promoting environmental responsibility for Ecuador's coastal and marine resources. Their expertise has been essential for the implementation and monitoring of the reef.

CONMAR has led coral research and restoration efforts, working closely with local fishermen from communities like Los Ciriales.

They provide training to fishermen to perform underwater tasks safely and efficiently, thus gaining an alternative source of income through conservation. The team focuses on coral gardening activities, such as the maintenance and monitoring of coral nurseries and reef building.

Since 2021, CONMAR has also run Corallium, a coral restoration initiative in Los Ciriales — the broader conservation framework through which CONMAR partnered with rrreefs to install the first clay artificial reef in the country. Beyond ecological value, this work has strengthened nature-based tourism, community empowerment, and knowledge exchange between scientists, conservation practitioners, and local residents.



Andrea Castillo, CONMAR Project Director


intro:
1 Islote Sucre

reef location: Islote Sucre, EC

why this location

We installed our reef near Islote Sucre, also called Isla El Sucre or Isla de Sucre — an islet off the west coast of Ecuador that is part of the Machalilla National Park. The park covers an area of 289.8 km², including a marine protected area (MPA) where our reef is situated.

This region hosts the largest concentration of coral reefs in continental Ecuador, alongside exceptionally high biodiversity.

Ecuador's reefs face threats from warming waters, ocean acidification and other human-caused disturbances. According to CONMAR, around 70% of coral areas in Ecuadorian waters have been lost in recent decades. In the Galápagos, the 1982–83 El Niño alone killed around 90% of shallow-water corals.





1.4750° S, 80.7842° W



rebuilding a degraded reef area

what we did

In May 2024, we regenerated a 25m² reef area near Islote Sucre, Ecuador. This marks the first time our system has been implemented in the eastern Pacific Ocean, enabling us to compare its regenerative potential across three different oceans worldwide.

The project is a collaboration with the Melitta Group, an internationally active, family-owned group of companies specializing in coffee and related products.

why it matters

Interacting human impacts, such as overfishing and global warming, are threatening the very existence of coral reefs worldwide. Habitat regeneration is one of the cornerstones of preserving these vital ecosystems.

Our system provides habitat and settlement surface for a wide range of reef dwelling organisms, thereby regenerating local biodiversity.



In 2025, it was reported that 84% of the world's coral reefs are under thermal stress, making projections of 90% coral loss by 2030 feel disturbingly plausible.

Reef restoration demands enormous effort, and given this urgency, partnerships like the one with rrreefs are essential: they are what make it possible to innovate and test new strategies that could prove key to conserving our reefs.

Andrea Castillo, CONMAR Project Director




monitoring
2 practices

scientific monitoring

the importance of research

Scientific monitoring underpins everything we do at rrreefs. It provides the data that allows us to measure the impact of our reefs, comparing them to a control site and tracking how marine life returns over time.

Our monitoring protocol combines fish and invertebrate belt-transect surveys with photomosaic and photogrammetry techniques, adapted to the small, highly complex structure of our clay reefs.

how surveys are conducted

Fish and mobile invertebrates are surveyed along three replicate 15 × 2 m belt transects at each site (clay reef, natural reef, sand control), recording all individuals within a 1 m band on either side of the line.

A photomosaic of the whole structure is captured by swimming its perimeter and surface in overlapping passes (~2,000–2,300 images per survey), and cryptic species are located by close visual search and photographed in situ for later identification. No organisms are collected or manipulated during surveys.

In addition, a total of 50 individual bricks across the structure were marked and photographed at regular intervals under standardized lighting to track colonization and biofouling at the block level over time.

comparison is key

Surveys were conducted at our clay reef and two control sites: a sand/rubble patch matching the clay reef site in seafloor, depth and environmental conditions, and a natural reef site.

For this report, we carried out surveys at four key points in time: baseline (prior to deployment), 3 months, 6 months, and 12 months after construction — extended in this update to a fourth survey at 24 months.

tracking change over 2 years

Tracking data over time is essential. They help us understand how our clay reefs develop, how species return, and how we can refine our approach for future projects.

- baseline
  prior to deployment
- 3 months
  after clay reef construction
- 6 months
  after clay reef construction
- 12 months
  after clay reef construction
- 24 months
  after clay reef construction





3 reef health

coral update

what are corals?

Corals are keystone species on reefs, forming the foundation of these vibrant ecosystems. They provide habitat, shelter and food for an unparalleled diversity of fishes and invertebrates – such as sea cucumbers, worms, nudibranchs, sponges, shrimps and clams.

Yet, when corals degrade, they can no longer fulfill this vital role of providing habitat, leading to the collapse of the entire ecosystem.



how to find coral recruits?

Corals are slow-growing, colonial, jellyfish-like animals with a calcium carbonate skeleton. These colonies begin with a single tiny polyp, known as a recruit, which is almost invisible to the naked eye.

To monitor coral recruitment, we typically use UV-light photography at night, a technique that reveals the natural fluorescence of the polyps and makes these early-stage corals visible for assessment.



outplanted corals reached up to 30 cm

Due to safety concerns at this particular site, night diving was not possible and recruitment monitoring could therefore not yet be conducted. Consequently, no empirical data on natural coral recruitment are available from this monitoring period. We are currently developing a black box system that will enable future monitoring of coral recruitment during daylight hours, allowing recruitment to be assessed under safer conditions.

Approximately 10 outplanted corals remain on the Clay Reef structure, with the largest observed colony reaching approximately 30 cm in diameter. Their continued presence and growth indicate successful persistence of the outplanted corals on the structure.



At rrreefs, we regenerate coral reefs by rebuilding a structurally complex reef environment for all reef organisms, as well as a stable surface for new corals to settle and grow. Diversity creates resilience.

Dr. Ulrike Pfreundt, co-founder of rrreefs

invertebrate update



Invertebrate abundance increased rapidly at both the Clay Reef and, later, the Non-regenerated Control Site, while the Natural Reef's recorded abundance rose only gradually. Diversity, by contrast, increased early and steadily at the Clay Reef but remained near zero at the Non-regenerated Control Site and Natural Reef until Jun-25. The initially low abundance and diversity recorded at the Natural Reef are likely attributable to its high structural complexity, which reduced the detectability of cryptic taxa during visual surveys rather than reflecting genuinely depauperate communities.

By the final survey, the Clay Reef and the Non-regenerated Control Site supported similar abundance of sessile invertebrates, but the Clay Reef's diversity was substantially higher. The high abundance observed at the Non-regenerated Control Site was to a large extent driven by a single sea urchin species (flower sea urchin, 45% of individuals), rather than by a broadly diversified community. These patterns suggest that the Clay Reef provided suitable substrate for colonization and facilitated the progressive establishment of a diverse benthic community, whereas community development at the Non-regenerated Control Site was slower and more skewed toward a single opportunistic species, likely due to the absence of comparable hard substrate and structural complexity.

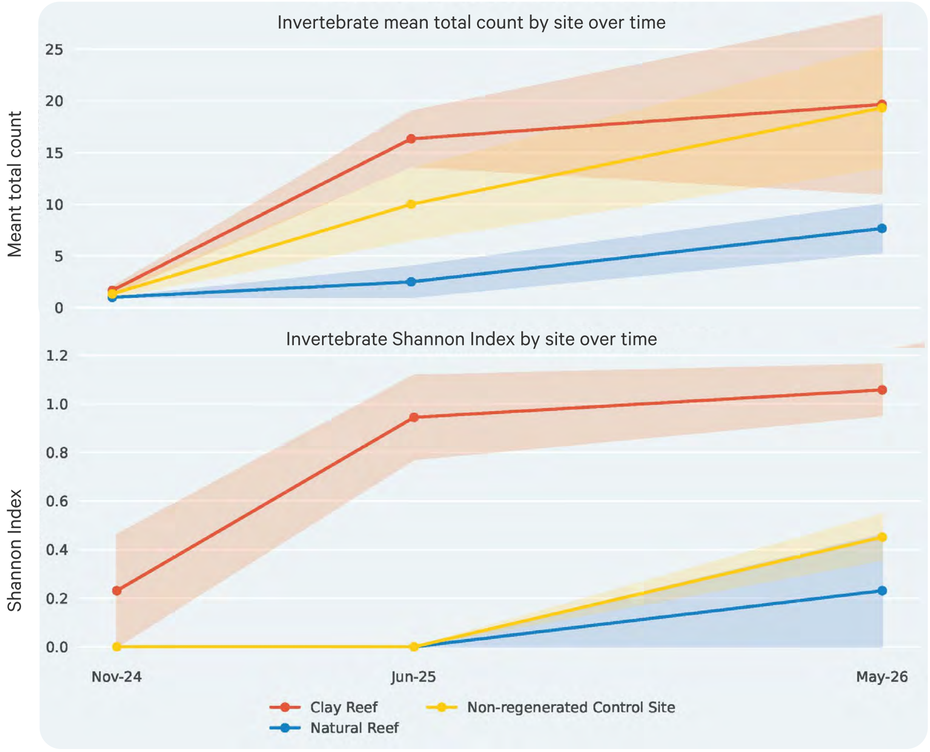


Fig. Temporal changes in the abundance and diversity of invertebrates at the Clay Reef, Natural Reef, and Non-regenerated Control Site between March 2024 and May 2026. Values represent mean (±SE) from three replicated transects per site.

fish update



Abundance at the Clay Reef rose steadily from March 2024 through June 2025, before declining somewhat by May 2026, while diversity (Shannon index) remained comparatively stable throughout the monitoring period. The Natural Reef showed consistently high, stable abundance and diversity across all four surveys, suggesting it functioned as a mature baseline against which the other sites can be compared. The Non-regenerated Control Site started at roughly a quarter of the Clay Reef's abundance and less than half the Natural Reef's diversity in March 2024, and the gap with both reef sites widened further through November 2024 and June 2025, as its abundance fluctuated at a low level and its community remained dominated by a single species at each survey (Banded serrano in Nov 2024, Scissortail damselfish in Jun 2025).

By the final survey, the Clay Reef and Natural Reef converged on similar abundance and diversity values, while the Non-regenerated Control Site's abundance and diversity also rose sharply between June 2025 and May 2026, narrowing the gap with the two reef sites. Unlike the earlier surveys, this later increase was spread across several species — including Cortez rainbow wrasse, Chameleon wrasse, and Pacific creole fish — with species richness nearly doubling from four to seven, indicating genuine community diversification rather than a single-species bloom. These patterns suggest that the Clay Reef supported a community approaching the abundance and diversity of the established Natural Reef more quickly than the Non-regenerated Control Site, though the broadly based late increase at the Non-regenerated Control Site indicates that meaningful community development also occurred there by the end of the study period.

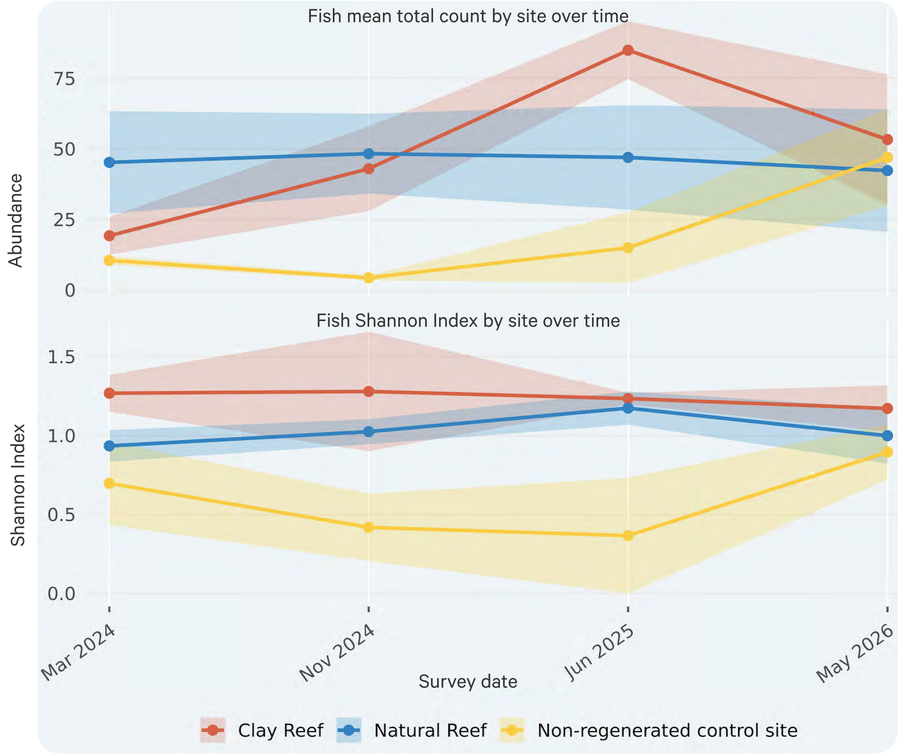


Fig. Temporal changes in fish abundance and diversity (Shannon index) at the Clay Reef, Natural Reef, and Non-regenerated Control Site between March 2024 and May 2026. Values represent mean (±SE) from three replicated transects per site.


testimonies
4 & news

voices from the community

I believe that coral restoration is marking a transformative milestone for the community, offering a sustainable development alternative to a population that depended solely on fishing.

At a global level, this type of initiative has shown that marine conservation transforms lives in a tangible way and lays the foundations for future generations. For this project to reach its full potential, it is essential to encourage an inclusive participation where personal interests are put aside in favour of teamwork.

I firmly believe that this unity is the true basis for ensuring the success and sustainability of our work in the territory.

LUIS CARRASCO, coral guardian & local tourism

The impact has been very positive. Thanks to the project I've met many people, and it has benefited both me and my fellow workers. Because when doing snorkelling tours, tourists can see the marine life that has recovered, and I can share with them the work we've been doing.

The tourists are very happy to see that there are people who care about the ocean, and there are others who didn't know about corals or restoration and are becoming interested.

It fills us with happiness to see people like you who care about our ecosystems, and it's a huge help, I'd say a tremendous help. Where before there was a cemetery, now it's full of pure life.

RONALD BAQUE, coral guardian & fisherman

Coral conservation and being able to do coral planting helps the community enormously. Especially if this community works in tourism, because it's the main draw for attracting visitors to discover new forms of life and experience something incredible that amazes them. Seeing how the fish and corals develop is something incredible. And it not only helps this ecosystem grow and become a refuge, but it also allows the community to generate income through organized and responsible visits to these coral patches.

That's unique and incredible, and thanks to this, many people can come to learn and get trained in the fact that we all need this ecosystem — even those who live far away are impacted, directly or indirectly, and it's been an extremely positive impact. One way or another, we all benefit. Thank you CONMAR and your partners, we hope we can continue with this project, with this drive, this momentum to keep going with this project that helps us generate resources to survive.

NESTOR FIGUEROA, coral guardian & fisherman





5 community & partners

reef building: a collective effort

One of the core goals of our project is to create long-lasting social impact through community engagement and knowledge sharing.

During the reef installation, the local community of Los Ciriales led the production of the reef's concrete foundation — the Nauplius structures — and managed logistics, including transporting materials on land and on their boats. Some of them, who already had more diving experience, participated in the process of submerging the material and assembling the reef.

Additionally, some fishermen who had previously been trained in coral ecosystem health monitoring and fish identification took part in the mid-year monitoring. Others contributed by providing their boats to help transport the team to the work site.



community benefits

sustainable development through reef regeneration

According to CONMAR's director Andrea Castillo, the reef has benefited the local community in many ways, as it has raised awareness about reef conservation. Additionally, she stated that the presence of an international organization working in their community gives them a sense of importance.

Today, the larger restoration project run by CONMAR engages at least 35 active Reef Protectors and 6 core community members from Los Ciriales who participate regularly in reef monitoring activities: artisanal fishers, tourism operators, young adults, students, and community leaders.



Since they rely on fishing, the recovery of the coral ecosystem directly contributes to a greater abundance of fishery resources in the long term.

Los Ciriales is a community where tourism is beginning to grow, and the clay reef has become a tourist attraction, increasing local income. Furthermore, it helps position them as a sustainable tourism destination. The boat operators, having worked alongside the CONMAR team throughout the reef installation process, now educate tourists about conservation.

I no longer hunt octopus, now I take care of them. Because I know that a live octopus is worth more than a dead one.

JESUS, coral guardian & fisherman

who are the reef protectors

why people join

While the project initially attracted community participation through its potential economic benefits and its relevance to protecting marine resources essential for local livelihoods, motivations have diversified over time. Today, young adults engage in the initiative not only as reef stewards but also as active contributors to scientific research and conservation. Their involvement reflects a growing interest in acquiring technical skills, supporting sustainable tourism, strengthening local leadership, and safeguarding the health of coastal ecosystems for future generations.

learning by doing

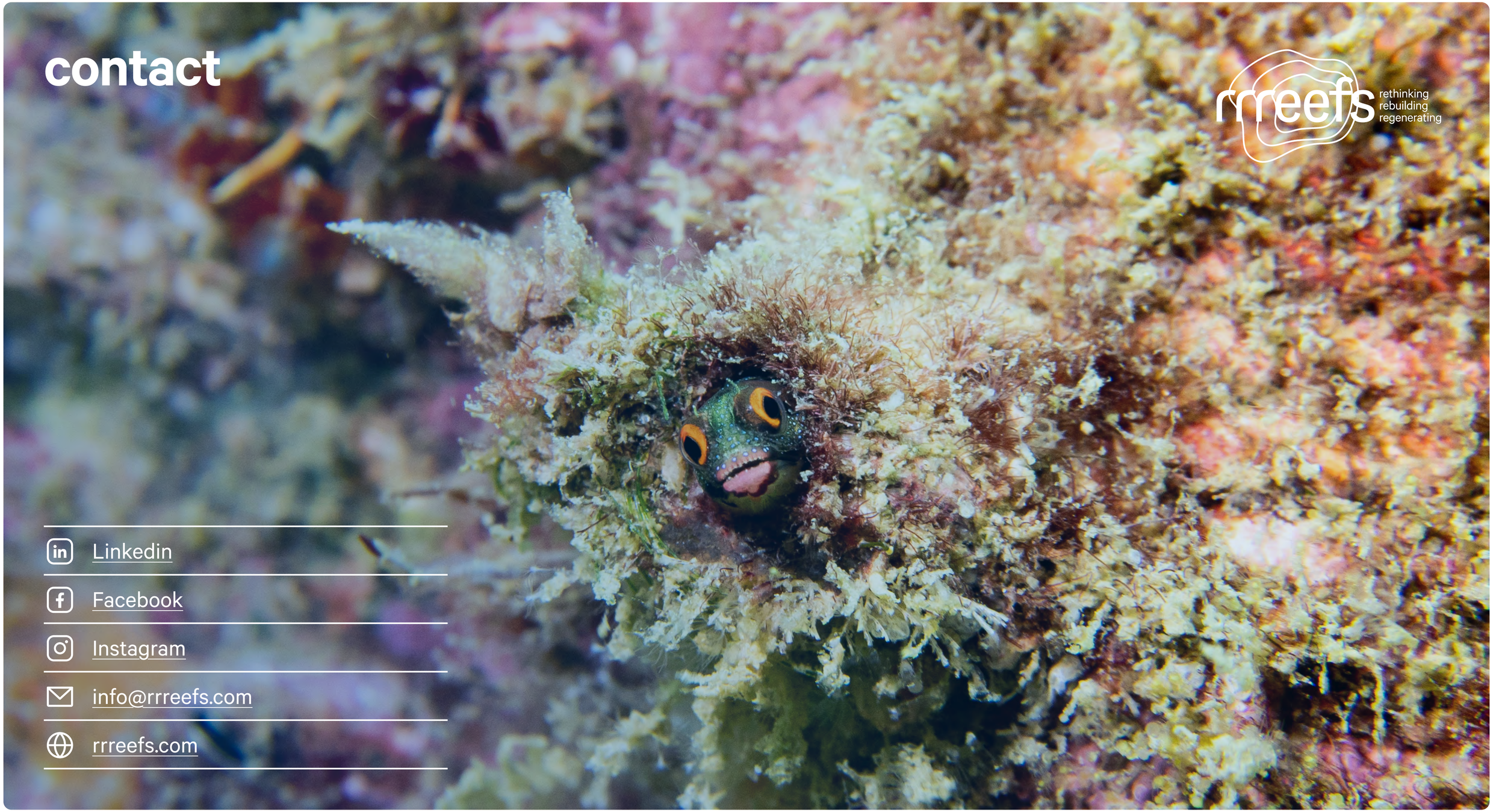
The educational backgrounds of participants vary, ranging from primary and secondary education to technical-level training. Limited economic opportunities have historically been one of the main barriers to pursuing higher education within the community. Through the project, we aim to strengthen participants' biological, ecological, and scientific skills, enabling them to take an active role in reef monitoring, conservation, and restoration efforts.

traditional knowledge, modern science

Traditional ecological knowledge is a fundamental component of the project. Community members possess valuable insights accumulated through generations of interaction with the marine environment, providing important historical perspectives on ecosystem conditions prior to the availability of scientific monitoring data. This local knowledge complements scientific methodologies and greatly enriches our understanding of ecological changes over time, helping guide regeneration and conservation strategies.

Through sustained participation, community members have strengthened their technical capacities in marine monitoring, species identification, and ecological data collection — fostering local leadership and community ownership of marine conservation.

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