Photo Credit: **Joe Lepore**

Blue Prosperity Vanuatu
2023 Coral Reef Study
Preliminary Science Report

LONG GOD YUMI STANAP

BLUE PROSPERITY VANUATU

VAITT INSTITUTE

Photo Credit: **Joe Lepore**

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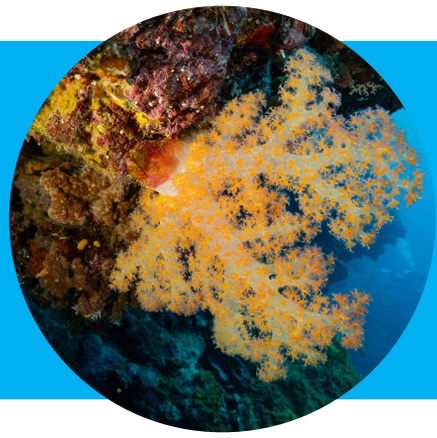

Photo Credit: **Joe Lepore**

FOREWORD

It is my honor to introduce the Blue Prosperity Vanuatu Coral Reef Study Preliminary Report. From September 1 to 21, 2023, the Government of Vanuatu, in partnership with Blue Prosperity Vanuatu and an array of local and international collaborators, undertook the largest coral reef study ever conducted across our six provinces. This milestone expedition represents more than just a scientific achievement; it provides a vital foundation for strengthening traditional governance and sustainable coastal management in Vanuatu.

The data gathered during this expedition—covering coral reefs, fish, invertebrates, and water quality—offers an unprecedented baseline for understanding the health of our marine ecosystems. It supports the integration of scientific findings with traditional knowledge, empowering communities to make informed decisions about coastal planning and resource management. This information is essential for preserving the livelihoods that our reefs sustain and for ensuring the long-term resilience of our coastal ecosystems.

This study also reaffirms Vanuatu's commitment to blending our ancestral governance systems with innovative scientific approaches, particularly through the Marine Spatial Planning (MSP) process. By doing so, we honor our traditions while equipping ourselves to meet the challenges of today's ocean management needs. The findings of this expedition will not only enhance ongoing research and monitoring but will also guide sustainable practices and conservation efforts that benefit all Ni-Vanuatu.

On behalf of the Government of Vanuatu, I thank the scientists, institutions, and local stakeholders who made this endeavor possible. Together, we are working toward a future where a healthy ocean sustains our communities, our culture, and our shared prosperity.

Sincerely,
Toney Tevi,
Head of the Maritime and Oceans Division, Ministry of Foreign Affairs

Photo Credit: **Andy Estep**

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EXECUTIVE SUMMARY

From 1-21 September 2023, the Government of Vanuatu, in partnership with Blue Prosperity Vanuatu, local NGOs, and international collaborators, conducted the largest nationwide coral reef study across all six (6) provinces of Vanuatu. This study gathered information about the status of coral reefs, fish species, invertebrate populations, and water quality across Vanuatu's waters.

Photo Credit: **Joe Lepore**

During the expedition, scientists from Vanuatu and across the globe collected data from coastal habitats, contributing insights into the overall health of Vanuatu's marine ecosystems. While this information will not provide stock assessments for individual species, it will help support traditional governance and decision making for coastal planning and establish a baseline for continuing to detect changes in Vanuatu's coral reefs as well as the effectiveness of management interventions aimed to improve coastal ecosystems and the livelihoods they support. It will also significantly enhance ongoing research and monitoring efforts. The data gathered will also be integrated into Vanuatu's Marine Spatial Planning (MSP) process, which combines scientific findings with traditional knowledge to guide sustainable ocean management.

The coral reef study was led by the Government of Vanuatu through the Blue Prosperity Vanuatu program, under the direction of the Department of Foreign Affairs, Vanuatu Fisheries Department and Department of the Environmental Protection and Conservation, as well as the Department of Geology and Mines, working in close collaboration with universities and non-governmental organizations including the University of the South Pacific (USP), CRIOBE, Big Blue Dive Shop, Scripps Institution of Oceanography, and the Waitt Institute.

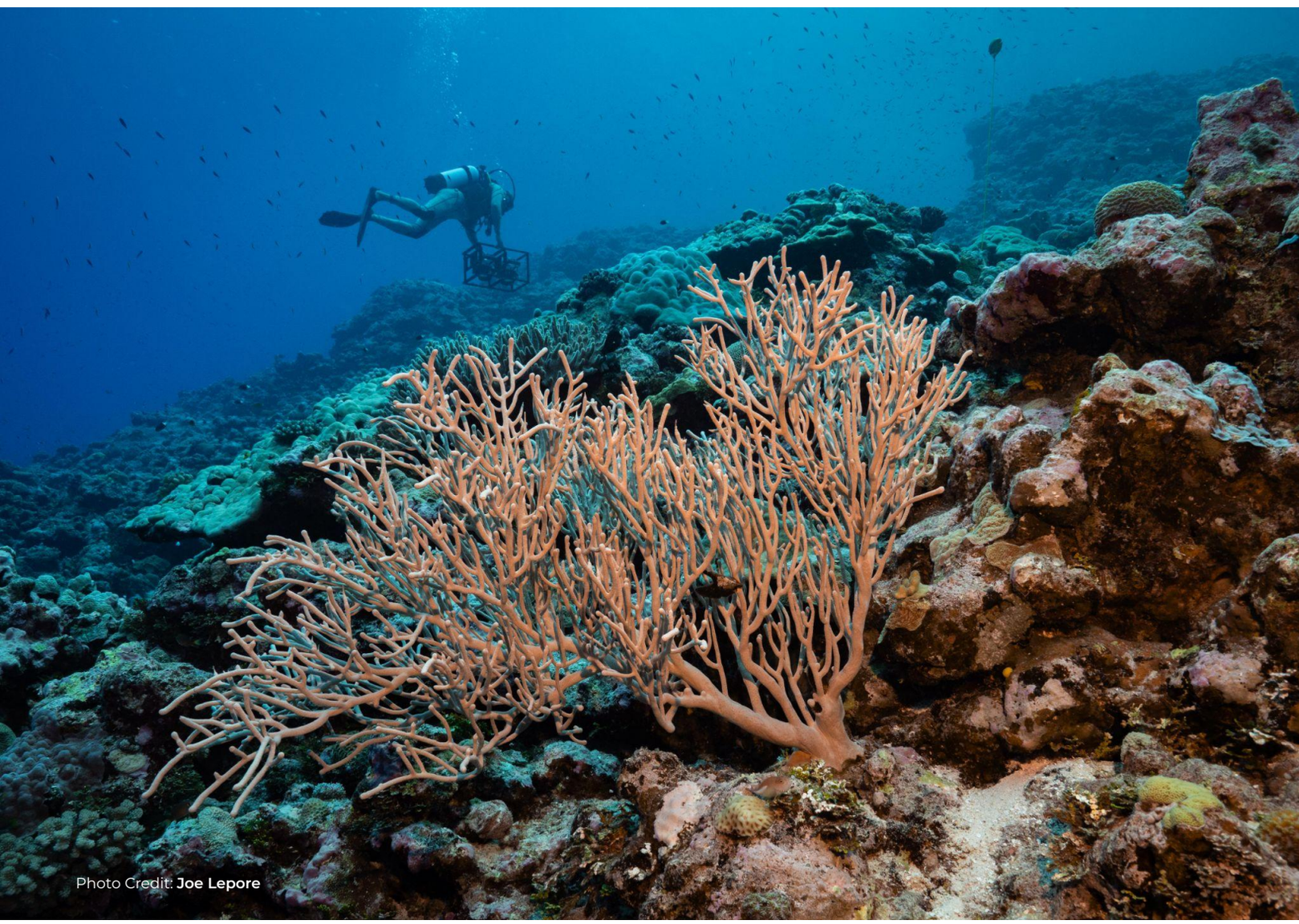

Photo Credit: **Joe Lepore**

The outcomes of this expedition will be shared through three primary deliverables:

- **Preliminary Science Report**: This document, offering an overview of the expedition's methods and observational information, serves as the first stage of analysis.
- **Provincial-level Reports**: These will provide a snapshot of findings to communities, ensuring that local communities have access to relevant data.
- **Final Science Report**: The final nationwide report will offer a comprehensive summary of the expedition's findings, informing decision-makers and stakeholders on the health of Vanuatu's marine ecosystems. In addition to the report, a final work package will include summary data, work products, and access points. A media package will feature distributable underwater and aerial photos and videos. All reports will undergo thorough review processes and stakeholder input to ensure accuracy.

02

INTRODUCTION

Photos by: **Joe Lepore**

From 1-21 September 2023, the Government of Vanuatu, in partnership with Blue Prosperity Vanuatu, local NGOs, and international collaborators, conducted the largest nationwide coral reef study across all six (6) provinces of Vanuatu. This study gathered information about the status of coral reefs, fish species, invertebrate populations, and water quality across Vanuatu's waters.

The Blue Prosperity Vanuatu Coral Reef Study aimed to gather important information about Vanuatu's coral reefs to better understand the status of marine life and resources and support the implementation of sustainably managing 100% and fully protecting at least 30% of Vanuatu's ocean.

The data will help support traditional governance and decision making in determining the most effective actions to improve ocean health, enhance food security, support livelihoods, and promote sustainable economic growth.

Expedition goals and objectives were aligned with national priorities and commitments. They supported the implementation of 1) the Vanuatu National Ocean Policy, 2) the Vanuatu Biodiversity and Strategic Action Plan 2018-2030, 3) the Vanuatu National Fisheries Sector Policy 2016 - 2030, and 4) the Vanuatu National Coastal Roadmap 2019 - 2030. The expedition objectives were endorsed by the Science and Technical Committee on Ocean Governance (STOG), which includes representatives from the Department of Foreign Affairs, Vanuatu Fisheries Department, and Department of Environmental Protection and Conservation, as well as the Department of Geology and Mines.

Blue Prosperity Vanuatu is a government-led initiative to strengthen sustainable ocean management and support a healthy ocean, thriving communities, and a brighter future for the people of Vanuatu. The program will help the National Ocean Policy, 100% sustainable ocean management, and fully protect at least 30% of Vanuatu's marine waters.

DEVELOPMENT OF THE SCIENCE PLAN

This expedition was sponsored through the Ministry of Foreign Affairs. The plan was co-developed by the Ministries of Foreign Affairs, Fisheries, Environment, Minerals, Geology, and Water. A team of Co-Principal Investigators (Co-PIs) was nominated to oversee the technical implementation of the expedition's planning, data collection, processing, analysis, and reporting, as well as engage with senior leadership at their respective organizations.

The Co-PIs:

- Steve Hango - Maritime and Ocean Affairs Division: Foreign Affairs Ministry
- June Brian Molitaviti - Vanuatu Fisheries Department: Ministry of Agriculture, Livestock, Forestry, Fisheries, and Biosecurity (MALFFB)
- Dean Wotlolan - Department of Environmental Protection and Conservation: Ministry of Climate Change Adaptation, Meteorology and Geo-Hazards, Energy, Environment and National Disaster Management
- Andy Estep - Waitt Institute
- Stuart Sandin - Scripps Institution of Oceanography (Blue Prosperity Global Co-PI)

Photo by: **Joe Lepore**

Photo Credit: **Joe Lepore**

Expedition Objectives

Coral reefs are relied upon for direct and indirect ecosystem services and are critical habitats for coastal planning and management. The research objectives of this expedition aimed to develop core insights into the condition of coral reefs and key species that inhabit them, both from an ecological and commercial exploitation perspective.

Research Objectives

1. Assess nationwide condition of coral reefs using common indices of reef condition (outlined in methodology).
2. Provide insights to major drivers (climate change, over-exploitation, development, etc.) of coral reef condition in Vanuatu.
3. Identify areas and characteristics of resilience in Vanuatu's coral reefs.
4. Assess distribution and abundance of ecologically important indicator species and commercially exploited species of fish and macroinvertebrates.
5. Establish long-term ecological monitoring stations.

Non-research Objectives

1. Design expedition and expedition outputs to support traditional governance.
2. Build local capacity and network connections for detailed assessment, analysis, and reporting of coral reefs in Vanuatu.
3. Ensure expedition outcomes and insights reach communities.
4. Collect actionable data to inform coastal marine spatial planning.

SURVEY SITE SELECTION

The Department of Foreign Affairs, Vanuatu Fisheries Department, and Department of Environmental Protection and Conservation directed site selection. Sites were established using a stratified-random sampling approach. All survey sites were assigned to 10 meter forereef habitats on the sides of islands that are sheltered from wind to deliver an archipelago-wide baseline of coral reef condition with the ability to provide statistically significant insights at all larger islands. This also ensured that data would deliver significant results at the provincial level.

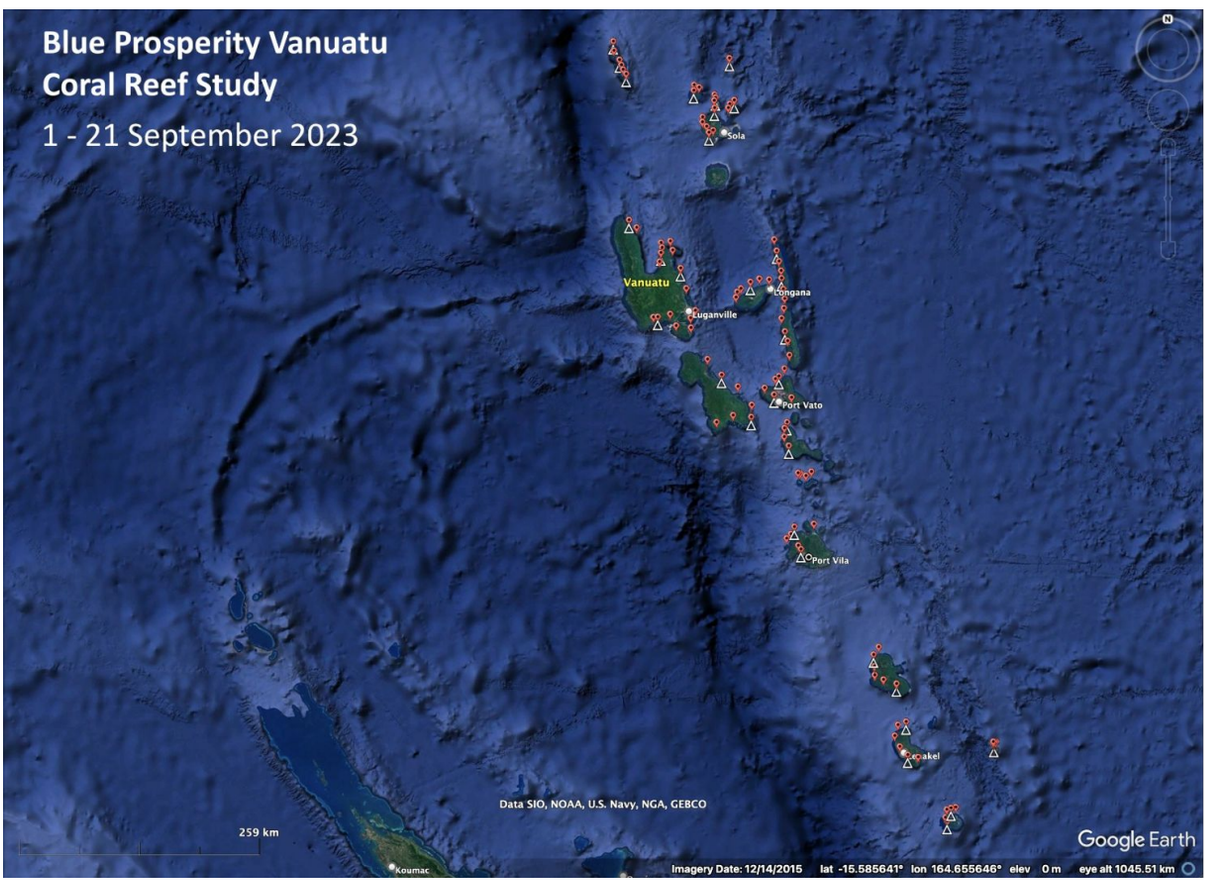

FIGURE 1:
Map of survey sites

Site selection criteria:

1. Select sites archipelago wide
2. Select sites in all provinces
3. Focus sample sites in larger islands in each province
    a. Exclude islands 4 kilometers or smaller in largest diameter
4. Select coral reefs
    a. Sample sites only on leeward (West, Northwest) forereefs
    b. Add sites in protected forereefs
        i. East, Southeast sides of
            1. Sanma
            2. Penama
            3. Malampa
    c. Select sites at 10 meters depth
5. Place at least 6 survey sites per larger island
6. Place a minimum of 3 survey sites for smaller islands
7. Avoid river outfalls and estuaries
8. Select sites where Fisheries and Environment share priorities
9. Maintain a minimum of 2 kilometer spacing between sites

SURVEY SITE SELECTION (continued)

Note on site selection: In some cases, all criteria were not able to be met. Sites selected in Torba required smaller sample sizes per island, given the geographic characteristics of the islands within the province (numerous, smaller islands). Shefa province also contains survey sites allocated to smaller islands. Several tabu areas have been selected for survey sites due to their cultural and societal importance.

The priority survey sites selected for this expedition can be found in Figure 2 below.

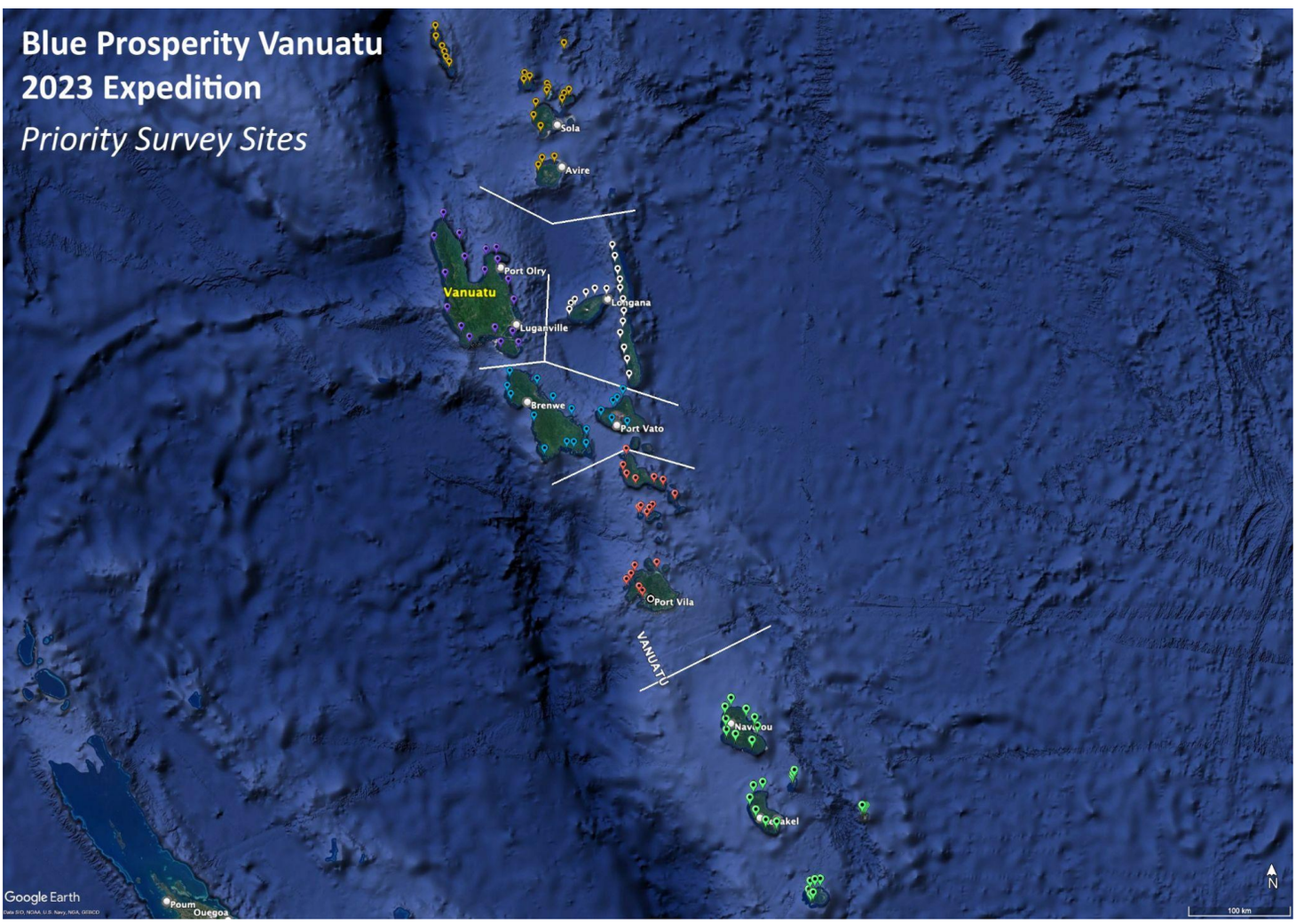

FIGURE 2:
Map of proposed priority survey sites color coded by province.

COMMUNITY CONSULTATIONS AND PERMISSIONS

Before and throughout the study, the Blue Prosperity Vanuatu team collaborated with relevant government agencies and community leaders to consult communities and obtain permission from the traditional custodians to conduct research in their waters. The National Security Council issued the final authorization after consultation.

Before the expedition's launch, the Blue Prosperity Vanuatu team and government partners briefed the CEO of the Malvatumauri (the National Council of Chiefs) to ensure their awareness and support for the initiative. The government also held a national press conference to inform all key stakeholders about what would occur. The Deputy Prime Minister and Minister of Foreign Affairs issued a public statement announcing to the government and the public that the expedition was happening. The Head of Vanuatu's Maritime and Ocean Affairs Division, Toney Tevi, and the Director of Science at the Waitt Institute, Andy Estep, participated in a TV Talkback show and a radio show ahead of the expedition. Additionally, there was a widespread social media campaign to provide updates and survey locations via the Blue Prosperity Vanuatu and Government Facebook and regular updates in the Vanuatu Daily Post.

The Head of Vanuatu's Maritime and Ocean Affairs Division, Toney Tevi, Blue Prosperity Vanuatu team members, and staff from Foreign Affairs reached out to community leaders to inform them about the expedition throughout the expedition as well. In addition Ministry of Fisheries staff reached out to provincial fisheries officers throughout the expedition to inform them about it.

Photo Credit: **Shayna Brody**

Photo Credit: **Shayna Brody**

Data Sharing Agreements

Data is co-owned by the Government of Vanuatu and the Blue Prosperity Coalition, as stated in the Blue Prosperity Vanuatu Memorandum of Understanding (MOU) signed in February 2023. As a member of the Blue Prosperity Coalition, Vanuatu's data is jointly-owned and stored by the Waitt Institute with Scripps Institution of Oceanography as technical partners responsible for expedition data collection and analysis. Raw and summarized data will be shared with other government ministries and can be available upon request by non-governmental organizations and stakeholders through the Ministry of Fisheries.

Data Storage

All raw data collected during the expedition was securely copied onto triplicate hard drives at the end of each survey leg. Copies have been distributed to the co-owners: Vanuatu's Maritime and Ocean Affairs Division within the Ministry of Foreign Affairs and the Waitt Institute. Additionally, the data is backed up on duplicate servers in the Sandin Lab at Scripps Institution of Oceanography in La Jolla, CA, USA.

Photo Credit: **Joe Lepore**

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EXPEDITION PARTICIPANTS

This effort was led by the Government of Vanuatu, under the direction of the Department of Foreign Affairs, Vanuatu Fisheries Department and Department of the Environmental Protection and Conservation, as well as the Department of Geology and Mines, working in close collaboration with universities and non-governmental organizations including the University of the South Pacific (USP), VEPA, CRIOBE, Big Blue Dive Shop, Scripps Institution of Oceanography, and the Waitt Institute.

Participants from local and international institutions who contributed to data collection are listed below, along with their affiliations. The initials following each participant's name correspond to the initials found in Table 1.

Expedition Dive Team

Fabrice Ballandon (FB)

Big Blue Dive Shop

Gilles Siu (GS)

Centre de Recherches Insulaires et Observatoire de l'Environnement (CRIOBE)

Ada Sokach (AS)
Hudson Feremaito (HF)

Ministry of Fisheries

Steve Hango (SF)

Ministry of Foreign Affairs

Anela Akiona (AA)
Gabe Turner (GT)
Katie Lubarsky (KL)

Scripps Institution of Oceanography (SIO)

Ana Ciriyawa (AC)
Apete Dabea (AD)

University of the South Pacific (USP)

Andy Estep (AE)
Joe Lepore (JL)
Lena Ousacheva (LO)

Waitt Institute (WI) / Plan B

Karen Stone (KS)

Vava'u Environmental Protection Association (VEPA)

Photo Credit: **Joe Lepore**

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SURVEY METHODOLOGY

The Vanuatu Coral Reef Study divers employed a variety of survey methods to obtain a comprehensive snapshot of the status of the coral reefs, fish populations, macroinvertebrates (such as giant clams and sea cucumbers), and water quality at each site.

This survey methodology is aligned with previous survey techniques used throughout Vanuatu so that data can be compared to surveys from previous years. The survey methodology followed an approved science plan developed in collaboration with the government and NGO partners.

Teams of six divers, split into three pairs, worked to collect data. **At each site, five surveys were conducted**:

- Large-area imagery surveys;
- Fish belt transects;
- Macroinvertebrate belt transects;
- Benthic photo quadrats; and
- Algae sample collection for stable isotope analysis.

Additionally, temperature loggers were deployed at a subset of sites to collect high resolution temperature data on reefs across the country.

Dive safety protocols were carefully followed to ensure the highest level of safety for all participants. A dive safety officer was present, overseeing all procedures and monitoring conditions. This included thorough pre-dive briefings, adherence to buddy systems, regular equipment checks, and close observation of dive conditions. Emergency response plans were in place, and dive teams were trained in first aid and rescue procedures, ensuring preparedness for any unforeseen situations.

Photo Credit: **Joe Lepore**

SUMMARY OF METHODS

Large-area imagery surveys

Large area imagery surveys provide high-resolution images of coral reefs, offering detailed insights into coral reef health and the species present in the area.

To collect this data, imagery was taken over a 100m² area to document coral cover, coral species, and overall reef health. These images, known as benthic (or bottom) photomosaics, create a permanent visual record of the reef habitat.

The benthic photomosaic system involves a diver equipped with two cameras to capture comprehensive images of the reef area. One camera takes "zoomed-out" images to cover a larger area with high overlap, while the other camera is "zoomed-in" for close-up, detailed shots that aid in ecological analysis. The diver follows a grid pattern over a 10x10 metre area, taking photos every second, which are then stitched together into one large image. This combined image can be transformed into both 2D and 3D models of the reef, enabling scientists to study reef structure (such as its "bumpiness") and coral growth over time.

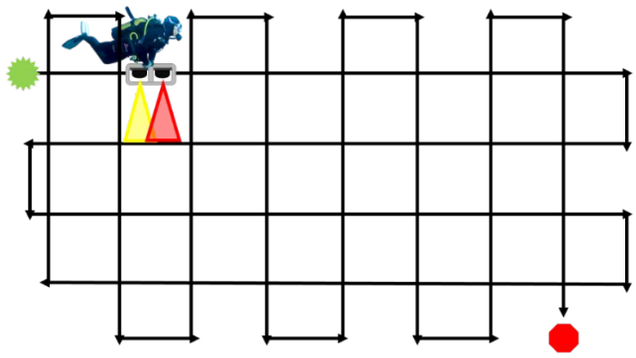


FIGURE 3:
Photomosaic data collection method. Each photomosaic is stitched together from ~2000 photos acquired by swimming back and forth over the reef in the pattern on the left.

Photo Credit: **Joe Lepore**

Fish belt transect surveys

Fish belt transect surveys help provide a snapshot of fish life through abundance and diversity of fish observed at each dive site.

A two-diver team conducted surveys of the fish present at each dive site using standard belt transect methods (BLT). The BLT surveys involved the dive team conducting three 25 m transects by laying out a transect line along the 10-meter depth contour to estimate abundance. Individual fishes were identified to species and total length (TL), estimated to the nearest 5 cm size class. Fish abundance estimates were made by conducting two passes for each 25 m transect. The pair of divers surveyed an 8 m width (200 m2 area) for individuals >20 cm TL on an outward swim, and a 4 m width (100 m2 area) for species ≤20 cm TL on a return swim.

Benthic photoquadrat surveys

Benthic photoquadrat surveys are used to understand the composition of the sea floor, including how much of it is coral, algae, sand, etc.

Benthic (seafloor) cover was estimated using photoquadrats, which are photographs of specific sections of the seafloor used to analyse benthic organisms. Following the completion of each fish belt transect survey, divers collected photoquadrat images along the same transect line, taking photos every 2 m, for a total of 13-15 photos per transect. A monopod was attached to each camera to ensure that photos were taken from a fixed distance and covered the same area of the benthos (approximately 0.72m2 per photo).

Macroinvertebrate belt transect surveys

Macroinvertebrate belt transect surveys provide an understanding of the large invertebrates present at a dive site, such as starfish, sea cucumbers, and urchins.

Estimates of key macroinvertebrate species were made using belt transect methodologies as outlined by the Global Coral Reef Monitoring Network (GCRMN). To summarise: at each site, a diver estimated the number of macroinvertebrates found along the three 25 m transects used for fish and photoquadrat surveys. For each survey, a 4 m wide swath was inspected for invertebrates, yielding a 100 m2 survey area for each transect.

Image: ***Benthic photoquadrat method.***

Photo Credit: **Joe Lepore**


Photo Credit: **Joe Lepore**

SUMMARY OF METHODS (continued)

Water quality measurements

Algae samples were collected at each site to provide insights into the local water quality. These samples undergo stable isotope analysis, which compares the ratios of nitrogen isotopes in the algae tissue to reveal the nutrient sources at each location. This information helps determine whether land-based pollution is impacting each survey site.

Water quality assessments were conducted by collecting five samples of the calcified macroalgae Halimeda spp. along the three transects at each site. In some cases, where algal cover was low or if Halimeda was not present at a site, a different alga (Tydemania spp.) was collected. Previous studies have shown that the two different algae species show similar results. For each site, three replicate samples (where available) were randomly selected for stable isotope analysis.

Temperature logger deployments

Temperature loggers were placed on the reef to gather long-term data on water temperature over time. These loggers will eventually be retrieved from each site to process the data. However, they will not be collected prior to the final report.

34 temperature loggers were deployed across the survey area to collect temperature at depth. Temperature loggers were secured to the reef using heavy-duty cable ties and stainless-steel rods hammered into the substrate. These instruments were placed near or within the mosaic plots to facilitate both the marking of the plots and the recovery of the sensors. The loggers are programmed to collect discrete samples every 45 minutes. They must be collected to access the recorded data.

Photo Credit: **Joe Lepore**

05

FIRST IMPRESSIONS

The data collected during the Vanuatu Coral Reef Study is still being analyzed, and the final results will be presented in a comprehensive Final Science Report. As analysis continues, these initial insights offer an early glimpse into Vanuatu's coastal ecosystems, providing valuable observations on the condition and complexity of the region. Below are some preliminary impressions from the team based on the 109 sites surveyed over 614 dives.

PRELIMINARY OBSERVATIONS

COASTAL ECOSYSTEMS AND COMMUNITIES

The expedition team encountered communities, settlements, and community members at or near most dive sites throughout the expedition, highlighting the connection between communities and coastal ecosystems. Many types of activities were observed at the coastline and at sea including fishing, recreation, bathing, and transportation.

The widespread distribution of communities with immediate access to coastal ecosystems, particularly coral reefs, illustrates the value and need for management of these essential resources to respond to a rapidly changing climate and its unique abundance of significant natural disturbances.

CORALS & SUBSTRATES

Coral reefs and coastal ecosystems varied significantly throughout Vanuatu. Much like terrestrial ecosystems, these ecosystems varied based on their geologic and oceanographic context. Impacts from natural disasters and climate change were apparent during the survey and underscore the value of building on all the knowledge bases and systems in Vanuatu for the widespread communities that depend on these resources.

- Coral reefs and benthic habitats were diverse in species, community structure, and condition.
- Coral and benthic communities were often unique to an island and varied by windward/leeward sides.
- Island geological context appears to play an important role in reef communities. Particularly, with active volcanic islands.
- Signs of physical destruction from cyclones Judy and Pam were observed along the cyclone paths.
- Baseline levels of coral disease and mortality were observed throughout Vanuatu.
- Abundant juvenile corals were observed on some reefs.

Photos by: **Joe Lepore**

FISH COMMUNITIES

Like coral communities, fish communities were similarly diverse and variable. Fish surveyors identified 462 species of fish and counted 128,533 fish across survey sites including several that are thought to be previously unrecorded in Vanuatu. This is not surprising given the high biogeographic variability of terrestrial and marine habitats in Vanuatu. Apparent signs of overfishing were observed throughout Vanuatu. Few fish were observed over 50 cm in length and even fewer over 1 m. Further analysis and dialogues with communities will help to better understand the data from this study.

- Clear biogeographic distribution of fish communities across Vanuatu.
- High fish diversity. 462 fish species identified.
- Several species are thought to be previously unreported for Vanuatu. Additional verification required to confirm this.
- Apparent signs of overfishing observed across Vanuatu.
- Abundance of meso and apex predators (large groupers, snappers, and sharks) was generally low.

MACROINVERTEBRATES

Coral reefs contain an incredible diversity of macroinvertebrates. Vanuatu is no exception. While this survey was not comprehensive for all macroinvertebrates, the diversity and abundance of subsistence/commercially exploited and ecologically significant macroinvertebrates were relatively high for forereef communities.

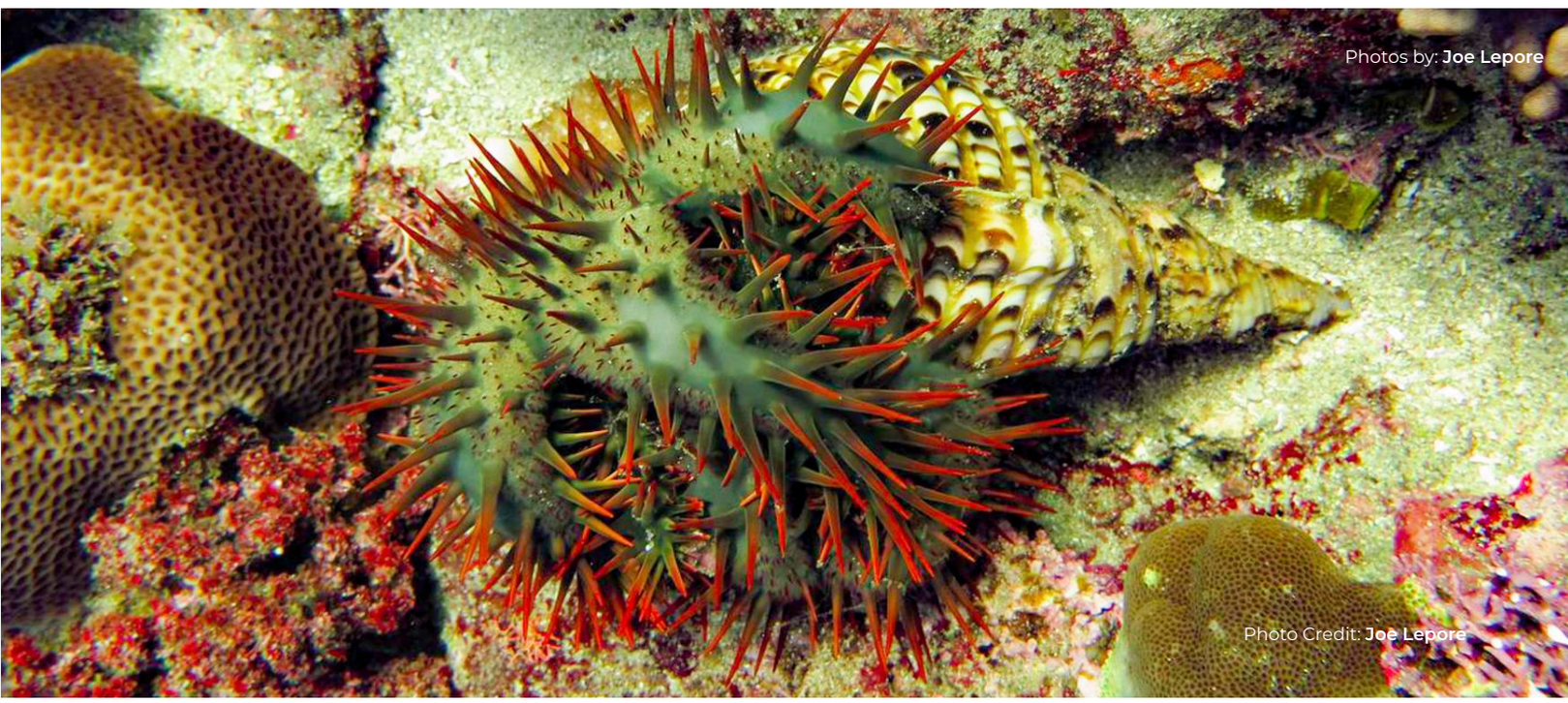
It is important to note that this survey will not serve as a stock assessment and does not indicate that these communities are necessarily intact. These data also do not reflect if subsistence/commercially exploited macroinvertebrates were at harvestable state or not. Further investigation beyond this study would be required to understand the status of macroinvertebrate communities.

- Diverse communities of macroinvertebrates were observed.
- 166 species of macroinvertebrates identified.
- 19,000 individuals
- Several sites with relatively high abundance of small to medium giant clams, sea cucumbers, and gastropods such as trochus
- No Crown of Thorns Starfish (COT) outbreaks were observed, but several individuals were observed.
- One Tritan's Trumpet was observed consuming a COT. This was a first time observation for the entire expedition team

WATER QUALITY

Visible observations of water quality were variable throughout Vanuatu including visibility, sedimentation, and temperature which can all be highly influential factors in coral reef condition. Some of the key observations were:

- Water temperature on the reef was significantly colder in the south of Vanuatu than in the north.
- Some reefs appeared to be experiencing high sedimentation.Rubbish and fishing gear were generally low on reefs.
- Some macroalgal blooms were observed.



Photos by: **Joe Lepore**

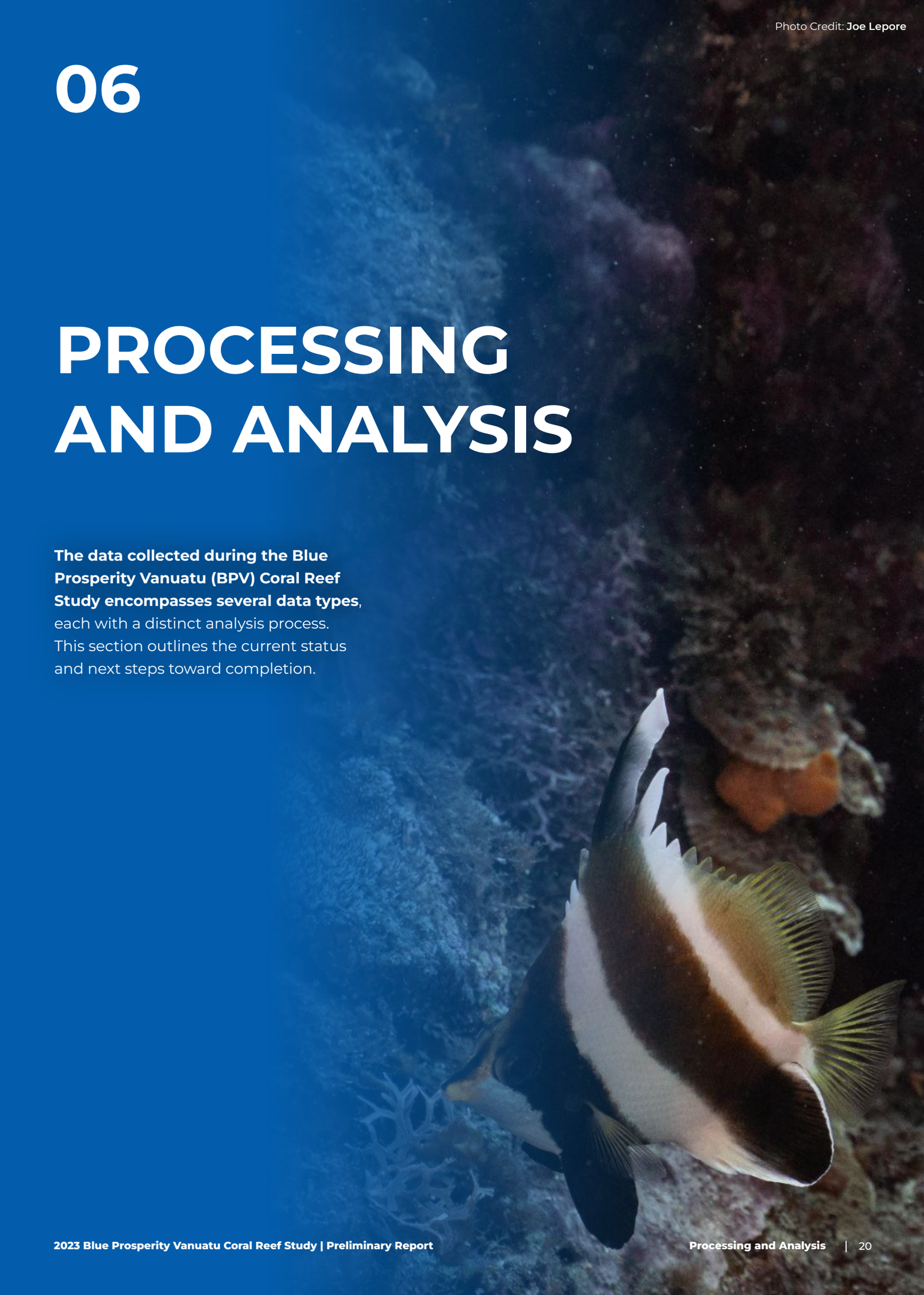
Photo Credit: **Joe Lepore**

Photo Credit: **Joe Lepore**

06

PROCESSING AND ANALYSIS

The data collected during the Blue Prosperity Vanuatu (BPV) Coral Reef Study encompasses several data types, each with a distinct analysis process. This section outlines the current status and next steps toward completion.



1. Benthic Photoquadrat Analysis

Benthic cover is being analyzed using photoquadrat images processed through ReefCloud software. The software projects 25 random points onto each image, and analysts identify the taxa present under each point.

A team of analysts from Vanuatu, contracted through the Institute of Applied Sciences at the University of the South Pacific (USP), in partnership with Blue Prosperity Vanuatu, began benthic taxonomy analysis in December 2024.

The team completed a refresher training on 12/3/24 and has started annotations. Photoquadrat analysis has officially launched in Q4 of 2024 and is anticipated to be complete by Q2 2025.

2. Fish Survey Data

To ensure accuracy, fish data collected in the field is undergoing an extensive quality control/quality assurance (QA/QC) process. Length-weight parameters for all observed species will be collated to calculate fish biomass. The Scripps Institution of Oceanography team will generate final data summaries that include species diversity, biomass, and abundance data by species, site, and province. Quality control of fish data is complete and data are ready for analysis.

3. Large-Area Imagery Surveys

High-resolution 3D and 2D photomosaics have been all sites where model data was collected. The raw imagery and model files are backed up on the Sandin Lab servers.

Two key data streams are derived from the imagery:

- **Rugosity (structural complexity of coral habitats):** Rugosity data, quantifying reef structural complexity, will be extracted using a simulated point gauge approach. In the Viscore analytics engine, a 10m x 10m area is sampled with 100 parallel transects spaced 1cm apart. The depth along each transect is recorded and compared to the linear distance, resulting in a rugosity ratio. Rugosity data analysis has been completed for 58 sites.
- **Coral Recruitment (number of new, young corals on the reef):** Juvenile coral analysis focuses on corals less than 5 cm in diameter. A 10m x 10m area is divided into 100 1m^2 quadrats, and five are randomly selected for sampling. Coral juveniles are tagged and identified to the lowest taxonomic level possible. Recruitment data analysis completed for 42 sites.

Photo Credit: **Joe Lepore**

4. Macroinvertebrate Survey Data

Macroinvertebrate data collected also underwent a rigorous quality control process.

5. Water Quality Surveys

Following field collection, algae samples (Halimeda spp. and Tydemania spp.) will be processed and packed for stable isotope analysis. The process includes rinsing samples with deionized water, decalcifying in a 5% HCl solution, and drying in a food dehydrator. The dried samples are then ground into a fine powder and sent to the Stable Isotope Facility at UC Davis. By analysing nitrogen isotope ratios, the origin of nutrients, whether from land-based pollution, agricultural runoff, or oceanic sources, can be identified, providing insight into the impact of runoff on the site.

Photo Credit: **Joe Lepore**

Photo Credit: **Joe Lepore**

07

EXPEDITION PRODUCTS & OUTREACH

Three main products will be delivered as a result of the BPV Coral Reef Study:

- Preliminary Science Report
- Provincial-Level Reports
- Final Science Report

PRELIMINARY SCIENCE REPORT

This report will provide an overview of the expedition, detailing the activities conducted, the data collected, the methods used for data collection, and the data analysis process. It will also outline the next steps toward completing the Final Science Report.

PROVINCIAL-LEVEL REPORTS

Provincial-Level Reports will be developed to provide a snapshot of information from the Blue Prosperity Vanuatu Coral Reef Study to local communities at a provincial level. This will give communities more relevant information about what was found from the expedition in their Province, and will give them access to additional data such as 2D maps of the reefs and photos and videos taken in their areas. These reports will be translated into Bislama.

These reports will include:

- Foreword by Mr. Toney Tevi
- Expedition Overview
- Community consultation details
- Expedition dates by province
- Data collected, including:
  - Number of survey sites by province
  - Number of species of invertebrates counted by province
  - Number of fish species counted by province
  - Number & type of threatened species counted by province
  - A list of the threatened species observed
- Map of dive sites by province
- Photos from dive sites
- Link to a digital copy of the Provincial-Level Reports
- Information about how expedition data will be used for Marine Spatial Planning
- Information about how communities can use data
- Information about Vanuatu's commitment to sustainably managing 100% of its ocean and fully protecting at least 30% of its ocean
- Information about the benefits of Marine Protected Areas
- Information about Marine Spatial Planning
- Information about Blue Prosperity Vanuatu and expedition partners

Photo Credit: **Joe Lepore**

FINAL SCIENCE REPORT

The Final Science Report will provide a detailed, nationwide summary of the expedition's findings, offering valuable insights into the health of Vanuatu's coral reefs, marine biodiversity, and ecosystems. It will present analyzed data, highlight significant trends, and offer recommendations for sustainable management. Drafted by SIO and led by the Co-PIs, the report will include final data packages, maps, graphs, and key findings.

A comprehensive report package will contain all expedition materials and data, including raw datasets, photomosaic and photoquadrat images, and digital copies of datasheets for fish and macroinvertebrates. It will also include photomosaic metadata, site metadata sheets from the field, and their corresponding digital files. Summarized and processed data will cover metrics such as benthic percent cover and fish species abundance or biomass. These outputs will be delivered as tabular data, geospatial packages, R-code scripts for analysis, photomosaics, 3D reef models, and well-organized photo directories.

Designed as a science-based resource, this report will support decision-makers, stakeholders, and conservation efforts, contributing to Vanuatu's Marine Spatial Planning process and long-term ocean protection goals.

Photo Credit: **Joe Lepore**

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REVIEW PROCESS

Each expedition product will go through a thorough review process that will include Government Ministries, partner NGOs involved in the expedition, the Blue Prosperity Vanuatu team, relevant scientists from the University of the South Pacific and Scripps Institution of Oceanography, and the Waitt Institute. There will be formal review periods, during which partners will have the opportunity to review and comment on the content of these products.

Photo Credit: **Joe Lepore**

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TIMELINE AND NEXT STEPS

The Blue Prosperity Vanuatu (BPV) team will continue working with partners to develop each expedition product. Data analysis teams will continue to analyze data and draft the Final Science Report. BPV and the Waitt team will develop and disseminate the Provincial-level Reports.

The information collected from the expedition will provide data to the Government of Vanuatu, stakeholders, and local communities to provide a deeper understanding of the state of Vanuatu's ocean. This knowledge will inform management decisions to improve ocean health, support food security, and boost local communities' livelihoods.

PROVINCIAL-LEVEL REPORTS

A template to share information at the provincial level will be developed and sent to government partners for approval. Upon approval of the Provincial-level Report template, the Blue Prosperity Vanuatu and Waitt Institute team will develop a Provincial-level Report for each of the Provinces where the expedition took place. All of these will then be sent to the Government for approval. Once finalised these reports will be shared back to the communities so that everyone has access to the data at a local level.


Photo Credit: **Joe Lepore**

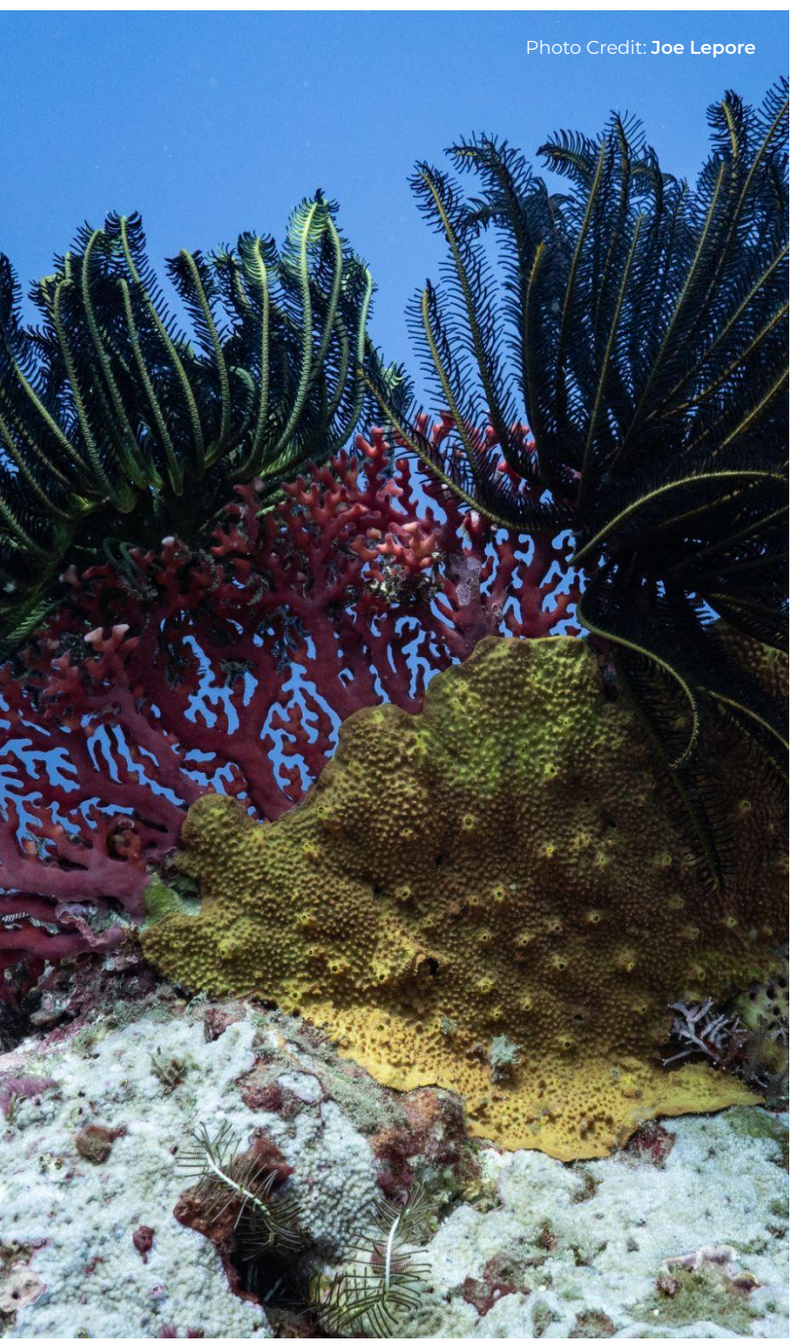
Photo Credit: **Joe Lepore**

MILESTONES & DELIVERABLES

2023 MILESTONES

- **September**
  - Expedition completed
  - Raw data handed over to the Government

2024 MILESTONES

- **A**pril 29th - May 3rd
  and another on December 4th
  - Photoquadrat Analysis Training and launch

TENTATIVE TIMELINE

2024

- **December**
  - Preliminary Science Report delivered

2025

- **Final Report circulation**
  - Report circulated to Government Ministries for review and approved
  - Then report circulated to NGOs for review
- Completed expedition data sharing agreement
- Provincial-level reports delivered
- Final Report delivery
  - Including data package and work products (e.g., maps, summarized processed data), as well as underwater and drone imagery

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PRELIMINARY REPORT DATA PACKAGES

1. **Metadata**	**Description**: Provides contextual information about data collected, divers, and location. **Data Downloadable**: Yes **Access Point**: Appendix and link below https://docs.google.com/spreadsheets/d/1yIhghLyrRzCiSkIc5S0HYRHH3zIyhOz9/edit?usp=sharing&ouid=115609538796142653377&rtpof=true&sd=true
2. **Daily Ship Logs**	**Description**: Daily records of ship activities, locations, and conditions. **Data Downloadable**: Yes **Access Point**: Link below https://drive.google.com/file/d/1GskP_UTfZpsaNHiiccAto0aG-kBEFQI4/view?usp=sharing
3. **ESRI Online Access Point**	**Description**: Online GIS platform for viewing spatial data. **Data Downloadable**: On request **Access Point**: Link below https://www.arcgis.com/apps/mapviewer/index.html?webmap=296e9d5bb3b04bc59db232b4c98bd439
4. **Photomosaic Fly-Throughs - 100 Island Challenge**	**Description**: High-resolution visualisations of coral reef habitats **Data downloadable**: Yes **Access point**: Link below https://drive.google.com/drive/folders/1lPN_VpZ5a3hpNcPoQNx7LTA88tPPLp_u?usp=sharing
5. **Underwater Photos**	**Description**: Collection of underwater photos taken during the expedition. **Downloadable**: Yes **Access Point**: Link below https://www.dropbox.com/scl/fo/jab8zgkqlbq6qn1an4luh/ANSePgUog9fyGPqSF4w-nC4?rlkey=krkgptz7578jaemdn0nu1uwow&st=jtoa5i20&dl=0
6. **Aerial Photos and Videos**	**Description**: Collection of drone footage and photos taken during the expedition. **Data downloadable**: Yes **Access Point**: Link below https://www.dropbox.com/scl/fo/eejwx0qem8bfqbynmf96w/AJxNvszhoZWpbVZer_JAsi8?rlkey=ag1f0jkjvg1zahs7hdtwp0fvc&st=0p5v0cc1&dl=0

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METADATA

TABLE 1: *Survey sites and associated metadata. Diver initials correspond to the initials listed in the Expedition Team section of this report. See full metadata here.*

DATE	ISLAND	Station _ID	Latitude	Longitude	Mosaic Area (m2)	Reef Type	Mosaic Divers	Fish Divers	Invert Diver	Data Collected	Temp Logger Serial #
2023-09-02	Aneityum	ANE_001	-20.25389	169.75871	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21723383
2023-09-02	Aneityum	ANE_003	-20.21625	169.73950	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-02	Aneityum	ANE_005	-20.12889	169.79366	100	FR	EO, AD	KL, AA	HF	F, B, M, I, T	21722885
2023-09-02	Aneityum	ANE_004	-20.14233	169.75154	100	FR	GT, AC	KS, AE	AS	F, B, M, I, A	NA
2023-09-02	Aneityum	ANE_006	-20.12205	169.84030	100	FR	GT, AC	KS, AE	AS	F, B, M, I, A	NA
2023-09-03	Futuna	FUT_007	-19.52501	170.19905	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-03	Futuna	FUT_011	-19.54263	170.20561	100	FR	EO, AD	KL, AA	HF	F, B, M, I	NA
2023-09-03	Futuna	FUT_009	-19.53532	170.20316	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722876
2023-09-03	Futuna	FUT_012	-19.51297	170.22380	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A	NA
2023-09-03	Futuna	FUT_010	-19.51361	170.20929	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A, T	21722883
2023-09-03	Futuna	FUT_008	-19.51247	170.19629	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A	NA
2023-09-04	Tanna	TAN_017	-19.44714	169.21753	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-04	Tanna	TAN_015	-19.34689	169.24661	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-04	Tanna	TAN_013	-19.31838	169.32642	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722869
2023-09-04	Tanna	TAN_014	-19.64753	169.45239	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A	NA
2023-09-04	Tanna	TAN_016	-19.62572	169.34926	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A, T	21722877

Reef Type: FR- Forereef, BR- Back reef
Data Collected: B- Benthic photoquadrats, F- Fish survey, M- Mosaic, I-Invertebrate survey, A-Algae collected, T-Temperature logger installed

METADATA (continued)

DATE	ISLAND	Station_ID	Latitude	Longitude	Mosaic Area (m2)	Reef Type	Mosaic Divers	Fish Divers	Invert Diver	Data Collected	Temp Logger Serial #
2023-09-04	Tanna	TAN_018	-19.54828	169.26918	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A	NA
2023-09-05	Erromango	ERR_024	-18.62841	169.04713	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A	NA
2023-09-05	Erromango	ERR_022	-18.69827	168.99777	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A, T	21722856
2023-09-05	Erromango	ERR_020	-18.80485	169.00723	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A	NA
2023-09-05	Erromango	ERR_019	-18.88696	169.01158	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-05	Erromango	ERR_023	-18.96689	169.22556	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722863
2023-09-05	Erromango	ERR_021	-18.92794	169.09758	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-06	Epi	EPI_025	-16.79830	168.17284	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A, T	21722873
2023-09-06	Epi	EPI_026	-16.63851	168.13188	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A	NA
2023-09-06	Epi	EPI_027	-16.71730	168.12967	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-06	Epi	EPI_029	-16.58554	168.15613	100	FR	EO, AD	KL, AA	HF	F, B, M, I, T	21722871
2023-09-07	Efate	EFA_032	-17.50585	168.41312	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A	NA
2023-09-07	Efate	EFA_034	-17.59597	168.19414	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A	NA
2023-09-07	Efate	EFA_036	-17.70098	168.26338	100	FR	GT, AC	KS, AE	KS	F, B, M, I, A	NA
2023-09-07	Efate	EFA_031	-17.53131	168.22607	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722878
2023-09-07	Efate	EFA_033	-17.63590	168.15221	100	FR	EO, AD	KL, AA	HF	F, B, M, I	NA
2023-09-07	Efate	EFA_035	-17.73426	168.28973	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722857
2023-09-08	Malo	MAO_041	-15.64100	167.25153	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-08	Malo	MAO_039	-15.72918	167.25470	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-08	Malo	MAO_037	-15.71024	167.11588	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-08	Santo	SAN_038	-15.63145	166.90389	NA	FR	GT, FB	AE, GS	AC	F, B, I, A	NA

Reef Type: FR- Forereef, BR- Back reef
Data Collected: B- Benthic photoquadrats, F- Fish survey, M- Mosaic, I-Invertebrate survey, A-Algae collected, T-Temperature logger installed

METADATA (continued)

DATE	ISLAND	Station_ID	Latitude	Longitude	Mosaic Area (m2)	Reef Type	Mosaic Divers	Fish Divers	Invert Diver	Data Collected	Temp Logger Serial #
2023-09-08	Santo	SAN_040	-15.62933	166.94418	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722874
2023-09-08	Santo	SAN_042	-15.60505	167.06068	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-09	Santo	SAN_043	-15.57259	167.29716	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-09	Santo	SAN_045	-15.37247	167.21428	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-09	Santo	SAN_047	-15.18915	167.16205	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722884
2023-09-09	Santo	SAN_044	-14.95652	166.98112	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-09	Santo	SAN_046	-14.94266	167.06821	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-09	Santo	SAN_048	-15.02510	167.08905	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-10	Ureparapara	URE_053	-13.53117	167.35313	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-10	Ureparapara	URE_051	-13.55883	167.30235	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722868
2023-09-10	Ureparapara	URE_049	-13.50856	167.30650	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-10	Vot Tande	VOT_050	-13.25745	167.64160	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722866
2023-09-10	Vot Tande	VOT_052	-13.25420	167.64308	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-10	Vot Tande	VOT_054	-13.25951	167.64073	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-11	Mota Lava	MOT_056	-13.64950	167.68158	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722948
2023-09-11	Mota Lava	MOT_058	-13.68410	167.63902	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-11	Mota Lava	MOT_060	-13.72071	167.62434	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-11	Rowa Islands	ROW_055	-13.59856	167.49652	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-11	Rowa Islands	ROW_059	-13.65302	167.49280	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-11	Rowa Islands	ROW_057	-13.62636	167.50595	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722898
2023-09-12	Vanua Lava	VAN_063	-13.85206	167.37961	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-12	Vanua Lava	VAN_065	-13.94814	167.44057	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722875

Reef Type: FR- Forereef, BR- Back reef
Data Collected: B- Benthic photoquadrats, F- Fish survey, M- Mosaic, I-Invertebrate survey, A-Algae collected, T-Temperature logger installed

METADATA (continued)

DATE	ISLAND	Station_ID	Latitude	Longitude	Mosaic Area (m2)	Reef Type	Mosaic Divers	Fish Divers	Invert Diver	Data Collected	Temp Logger Serial #
2023-09-12	Vanua Lava	VAN_061	-13.92879	167.48003	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-12	Vanua Lava	VAN_062	-13.72112	167.49500	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722882
2023-09-12	Vanua Lava	VAN_064	-13.80601	167.38208	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-12	Vanua Lava	VAN_066	-13.89290	167.41907	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-14	Torres Islands	TOR_068	-13.40370	166.67114	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722861
2023-09-14	Torres Islands	TOR_070	-13.36181	166.64211	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-14	Torres Islands	TOR_072	-13.32005	166.62634	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-14	Torres Islands	TOR_071	-13.27167	166.61018	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722879
2023-09-14	Torres Islands	TOR_067	-13.09904	166.55348	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722859
2023-09-14	Torres Islands	TOR_069	-13.18499	166.55803	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-15	Santo	SAN_074	-14.74850	166.68370	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722890
2023-09-15	Santo	SAN_076	-14.81676	166.75403	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-15	Santo	SAN_075	-15.12935	166.96513	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-15	Santo	SAN_077	-15.04732	166.97920	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A, T	21722951
2023-09-15	Santo	SAN_073	-15.00138	166.99065	100	FR	EO, AD	KL, AA	HF	F, B, M, I, A	NA
2023-09-16	Ambae	AMB_079	-15.31552	167.81712	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, T	21722903
2023-09-16	Ambae	AMB_081	-15.28663	167.90154	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA
2023-09-16	Ambae	AMB_083	-15.29455	167.99356	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I	NA
2023-09-16	Ambae	AMB_080	-15.45503	167.67961	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-16	Ambae	AMB_082	-15.40681	167.69121	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-16	Ambae	AMB_084	-15.37522	167.72751	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-17	Maewo	MAE_089	-15.12705	168.08778	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA

Reef Type: FR- Forereef, BR- Back reef
Data Collected: B- Benthic photoquadrats, F- Fish survey, M- Mosaic, I-Invertebrate survey, A-Algae collected, T-Temperature logger installed

METADATA (continued)

DATE	ISLAND	Station_ID	Latitude	Longitude	Mosaic Area (m2)	Reef Type	Mosaic Divers	Fish Divers	Invert Diver	Data Collected	Temp Logger Serial #
2023-09-17	Maewo	MAE_087	-15.03190	168.06668	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A, T	21722867
2023-09-17	Maewo	MAE_085	-14.92912	168.04401	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA
2023-09-17	Maewo	MAE_090	-15.21306	168.10695	100	FR	GT, FB	AE, GS	AC	F, B, M, I	NA
2023-09-17	Maewo	MAE_088	-15.28160	168.11023	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722858
2023-09-17	Maewo	MAE_086	-15.37919	168.12552	100	FR	GT, FB	AE, GS	AC	F, B, M, I	NA
2023-09-18	Pentecost	PEN_091	-15.55314	168.13087	NA	FR	EO, AS	KL, AA	HF	F, I	NA
2023-09-18	Pentecost	PEN_093	-15.76452	168.13939	100	FR	EO, AS	KL, AA	HF	F, B, M, I, A, T	21722881
2023-09-18	Pentecost	PEN_095	-15.97858	168.18127	100	FR	EO, AS	KL, AA	HF	F, B, M, I	NA
2023-09-18	Pentecost	PEN_092	-15.46698	168.13860	100	FR	GT, FB, AD	AE, GS	AC	F, B, M, I, A	NA
2023-09-18	Pentecost	PEN_094	-15.64536	168.10783	100	FR	GT, FB, AD	AE, GS	AC	F, B, M, I, A, T	21722880
2023-09-18	Pentecost	PEN_096	-15.84973	168.16463	100	FR	GT, FB, AD	AE, GS	AC	F, B, M, I	NA
2023-09-19	Ambrym	AMR_098	-16.36162	168.19914	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-19	Ambrym	AMR_100	-16.33640	168.03381	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722897
2023-09-19	Ambrym	AMR_102	-16.27468	167.94514	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-19	Ambrym	AMR_101	-16.19392	168.04695	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA
2023-09-17	Maewo	MAE_087	-15.03190	168.06668	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A, T	21722867
2023-09-17	Maewo	MAE_085	-14.92912	168.04401	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA
2023-09-17	Maewo	MAE_090	-15.21306	168.10695	100	FR	GT, FB	AE, GS	AC	F, B, M, I	NA
2023-09-17	Maewo	MAE_088	-15.28160	168.11023	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722858
2023-09-17	Maewo	MAE_086	-15.37919	168.12552	100	FR	GT, FB	AE, GS	AC	F, B, M, I	NA
2023-09-18	Pentecost	PEN_091	-15.55314	168.13087	NA	FR	EO, AS	KL, AA	HF	F, I	NA
2023-09-18	Pentecost	PEN_093	-15.76452	168.13939	100	FR	EO, AS	KL, AA	HF	F, B, M, I, A, T	21722881

Reef Type: FR- Forereef, BR- Back reef
Data Collected: B- Benthic photoquadrats, F- Fish survey, M- Mosaic, I-Invertebrate survey, A-Algae collected, T-Temperature logger installed

METADATA (continued)

DATE	ISLAND	Station_ID	Latitude	Longitude	Mosaic Area (m2)	Reef Type	Mosaic Divers	Fish Divers	Invert Diver	Data Collected	Temp Logger Serial #
2023-09-19	Ambrym	AMR_099	-16.16879	168.08115	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A, T	21722906
2023-09-19	Ambrym	AMR_097	-16.10082	168.13263	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA
2023-09-20	Malekula	MLK_103	-16.15649	167.54021	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A, T	21722950
2023-09-20	Malekula	MLK_105	-16.42865	167.82321	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I	NA
2023-09-20	Malekula	MLK_110	-16.52096	167.64655	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA
2023-09-20	Malekula	MLK_104	-16.01468	167.40826	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-20	Malekula	MLK_106	-16.26159	167.69284	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-20	Malekula	MLK_108	-16.53801	167.81790	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722901
2023-09-20	Malekula	MLK_109	-16.58368	167.49002	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-21	Cook's Reef	COO_113	-17.04716	168.28154	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA
2023-09-21	Cook's Reef	COO_111	-17.04436	168.26042	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA
2023-09-21	Emae	EMA_114	-17.03290	168.38795	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-21	Emae	EMA_112	-17.06962	168.33475	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-19	Ambrym	AMR_099	-16.16879	168.08115	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A, T	21722906
2023-09-19	Ambrym	AMR_097	-16.10082	168.13263	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA
2023-09-20	Malekula	MLK_103	-16.15649	167.54021	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A, T	21722950
2023-09-20	Malekula	MLK_105	-16.42865	167.82321	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I	NA
2023-09-20	Malekula	MLK_110	-16.52096	167.64655	100	FR	EO, AD, AS	KL, AA	HF	F, B, M, I, A	NA
2023-09-20	Malekula	MLK_104	-16.01468	167.40826	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-20	Malekula	MLK_106	-16.26159	167.69284	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA
2023-09-20	Malekula	MLK_108	-16.53801	167.81790	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A, T	21722901
2023-09-20	Malekula	MLK_109	-16.58368	167.49002	100	FR	GT, FB	AE, GS	AC	F, B, M, I, A	NA

Reef Type: FR- Forereef, BR- Back reef
Data Collected: B- Benthic photoquadrats, F- Fish survey, M- Mosaic, I-Invertebrate survey, A-Algae collected, T-Temperature logger installed