INDONESIA DISSERTATION/THESIS PROJECT

Building Resilient Reefs: Evaluating Coral Restoration Efforts in Indonesia's Wakatobi Marine Park

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Coral reefs are vital marine ecosystems that support around 25% of all marine species despite covering just 0.2% of the seafloor. They provide critical ecosystem services, including coastal protection, fisheries productivity and livelihoods for hundreds of millions of people. However, coral reefs are among the most threatened ecosystems globally, facing unprecedented pressures from climate change, ocean acidification, land-based pollution, overfishing and destructive fishing practices. These combined stressors have led to widespread degradation of reef habitats.

Long-term monitoring efforts have been crucial in understanding how coral reef ecosystems respond to these pressures. At Hoga Island in the Wakatobi region of Indonesia, over 25 years of reef monitoring by Operation Wallacea have provided key insights into coral cover trends, fish and invertebrate assemblages and habitat complexity. Reef restoration initiatives are now being explored as a means of actively supporting reef recovery. Among the most promising approaches is the MARRS (Mars Assisted Reef Restoration System) protocol, which uses hexagonal “reef stars” to stabilise rubble fields and provide a platform for coral fragment growth.

The MARRS protocol was introduced to Hoga in 2019, with reef stars installed at varying depths at the Buoy 2 (B2) dive site. These structures were initially part of a PhD study and have since been maintained and expanded, with new reef stars added as recently as 2024. Monitoring of these structures has shown that coral survival rates vary significantly by depth, with shallow installations showing higher coral cover and survival than those in deeper water. Fragment outcomes have also been influenced by position on the reef star and by competitive overgrowth from organisms such as encrusting sponges and algae.

Monitoring in 2024 and 2025 included photographic documentation of over 4,000 coral fragments, Coral Point Count (CPC) transects and 3D mapping. These efforts have generated a substantial dataset to assess not just coral survival and growth, but also the influence of spatial and environmental variables on restoration outcomes.

Given the scale of restoration activity and the availability of long-term data from the region, Hoga presents a unique opportunity to evaluate the ecological efficacy and limitations of reef restoration interventions. The results from ongoing monitoring can inform future installation strategies, species selection and adaptive management approaches.

Participants will have the opportunity to get hands-on experience of maintaining restoration installations, as well as conducting data collection for their own project.

This project could focus on several areas, including:

1. Comparative analysis of coral fragment survival across depths and positions on reef stars
This project would use existing photographic monitoring data from 2024 and 2025 to statistically assess survival and condition of coral fragments across different reef star blocks. The analysis could compare outcomes between shallow (4–8m) and deep (12m) installations, and evaluate how

fragment position (top, side, base) affects survival rates. The study could also consider factors such as sponge overgrowth, time since installation and fragment species.

2. Assessment of encrusting sponge overgrowth and its impact on coral fragment success
Building on the observation of high sponge overgrowth on deeper blocks, this project would focus on identifying spatial patterns of sponge colonisation and their correlation with coral mortality. This could involve re-analysis of existing imagery to map sponge presence across fragment positions and blocks, and potentially testing hypotheses about competition or environmental conditions that favour sponge over coral dominance.

3. Evaluation of structural complexity and habitat function provided by reef star installations
Using 3D models and CPC (Coral Point Count) data, this project could quantify the structural complexity created by reef star installations and compare it with nearby natural reef areas. The aim would be to assess whether restored sites are providing suitable habitat for juvenile fish or invertebrates. This study could also explore whether coral growth on reef stars contributes significantly to increases in habitat complexity over time.

The data collection for these projects would require SCUBA diving.

Recommended reading:

Lamont, T. A., Razak, T. B., Djohani, R., Janetski, N., Rapi, S., Mars, F., & Smith, D. J. (2022). Multi-dimensional approaches to scaling up coral reef restoration. Marine Policy, 143(105199).

Smith, D. (2006). Wakatobi Field Report. Operation Wallacea.

Watt-Pringle, R., Razak, T.B., Jompa, J. et al. Coral reef restoration in Indonesia: lessons learnt from the world's largest coral restoration nation. Biodiversity Conservation 33, 2675–2707 (2024). https://doi.org/10.1007/s10531-024-02897-8

Watt-Pringle, R., Smith, D. J., Ambo-Rappe, R., Kaimuddin, M., & Jompa, J. (2024). Survival rates of branching Acropora morphologies on coral rubble stabilization structures. Restoration Ecology, 32(7), e14249.

Williams:, S., Sur, C., Janetski, N., Hollarsmith, J., Rapi, S., Barron, L., . . . Mars, F. (2018). Large-scale Coral Reef Rehabilitation After Blast Fishing in Indonesia: coral reef rehabilitation. Restoration Ecology, 27(2).