# Background

Mangroves have been reported to support up 20% of the benthic biodiversity in their habitats (Carugati et al. 2018). They provide essential nutrients, temperature controls, and protection from predators for marine life (Blue Forests 2012). The root systems of mangroves provide protection for juvenile fish, allowing them to grow and develop safely away from predators and act as a buffer against strong currents and waves, creating calmer and more stable environments (Daniel M. Alongi 2008). Areas with intact mangroves have been shown to support higher fish abundance and diversity compared to areas without mangroves (Nagelkerken et al. 2008).

As a response to extreme habitat loss, the Indonesian government has committed to the most ambitious mangrove restoration project in the world. Tanakeke Island in South Sulawesi is one location where this restoration is taking place. 70% of its historical cover of mangroves were converted into aquaculture ponds since the 1980s (Brown et al., n.d.). However, in response to mangrove restoration, the community has seen great success in both engagement and successful mangrove rehabilitation (Blue Forests 2012).

Mangroves provide refuge for about 55% fish catch biomass in Indonesia (World Bank 2022). Mangroves are an essential component to the health of Indonesia’s fisheries and contribute significantly to the food security of those directly reliant on small scale fisheries as a key source of nutrition, including on Tanakeke Island where locally-caught seafood is the main source of protein (Blue Forests 2012). While these mangrove restoration efforts have resulted in increased flood prevention and ecotourism, little research has been done to assess the improvements in marine biodiversity and benefits to fish stocks. In this project, we aim to understand how this restoration is affecting local marine biodiversity and the sustainability of commercially fished species on Tanakeke Island. We will use Unbaited Remote Underwater Video (URUV), methods which are non-invasive and cost effective, to assess the marine biodiversity of mangrove habitats and compare them to the biodiversity of areas that have not undergone mangrove rehabilitation. Further, we will collect temperature and light data to create a statistical analysis of which variable is the most important when fostering biodiversity in mangroves.

# Aims

1. Determine mangrove restoration's effect on marine biodiversity on Tanakeke Island, Indonesia.
2. Uncover what aspects of mangrove cover is most beneficial to juvenile fish populations.
3. Disseminate these findings to the local community on Tanakeke with the help of the NGO Blue Forest as part of their community engagement program.

# Methods

## Site description:

Pulau Tanakeke is situated about 40 km southwest of Makassar in South Sulawesi, Takalar Regency. The island is a coral atoll covering about 3,930 hectares. About 392.25 hectares of mangrove has been restored (Cameron, Hutley, and Friess 2019). Access to the island presents a challenge as rough seas make sea crossings difficult during rainy seasons. The island comprises of five villages or desa: Balangdatu, Maccinibaji, Mattirobaji, Rewataya, and Tompotana. Historically, the island was populated with about 1,776 hectares of Mangroves, most of which has been destroyed for aquaculture.

## Data Collection:

In this project, we plan on selecting three different sites across the island. Within each site, we will locate a recently restored mangrove, mangroves that were restored over ten years ago, and an area where mangroves have not been rehabilitated yet. Recently restored mangrove sites will be in Lantangpeo, where Blue Forests is currently working on mangrove rehabilitation. Sites that have been restored over ten years ago and unrestored sites will be located in Tompotanah and Ujungtanah. At each site, we will place two cameras at 1m depth facing horizontally at a 7 degree angle from one another in order to measure fish length and water visibility. Next to the cameras, we will place the light and temperature loggers which will collect throughout the duration of filming. With two cameras per location, this will total 18 cameras deployments per month for nine months between February 2024 and September 2024. Cameras will record for 1 hour. After which, the cameras and loggers will be extracted from the site, the recording will be downloaded, and then the cameras will be moved to the next site where we will conduct the same experiment. Sampling of each site will occur on a monthly basis. Methodology in this research will involve only observation and observation with video. No direct contact with animals will occur over the course of this project.

## Analysis:

We will measure biodiversity using the MaxN calculation method, as it is the most robust calculation for relative abundance (Whitmarsh, Fairweather, and Huveneers 2017). Further, we will use the data collected from the temperature and light loggers to create a statistical model of fish abundance in order to determine if fish abundance is more attributed to decreased water temperature or the shaded areas provided by mangrove habitats. As has been found in previous literature, we expect the sites with older, more established mangroves to foster the most biodiversity of juvenile fishes due to better shelter from predators and cooler temperatures. We expect the areas with no mangrove restoration to exhibit the least amount of biodiversity due to the exposure of these environments to predators and higher temperatures.

# Indonesian Research Permit

This project has obtained a research permit from the Indonesian government and undergone the required Ethical Clearance for Foreign Researchers process. A copy of this permit is included in this application.

1. **References**

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1. **Outputs**

The main outcome of this project is to disseminate its results to the local community with the aid of Blue Forests. With their help, we will incorporate this study into their curriculum for educating the public on the benefits of mangroves. This NGO also aims to use these findings to demonstrate the value of their efforts to these potential funding sources so they can continue their mangrove restoration. Further, I have partnered with Dr. Ambo Rappe, a professor of marine fisheries at Universitas Hasanuddin. I will assist her lab by leading data science and coding seminars for students to help them learn data organization and analysis for their own research. Finally, Dr. Ambo Rappe and I intend on publishing this research in an international journal.

1. **Possible Problems**

Despite being cheap, non-invasive, and easy to install, URUV’s do come with potential field-work challenges. Water visibility is a common concern, as species need to be detectable by the cameras. This can be especially true in mangrove habitats, where shade and detritus particles can limit visibility. We will address this through careful site selection as the channels between mangrove replanting sites may exhibit more visible waters. Further, as mangroves are coastal habitats, tides will also pose a challenge to this research. Blue Forests has offered to help select sites that remain underwater throughout the tidal cycle. Weather can also be an issue as Indonesia goes through significant rainy and dry seasons. The Island of Tanakeke is relatively inaccessible during rainy seasons, so this project will only occur during the dry months of February-September. If weather conditions are poor during sampling events, we will create an alternative sampling schedule to make up for lost samplings.

A final challenge will be the support and a positive relationship with the local community of Tanakeke island. As they have been working on this island for over a decade, Blue Forests will help introduce the researchers to community leaders and create an understanding of the activities and purpose of this research.

1. **Benefit to Animal Welfare**

The most direct benefit to animal welfare will be to improve our understanding of how mangroves benefit fish stocks. Our overall intention is to use this research to help educate public groups on the benefits of mangroves, including their role in biodiversity retention and extreme weather mitigation. Further, Blue Forests also intends to use the findings of this research to show the positive outcomes of their efforts and continue mangrove replanting around the country, potentially benefiting fish habitats in those areas as well.