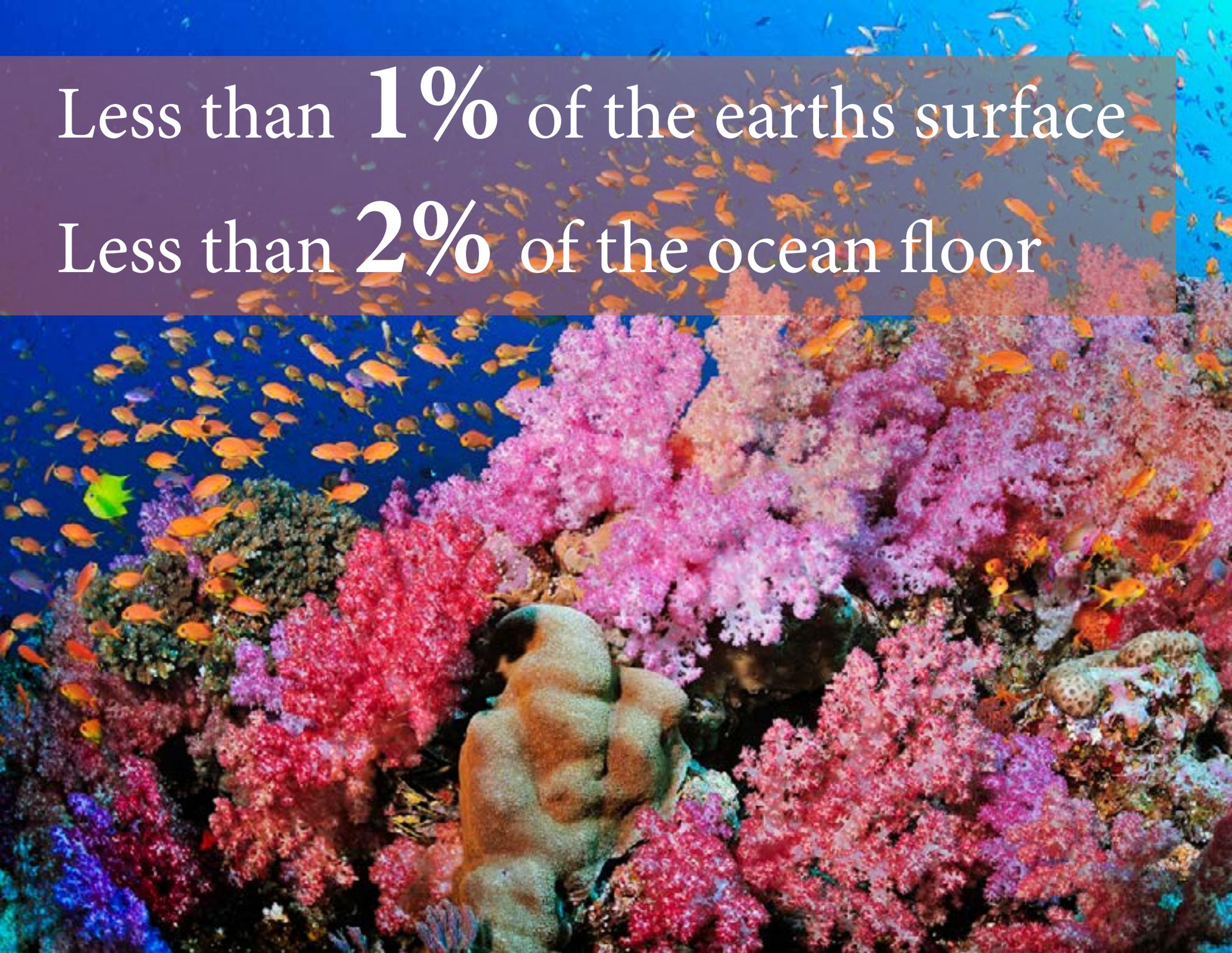


Restorative Reefs



Less than **1%** of the earth's surface

Less than **2%** of the ocean floor





25% of all marine life

An underwater photograph of a vibrant coral reef. The scene is filled with various types of coral, including branching and brain coral, in shades of yellow, orange, and brown. Numerous colorful fish, such as orange tangs, black and white damselfishes, and other species, are swimming around the reef. Sunlight rays penetrate the clear blue water from the top right, creating a bright and lively atmosphere.

Protect coastlines

Produces **billions** of dollars

Reefs



Four main type of reefs

Fringing

Barrier

Platform

Atoll

Fringing Reefs

Fringing reefs are the most common type of reef

Directly attached to the shore

Expand seaward



Barrier Reefs

Resemble later stages of fringing

Barrier reefs are separated from the mainland or island

Expand farther out into the open sea



Platform Reef

Form on the continental shelf and open ocean

Platform reef can grow in any direction



Atoll Reef

Circular reef

Extend around a lagoon without a central island

Developes when an island erodes away or sinks below the level of the sea



Reef Locations

Tropical and temperate water

30 degrees north to 30 degrees south of the equator

Depths no deeper than 50 meters

Temperature from 79-81 degrees



Biodiversity in Reefs

Coral reefs are some of the most productive ecosystems

Protect coast line, provides protection for smaller marine life, feeding ground and homes

Algae

Sponges

Fish

Invertebrates

Sea snakes

Sea turtles

Giant clams



Threats to Coral Reefs



Reef Threats

In 1998 an underwater heat wave killed about 16% of reefs

2015 the world's longest ever bleaching event recorded



What is Coral Bleaching?

Coral loses its symbiotic algae

Water temperatures, sunlight, dilution

Bleached coral does not die right away

Dies from starvation or diseases



Global Threats

Warming water temperatures

Lose of the microscopic algae that produces its food

Severe or prolonged bleaching can kill coral



Local Threats

Over fishing

Boats and their anchors

Invasive species

Runoff

Sewage

Soil erosion



Protecting Coral Reefs



Reef Protection

Healthy fish community

Fish eat seaweed

Fish eat predator

Water around the reef should be clean



Reef Stabilization

Stabilize reefs framework can speed up the recovery time

Adding structure with complex topography or that mimic natural reef framework

Increasing public awareness through coral nurseries and gardening



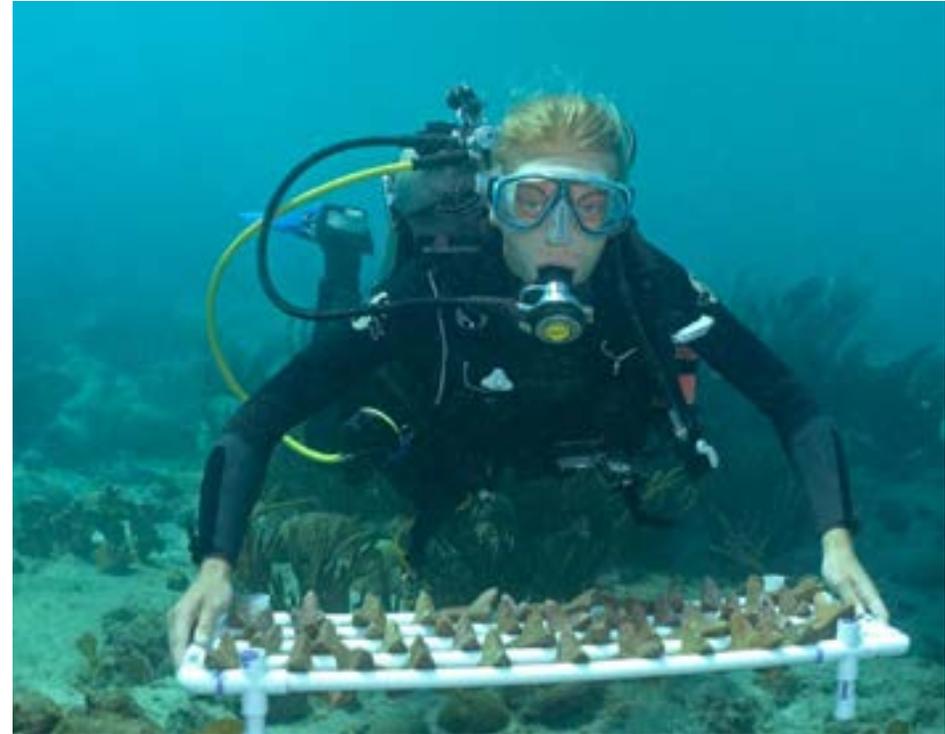
Outplanting Coral

Coral is grown in nurseries

Taken to a reef restoration site

Directly attached to the reef

Maintained and monitored



Design Question

What can landscape architects do to help counteract the effects of coral bleaching and educate the public in an interesting way while providing every one with access to the reef?

The Site



My site: Hanauma Bay

Located on O'ahus along the southeast coast

Hawaiian words “hana” and “uma”

Formed in a volcanic cone



Hanauma Bay Time Line

1800s

Bay was used by royalty



1930

The road leading to the bay was paved and a few other amenities where added



1967

Declared the Bay a marine protected area

The Bay was then purchased but the city and county of Honolulu



1941

Barbed wire and bunkers were built. Reef was blasted for a transoceanic cable



1980
13,000 visitor a day, people
kicked up sediment killing
coral



2002
Marine education center
was opened



1970
The city clears more reef



1990
Measures were taken to
limit the use of the bay



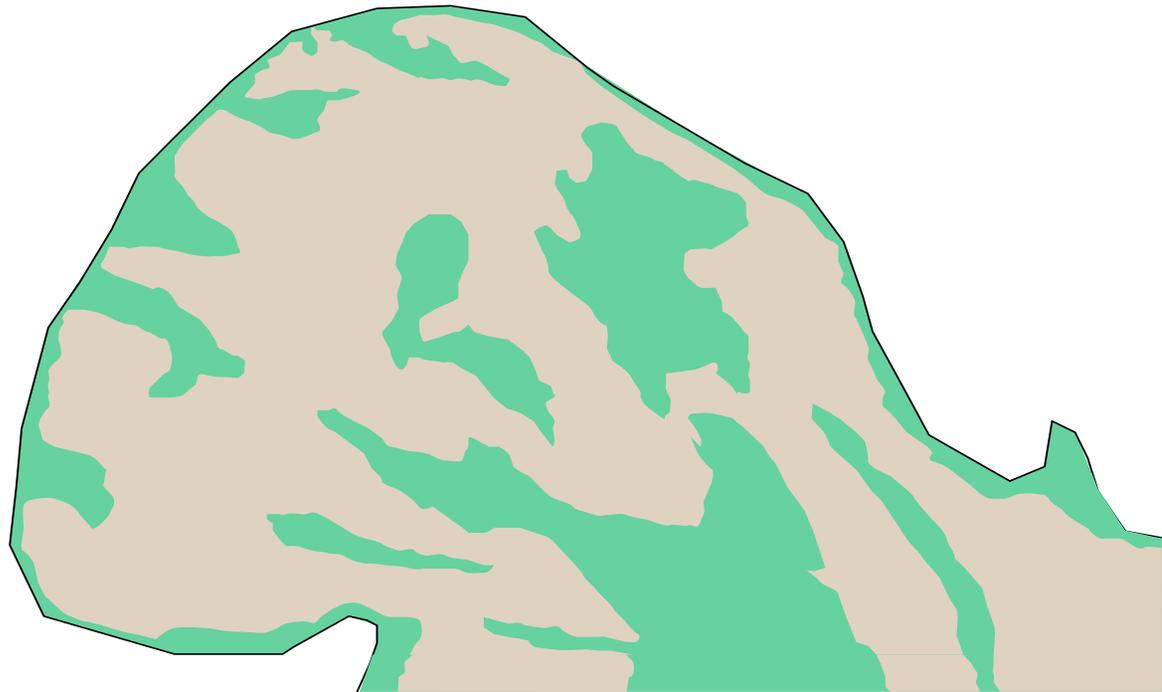
Today
Bay is closed on Tuesday to
give the reef time to rest and
recover

The Bay

400 species of fish

Abundance of green sea turtles

2014 and 2015 47% of the bay was suffering from coral bleaching close to 10% of the coral died.



Thesis Statement

Preserving the Hanauma Bay Nature Preserve coral reefs through recreational opportunity and public education

Project Goal

Reef Restoration

Recreational Education

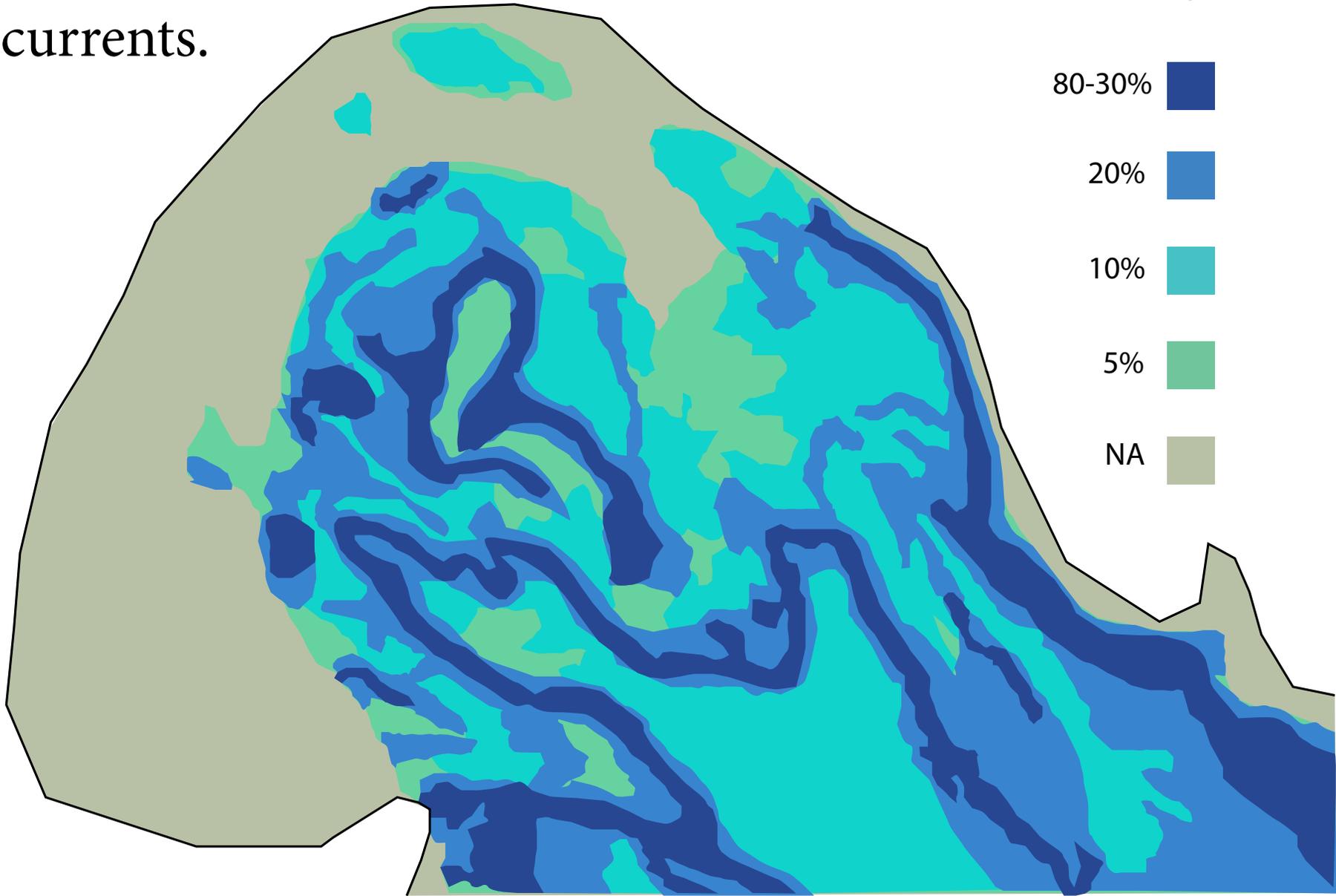
Accessibility

Site Analysis



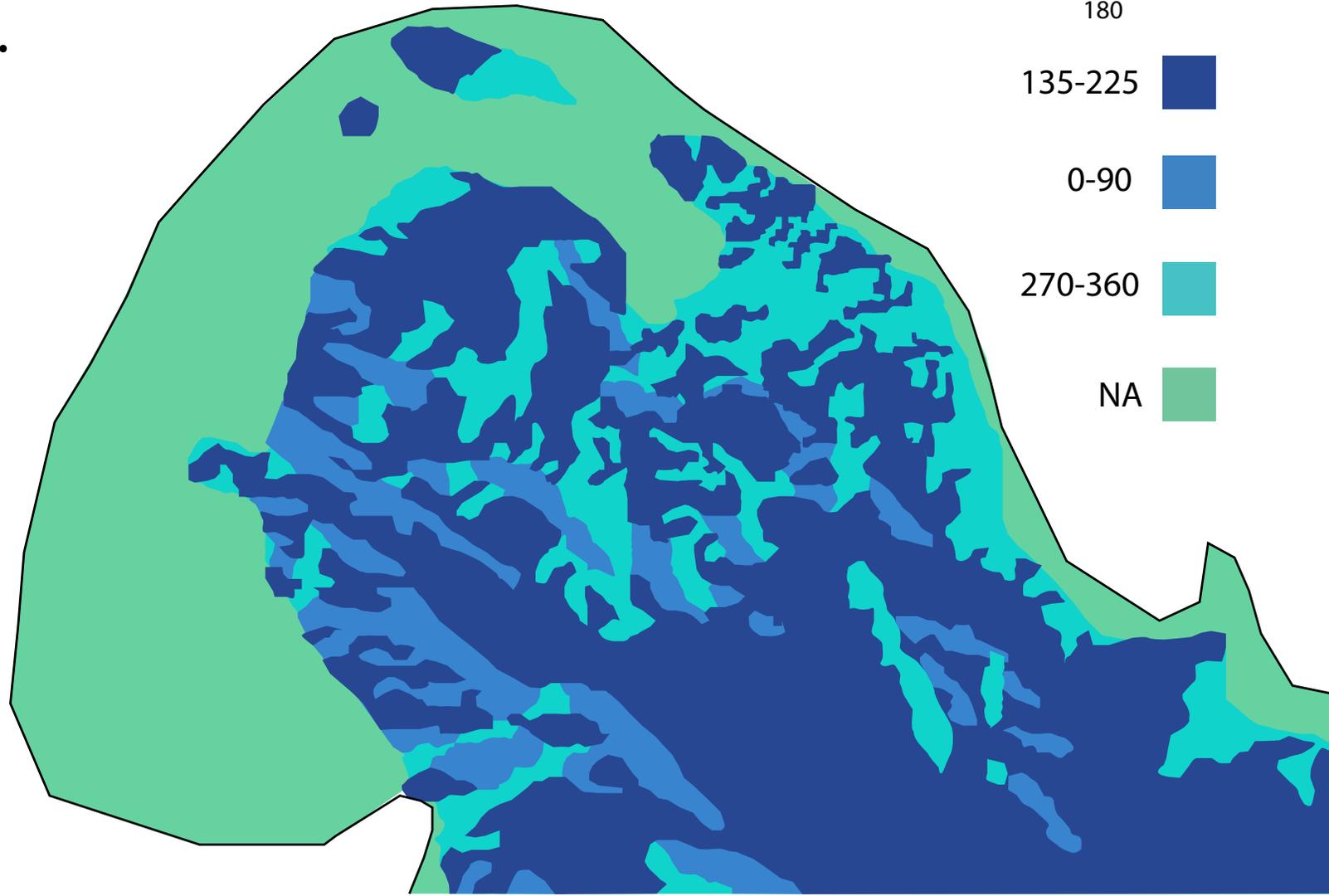
Slope Analysis

The steepest slope is shown in a dark blue ranging from a 30-80% slope this mean these areas will be hit with strong ocean currents.



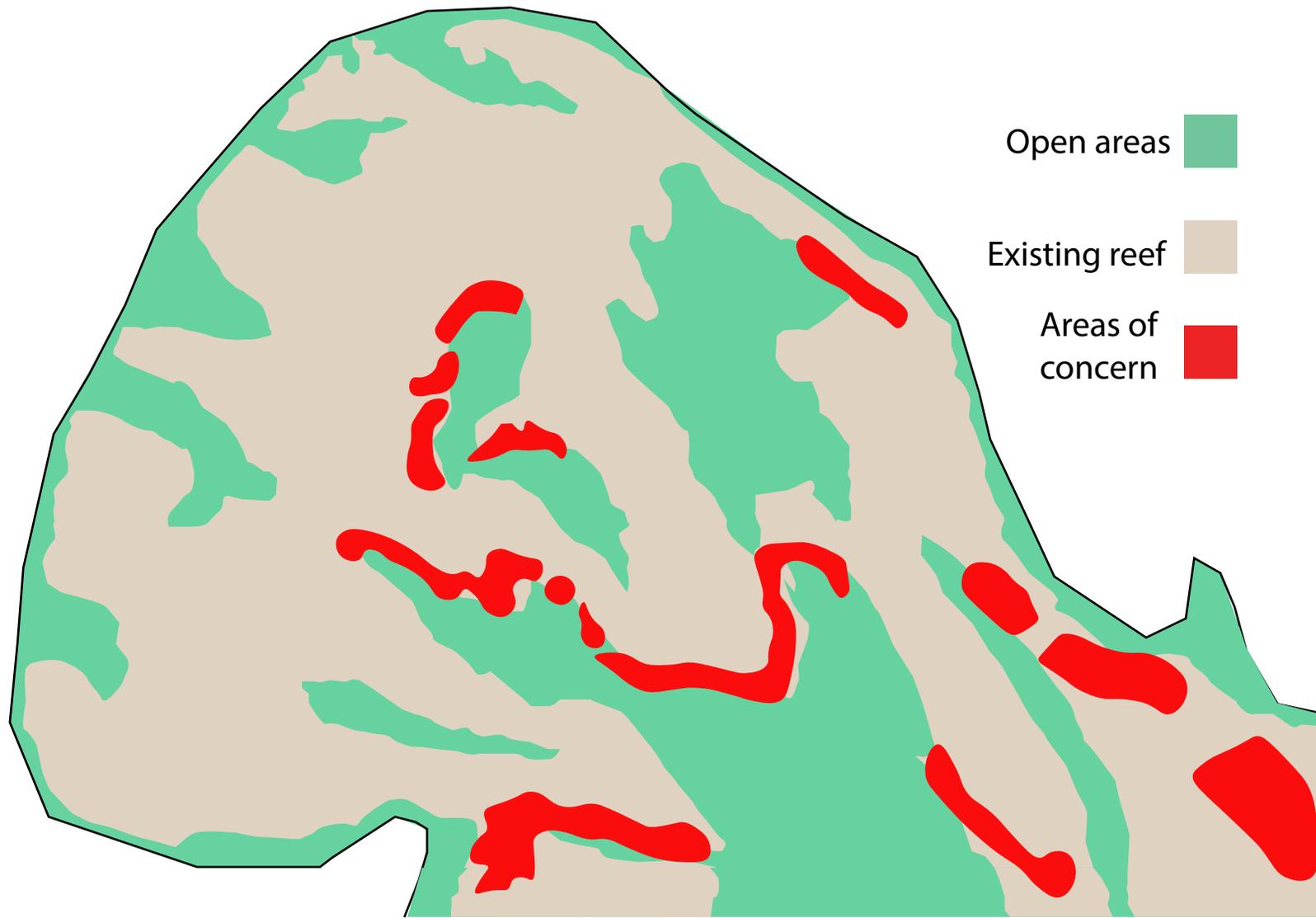
Aspect Analysis

The aspect map shows the direction the sea floor is facing area in the 135-225 degree zone will get the most direct sunlight for the longest time.

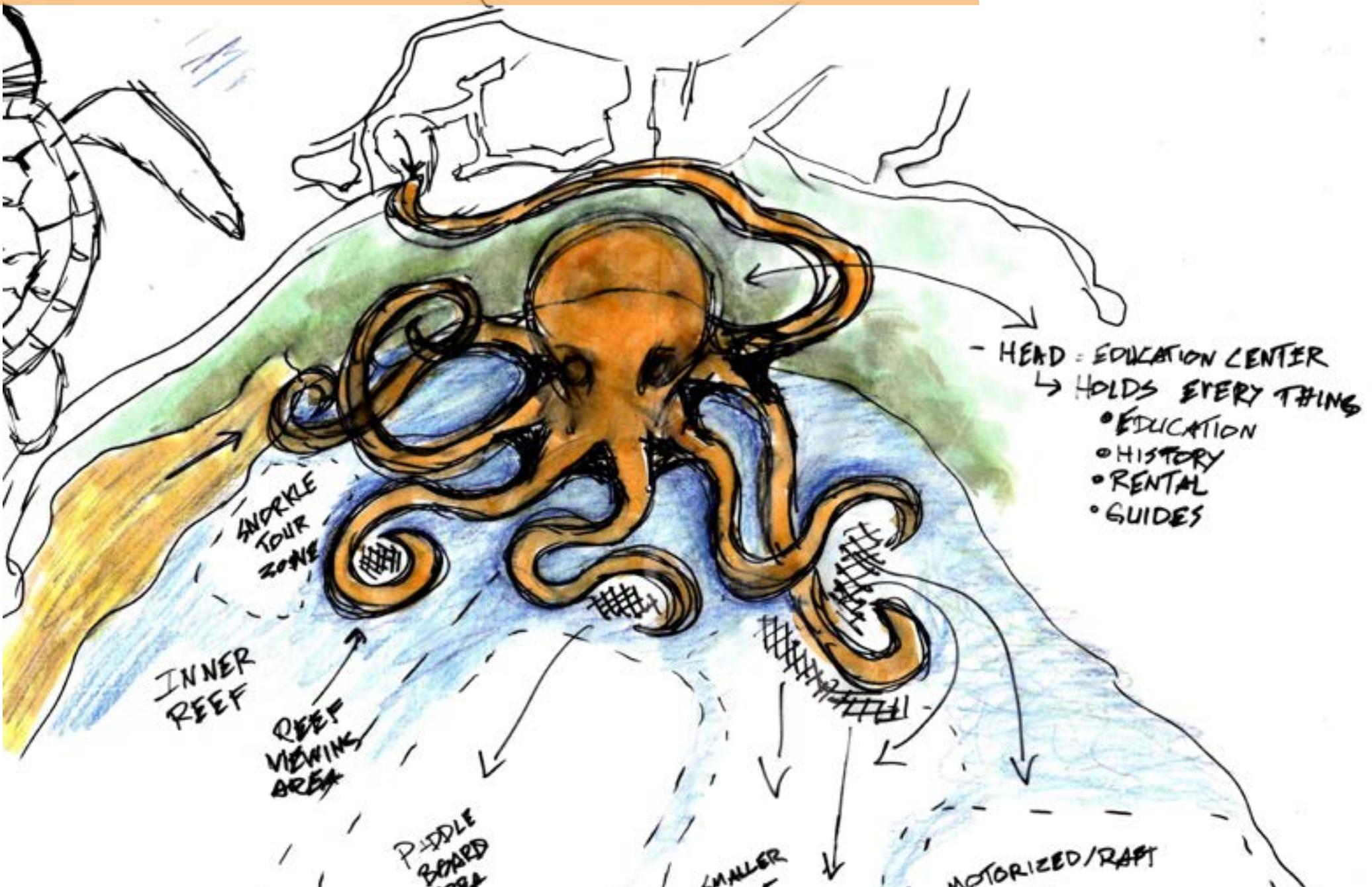


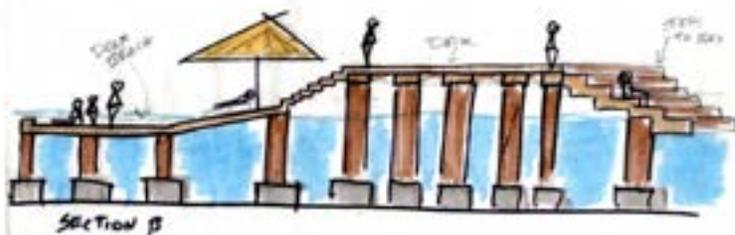
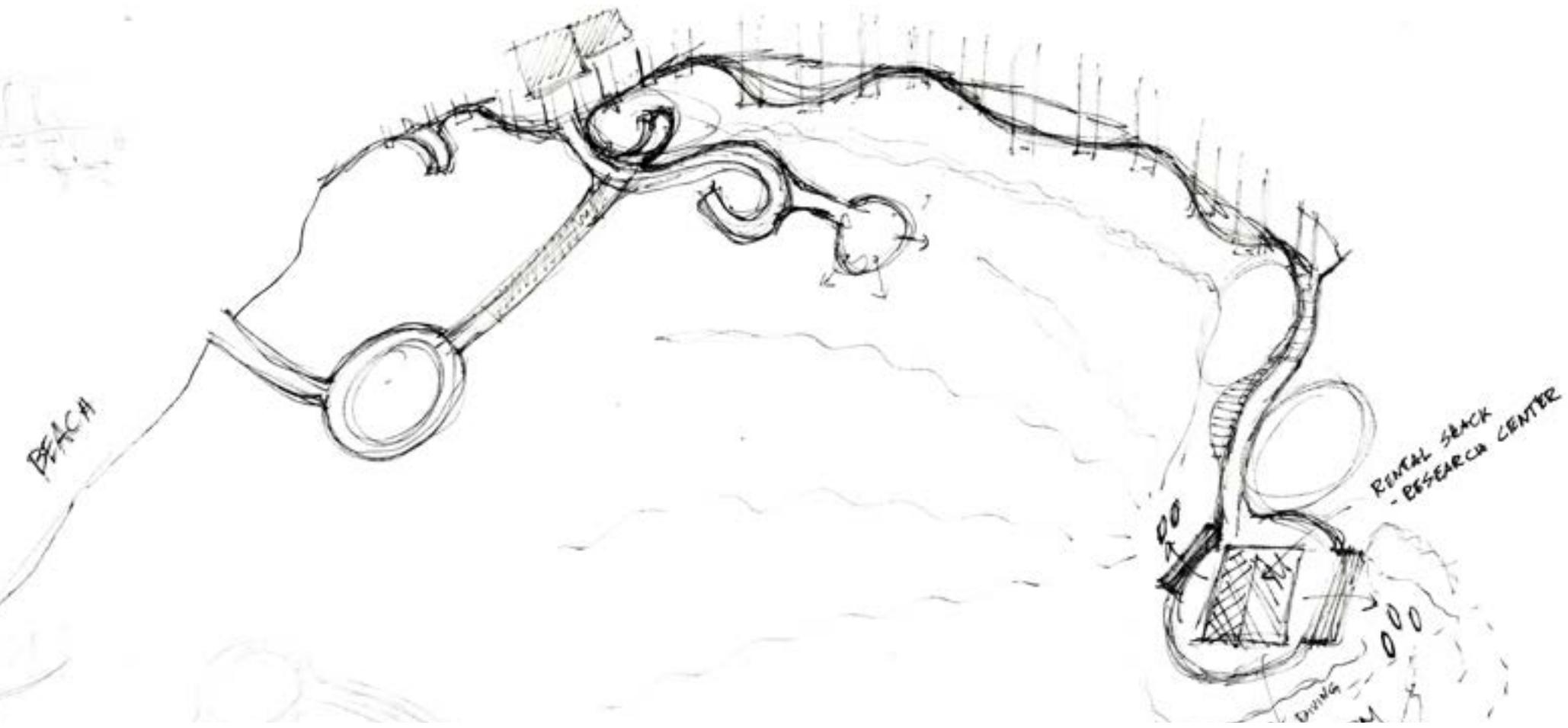
Reef Area Analysis

This reef map shows the area of the bay that I feel would be in the most danger of bleaching due to their location on the steepest slopes and in the longest direct sunlight.



Design Concepts



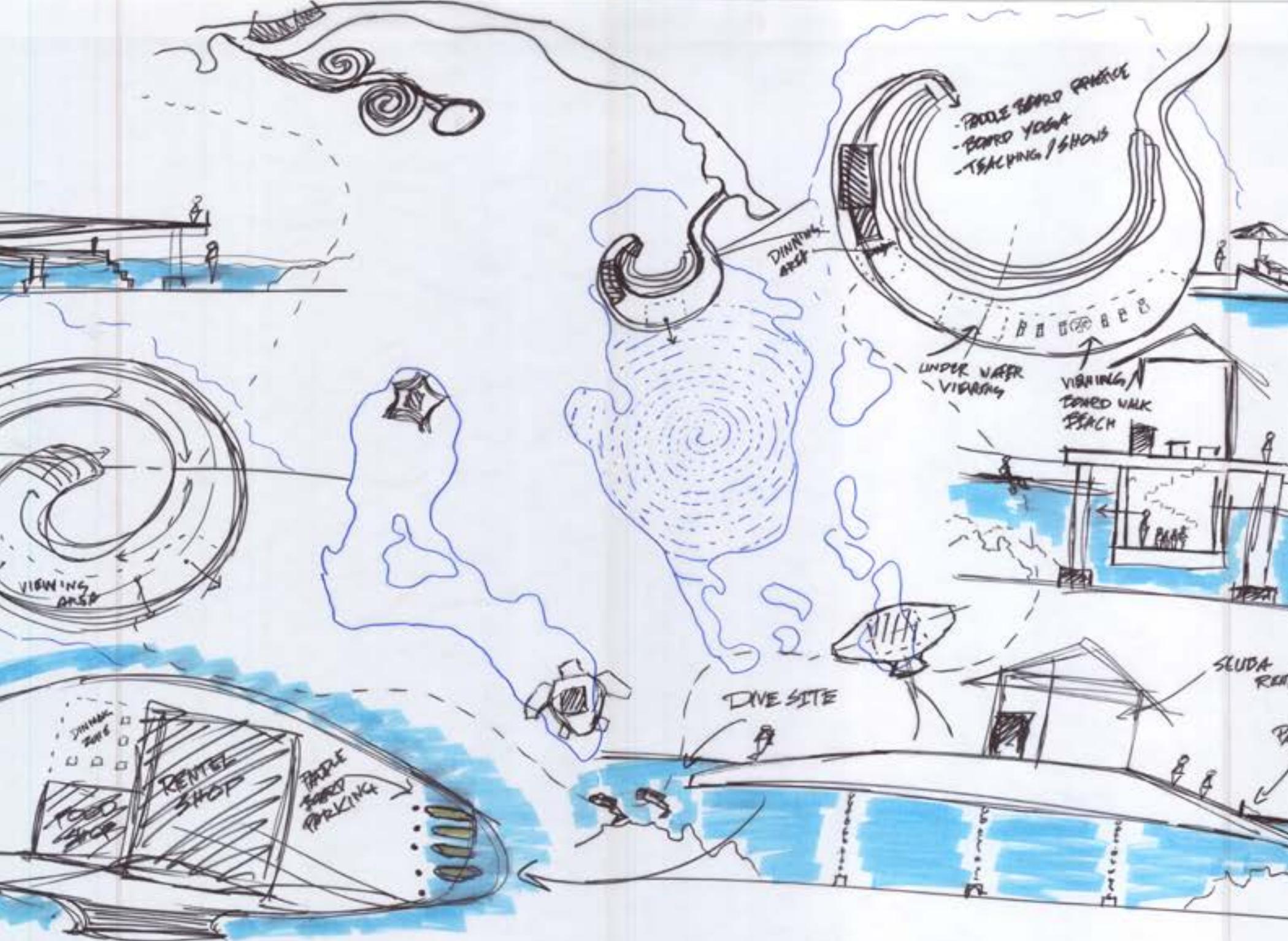


SECTION B



STAGE 4 SECTION





- PADDLE BOARD PRACTICE
- BOARD YOGA
- TEACHING / SHOWS

DINE AREA

UNDER WATER VIEWING

VIEWING / TONED WALK BEACH

VIEWING AREA

DIVE SITE

SLUDA RE

RENTAL SHOP

FOOD SHOP

PEOPLE BOARD PARKING

DINE AREA



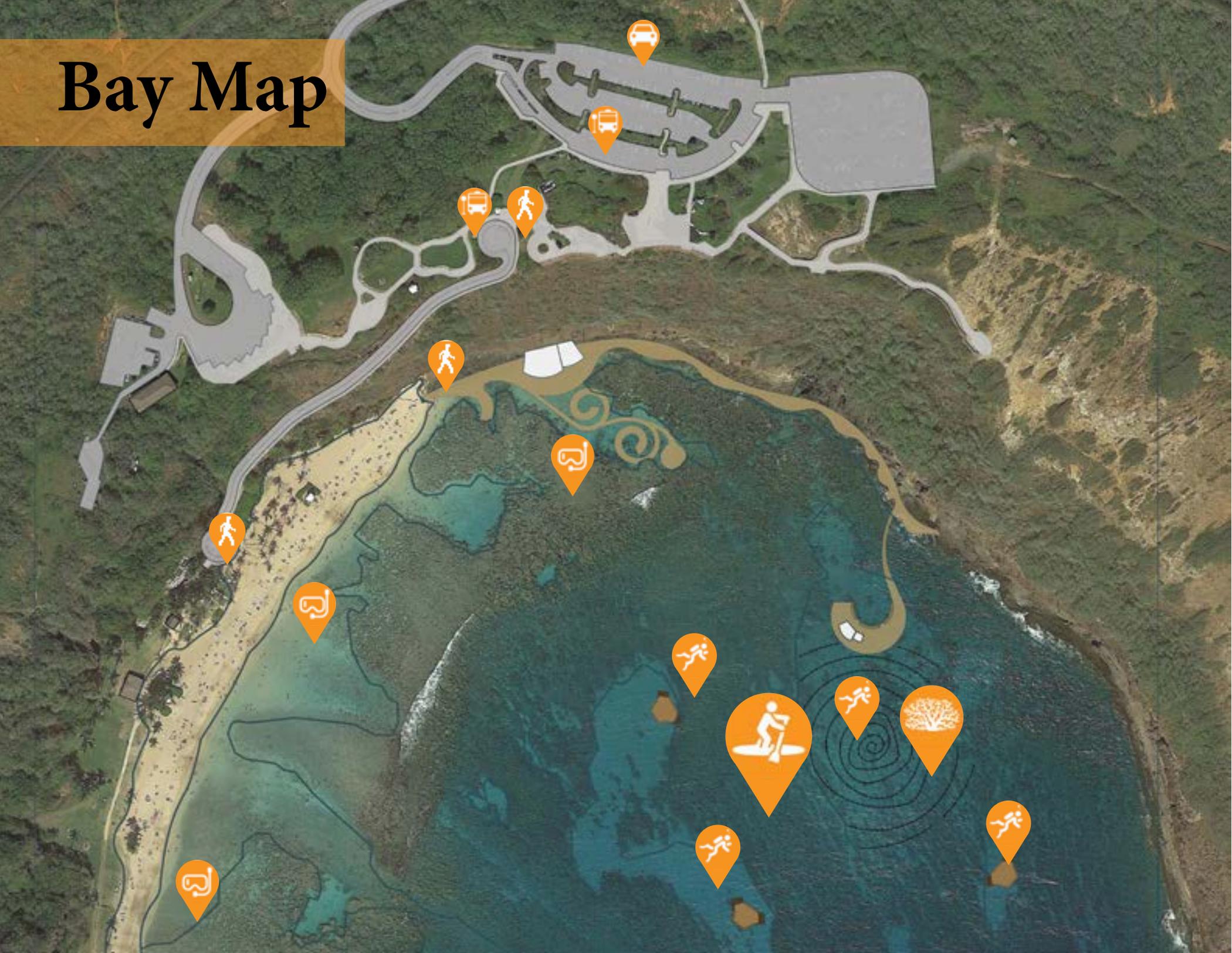
GOALS

- 1 CORAL RESTORATION
- 2 RECREATION ACTIVITIES
- 3 ACCESSIBILITY

ZONE FOCUS/ACTIVITIES

- ZONE A** - SHALLOW BEACH ZONE COULD BE USE FOR SHOPPING, SWIMMING, RESTORATION WILD LIFE VIEWING ■
- ZONE B** - DESIGN FOCUS AREA BEACH ACCESS OPTION FOR BOARDWALK, RESTORATION, SHORE PADDLE BOARDING, DIVING ■
- ZONE C** - PADDLE BOARDING ZONE SPACE FOR SHORE BOARDING, DEEP SNORKLING ■
- ZONE D** - FLATTER UNDER WATER AREA ZONE PERF FOR REEF RESEARCH, UNDER WATER REEF GARDEN DEEP DIVING TOURS, MORE ADVANCED BOARDING ■
- ZONE E** - DANGER ZONE AREA WHERE REEF MAY BE VERY VULNERABLE ■
- ZONE F** - MIXED USE MORE ADVANCED LEVEL OF DIFFICULTY FOR ACTIVITIES ■
- ZONE G** - OUTER BAY ZONE ■

Bay Map





- Paddle board route 1 
- Paddle board route 2 
- Paddle board route 3 
- Paddle board route 4 
- Paddle board route 5 
- Paddle board route 6 


Snorkeling


Paddle Boarding


Scuba Diving


Coral Restoration Area

Inner reef

Outer reef

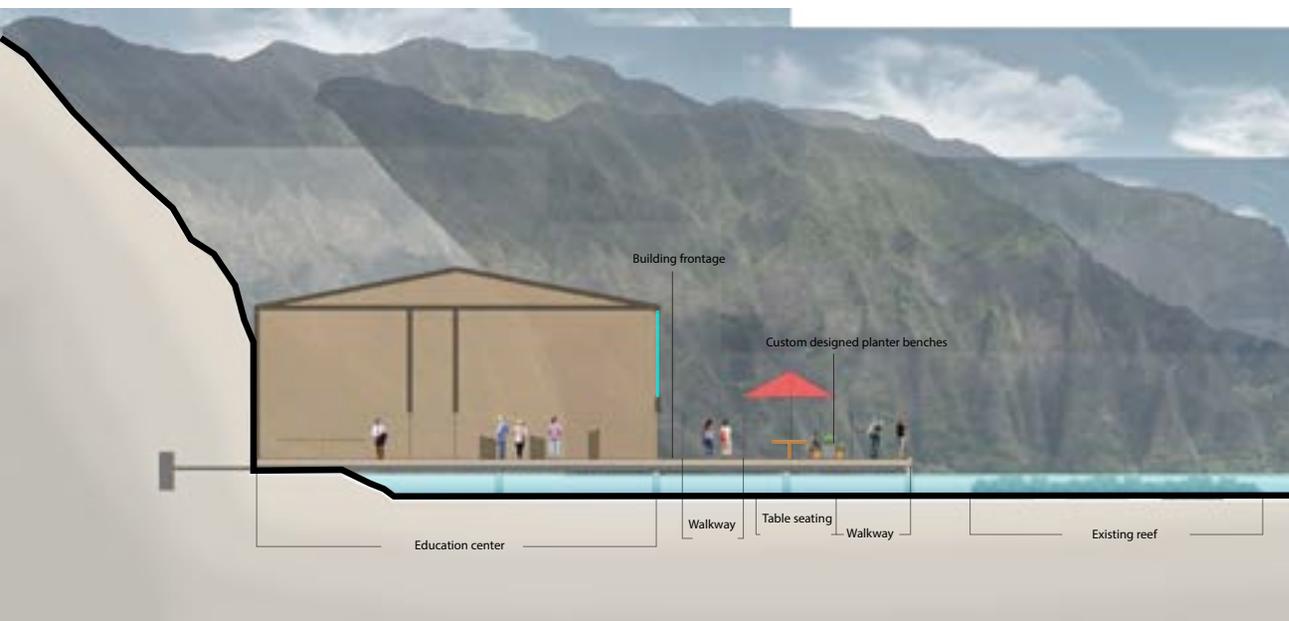
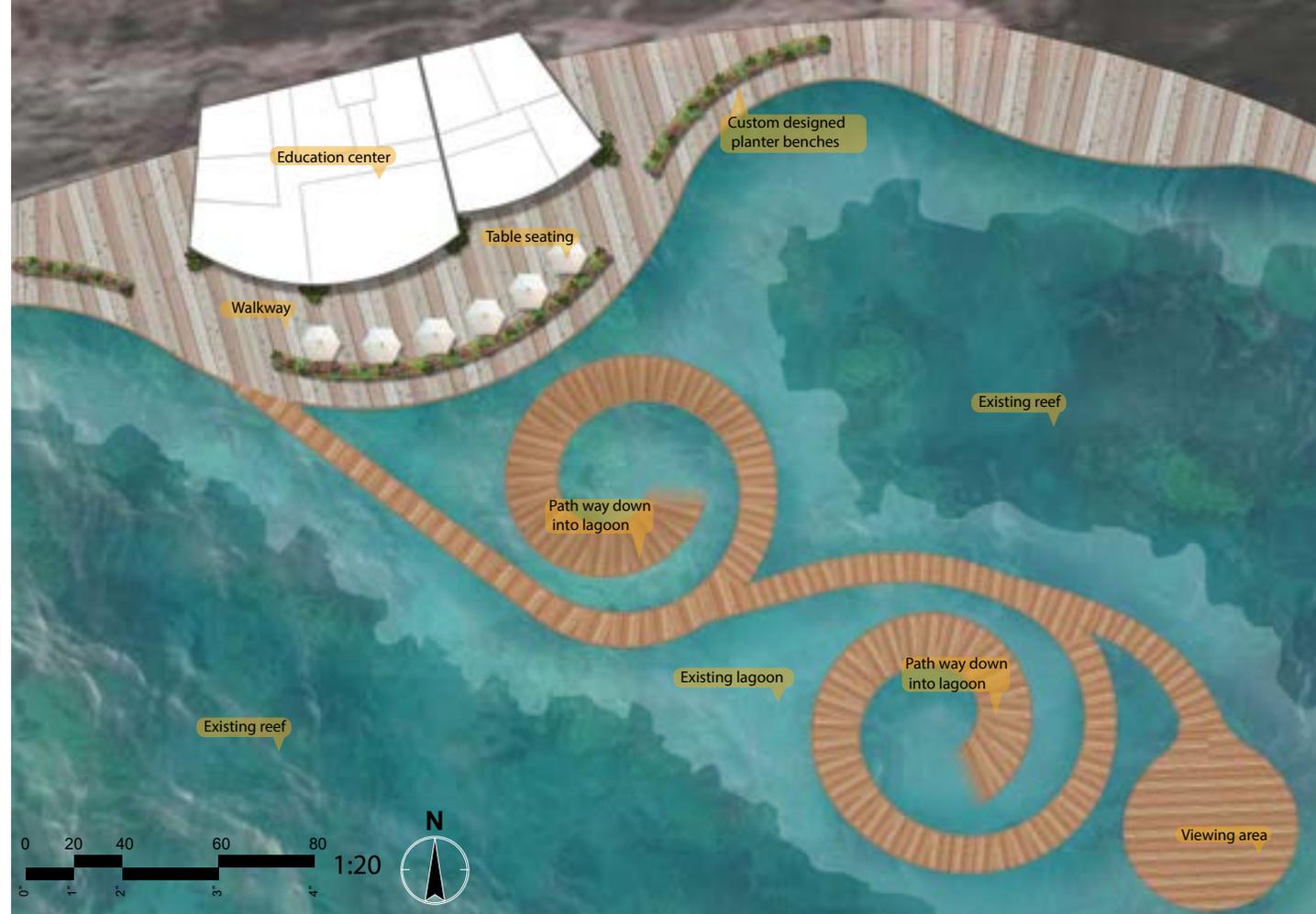
Master Plan

Educational Center Site

Designed around the existing coral reef

Boardwalk would be cantilevered out over the water

Designed to bring people close to the reef



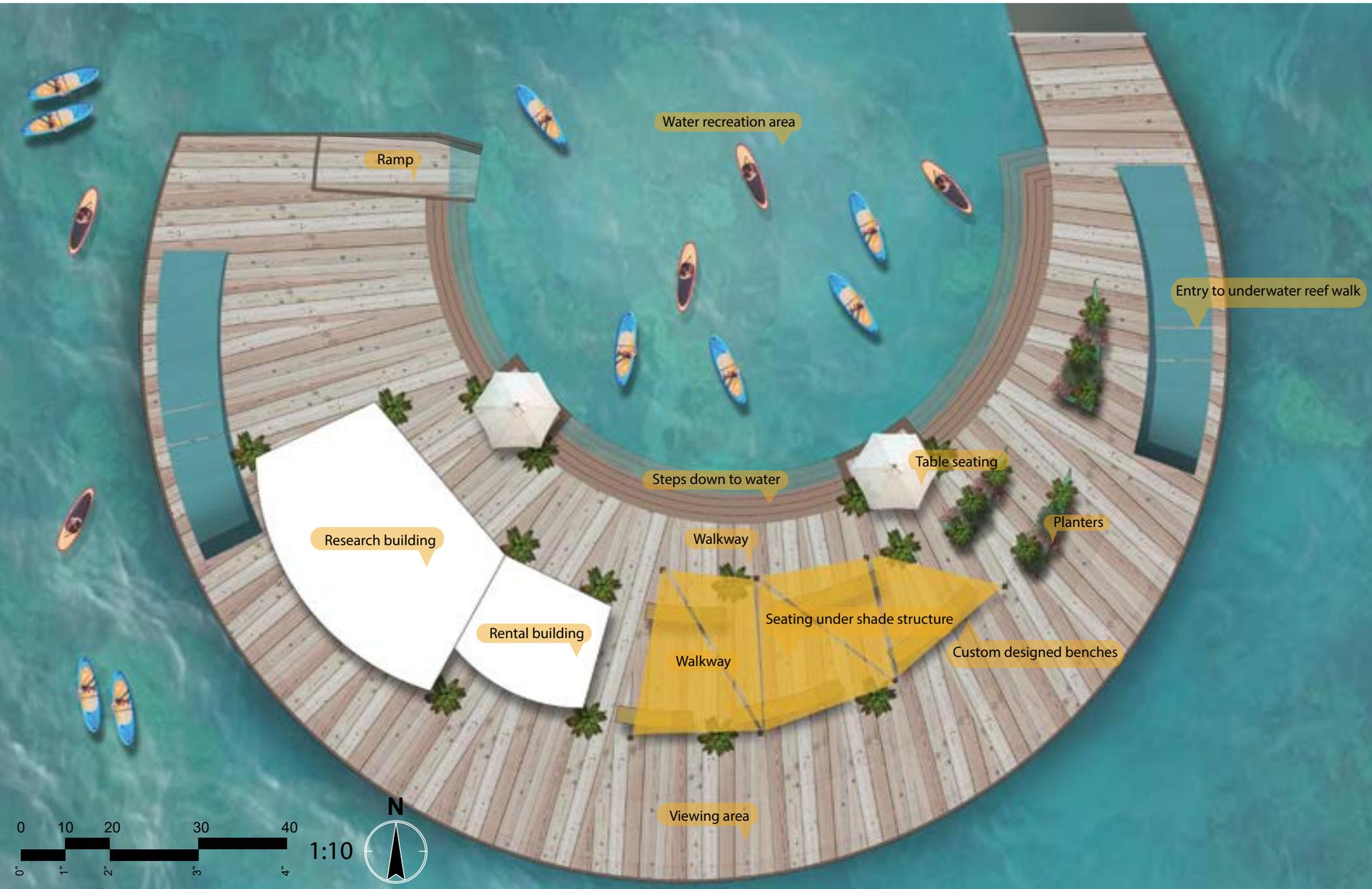
Location Map



Educational Center Boardwalk



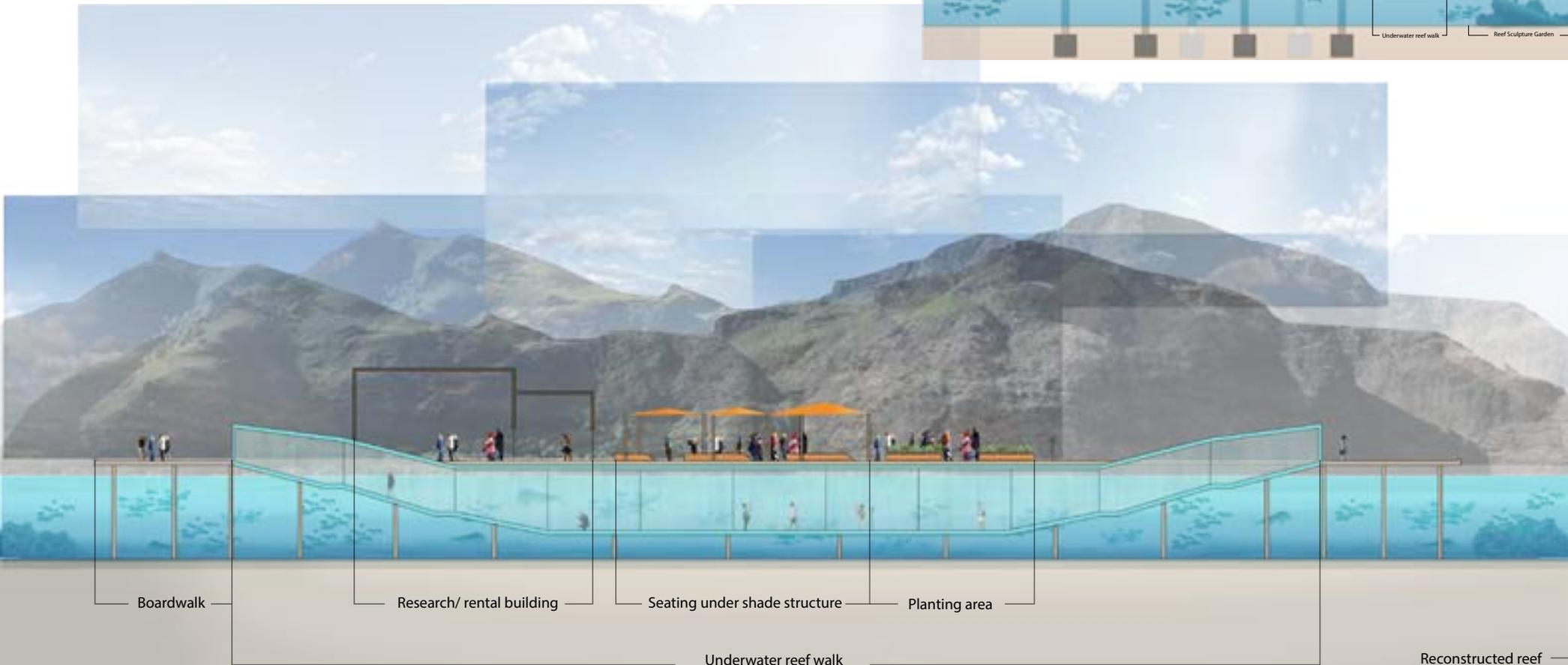
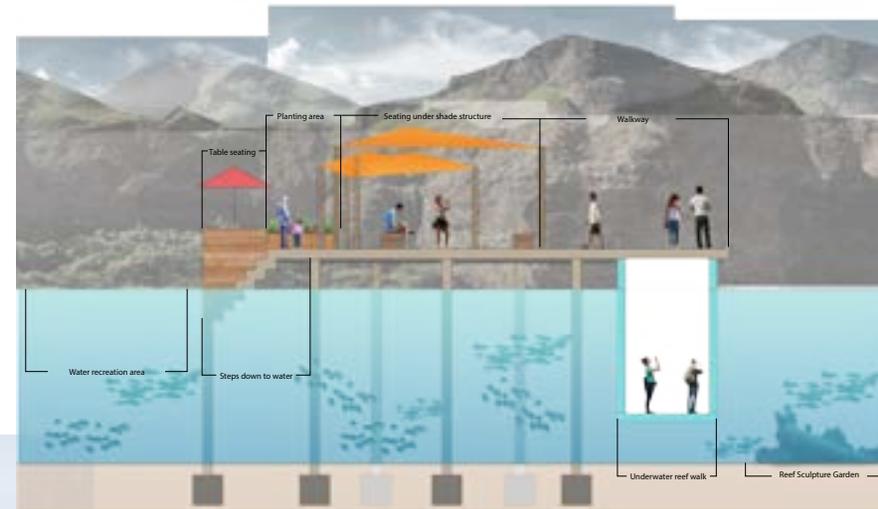
Recreational Area & Underwater Walk



Recreational Area & Underwater Walk Section

Access to view the coral restoration garden

This walk makes the reef accessible to everyone



Recreational Area Boardwalk



Reef Sculpture Garden



Design Details

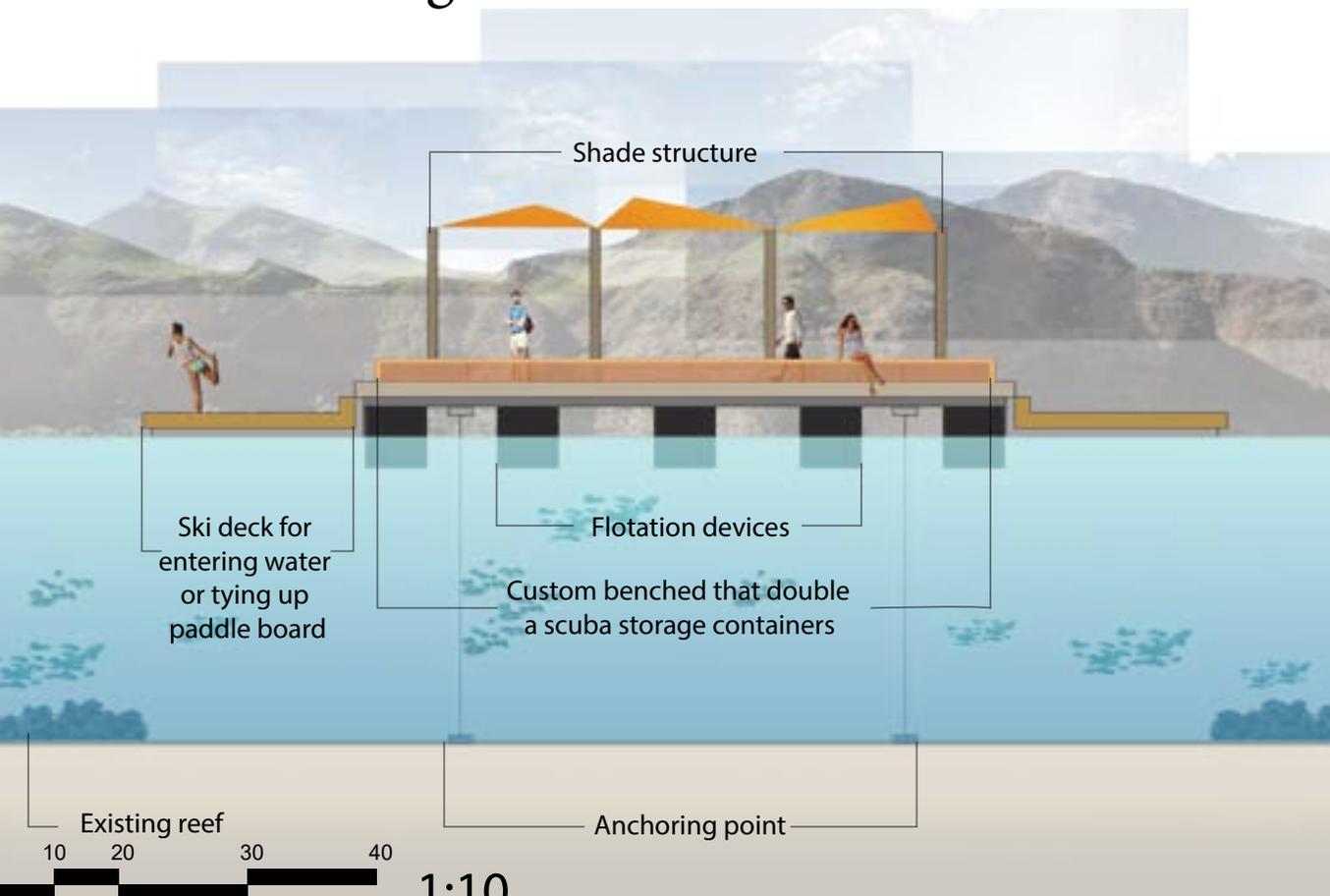
Raft Detail

- Stopping point for paddle boarder
- Anchored down
- Scuba dive
- Custom storage benches



Boardwalk Detail

- Constructed very carefully
- Withstand years of sea water
- Materials that won't harm the reef



Conclusion

Through my design I believe that providing people with access to areas of recreational education, people will come to understand and value the reefs while also helping to restore them to a natural state.

Throughout this project I have learned so much about coral reefs and all they do for the world. I hope to continue learning about reefs and designing ways to help them in the future.

Restorative Reefs

Thank you
Questions?

