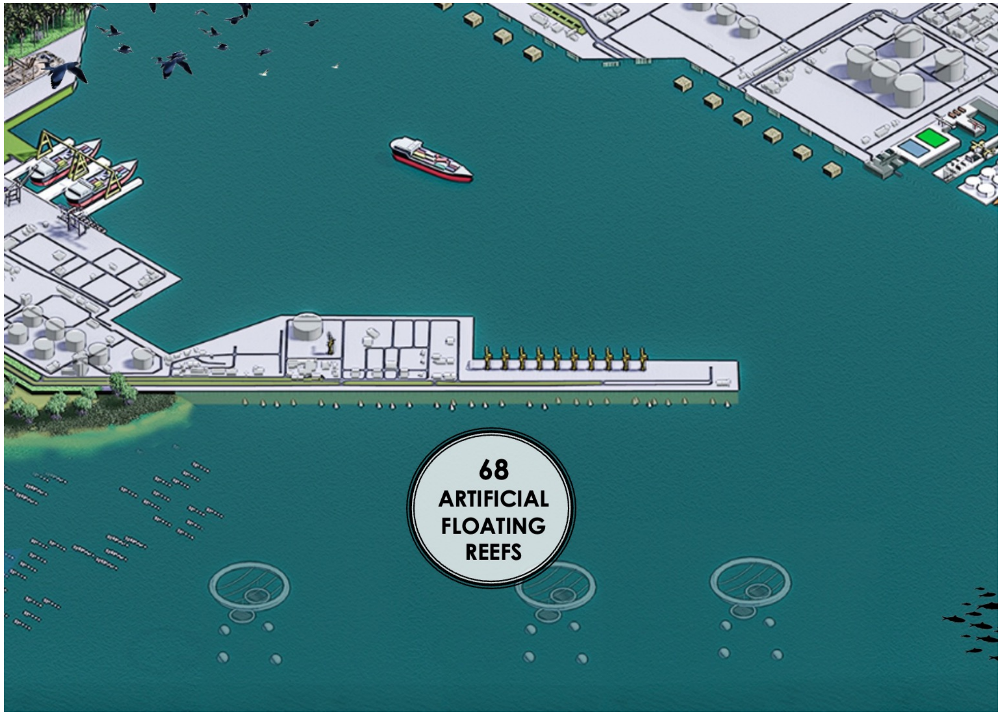
NbS-68 ARTIFICIAL FLOATING REEFS



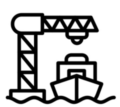
Artificial floating reefs and pontoon-based structures are created to enhance marine biodiversity and ecosystem services by providing settling substrates for various organisms, including algae, mussels, sponges, and oysters.

These structures mimic natural reef functions by creating habitat complexity in otherwise smooth and artificial underwater environments, such as port areas, industrial coastlines, and urban waterfronts. By fostering the growth of filter-feeding organisms, floating reefs contribute to water purification, nutrient cycling, and the creation of fish habitats, ultimately supporting marine biodiversity in degraded or highly engineered coastal zones.

In port and coastal industry settings, artificial floating reefs offer multiple benefits. They enhance water quality by reducing suspended particulates and excess nutrients through filter feeders, making them particularly relevant for polluted or eutrophic waters. Additionally, they provide refuge and breeding grounds for fish, improving local fisheries and contributing to ecosystem restoration.

Over time, the accumulation of marine life on these structures can also offer wave attenuation benefits, reducing coastal erosion and improving shoreline resilience. However, challenges such as maintenance, biofouling management, and integration with port operations must be carefully addressed to maximize long-term benefits.

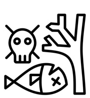
LANDSCAPES SUPPORTED



EbA (ECOSYSTEM-BASED APPROACHES)

- HABITAT RESTORATION & CREATION
- WATER QUALITY IMPROVEMENT
- COASTAL & MARINE ECOSYSTEM CONNECTIVITY
- CLIMATE ADAPTATION & RESILIENCE
- SUSTAINABLE BLUE ECONOMY

MAIN PROBLEMS ADDRESSED



BIODIVERSITY LOSS

FLOOD CONTROL

ECOSYSTEM SERVICES AND ACTIONS

SUPPORTING

- Provide artificial substrates for marine biodiversity, fostering settlement of algae, mussels, oysters, and fish nurseries.

REGULATING

- Improve water quality by promoting filter-feeders (e.g., mussels, oysters, sponges) that remove excess nutrients and pollutants.

PROVISIONING

- Enhance local fisheries by creating habitats that support fish stocks and shellfish populations.

SOCIAL BENEFITS

- Promote eco-tourism and recreational fishing opportunities in urbanized port environments.

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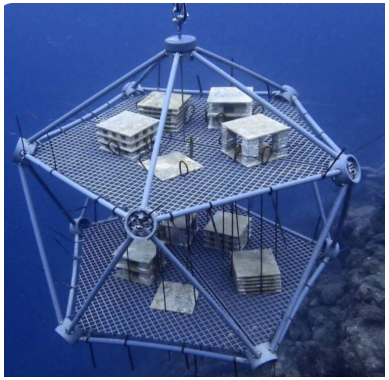
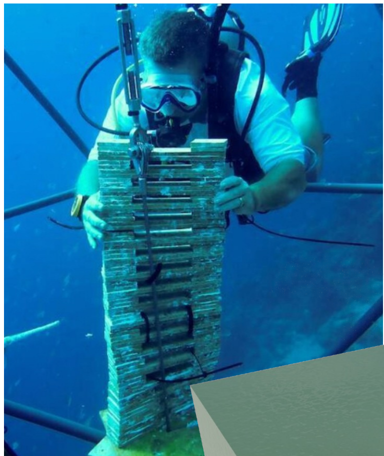
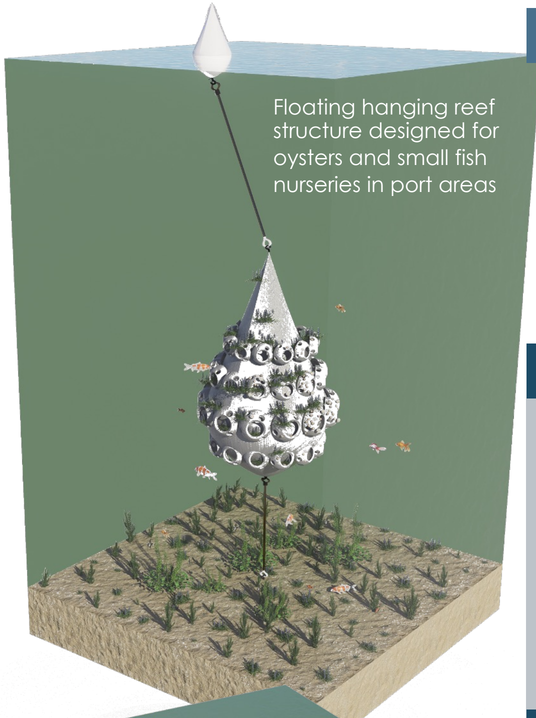
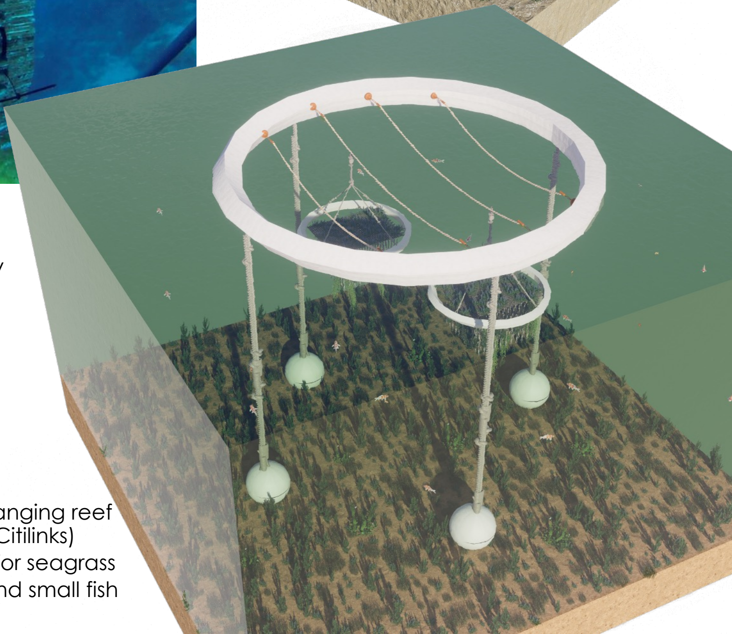




Coral Arks floating reef structures built by Sand Diego University



Floating hanging reef structure designed for oysters and small fish nurseries in port areas



Floating hanging reef structure (Citilinks) designed for seagrass capture and small fish nurseries

PROJECT'S CHALLENGES & RISKS

- **Biofouling and Maintenance:** Excessive accumulation of marine organisms can lead to structural degradation.
- **Water Pollution and Contaminants** – Ports often have high levels of pollutants, which may hinder the growth of beneficial marine species on the reefs.
- **Structural Stability and Storm Resilience:** Floating and hanging reef structures must withstand extreme weather events, strong currents, and typhoons.
- **Stakeholder Conflicts and Navigation Safety:** Balancing ecological benefits with port operations, shipping routes, and industrial activities can create regulatory and spatial planning challenges.

NbS co-BENEFITS AND THEIR INDICATORS

- **Marine Biodiversity Enhancement**
  Increase in fish and invertebrate species observed per square meter of artificial reef surface.
- **Improved Water Quality**
  Reduction in suspended particulate matter and nutrient pollution through filtration by mussels, oysters, and sponges.
- **Wave Attenuation, Coastal Protection**
  Reduction in wave energy by a measurable percentage due to reef structures.
- **Support for Small-scale Fisheries**
  Increased local fish stocks, with higher catch rates reported by nearby fishers.
- **Carbon Sequestration**
  Biomass growth and calcium carbonate deposition contributing to measurable carbon capture in marine sediments.
- **Educational and Recreational Value**
  Number of awareness programs, diving activities, or eco-tourism initiatives linked to the artificial reef sites.

COST ANALYSIS

- **Direct Costs**
  Installation costs range from $50k to $500k/ha, depending on materials, design complexity, and deployment scale.
- **Indirect Costs**
  Monitoring, maintenance, and regulatory compliance can add $5,000 to $20k/year/site.
- **Time Horizon**
  Effective over a 15-30 year lifespan with discount rate of 5-7% for ecosystem service valuation.
- **Direct Benefits**
  Enhanced fisheries productivity and eco-tourism can generate $10k to $100k/year/reef, depending on location and biomass accumulation..
- **Indirect Benefits**
  Improved water quality, shoreline protection, and carbon sequestration
- **Risk Assessment**
  Risks include biofouling, structural degradation, and storm damage

REFERENCES:

ECOCEAN's Biohut Reef system consists of artificial reef modules suspended from docks and piers to act as nurseries for marine life, **France and Asia.**

Floating Reef Balls Project **(Florida, USA & Thailand)**

IMPLEMENTATION OPPORTUNITIES:

Port of **Singapore**
Manila Bay, **Philippines**
Jakarta Bay, **Indonesia**
Chonburi & Rayong Ports, **Thailand**
Tanjung Priok Port, **Indonesia**