

An Exploratory Study of Reef Ball Projects: A Global Review of Reef Ball® Initiatives

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Abstract:

This research study aims to investigate and analyze existing projects utilizing Reef Ball®, a type of artificial reef module, in various applications, including offshore reefs, breakwaters, and living shorelines. A comprehensive survey of global initiatives will be conducted to explore the effectiveness, benefits, and challenges of Reef Ball projects in enhancing marine ecosystems, promoting sustainable coastal management practices, and providing coastal protection.

Introduction:

Reef Balls® are a popular choice for artificial reef construction due to their unique design and functionality. Despite their widespread adoption, there is a need for a comprehensive review of Reef Ball projects to assess their overall impact and identify areas for improvement.

Objectives:

1. Identify and document existing Reef Ball® projects worldwide, including offshore reefs, breakwaters, and living shorelines
2. Evaluate the environmental impact and efficacy of Reef Ball projects in different applications
3. Analyze the social and economic benefits of Reef Ball® initiatives
4. Investigate challenges and limitations faced by Reef Ball projects
5. Provide recommendations for future improvements and best practices

Methodology:

1. Literature Review: A thorough review of academic journals, reports, and online resources to identify existing Reef Ball projects
2. Survey Design: A comprehensive survey questionnaire will be developed to gather information on project details, environmental impact, social and economic benefits, and challenges faced
3. Data Collection:
 - Online Surveys: Distributed to project managers, researchers, and stakeholders involved in Reef Ball initiatives
 - Site Visits: Selected finished projects will be visited to conduct:
 - Visual Surveys: Photography and visual assessments of Reef Ball structures and surrounding environments
 - Electronic Surveys: Using electronic devices to collect data on water quality, sediment characteristics, and marine life

- Wave attenuation Wave height measurements on each side of breakwaters will provide positive data on the wave attenuation.
 - Snorkeling and or SCUBA surveys will provide qualitative analysis of the project.
 - Kayaking with Deeper Sonar for mapping the site and bottom conditions.
 - Hydrophone for recording the sound characteristics of each site.⁵
- Remote Sensing: Satellite imagery and aerial photography will be used to assess project sites and surrounding areas
4. Data Analysis: Descriptive statistics, thematic analysis, and content analysis will be employed to analyze survey responses, site visit data, and remote sensing information

Visual and Electronic Surveys:

- Photography: High-resolution, and 360° images will be taken to document Reef Ball structures, marine life, and habitat diversity
- Electronic Devices: Specialized equipment, such as:
 - Water Quality Sensors: To measure parameters like pH, temperature, and nutrient levels
 - Sediment Corers: To collect sediment samples for analysis
 - Underwater Cameras: To survey marine life and habitat diversity
 - Acoustic Sensors: To monitor marine life and water quality

Inclusive Study Areas: (add locations as information is provided by project managers)

1. Offshore Reef Balls: Evaluating the effectiveness of Reef Balls in creating artificial reefs in offshore environments
 - a. Hernando County ReefBall Reef, and/or Snorkeling Reef - Hernando County, Florida
 - b. Indian Riverside Park - Martin County, FL
 - c. Charles H. Kirbo Memorial Reef - Duval County, FL
 - d. Eternal Reefs site, Ft Lauderdale / Miami
2. Reef Balls for Breakwaters: Assessing the performance of Reef Balls in breakwater construction for coastal protection
 - a. Paradise Cove - Bahamas
 - b. Paradise Cove - Bahamas
 - c. St Lucie Reef Ball Breakwater - Florida
 - d. Lamlash Reef Ball Breakwater Civil Protest - Scotland
 - e. Stratford Point - Connecticut
3. Living Shoreline Reef Balls: Investigating the use of Reef Balls in living shoreline projects for habitat restoration and erosion control
 - a. Dolphin Island Reef Ball shoreline protection project - Alabama
 - b. Bird Island Alafia River - Florida
4. Freshwater Habitat: Evaluating the effectiveness of Reef Balls used in reservoirs.

- a. Reservoir - (Tennessee)
- 5. Oyster Restoration: Projects with specific objectives to provide habitat for oysters.
- 6. Living Seawall: Evaluating the habitat, species diversity, on and near to the seawall.
 - a. Palmetto Green Bridge Eco-Rap
 - b. O'Laries Eco-Rap - Sarasota
- 7. Carbon Sequestration behind breakwater reefs⁷
 - a. Carbon Sequestration in sediments
 - b. Calcium Carbonate sediments from coral reefs

Selected Site Visits:

1. The Reef Ball Project, Florida,- Offshore Reef
2. The Breakwater Reef Ball Project, Netherlands (Completed in 2012) - Breakwater
3. The Living Shoreline Project, Chesapeake Bay, USA (Completed in 2018) - Living Shoreline
4. Paradise Cove - Bahamas
5. Dolphin Island Reef Ball shoreline protection project - Alabama
6. Paradise Cove - Bahamas
7. St Lucie Reef Ball Breakwater - Florida
8. Lamlash Reef Ball Breakwater Civil Protest - Scotland
9. Reservoir - (Tennessee)
10. O'Laries Eco-Rap - Sarasota
11. Palmetto Green Bridge Eco-Rap
12. Charles H. Kirbo Memorial Reef - Florida
13. Eternal Reef Site Miami

Site Visit Objectives:

1. Conduct visual inspections of Reef Ball structures
2. Survey marine life and habitat diversity
3. Interview local stakeholders, fishermen, and community members
4. Collect water quality and sediment samples (if permitted)

Expected Outcomes:

1. A global database of Reef Ball projects, including offshore reefs, breakwaters, and living shorelines
2. An assessment of the environmental impact and efficacy of Reef Ball projects in different applications
3. An evaluation of the social and economic benefits of Reef Ball initiatives
4. Identification of challenges and limitations faced by Reef Ball projects
5. Recommendations for future improvements and best practices

Timeline:

- Literature review: 2 weeks
- Survey design and distribution: 4 weeks
- Site visits: 12 weeks (1 weeks per site)
- Data collection and analysis: 16 weeks
- Report writing and submission: 4 weeks

Significance:

This study will contribute to the understanding of artificial reef initiatives and provide valuable insights for researchers, policymakers, and practitioners involved in coastal management, marine conservation, and sustainable development. The study will help identify best practices when using Reef Balls.

References and Resources

1. Acoustics Research <https://www.nature.com/articles/srep33326>
2. Reef Ball Specifications for Comparison to Other Reef Material
 - a. BioMass <https://www.reefball.org/technicalspecs.htm>
 - b. Comparative mass
 - c. Worldwide Mapping System
https://www.google.com/maps/d/viewer?mid=1KrENaH-kJn_LCDrCbgtW_1aW-ciY-M&fbclid=IwAR2sBJEY9_dycxRSKzcgZI5QUx7OQEJZM4zS985bknCxxYVceDxsmNmmdmQk&ll=-3.81666561775622e-14%2C0&z=1
3. Design for Reef Ball site Indian River Lagoon Survey
https://www.reefball.org/album/florida/EastCoast/martincounty/indianriverlagoonproject/river_reef_design_report.pdf
4. [Acoustic Tracking of Fish Movements to Support Habitat Management - NCCOS Coastal Science Website \(noaa.gov\)](#)
5. Build a hydrophone <https://youtu.be/ouCVtEnsiR4?si=n15Dd7qJRwokqNno> COSEE TEK: Resources
6. Reefs & Sediment [Scientists provide first detailed estimates of how much sediment is supplied to coral islands from the reef system \(msn.com\)](#) ..
7. Meta-Study of Carbonate Sediment Delivery Rates to Indo-Pacific Coral Reef Islands, Baptiste Ainési, Gerd Masselink, Paul Kench, 24 February 2024
- 8.

Sponsors

1. Anonymous - donation for project surveys to the Reef Ball Foundation \
2. Reef Innovations, <https://reefinnovations.com/>
3. Reef Ball Foundation, <https://www.reefball.org/>
4. Deeper, UAB sonar survey mapping, and bottom conditions
<https://deepersonar.com/en-us/pages/about-deeper>
5. ? DolphinEar Hydrophones, <https://dolphinearglobal.com/>
6. ? Lidar Scanner for 3d images
<https://voyis.com/quote-thank-you/?submissionGuid=323bf7a3-0fed-4851-8ab1-788ca9eda68d>
- 7.
- 8.

Budget

1. Hourly for researcher \$35/hr \$1400/week 38 weeks = \$53,200
(AI cost / projection)
Researcher with a graduate degree in a relevant field (e.g., marine biology, environmental science), and considering the project's scope and complexity, here are some estimated hourly cost ranges:
 - Researcher hourly cost: \$75-\$150 per hour
 - Research Assistant hourly cost: \$40-\$75 per hour
 - Equipment and software costs: \$25-\$50 per hour (amortized over the project duration)
 - Overheads (institutional, administrative, etc.): \$25-\$50 per hour*Based on these estimates, the total hourly cost for this research project could range from \$165 to \$325 per hour.*
2. Travel mileage \$.67/mile
3. Per diem \$167
4. Dive Boat
5. Kayak Rental \$40/half day
6. Flights

Trips

1. Indian Riverside Park on Reef Balls,
 - Martin County proposes to use Reefball artificial reef units as described in the accompanying reports. All construction will take place in water depth of 8 feet or more. A minimum clearance of 6 feet between the water surface and the artificial reef units will be maintained in all cases.
<https://www.artificialreefs.org/Articles/martincounty3262002.htm>
2. Causeway site on Indian River Lagoon, (link above)
 - Kayak

3. Florida Power, St Lucie County Reef Ball Breakwater
 - Kayak, snorkel, dive

Notes: Items to follow up research

1. Mississippi Comparison of Reef Balls to Limestone Piramids
<https://dmr.ms.gov/wp-content/uploads/2020/02/Coastal-Markers-Win-09.pdf>
2. Define the differences making a reef porous
3. Define the differences making a reef complex

Teach the Teacher

STEM STEAM

Obviously it will take many people to monitor and continue the monitoring and design of Reef Ball sites.

1. Summer Teacher inservice
 - a. learning how to build wave height measuring devices
 - b. Learn how to build a hydrophone
 - c. Building testing devices for salinity and turbidity
 - d. Measuring long shore currents
2. Local leader training
3. Site surveys
 - a. Fish count
 - b. Use of sonar
 - c. Photography
 - d. 3D images
4. How to build a Reef Ball

School Year - Series for students of Marine Biology Oceanography.