DISMANTLING SHIPS TO REVITALIZE CORAL REEFS WITH ARTIFICIAL REEFS

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ABSTRACT

Australia's Great Barrier Reef is an immense swath of coral made up of about 2,900 reefs, 600 mainland islands, and 300 coral atolls. It stretches for 2,200 kilometers, ranging in width from 30 km to 740 km. This natural wonder is visible from space and is the largest structure in the world made solely by living organisms. The corals that form this barrier are essential for marine biodiversity and were elected as a World Heritage Site in 1981. However, the Great Barrier Reef faces serious challenges, including bleaching caused by rising temperatures and the impacts of climate change. One strategy for revitalizing reefs is the use of sunken old ships to create artificial reefs. This approach not only conserves the marine environment, but also promotes scientific research and the production of bioproducts. Artificial ship reefs provide substrates for the marine community and simulate environments similar to natural reefs, contributing to the protection and revitalization of this important barrier reef. It is essential to develop strategies to preserve the oceans and mitigate the impacts of human activities, ensuring the survival of this ecosystem and protecting it as a treasure.

KEYWORDS

Revitalization of Australia's Barrier Reef, Artificial Ship Reefs, Bioproducts.

1. INTRODUCTION

The creation of artificial reefs with ships provides an environmentally friendly destination, extending the useful life of vessels that can no longer sail. Dismantled ship structures, when introduced into shallow tropical waters, within 20°C isotherms and between latitudes 30° S and 30° N, attract species and create a habitat conducive to the development of marine biodiversity (Ormond et al., as cited in CPA Cardoso, 2024). Among the anthropogenic factors that cause the degradation of the seabed, illegal trawling stands out. The creation of artificial reefs with ships is a solution to mitigate these degraded areas, marine organisms grow on and around the dismantled structure, rebuilding life in this habitat (CPA Cardoso, 2024). In addition, the dismantling of ships to form artificial reefs enables the creation of natural reserves, promotes the sustainable use of environmental resources, and represents a viable alternative to boost the development of scientific research (CPA Cardoso, 2024). Australia's Great Barrier Reef is a reef formation of extreme importance for the health of the oceans. However, the impacts of bleaching caused by rising global temperatures are alarming. To preserve these ecosystems, it is crucial to reduce greenhouse gas (CO_2) emissions and limit global warming to 1.5°C. Otherwise, coral reefs may suffer irreversible damage, taking decades or even centuries to recover (Soares, as cited by CPA Cardoso, 2024). The solution to revitalizing coral reef ecosystems is to create artificial reefs with abandoned or disused ships. This approach aims not only to restore habitats, but also to promote biodiversity, direct the country towards the growth of the bioeconomy and the sustainable use of marine resources (Brazil, as cited in CPA Cardoso, 2024). In the ecosystems of artificial ship reefs, some species of marine sponge produce substances with pharmaceutical potential. In addition, other marine organisms have bioactive compounds, being

sources to produce medicines, such as antibiotics and antitumors (Nogueira, as cited in CPA Cardoso, 2024). CPA Cardoso (2024) highlights that coral reefs are true treasures due to their socioeconomic and ecological importance. In addition to enabling the discovery of new enzymes, calcareous algae that grow on artificial reef structures by ship allow the extraction of antifouling substances for bioproducts without biocide. Revitalizing degraded areas with artificial ship reefs is essential to advance scientific research and the development of bioproducts. These substances can be applied in various areas of industry, including food products, cosmetics, and even in the textile industry (Nogueira, as cited in CPA Cardoso, 2024). Protecting the oceans is crucial for maintaining life in the world, since biodiversity represents the largest living structure on the planet. These ecosystems are threatened by climate change and can be lost if we take action to reverse this situation (CPA Cardoso, 2024).

2. GENERAL OBJECTIVE

Dismantle old ships to revitalise Australia's Great Barrier Reef with artificial reefs.

2.1. Specific Objetives

- Mitigate the environmental impacts caused by coral bleaching; • Revitalize marine ecosystems with artificial reefs near the coral reefs of Australia's N/NE Coast; • Give an environmentally correct destination to ships that can no longer sail; • Encourage the practice of sustainable diving; • Instigate the production of bioproducts;
- Foster the development of scientific research.

3. SHIP ARTITICIAL REEFS

The artificial reefs of dismantled ships are implanted in the marine environment with the aim of revitalizing biodiversity lost due to anthropogenic actions and global warming. These structures provide attachment sites for marine organisms, such as corals, algae, and sponges (White et al, as cited by CPA Cardoso, 2024). The creation of artificial reefs provides shelter for various marine organisms and promotes the development of activities such as fishing, sustainable diving, and planning of a structure for surfing (Mead & Black, as cited by CPA Cardoso, 2024). According to Whitmarsh et al. (2008), artificial reefs provide habitats for diverse marine species, contributing to the health of the oceans and the development of marine biodiversity. Thus, by sinking decommissioned ships to create artificial reefs, environmental, social and economic benefits are obtained. These marine areas transformed into underwater sanctuary favor the flourishing of marine life and the production of biomass, helping to mitigate the impacts caused by the greenhouse effect (CPA Cardoso, 2024).

> “Shipwreck diving is fascinating... The hull of the ship emerges covered in colorful sponges and vibrant corals. Fish swim around the portholes, as if exploring the caves and bulkheads, the algae gently ripple creating an ethereal backdrop. Corals, once small fragments, now cling to metal surfaces, forming underwater gardens, where schools of fish circulate finding shelter in empty compartments." (CPA Cardoso,
> 2024).

CPA Cardoso (2024) points out that places where there are shipwrecks become attractive environments for diving, providing a magical setting with indescribable sensations. These giants of the seas become an oasis of marine biodiversity, and the seabed, with its shipwrecks, holds

endless stories and becomes a scene of enchantment in the depths of the ocean. For the author CPA (2024), decommissioned ships, such as tugboats, can contribute to marine life since they are no longer useful in navigation. With a commercial lifespan of around 30 years, when they become reefs, sunken ships can be used to preserve the oceans and enrich marine ecosystems.

> "Offering a new habitat for marine species, especially in areas with sandy bottoms where natural fixation is difficult. Artificial ship reefs are more attractive to fish than natural reefs, increasing marine biodiversity." (Arena et al., as cited by CPA Cardoso, 2024).

The creation of artificial reefs through the dismantling of ships contributes to revitalizing marine biodiversity, promoting the health of the oceans, and mitigating the impacts of climate change. This ecological strategy is ecologically sustainable, economically viable and of great value for preserving the marine environment, in addition to boosting scientific research related to bioproducts.

3.1. Revitalizing the Barrier Reefs

Corals are vital ecosystems for the maintenance of life in the world, but they are threatened by ocean warming, a result of climate change (Cardoso, CPA 2024). Ocean acidification, caused by the greenhouse effect and CO2 absorption, makes coral reef structures more fragile and susceptible. To preserve these ecosystems, it is crucial to reduce CO2 emissions from climate change, as coral reefs play a key role in fixing atmospheric carbon, the chemical balance of the oceans, and the global carbon cycle (Villaça, 2009). Rising ocean temperatures are causing mass coral bleaching. When subjected to heat stress, corals expel their zooxanthellae, resulting in a white appearance and making them vulnerable to disease. Zooxanthellae are dinoflagellate symbionts that provide 90% of the nutritional needs of corals and depend on luminosity to perform photosynthesis and contribute to reef growth (Barros, 2019). Coral loss has devastating consequences for biodiversity, as reefs also act as a physical barrier against wave action, preventing further coastal sediment loading, providing sediment retention (Villaça, 2009, p 399). According to Bertagnolli et al. (2014), coral reefs face several harmful factors from anthropogenic actions. These factors include the use of agricultural fertilizers and dumping sewage into the sea. The eutrophication of algae is a direct consequence of excess nitrogen (N) and phosphorus (P) in the oceans. These nutrients stimulate algal blooms, choking reefs and affecting the life of marine ecosystems. Biofouling, a vital process in reef structures and the growth of organisms such as algae, bacteria and other vertebrates, can also be affected. The biofouling process creates habitats for fish, crustaceans and various organisms. Organic matter plays a crucial role in reef health, and biological sediment-generating organisms contribute to the maintenance of marine life (Villaça, 2009). Reefs, according to Villaça (2009), are formed by building organisms, such as calcareous algae (Rhodophyta), which contribute to bioconstruction by secreting calcium carbonate. This substance strengthens the reef and serves as a source of bioproducts. The main builder of coral reefs are the sessile beings of the stony corals (Hexacorallia), which form calcareous skeletons from calcium absorbed from seawater, forming the basis for the reef. According to FUNIBER (2024), the excess of nutrients, such as nitrogen (N) and phosphorus (P), stimulates the growth of these organisms, resulting in the cover of corals by high scale. This reduces the amount of sunlight that reaches the coral tissues, making it difficult for corals to feed. In addition, excess (N) and (P) cause coral bleaching, alter the chemical balance of the water, and affect the calcification of coral structures. In short, the relationship between organic matter, sediments, and algae on reefs is delicate and crucial for the survival of these marine ecosystems. Protecting reefs from excess nitrogen (N) and phosphorus

(P) is critical to the health of the oceans and the well-being of millions of people who depend on these resources for survival.

3.2. Chemistry in the Oceans

According to FUNIBER (2024), in the oceans we find all the gases in the atmosphere dissolved. The most relevant are nitrogen (N), oxygen (O) and carbon dioxide (CO_2). Each gas has specific solubility characteristics. Any change in this cycle can have catastrophic proportions for the environment. CO_2 passes from the sea to the atmosphere and vice versa, making it a dynamic process. When the flow of gas (CO_2) in both directions is equal, the environment is in equilibrium, which can be altered by variations in atmospheric pressure. The greenhouse effect is part of this balance, regulating the distribution of heat around the planet, influencing weather patterns and ocean currents. The balance between gases (N, O, CO_2) is fundamental for life in different regions of the world. Therefore, the excess of one of the gases in the atmosphere (CO_2) deregulates the biogeochemical cycle, increasing the temperature on the planet. This worsening is the result of anthropogenic actions that have a significant impact on the environment with catastrophic proportions. We must seek sustainable solutions to mitigate the impacts of this delicate balance, as the interaction between gases (N, O, CO_2) and the oceans is fundamental for the respiration of marine fauna, human beings and for the maintenance of environmental balance.

3.3. Nitrogen in the Oceans

Although nitrogen itself is not toxic, it can cause asphyxiation in environments with low oxygen (O) concentration, affecting the ecosystem and leading to the extinction of biodiversity. Some strategies are crucial to minimize the impacts of nitrogen (N) in the oceans:

- Efficient use of fertilizers;
- Planting cover crops, such as legumes;
- Proper waste treatment, manage agricultural and urban waste;
- Reduction of nitrogen oxide (NOx) emissions;
- Recovery of degraded ecosystems, artificial reefs from ships.

4. SCIENTIFIC RESEARCH METHOD

The research method developed was based on the bibliographic approach, involving search, selection and analysis of written sources, such as books, scientific articles, documents and teaching materials from the 2024 Master's Degree in Marine Science and Technology - FUNIBER. The objective of this method was to obtain information on the environmental impacts caused by anthropogenic actions and to develop strategies capable of mitigating the increase in sea surface temperature (SST).

4.1. Method for Building Artificial Reefs from Ships

Coral reefs develop in tropical surface waters, comprised in isotherms of 20° C, between latitudes 30° S and 30° N. In these geographic coordinates, the conditions are ideal to tolerate temperatures and not affect the biological cycle. Ideal temperatures range between 23°C and 25°C (SST), although some corals can tolerate up to 36°C (SST), none survive in temperatures below 18°C (SST). It is important to note that coral reefs cannot survive in areas with incidences of upwellings. This explains the absence of coral reefs on the western coast of South America and much of Africa. In these areas, strong sea currents operate, such as the Humboldt Current

(Peru) and the Benguela Current (Africa). The deeper waters when they rise are called upwellings, they are cold and very rich in nutrients. The large contribution of suspended material in areas with upwelling incidences causes turbidity of the waters, which prevents the development of coral reefs. Another determining factor for corals is salinity, which should be between 32% and 36%. Sedimentation also plays a crucial role. When elevated, it increases the turbidity of the water, reducing the penetration of light necessary for the photosynthesis of zooxanthellae, which are responsible for the bleaching of coral reefs.

4.2. Building Reefs Artiticial Ship

According to CAP Cardoso (2024), Specialist in Marine Sciences, it is necessary to know the environment in which the ship must be anchored, it is necessary to perform calculations to determine the center of gravity, inclination and speed for the ship to sink safely. To choose the best location, it is essential to consider the following factors:

- The place must have adequate depth allowing the vessel to be submerged;
- It is important that the site is accessible for divers;
- The reef must be at a safe distance from the shore;
- Ships must be placed in areas with favorable conditions for marine life;
- The conditions of currents, waves and visibility must be analyzed;
- Locations should be chosen where marine biodiversity can benefit from the artificial reef;
- Areas with little marine life may not be ideal;
- Obtain necessary permits to sink the vessel;
- Consider the environmental impact of sinking, such as the removal of polluting materials and proper preparation of the vessel.

Finally, each location has its particularities, and a thorough evaluation is essential for the success of the revitalization project with artificial coral reefs.

4.3. Results

The technique of artificially creating reefs with ships can boost underwater tourism, generating revenue for local communities and encouraging sustainable fishing. Artificial reefs play an important role in marine conservation, and it is necessary to manage them sustainably to protect biodiversity and marine ecosystems. One solution to mitigate environmental impacts is the controlled sinking of ships in designated areas to create artificial reefs, these structures provide the revitalization of the environment, attracting species and transforming the habitat for a vast marine biodiversity. In short, coral revitalization in Australia is crucial for several reasons:

- Coral reefs are home to about 25% of all marine life, including 65% of fish;
- About 1/4 of all fish species depend on corals for survival;
- It is necessary to recover the areas affected by coral bleaching;
- Corals provide food, medicine and bioresources;
- They support the fishing and tourism industry;
- Coral reefs act as natural barriers against erosion and storms;
- Coral islands in Australia, such as the Coral Sea Islands, extend the country's jurisdiction by more than one million square kilometers. The disappearance of these islands also has geopolitical implications.

Therefore, investing in coral revitalization, with the creation of artificial ship reefs, is essential to preserve these marine ecosystems and ensure a sustainable future. Finally, these dismantled structures will provide the revitalization of marine biodiversity, coastal protection, scientific research, and sustainable use of marine resources. In summary, creating coral reefs with ships offers economic and scientific benefits.

5. CONCLUSION

Coral reefs constitute one of the most productively biodiverse ecosystems on the planet. They are essential for maintaining the life cycle on Earth and for the economic development of the country. It is extremely important, for the regularization of the world's climate, to revitalize the marine environment, reduce the effects of CO_2 and develop sustainable practices to mitigate the environmental impacts of global warming. Despite this, few measures have been developed to mitigate the environmental impacts on the coast of northeastern Brazil, which has also been affected by reef bleaching. In 2020, the Federal Government of Brazil proposed the establishment of artificial reefs on the Brazilian coast, in environmental protection areas. IBAMA NORMATIVE INSTRUCTION NO. 22, OF JULY 10, 2009, provides for environmental licensing for the installation of artificial reefs. It should be noted that laws in Brazil are slow, making it difficult to develop scientific projects and research. Thus, the research developed on Artificial Reef: National Treasure, cannot be accepted as an application for the Sovereignty for Science Award, as only one project can be presented. I also highlight the disappointment with the MB OM, who did not show desire to read the research developed, demonstrating a lack of empathy. Given the above, it is up to scientists and researchers in Brazil to try to contribute to the restoration of life in the oceans in partnership with other countries. Without further ado, as a Specialist in Marine Sciences and Master's student in Marine Science and Technology, I am available to contribute to the development of projects that can restore coral structures and protect the oceans.

5.1. Shipwreck Enchanted Reef

From bow to stern, at the bottom of the sea, all its wrecks like lindeira, are storytellers in each hull of steel or wood. The shipwrecks rest imposingly on the bottom of the endless sea, where the deck turns into a garden. Covered with corals, sponges and algae become Sunday docks. The seabed with sunken reefs is a never-ending voracious spectacle, assimilated to the narwhal ivory tusks. In the blue of the ocean, lives a sovereign world. Fish dance in harmony, each being has its symphony. In an extraordinary ballet, shoals paint the scenery. As musical notes we find refugee reef fish in the portholes and ancestral holds. The old ship that braved the rough sea, is now a portal to a monumental underwater world. Even the mast revitalizes the ocean floor with organic bioproduct. Once fearless navigators, they now harbor secrets and endless mysteries. The fearless shipwrecked enchants with praise. His infinite majesty contemplates life as painite. Each shipwreck is a chapter of the past, which the wind sowed at will, becoming a witness to the storm. Under filtered light, the dead works come to life, transforming themselves into scenarios of color images. The rusty hull and the rudder worn out by the shipwrecked time now tell stories, eternalizing glories. Their names whispered by the chains become shelter, as guardians of the abyss is pure exhibition. The shipwrecks, like artificial reefs, remind us that the sea is an endless graveyard, creating an indescribably beautiful scenery. Forgotten sailors are more than sunk, stranded or abandoned metal and wood. They are treasures, submerged poems, like the organic beauty of the entire ocean depth. The sea creatures, the secrets of the waves, and the sense of belonging to the ocean connect us deeply with our nature. We come from the sea, salt water is our home. The waves whisper secrets that are our plots. Our roots plunged into the depths, fullness and fortitude emerge. In navigated art we find our true home. The oceans

present us with pearls of wisdom, in it we find the essence of full realization with mastery. We are part of this vast ocean forming a sovereign people, the sea sustains, the ocean feeds us.

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