AN ASSESSMENT OF TOURISM EARNINGS FROM JAMAICA'S CORAL REEFS TOWARDS QUANTIFYING THEIR BLUE ECONOMY POTENTIAL

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

AN ASSESSMENT OF TOURISM EARNINGS FROM JAMAICA'S CORAL REEFS TOWARDS QUANTIFYING THEIR BLUE ECONOMY POTENTIAL

Tonya King

The coral reef is very important to many Small Island Developing States(SIDS). It is made up of abiotic and biotic components, that protect beaches and sustain livelihoods. This paper focuses on other benefits of the coral reef through the blue economy. The Blue Economy represents a vision for sustainable ocean development that promotes and seeks to balance economic growth, social inclusion and livelihood, and the environmental sustainability of oceans and coastal areas(World Bank United Nations Department of Social Affairs,2017) Through the blue economy lives are enhanced either by the experiences it provides through snorkeling, diving, exciting glass bottom boat tours or by the revenue generated by these activities.

Through this paper an assessment of the true potential of the economic value of select coral reefs with respect to the blue economy was looked at. Several active scuba diving operations across Jamaica were interviewedto complete this assessment factors such as location of dive shops, the number of man dives, size of the reef as well as the income generated through scuba diving and snorkeling activities were looked at. In any given year in Jamaica, the coral reefs account for at least 27 % of Jamaica's Gross Domestic Product(GDP).

This data collected revealed that the dive shop operators are a small group of persons and this prevented appropriate statistical analysis.The North Coast

generates more income than the South Coast. On a daily basis the North Coast generates an estimated income of $210717.56USD while the South Coast generates an estimated income of $6075.00USD.These figures show avast difference between the income generated by the North and the South Coast respectively. The amount of capital generated in the North more than triples that generated in the South.

This paper also realized that the information gathered could be used as a basis for further research which could then be used to fully assess the blue economy potential of the coral reefs around Jamaica. It also provides a guide for the areas in Jamaica where the coral reefs need more protection or greater enforcement of legislation.

Keywords: Blue Economy; Coral Reefs; Scuba Diving; Jamaica

1. INTRODUCTION

Jamaica is an island nation with a beautiful geography that includes mountains on the interior and beaches with coral reefs on the exterior. Numerous all-inclusive resorts in this nation may be located on the North Coast in Montego Bay and Negril, the former for its British colonial architecture and the latter for its diving and snorkeling spots.

The objective of this study was to determine if there is a relationship between dive shop location, reef size and the income generated by the dive shop operators around the country. This information will then be compiled to give an assessment of the blue economy potential of the Coral Reef's around Jamaica.

To fully understand the contribution of the Coral Reef to the Blue Economy, this paper uses available data from The National Planning and Environmental Agency(NEPA), Allen's Coral Atlas to estimate the size of the reef systems around the island. To determine the income generated by dive shop operators; questionnaires were used.

The paper comprises of a literature review, site description, methodology, results, discussion and a conclusion which all will be used to answer the outlined research question.

2.LITERATURE REVIEW

Submerged beneath the oceans waters lies one of the oldest complex natural communities known to man, the coral reef. Coral reefs are large underwater structures composed of the skeletons of colonial marine invertebrates known as coral. There are two types of coral found in the oceans; soft coral and hard coral. Soft corals are flexible organisms that often resemble plants and trees and do not form reefs, while corals that build reefs are called 'hard' or 'reef- building' corals. Hard corals remove calcium carbonate from the saltwater which produces a tough exoskeleton that shields their soft, sac-like bodies from the elements. (Coral Reef Alliance 2023) Each individual coral is referred to as a polyp, each polyp lives on the calcium carbonate secretions of their ancestors and over time a massive coral reef structure is established.

Corals are not the only organisms which make up the coral reefs, various types of algae, sponges, seaweed, sediment and mollusk can be found there. Coral reefs' growth is further enhanced by dead organisms as their remains serve as foundations for new corals. Corals have a symbiotic relationship with zooxanthellae; photosynthetic organisms that live inside the coral polyps and produce energy for themselves and the polyps.

These magnificent underwater structures are located in clear, shallow waters where sea surface temperatures range from 20-36^{o}C (Woodward 2022). More than 90% of the world's coral reefs occur throughout tropical and subtropical oceans in the Indo-Pacific and Atlantic, normally between the Tropic of Capricorn and Tropic of Cancer. (Florida Museum 2017)

Coral reefs are swarming with life, more species are found in coral reefs than in any other marine habitat, and they are second only to rainforests in terms of biodiversity. A large variety of creatures rely on these large calcareous structures

for survival, yet these important habitats are one of the most endangered in the world. The threats to coral reef ecosystems come in a variety of forms; pollution, unsustainable fishing practices and climate change. (US Department of Commerce n.d.)

Scientists have concluded that the degradation of the coral reefs over the years have been due to both anthropogenic and human factors. The Caribbean alone has lost 80% of their coral cover.

2.1 Importance of Coral Reefs

Tropical coral reef ecosystems around the world offer a variety of human advantages, both commercial and noncommercial. Many of these advantages or ecosystem services have a high economic value and are quite significant to local and global economies. Coral reefs serve as habitats for fish with high commercial value and draw people to the coast for recreational activities.Additionally, they diminish the effect of waves on the shore, which slows erosion, stops the loss of beaches, and lessens storm damage. Some of these services have a direct impact on tourism.

Provisioning services such as fisheries play an important role in the tourism experience a country has to offer. Many tourists are losing interest in the traditional sun, sea and sand packages and are more interested in experiencing something more authentic. Fishing activities as well as buying freshly caught fish can increase the willingness for tourists to visit a coastal area.(Budzich-Tabor, Burch, and Gomes da Silva 2014) Fisheries also provide food for restaurants which are patronized by both locals and tourists alike. Knowing that fresh hot meals are available can also increase the likelihood of tourists visiting the area. Some tourists also like the idea of mingling with locals and immersing themselves in the culture.

Cultural services are not limited to recreation, there is also research and education. Coral reefs are vast storehouses of genetic resources with significant

medical potential. Due to their solitary nature they have developed chemical defenses against predators. These substances are being studied and have the potential to be important sources in medical treatment and supplements. This recognition from the medical community results in research tourism. (Scuba.com 2021)

Regulating services like shoreline protection and erosion regulation play an important role in the tourism product a country is able to produce and market. In the case of the shoreline protection provided by coral reefs, the reef's presence attenuates the energy contained in waves as they approach the shore, and this attenuation reduces the extent of wave-induced shoreline erosion, damage to buildings and property, and danger to people and livestock during storms. (Principle et al. 2012) The tourism benefits from shoreline protection would be calm bay-like bathing areas, beachfront hotels and sandy/volcanic beaches.

Support services include habitat and biodiversity. Tourists travel to see the many species found in these gardens of the sea. Fish such as the parrotfish are especially important to the coral reef ecosystem and tourism. Parrotfish feed on the coral, break it down and then excrete the popular white sand that tourists flock to. A single parrotfish can produce 840 pounds of sand each year. (Coral Reef Alliance 2023)

Many academics throughout the world have sought to value the products and services produced by the coral reef system. As a result, it is estimated that coral reefs around the world provide a total net benefit each year is US29.8 billion. Tourism and recreation account for US9.6 billion, coastal protection US9.0 billion, fisheries US5.7 billion and biodiversity US5.5 billion (Cesar et al.2003)
However, the values vary greatly at the regional level, mostly because of the different types and sizes of coral reef systems as well as the beneficiaries' underlying socioeconomic circumstances. With that being said, the annual net benefit provided by coral reefs in terms of fisheries was estimated at about US300 million (Burke and Maiden,2004).

2.2Tourism and Jamaica

Tourism is a social, cultural and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes.

The Caribbean economy depends heavily on tourism. Each year, thousands of tourists travel to these islands. Particularly in Jamaica, the tourism sector has long been one of the fastest-growing sectors in the nation and is the largest source of foreign cash, GDP, and jobs. A total of 175 000 Jamaicans are employed directly by the tourism industry, and another 354,000 are employed indirectly. It powers 21.0 percent of utilities, agriculture, and fisheries, 15.0 percent of manufacturing, 10.0 percent of banking and finance, and 15.0 percent of construction. Over the previous 30 years, the tourist industry has expanded by 36.0% overall, above the 10.0% expansion in the overall economy.(Waller 2022)

Generally speaking, Jamaica's tourism sector has established itself as a solid pillar of the country's economic growth, mostly as a result of the crucial economic connections it has enabled within the larger macroeconomic framework. Already, a number of sectors are included in the tourism value chain. Its promotion calls for the development of fundamental infrastructure services, such as energy, telecommunications, and environmental services, agriculture, manufacturing, and other support services, as well as the building and operation of hotels, restaurants, and other tourism-related facilities through backward linkages.In addition, a variety of forward connections with industries that provide tourism-related services have been made. These include banking, telecommunications, retail, leisure, the arts, hospitality, personal, security, and health services. In addition, the expansion of the tourist industry has necessitated the construction of additional tourism-related infrastructure, such as airports, safe roads, ports, hospitals, and banks. These facilities are crucial for facilitating access to high-quality services and fostering competition among travel destinations. (Waller 2022)

2.3 The Blue Economy

The sea has always played a significant role in the economic life of every culture throughout history as a source of food, a mode of transportation, and a venue for trade.The phrase "Blue Economy(BE)" has gained popularity in recent years as a word that refers to maritime resources and developed economies in the oceans. In the perspective of the sustainable development goals, it is also viewed as a means of achieving sustainable ocean development.

The concept of the Blue Economy has a long history. According to Voyer et al. (2018) the origins of the BE can be traced as far back as 1987 where it appeared in the Bruntland Report as a manifestation of sustainable development thinking where the environment is exploited for economic gain but also protected at the same time.(Midlen 2021) The BE is similar to the green economy in the sense that it emphasizes market based instruments to address environmental threats. (Arsel and Büscher 2012; Castree 2010a, b; Corson et al. 2013).

The phrase was later mentioned again in 2009 at the United States Senate Committee on Commerce, Science, and Transportation's congress due to its importance in the US economy. There are great prospects for new blue employment in renewable energy, great commercial opportunities while tackling concerns about climate change. Later in the same year, the International Symposium on Blue Economy Initiative for Green Growth in Korea took place, thus allowing this concept to gain further traction.(Martínez-Vázquez, Milán-García, and de Pablo Valenciano 2021)

After the Korean symposium it was introduced at a United Nations(UN) summit in 2012. It was at this summit that the UN for the first time discussed the "blue economy" and stressed sustainable management, arguing that healthy marine ecosystems are more productive. This argument was backed by scientific findings that show the earth’s resources are limited and greenhouse gases are damaging the planet.(Martínez-Vázquez, Milán-García, and de Pablo Valenciano 2021)

The UN reiterates that the Blue Economy should"promote social participation, economic progress, and the enhancement or maintenance of livelihoods while preserving the environmental sustainability of the oceans and coastal areas." (UNRIC,2022)

The blue economy has a variety of components, such as long-standing ocean sectors like fishing, tourism, and maritime transportation, as well as new and developing activities like offshore renewable energy, aquaculture, seabed extraction, marine biotechnology, and bioprospecting. These components can be grouped into five broad categories; harvesting and trade of marine living resources, extraction and use of marine non-living resources, use of renewable non-exhaustible natural forces (wind, tidal, wave energy), commerce and trade in and around oceans and indirect contribution to economic activities and environments.(The World Bank 2017)

2.4 Unexplored Blue Economy

Almost three-quarters of the earth's surface is covered by oceans, yet the world is far from capturing the benefits it can offer for sustainable development.(Patterson et al. 2022)

Small island developing states like Jamaica have a greater ability to utilize their marine resources for sustainable growth than they realize and this is due to a lack of proper understanding, training and education. Jamaica is an island surrounded by the Caribbean Sea and just like all other SIDS they occupy a small land mass but their exclusive economic zone is much bigger. In the case of Jamaica, the island is approximately 10,000sq.km, with a coastline of approximately 1022km, but its Exclusive Economic Zone (EEZ) is way bigger than those two combined.(Caribbean Maritime University- Centre for Blue Economy & Innovation 2022)

3. OBJECTIVES & HYPOTHESIS

3.1 Objectives

- To determine the extent (length and width) of selected reefs used for scuba diving around Jamaica
- To determine approximate income generated by selected reef sites
- To determine approximate number of visitors to the scuba diving reef sites
- To assess any relationship between reef extent, position (north vs. west vs. south coast) and earnings
- Compare income generated for reef sites during high & low tourist seasons

3.2 Hypothesis

North Coast Coral Reef sites used for scuba diving generate more income than South Coast sites.

4. STUDY SITES

Six dive locations on the North Coast are represented by yellow circles while dive locations on the South Coast are represented by red circles.

4.1 The North Coast of Jamaica

Selected North Coast dive locations are outlined in the Google image below. The locations of interest are Negril,Montego Bay, Discovery Bay, Ocho Rios, Oracabessa and Port Antonio(*see figure 1*).

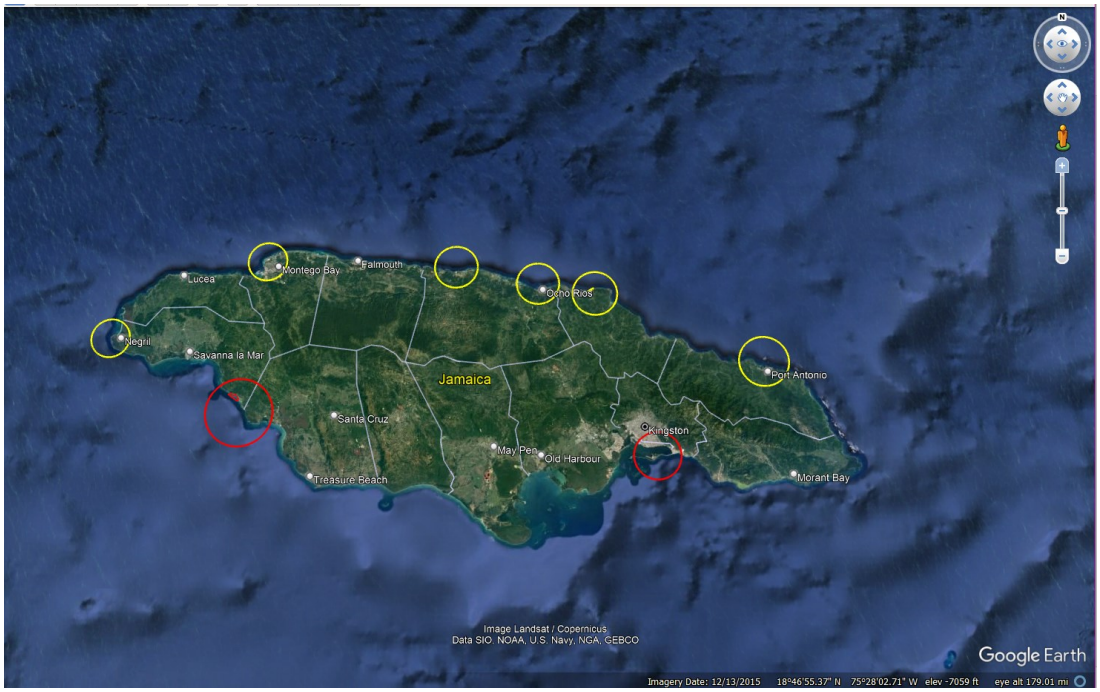

Figure 1 – Eight dive locations where respondents were located.

Negril

A marine protected area was established at the westernmost point of Jamaica, the Negril Marine Park (NMP), in 1998. Within this protected are 160 km^2 of coral reefs, seagrass beds, mangroves, beaches, and cliffs. The NMP's goal is to safeguard the health and integrity of the natural marine and coastal resources while promoting sustainable economic and social development in the Negril Environmental Protection Area. Swimming, non-motorized craft, motorized craft, diving, replenishment, fishing, anchorage, and no fly are the eight zones that make up the NMP(Pena et al. 2007).(*See Figure 2)*

Within the NMP dive locations are fifteen to twenty minutes' (by boat) from the shore and are located off Negril's main 7-mile beach. The depths of these places range from 30 to 130 feet. The names; Throne Room, The Caves, Kingfish Point, Middle Shoal Reef, Gallery, Arches, Booby Cay Island, Shallow Plane, Sands Club, Surprise Reef, Fish Pond, Shark's Reef, Frenchman Hole, Tug Boat, Deep Plane, Chinese Reef, and Middle Shoal Reef have been given to some of these sites, based on their features.

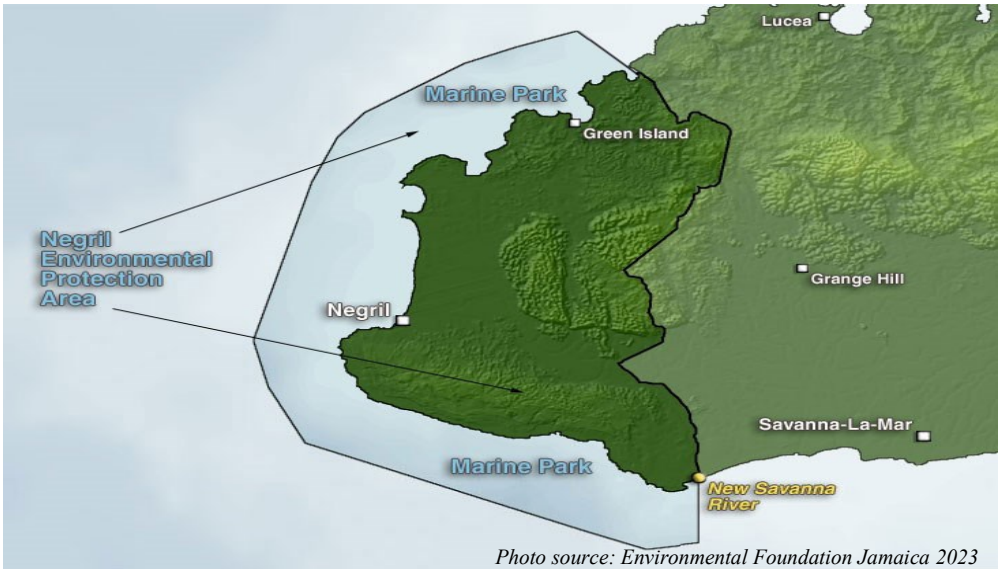

Photo source: Environmental Foundation Jamaica 2023

Figure 2 - Negril Marine Park Boundary

Montego Bay

The Bogue Island Lagoon Special Fishery Conservation Area, established in 1979 (Bogue Lagoon), and the Airport Point Special Fishery Conservation Area (Montego Bay Point), established in 2009, are the two fish sanctuaries that make up Montego Bay Marine Park, which was Jamaica's first designated Marine Protected Area (MPA). These regions, which cover more than 15 km^2 of mixed-use coastal habitat, enjoy extensive legal protection that limits permissible use(Montego Bay Marine Park n.d.).

This park extends to the Seawindreef in the southwest from the seaward boundary, which is indicated by Sandy Reef(*See Figure 3)*. The reef system is around seven kilometers long and 10 to 20 minutes away from the coast.

The park has 11 dive sites, with depths ranging from 20 to 90 feet. They are named, Rose Hall Reef, The Spanish Anchor, Widow-Cave, maker's Sergeant Major, Airport Reef, Sting Ray City, Basket Reef, The Arch, The Wreck, Chub Reef, and The Point, based on their features or proximity to landmarks(ScubaDiveJamaica 2023).

Photo source: Environmental Foundation Jamaica 2023

Figure 3 - Montego Bay Marine Park Boundary

Ocho Rios

In Ocho Rios, a small section was designated as a protected area in 1966; by November 1999, the area had been enlarged.This 133.19 km2 area is known as the Ocho Rios Marine Park Protected Area.

The White River Fish Sanctuary is located just offshore of Ocho Rios. The sanctuary, which extends 150 hectares to the west and east of White River, was gazetted as a marine protected area in 2017. Within three to twenty minutes of the coast in Ocho Rios, these two zones cover the ten to fifteen diving sites.

Some of the dive sites on this list include Jacks Hall, Top of the Mountain, Sandals Reef, Maffessanti Reef, Fish Reef, Middle Reef, Middle East, Ship Wreck (The Catherine), Ocho Rios Wall, Barracuda Reef, Jamaica Wall, Dickies Reef, Dunn, Devils Reef, and Dunn's Deep.(*See Figure 4)*

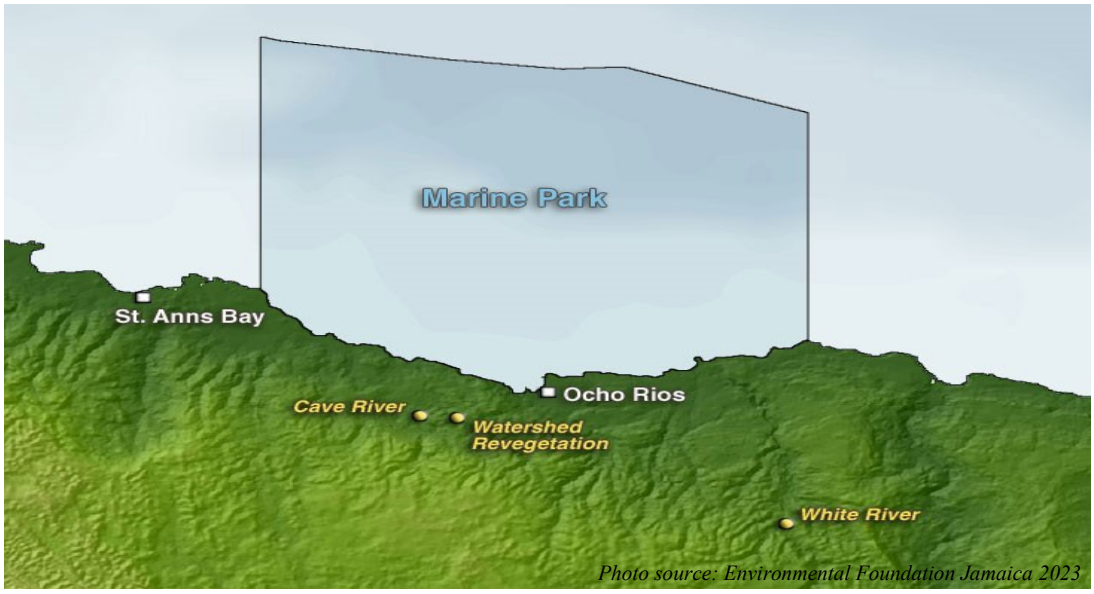

Figure 4 - Ocho Rios Marine Protected Area Boundary

Oracabessa

In 2010, the Oracabessa Bay Fish Sanctuary was created. The cliffs that form the northern limit of the Oracabessa Bay Fish Sanctuary start from 60 feet and plummet down to nearly 150 feet, in close proximity to the edge of the Cayman through. (*See Figure 5)*Since its founding, tens of thousands of new corals have been planted, and marine turtles have also been reintroduced. (Oracabessa, n.d.)The protected area, which is about 15 to 20 minutes' by boat from James Bond Beach's shore, contains various dive locations. These locations are names; Wreck Reef, Commander Reef, Nursery, GE Channel, Concrete Jungle, and Golden Clouds. Due to its size and proximity to the Cayman Trough, Golden Clouds is one of the most popular reefs in the Oracabessa Bay region.

Figure 5 - Oracabessa Bay Fish Sanctuary Boundary

Discovery Bay

The Discovery Bay Marine Protected Area spans from the dock of the Discovery Bay Marine Lab to approximately 10-15 minutes from the shore (Figure 6). It was dedicated a Special Fisheries Conservation Area in 2012. This area is used mainly for research dives, however for more recreational dives, customers are taken to one of the following six dive sites which are closer to Runaway Bay. These six dive sites are: Reggae Queen, Pocket's Reef, Canyon, Planes, Groupers Drop, Nursery, and Spanish Anchor. These sites' depths range from 30 to 150 feet.

Figure 6- Discovery Bay Marine Protected Area

Port Antonio

The East Portland Fish Sanctuary, which was gazetted in 2016, contains dive spots for the Port Antonio area. This fish sanctuary covers 6 km^2 of coastal waters and contains coral reefs, mangroves, seagrass beds, and deep water habitats, all of which are critically endangered and ecologically sensitive. The Alligator Head Foundation manages the Fish Sanctuary. (Alligator Head Foundation 2016).

From the shore of the Alligator Head Foundation, the dive spots in area are located 15–20 minutes away by boat*(Figure 7).* Boston, Trident Wall, Alligator Head, Alligator Deep, Alligator Long, Courtney's Reef, Fisherman's Reef, Bluehole, Dragon's Mouth, High Point, Fairy Hill, Two Houses, and Alligator Deep are the names given to these sites. These dive sites have depths ranging from 30 to 160 feet.

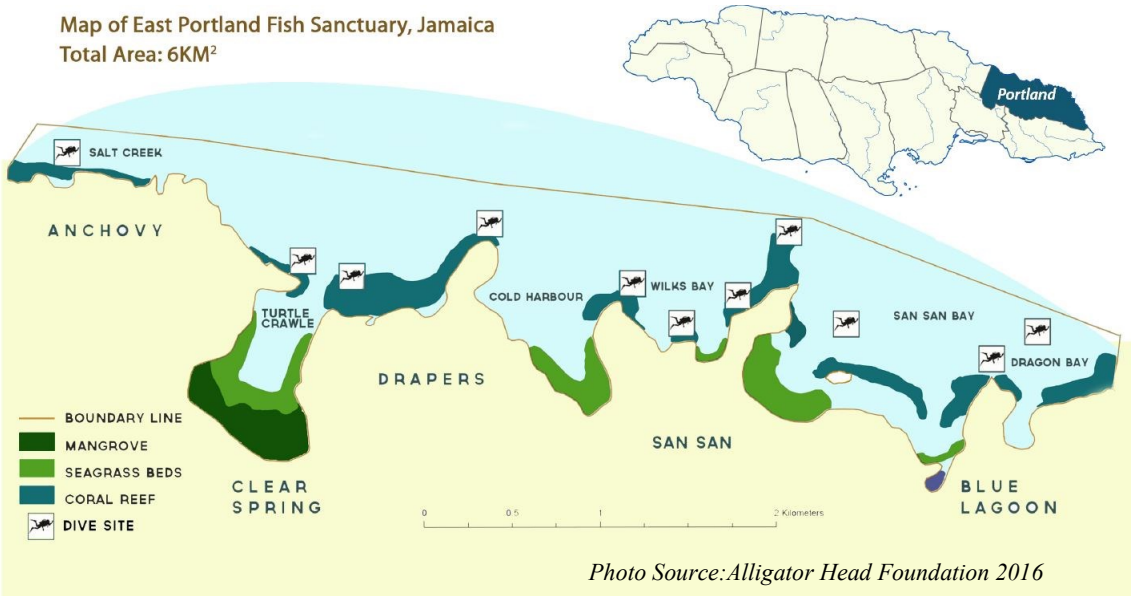

Figure 7– Dive sites within the East Portland Protected Area

4.2 The South Coast of Jamaica

The selected South Coast sites are Whitehouse and the Port Royal-Palisadoes area.

Whitehouse

The Whitehouse Special Fisheries Conservation Area(WSFCA) is managed by the Sandals Foundation and was opened in January 2015. The marine sanctuary covers an area of 782.45acres.(*See figure 8)* Majority of the dive sites for this area are located within the Marine Sanctuary. The dive sites can be found 5-25 minutes from Treasure Beach with depths ranging from 30-100ft. These sites are; French, Maize, Chubb Reef, Cottage, Treasure Reef, Lobster Reef, Dutch, Sandals, Chubb #2, Deep Cottage, Peter Tosh, Belmouth Reef, Bluefield Reef, Coral Garden, English Reef, Arches Reef, Welch Reef and South Sea park.

Figure 8– Map showing boundaries of WSFCA

Palisadoes-Port Royal

The Palisadoes-Port Royal Protected Area (P-PRPA) is located in the southernmost region of the island of Jamaica. On September 18, 1998, a protected area was established. It measures about 86.45 Km2 (8,645 hectares) in area. (*See figure9*)Its southern border is the Caribbean Sea, while its northern limit is the protected area's Kingston Harbour, the seventh-deepest natural harbor in the world.

The P-PRPA has two types of dive sites; Artificial and natural reefs. Sunken marine craft were used to produce artificial reefs. All artificial reefs, with the exception of "blacktip/deep," are named based on the actual ships located there. Dive sites for these wrecks include Texas, Cayman Trader, Edina, and Blacktip/Deep. While Don Quarry, Big Anchor, Little Anchor, Maiden Key Wall, Maiden Key, and Fairwell are natural reef dive destinations.

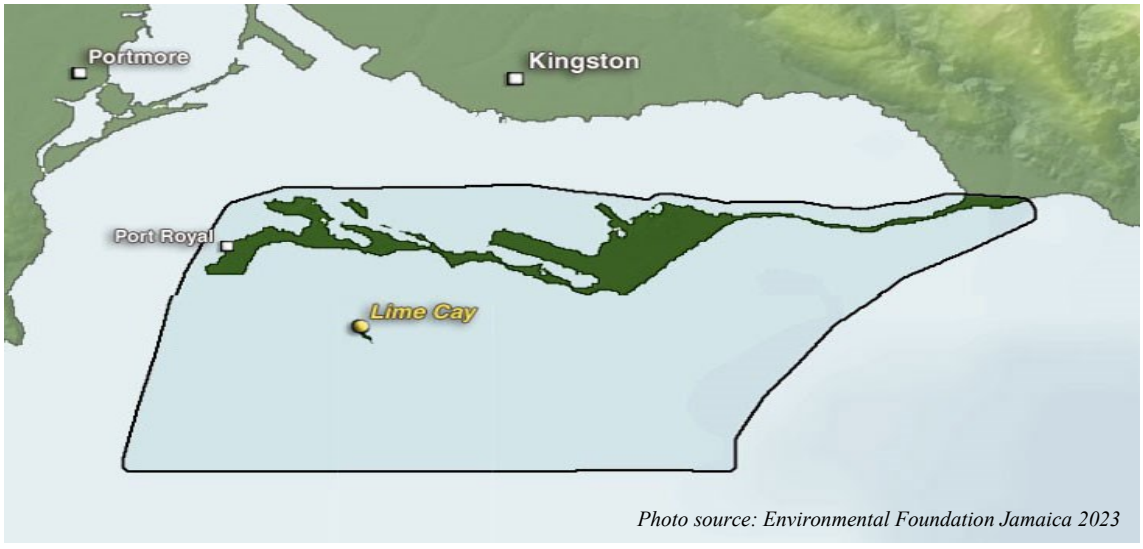

Figure 9– Palisadoes-Port Royal Protected Area Boundary

5. METHODOLOGY

5.1 Surveys

There are a varying number of diving shops in Jamaica, however documented information with respect to the actual number of dive shops in Jamaica was unattainable. Also some of these dive shops are unregistered. Therefore, for this survey only those shops that could be contacted were used for this research report.

Following communication, the dive shops' positions were collated, leading to the assessment of the following eight spots along the island's north, west and south coasts: Negril, Montego Bay, Discovery Bay,Ocho Rios,Oracabessa, Port Antonio, Whitehouse and Port Royal.

The socioeconomic survey was built on the questionnaire that was sent out to dive shops located in the eight research zones to determine willingness to participate. Online polls and phone interviews generated 20 completed questionnaires between January and May 2023. The questions on the online survey focused on the frequency of diving and snorkeling in the region, the most well-liked dive spot, the cost of a dive, and how the government could improve the marine environment to encourage diving and other marine related recreational activities.*See Appendix11.1*.Factors that may affect the longevity and health of the nearby coral reefs, as well as the possible applications of these ecosystems, were also discussed over the phone.

5.2 Estimating average daily income generated per dive location

The analysis is founded on an assessment of the financial contribution made by coral reefs to Jamaica's economy and some of its key components. We are conscious of the fact that industrial revenue does not always equate to net

economic gains. For that, we would have to calculate the operating expenses. Due to the fact that it would have been beyond the scope and time constraints of the study, this was not tried. Revenue, however, is a useful indicator of the sector's economic importance.

A cautious approach was taken when writing this report. For example, a comprehensive analysis of the financial benefits of marine recreational activities would take into account the wages paid by businesses like hotels and restaurants that are directly impacted by the existence of marine tourism. However, this research project was restricted to the money made from snorkeling and scuba diving.

Daily business income from diving and snorkeling activities was estimated using:

Average Daily Diving Income+ Average Daily Snorkeling Income

Average Daily Diving Income =

*Mean Diving Cost * Dive Trips Per Day * Customers Per Day*

Average Daily Snorkeling Income =

*Snorkeling cost * Snorkel Trips Per Day * Customers Per Day*

5.3 Statistical Analysis of data

Statistical analysis of the data was attempted, however due to the small size and exclusivity of the diving community in Jamaica, thorough statistical analysis was not possible. Instead, we used excel graphs and estimates of standard error to represent the data collected visually.

It should also be noted that even though statistical analysis could not be done on the data collected, this information can still be used as a guide to gain better understanding of the impact and influence coral reefs have on the blue economy. This information can also be used as a basis for further and more in-depth research into the topic. However, even with the current analysis allowed with the

data it is clear that the blue economy depends on the coral reef and the marine recreation activities that entail it, and this relationship should not be disregarded.

6. RESULTS

Descriptive Analysis

The results display the geographic distribution of dive sites, their specific location, income generated for scuba diving, price ranges for snorkeling across sample sites, improvements that can be made by the Government of Jamaica to improve dive numbers and dive locations as well as the reasoning behind most popular dive sites. The results are displayed in bar graphs and pie charts.

6.1 Geographic distribution of dive shops

60% of the dive shops in Jamaica are located on the North Coast ,15% are located on the South Coast and 25% are located on the West Coast of the island.(*figure 10*).

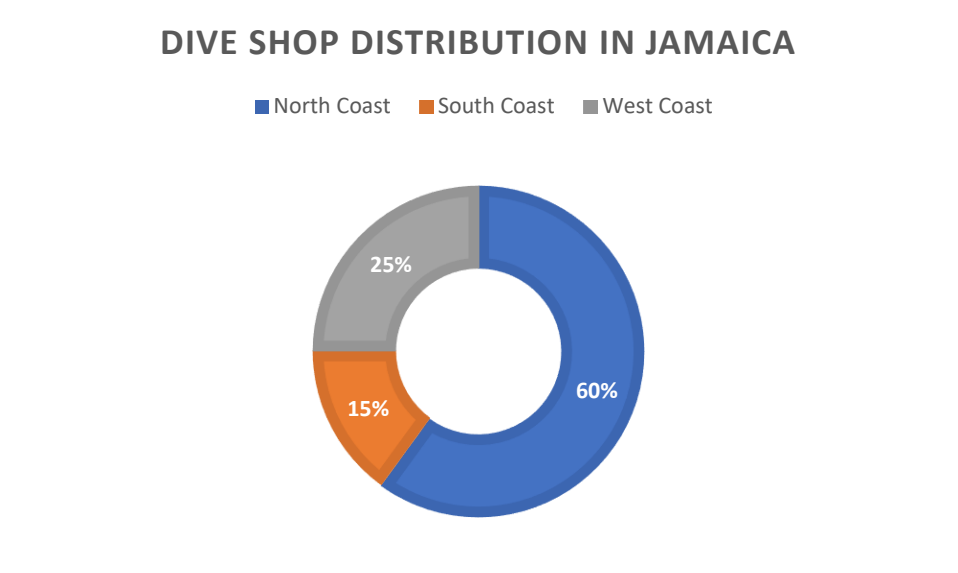

Figure 10– Dive shop distribution in Jamaica

Interviews were conducted with twenty different dive shops. The distribution of the dive shops surveyed is depicted in the graph below. With a total of five dive shops, Negril had the most dive shop interviews; four dive shops were interviewed in both Montego Bay; three dive shops were interviewed in Ocho Rios; two dive shops were interviewed each in Discovery Bay,Port Royal and Portland; while only one dive shop was interviewed in Oracabessa and Whitehouse(*figure 11*).

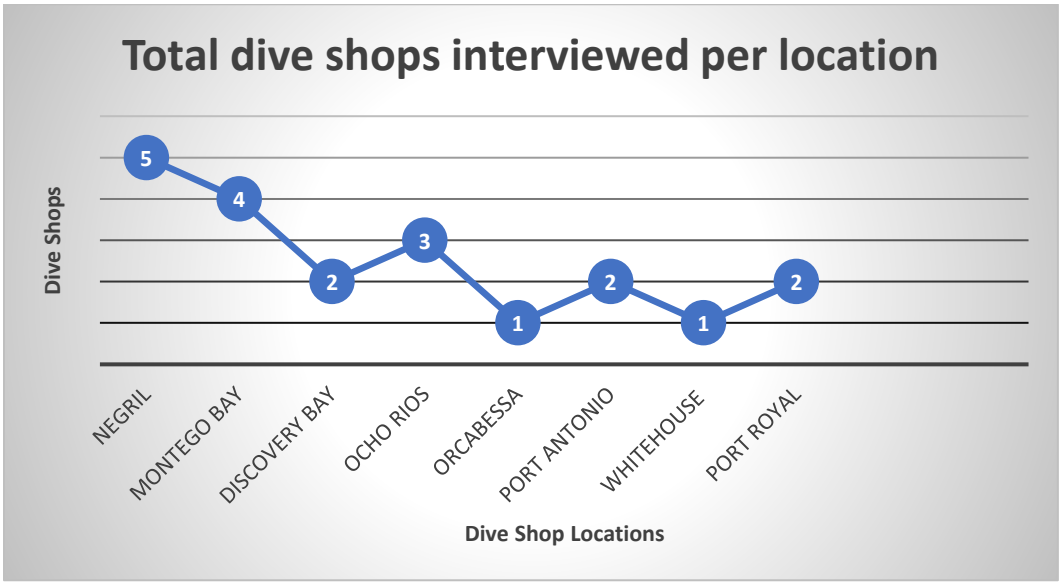

Figure 11– Dive shops interviewed distributed by location.

6.2Snorkel activity prices across locations

Prices for snorkeling are listed in US dollars (USD). Depending on where the dive shop is located, snorkeling costs might range from 35USD to65USD (*table &figure 12*) The information displayed in *table 1* is visually displayed in *figure 12*.

Table 1 – Snorkel activity price ranges across locations

Snorkel Activity Prices Across Locations							
Negril	**Montego Bay**	**Discovery Bay**	**Ocho Rios**	**Oracabessa**	**Port Antonio**	**White House**	**Port Royal**
35	45	40	40	35	35	38	35
35	38	38	38				65
38	38		40				

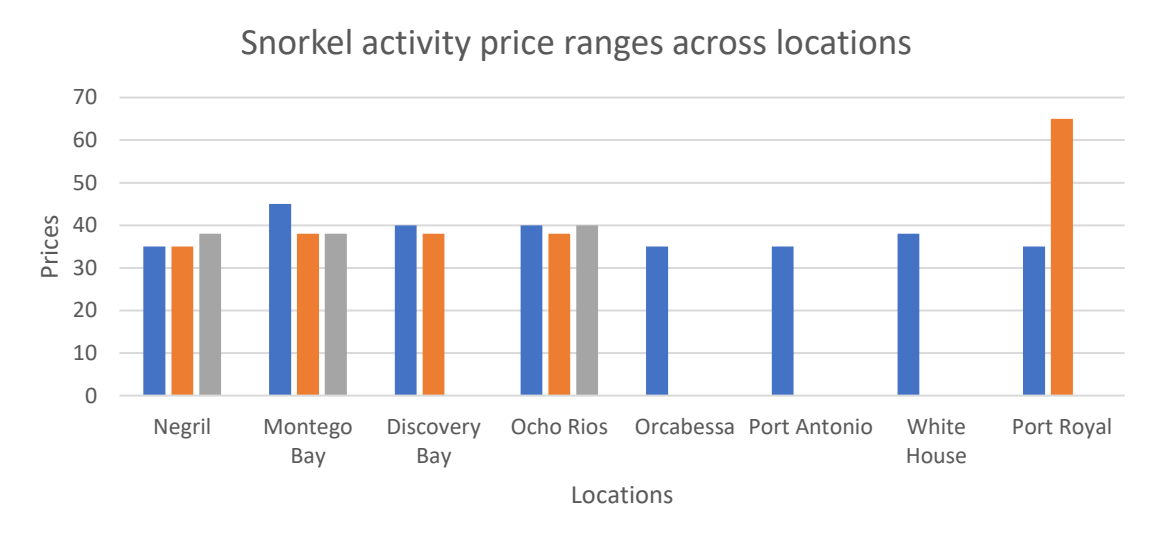

Figure 12 – Snorkel activity price ranges across locations in Jamaica

6.3 Average Daily Income

Average daily income is calculated in United States Dollars(USD). *Figure 13* below shows the average daily income for seven of the nine locations. The North Coast had the greatest estimated income; Negril had the highest daily income ($9360 USD), followed by Montego Bay ($8360 USD). White House had the third-highest daily income overall and the greatest daily income for the South Coast. The lowest computed average daily income was found in Lucea($315USD).

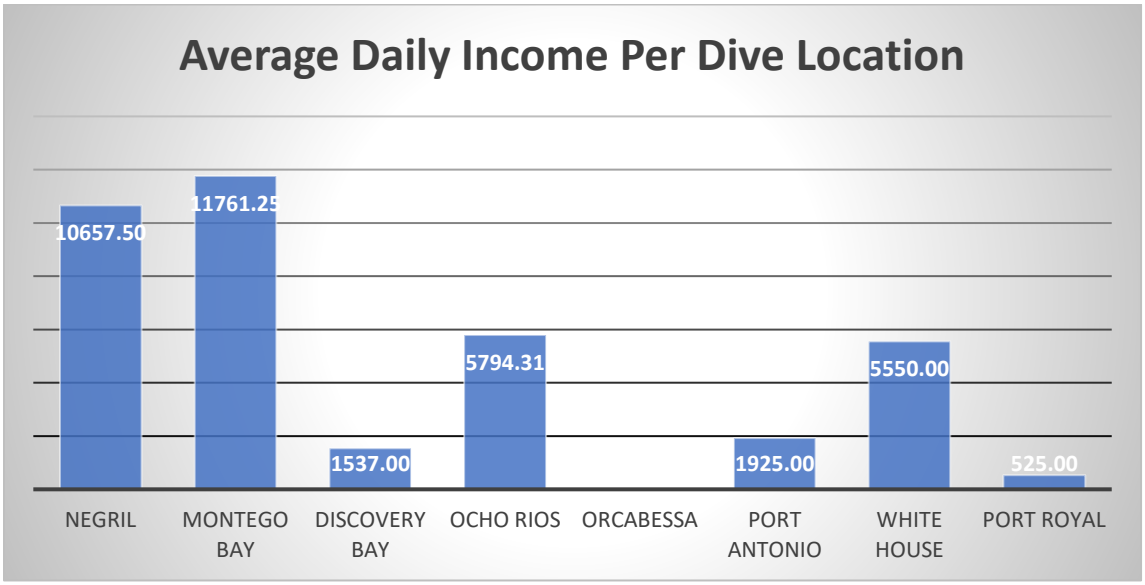

Figure 13– Calculated Average Daily Income Generated Per Dive Location

6.4Average Daily Income by Coast

The research locations were categorized by their geographic location (*figure 14*). The daily income is recorded in USD. This graph shows that the North Coast of the island generates more income daily ($21017.56 USD) when compared to the south coast ($6075. USD) and west coast ($10657.50). The south coast of Jamaica generates the least income based on the responses obtained.

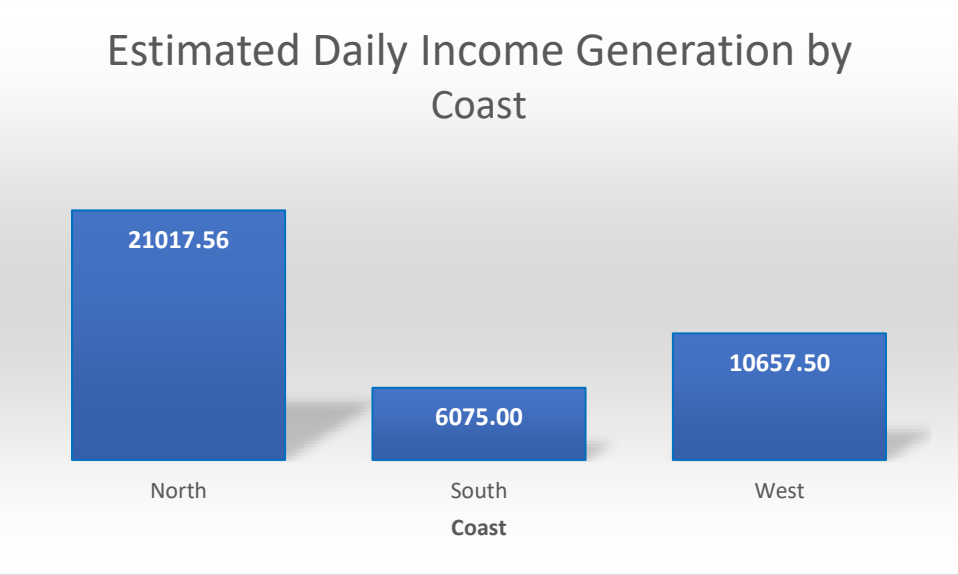

Figure 14– Estimated daily income by coast

6.5 Average Daily Income compared to Reef Size.

This graph shows the estimated daily income for each of the research locations and the size of each reef at these locations (*figure 15*). From this graph it can be seen that Negril has the largest reef system in Jamaica (43.2km^2) and generates the second highest daily income ($10657.50 USD), the second largest reef system is located in Port Royal (18.1km^2) and generates the least daily income ($525 USD). It can also be seen from this graph that Montego Bay generates the daily income ($11761.25 USD), however is has one of the smaller reef systems (8.8 km^2).

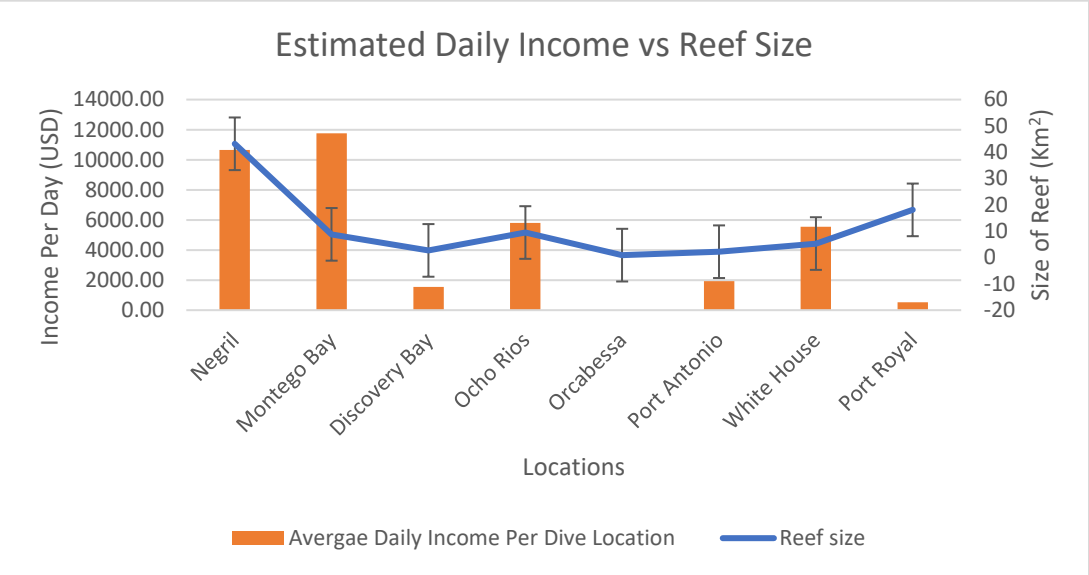

Figure 15– Comparison of Average Daily Income and Reef Size

6.6 Actions that could improve dive numbers and accessibility to dive sites.

According to 45% of respondents, enforcing existing laws could increase accessibility to dive locations and increase the number of divers in Jamaica. Twenty percent of respondents thought that more financing from could boost diving in Jamaica and make dive spots more accessible. 15% of respondents thought that increasing the number of moorings may boost diving in Jamaica and make dive locations more accessible. 10% of respondents said that increasing artificial reefs and promoting education might promote diving in Jamaica and make dive locations more accessible(*figure 16*).

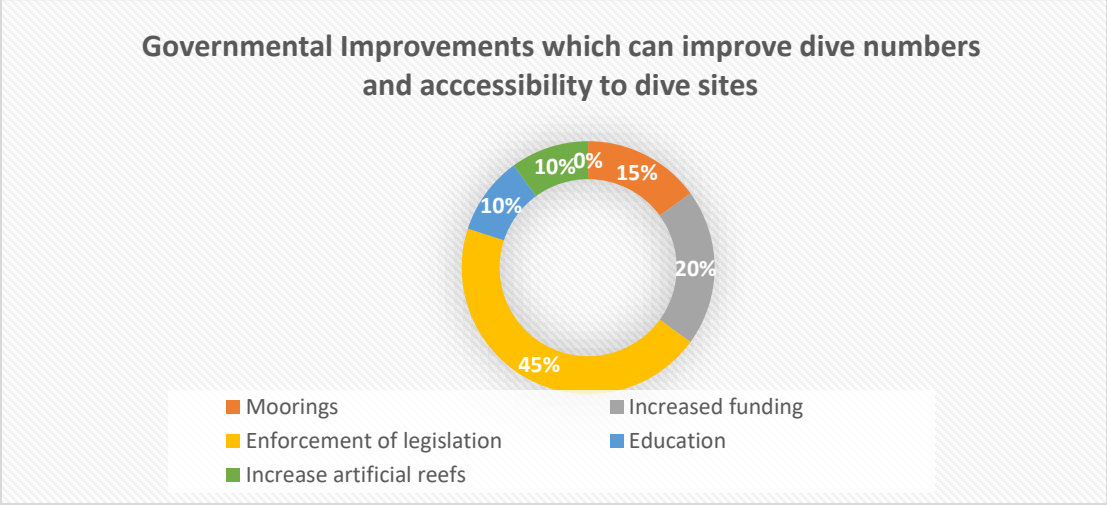

Figure 16 – Improvements that can be made by the Jamaican Government to improve dive numbers and accessibility to dive sites.

7. DISCUSSION

Location

Several factors could account for the location of the dive shops, however the findings of this research indicates that proximity to clientele and dive sites play a major role in where the dive shops can be found. The North and West Coast of Jamaica according to (Stupart and Shipley 2012) were developed as main tourist centres or resort areas because of their white sandy beaches and pleasant weather. When looking at *figures 10&11* it can be seen that the North and West Coast of the island are where majority of the dive shops are located and operate from. The prevalence of dive shops in this area aligns with Stupart et al. 2012 findings about the North and West Coast being developed as main tourist areas. In order to maximize gains, dive shops are strategically placed where they believe they will have the best results in finding customers. This is borne out in *figures 3-9*where the reefs visited by tourist are no more than 25 minutes away from the shore.

Snorkeling

One of the additional findings from this research is that marine recreational activity prices are not regulated. *Table 1&Figure 12* shows that the price of snorkeling (30-50USD) with the exception of one dive shop located in Port Royal that charges $65USD varies amongst the dive shops.

Income

Using *figures 11 & 15* it can be seen that the highest number of dive shops interviewed were in Negril, and it is therefore interesting to see that this area is not the highest earning location. However, in Montego Bay, one less dive shop was interviewed, making it four and this location is the greatest revenue generating area when compared to the other six dive locations. Caution must be taken here as this could be due to the number of visitors frequenting Montego Bay as opposed to Negril rather than being influenced by the health of the reef as previously assumed.

This increase of revenue could also be attributed to the dive site visitors are taken to. As stated previously, visitors prefer dives sites of historic values eg. wrecks. They also prefer areas with interesting or unique biodiversity; in this case it is sting rays which Montego Bay lends itself to.

What is also interesting about these results is Discovery Bay and Port Royal(*see figure 15*). Both locations recorded low revenues and this could be attributed to the type of divers they attract. When interviewed one dive shop in each of these areasprovides recreational activities while the other is mainly utilized for research activities. Hence the low revenues, as many persons would not be utilizing the research dive area.This finding also shows that recreational diving is not the only type of diving that takes place in Jamaica.

Another interesting finding would be that of Oracabessa. The lone dive shop interviewed in this area for circumstances beyond my control was unable to give an accurate account of the revenue generated by dive or snorkel activities due to the very high fluctuations in dive numbers. The questionnaire for this paper asked respondents about average daily numbers and for some of these dive shops, some days even weeks they did not have customers for diving or snorkeling.

Finally, Whitehouse. One dive shop was interviewed in that area, again circumstances beyond my control. This dive shop even though on the south coast was able to have an average daily income of $5550.00 USD. This is interesting to note because the North and West Coasts are designated tourist areas, tourism

business is still happening on the South Coast with some success. The level of income is more based on the type of dive shop being operated in the area.

Figure 14 gives a more concise representation of the earning of each coast. The exact reason for the higher revenue is not clear from the findings obtained during this research process and can only be assumed. For instance, one possibility could be that the all-inclusive hotels make most of their money from dive courses versus recreational dives. As dive courses cost $500USD and recreation dives cost $100 USD. To be sure further research or a more in-depth study can be undertaken.

Governmental Improvements

Increased enforcement of legislation (*figure 16*) would allow for better licensing, record keeping and monitoring of dive shop operators. This would also decrease the amount of illegal fishing in the sanctuaries and help to increase the health of the coral reefs.

8.CONCLUSION

In conclusion the research findings substantiate my hypothesis in that North Coast Coral Reef dive sites used for scuba diving generate more income than South Coast sites. Daily figures gathered during this research period revealed this.Data collected on reef size, location and income did not lend itself to adequate statistical analysis in order to determine if there is a statistical relationship between these variables. However, with thisdata it can be inferred that there is a positive relationship between the location and the income generated by the dive shop operators.

There is also a scope for wider in-depth research based on the findings in the report. These findings can be used as a base for other researchers as they look into this topic.

9. LIMITATIONS

Literature

The Blue Economy is a fairly new concept and thus the literature on this topic is limited. Coral Reef earnings assessments with respect to the blue economy is also a fairly new concept, especially in Jamaica and thus this also presented a challenge in establishing best practices for collecting and analyzing data.

Comprehensive data gathering and sampling was challenging due to the following:

- Majority of the dive and scuba tourism is done through the hotels in Jamaica and contacting them and gathering information from them was difficult.
- All- inclusive hotels dominate the North and West which reduces the amount of business generated by small dive shop operators.
- Unlicensed/unregistered dive operators and these types of operators either refused to comment or were unreachable.
- Some local dive shops do not have an online presence which made it difficult to gather information from these shops.
- Recently established dive shops were unable to give accurate visitor numbers
- Dive operators are still being affected by Covid-19 as tourist numbers are still low which prevents an accurate representation of the income gained from diving and scuba activities.
- Exact GPS locations for the dive sites were unavailable as dive operators protected this information.
- Dive sites are not marked which makes finding them without GPS coordinates difficult, there plotting them on a map was unsuccessful.

- This paper was restricted to diving and snorkeling, however other marine recreational activities contribute to the revenue of these dive shops eg.glass bottom boat tours.
- Poor or inaccurate record keeping by the dive shop operators prevented accurate data collection.

Statistical Data Analysis

Statistical data analysis was attempted, however due to the small sampled size and limited information gathered when conversing with respondents, it was realized that sound meaningful statistical analysis was unattainable.

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11. APPENDICES

11.1 Questionnaire

Research Project Questionnaire

Goodday, my name is Tonya King and I am a Graduate Student at the University of the West Indies Mona Campus. I am currently in my final semester of my degree and my chosen project is 'An assessment of Jamaica's Coral Reefs as contributors to the Blue Economy'.

In order to gather data for my research project I would like to ask for some information from your dive shop. The information required for my project is to be done in two months for comparison; either November and January or January and March.

The information gathered from the telephone questionnaire if you agree will be used for the sole purpose of completing my research project.

Confidentiality and anonymity will be maintained by use of a participant ID code. These codes will be used as substitute for each company and participant's name in all analysis and all reporting of the research.

The questionnaire will only take 5-10 minutes of your time.

Participant Information

Participant #:

Dive Company:

Date:

Parish:

North/South/West Coast:

Reef Data

1) How many dive sites do you take tourist to?

   _____

2) Why are these dive sites used more than the others on the reef?
3) What are the names of these dive sites?
4) Based on customer feedback what is the most popular/requested dive site(s)?
5) Please rate the health of the reefs at each dive site, from 1-5.

   1) critical 2) poor 3) fair 4) good 5) very good

6) What is the cost of the following;
   a) 1 tank dive_____
   b) 2 tank dive _____
   c) Refresher dive _____
   d) Discover Scuba Dive_____
7) Is gear included in the above cost? If NO, please provide the cost with gear.
8) How many Dive trips do you make per day?

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Other_____

9) How many Divers go on a dive at any one point in time?

☐ 1-2 persons

☐ 2-4 persons

☐ 4-6 persons

☐ 6-8 persons

Enter own amount _____

Snorkeling Data

10) What is the price of a snorkel trip?
11) How many snorkel trips do you do per day?
12) How many visitors are on each snorkel trip?

☐ 1-2 persons ☐ 2-4 persons

☐ 4-6 persons ☐ 6-8 persons

Enter own amount _____

13) What improvements can be made by the government to improve diving numbers or accessibility to dive sites.

End of Questionnaire

Thank you for participating

11.2Collated Responses from Research Questionnaire

Collated Data from Research Questionnaire

Participant #	Location	Coast	Number of Dive Sites	Reef Condition	Reef area/size(Km^2)	1 tank dive (gear included)	2 tank dive (gear included)	Number of Dives per day	Number of divers per dive	Refresher Dive	Discover scuba	Mean Diving costs	Snorkeling Cost	Number of snorkels per day	Number of person snorkeling per trip	Income from snorkeling	Income from diving	Overall Income/Day for each shop
4	Discovery Bay	N	12	5.0	2.7	60	110	3.00	4.00	30	99	74.75	40	2	8.00	640.00	897.00	1537.00
18	Discovery Bay	N	10	2.5	2.7	80	80	0.00	0.00	0	0	40	37.5	0	0.00	0.00	0.00	0.00
9	Lucea(uses sam	N	10	3.0	8.8	70	100	1.50	3.00	0	0	42.5	0	0	0.00	0.00	191.25	191.25
3	Montego Bay	N	20	3.5	8.8	90	130	2.00	2.00	120	130	117.5	45	0	4.00	0.00	470.00	470.00
14	Montego Bay	N	10	2.5	8.8	80	100	2.00	25.00	0	0	45	37.5	4	22.00	3300.00	2250.00	5550.00
16	Montego Bay	N	10	2.5	8.8	80	100	2.00	25.00	0	0	45	37.5	4	22.00	3300.00	2250.00	5550.00
1	Negril	W	15	3.5	43.2	60	0	2.00	2.50	90	100	62.5	0	0	0.00	0.00	312.50	312.50
2	Negril	W	15	3.5	43.2	70	130	2.00	3.00	130	140	117.5	0	0	0.00	0.00	705.00	705.00
15	Negril	W	15	2.5	43.2	80	100	2.00	25.00	0	0	45	37.5	4	22.00	3300.00	2250.00	5550.00
19	Negril	W	20	2.5	43.2	80	140	2.00	4.00	0	0	55	35	2	6.00	420.00	440.00	860.00
20	Negril	W	15	5.0	43.2	80	100	2.50	20.00	0	0	45	35	2	14.00	980.00	2250.00	3230.00
17	Ocho Rios	N	13	2.5	9.5	80	100	2.00	25.00	0	0	45	37.5	4	22.00	3300.00	2250.00	5550.00
5	Ocho Rios	N	12.50	3.5	9.5	80	150	1.00	3.00	40	20	72.5	40	0	0.00	0.00	217.50	217.50
12	Ocho Rios	N	3	3.0	9.5	50	100	0.14	5.00	0	0	37.5	40	0	0.57	0.00	26.81	26.81
8	Orcabessa	N	5	4.0	0.9	120	160	0.00	3.00	130	130	135	35	0	3.00	0.00	0.00	0.00
7	Port Royal	S	10	3.0	18.1	80	100	1.00	7.00	120	0	75	65	0	0.00	0.00	525.00	525.00
10	Port Royal	S	12.50	2.0	18.1	0	0	0.00	3.00	0	0	0	0	0	0.00	0.00	0.00	0.00
6	Portland	N	6.50	5.0	2.2	0	120	4.00	7.00	0	140	65	0	0	0.00	0.00	1820.00	1820.00
11	Portland	N	0	3.0	2.2	0	0	0.00	0.00	0	0	0	35	1	3.00	105.00	0.00	105.00
13	White House	S	18	2.5	5.3	80	100	2.00	25.00	0	0	45	37.5	4	22.00	3300.00	2250.00	5550.00